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E-LEARNING AND THE NEXT STEPS FOR EDUCATION

27 – 30 June 2006

Tokyo, Japan

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K. Cho, and M. Yoshimura

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ISPRS Headquarters 2004-2008
c/o ORHAN ALTAN, ISPRS Secretary General
Division of Photogrammetry, Faculty of Civil Engineering
Istanbul Technical University
Ayazaga, 34469 Istanbul, Turkey
Phone: +90 212 285 38 10
FAX: +90 212 285 65 87
Email: oaltan@itu.edu.tr

ISPRS WEB Homepage: http://www.isprs.org

Available from
GITC bv
P.O.Box 112
8530 AC Lemmer
The Netherlands
Tel: +31 (0) 514 56 18 54
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PREFACE

It is our great pleasure to organize the ISPRS Commission VI Symposium in Tokyo, Japan from 27 to 30 June, 2006. The theme of Commission VI is “Education and Outreach”. In recent years, meaning and role of e-Learning are expanding in the field of education. The highly integrated multimedia & internet technologies are pushing e-Learning to change the style of education. The needs of education are also changing. The rapid advancement of technologies is increasing the needs for on job training and life-long education. Reduction of children’s interest to science is requesting some excitement to science education. Recognizing the importance of face-to-face education, we have to think about optimizing e-Learning for education.

The main theme of the Symposium is “e-Learning and the Next Steps for Education”. In order to clarify the main theme, we have invited three experts on education from different fields as keynote speakers, namely Prof. Hans van Ginkel, Prof. Yasunori Matogawa, and Prof. Joachim Höhle. We would like to thank them for kindly accepting our invitation in spite of their busy schedules.

Total of 60 papers, including manuscripts of the three keynote speakers, have been submitted to the Symposium. We would like to thank all the authors for providing their papers in due time for printing the proceedings. Reflecting the activities of the five Working Groups and one Special Interest Group of the Commission, the themes of the papers include, but not limited to, s-Learning, training, capacity building, distance education, datasets, and student organizations. We believe that this symposium will give us an excellent overview of the current status and the future of various aspects of education in the field of remote sensing, photogrammetry and GIS.

Finally I would like to thank Mitsunori Yoshimura and Takahiro Endo of the symposium secretariat group for their dedicated work on preparing the proceedings.

Kohei Cho
Commission VI President

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Appendix:

United Nations University
"Advancing knowledge for human security, peace and development"

"Sharing Knowledge: Roles of E-Learning in Creating the Global Learning Space" (Abstract)

Hans van Ginkel
Rector of United Nations University, Tokyo,
Under-Secretary-General of United Nations

E-Learning is rapidly changing the theory and practice of education and training, indeed of all learning. The Global Learning Space in-the-making will make it possible to learn everywhere from knowledge available anywhere; to share knowledge worldwide. The pre-condition is an Information Society Open-to-All. The challenge: an optimally balanced, creatively linked, development of education science, substantive knowledge and technical capabilities.

The explosion of place-based information has re-united physical and human geography and made the linkage between the social, economic and cultural sciences from one side and the natural and earth sciences at the other, not just possible, but also the obvious, action to take. In this way it has become possible to use scientific knowledge in a much more holistic manner to further sustainable development. It has not only become possible to relate in a functional manner diverse, topical data, but also to related information at different levels of geographical scale. This is important not only in planning, but also in education.

In the context of UN's Decade of Education for Sustainable Development (DE*f*SD) (2005-2014), UNU and its partners in the Ubuntu Alliance promote actively the creation of a Global Learning Space focused on Education for Sustainable Development (E*f*SD). This Global Learning Space will be based on e-linked Regional Centres of Expertise (RCE), networked institutions focusing their programmes on E*f*SD within regions such as Catalunya, Bretagne or Tohoku. At this moment already twelve of these RCEs do exist. By the end of this year we do expect a total of 25. By the end of this DE*f*SD there may be some 300; all linked within the Global "E*f*SD" Learning Space.; the most tangible outcome of UN's Decade. It is envisaged that

UN's year for the Planet Earth (2008) will, among others, give a strong boost to this Global Learning Space for E*f*SD. UNU-IAS (Yokohama) will host the Global Service Centre of the Global Learning Space for E*f*SD.

Worldwide, many activities are being undertaken to achieve these goals, both by partners of the Ubuntu Alliance and others. Within UNU the UNU-IAS, aided by the UNU-On-Line-Learning Initiative (UNU-OLL), located in the Media Studio, created with Keio University and CISCO Systems, is responsible for these activities. Different pilot-projects and activities have been developed to size up opportunities and challenges: among others the Global Virtual University (UNU-GVU, with support of UNEP and the Norwegian Government), the Asia Pacific Initiative and the e-Cases project.

The Global Service Centre at UNU-IAS will be linked to the Higher Education for Sustainability Resource Project, as well as to IUCN's (World Conservation Union's) Resource Centre. Connectivity and creativity will make it possible to link all good initiatives in creating the Global Learning Space, which will truly shape the new reality for learning: worldwide sharing of knowledge.

United Nations University
Headquarters
53-70, Jingumae 5-chome
Shibuya-ku, Tokyo 150-8925
Japan
Tel. (03) 3499-2811 / Fax (03) 3499-2828
E-mail mbox@hq.unu

Sparking New Interest in Children's Minds
——Space Activities for Our Next Generations——

Yasunori MATOGAWA
Director, Space Education Center,
Japan Aerospace Exploration Agency
e-mail: matogawa.yasunori@jaxa.jp

ABSTRACT

Japan Aerospace Exploration Agency (JSEC) established "Space Education Center" (JSEC) in May 2005 in Sagamihara City, Kanagawa, Japan.

The establishment aimed to assist young people, in partnership with a lot of likely-minded people, to candle a bright flame in children's hearts, to respect Mother Nature and the lives of all creatures on earth, and to hope for bright future. The aims would be achieved by full use of our attractive space materials, knowledge and techniques acquired through the exploration and use of outer space.

Activities of JSEC have three main pillars:

(1) Activities to support schools and teachers in their classroom teaching,
(2) On-site educational activities organized by JAXA using its own programmes mainly for primary and secondary school students, and
(3) Dissemination of information mainly through JAXA web sites.

In addition to these three pillars, activities in international cooperation to promote space education constitute an important part of JSEC activities. The cooperation includes, for examples, the activities in relation to the Asia-Pacific Regional Space Agency Forum (APRSAF), International Space Congress (IAC), UN/IAF Workshop on the occasion of IAC, International Space Education Board (ISEB), and International Space University (ISU).

This paper describes the outline of JSEC, and summarizes its one-year experience since the establishment.

EDUCATION AND TRAINING IN PHOTOGRAMMETRY AND RELATED FIELDS – REMARKS ON THE PRESENCE AND THE FUTURE

Joachim Höhle

Aalborg University, Department of Development and Planning, Division of Geomatics, Research Group of Geoinformatics,
11 Fibigerstraede, DK-9220 Aalborg, Denmark -
jh@land.aau.dk

Commission VI

KEY WORDS: Photogrammetry, Remote Sensing, Education, Teaching, Learning, Cooperation

ABSTRACT:

Changes in technology and social-economic conditions have influence on the education and training in photogrammetry and related fields. From a European point of view the present situation is analyzed and possible future developments are discussed. E-learning will play an important role in the continuing professional development as well as in the education at universities. The education at universities has to change if the available resources are reduced and if the number of students becomes smaller. Then cooperation between educational institutions is necessary, nationally and internationally. The quality of education will become a decisive factor in the international competition of products and services in the mapping and geo-data field. Quality management and quality control of the education are important tasks and international organizations like the ISPRS should engage themselves and give guidelines.

1. INTRODUCTION

Photogrammetry is an old science but has changed drastically in the last 30 years. These changes are not only technical ones, but the social and economic conditions are also different today. The changes and the new conditions have consequences for education and training in this subject that now also includes remote sensing and some other fields. It is the goal of this paper to analyze the present situation and to formulate next steps for education in Photogrammetry and its related fields. The education in Photogrammetry is no longer restricted to a few years of study at universities, it must be lifelong. The Internet and e-learning will play a bigger role in the future education and training. The methodologies in teaching and training have to be adapted to the new conditions. International cooperation has to be organized and organizations like ISPRS have a mission to accomplish this.

2. CHANGES IN TECHNOLOGY AND SOCIAL-ECONOMIC CONDITIONS

The changes in technology **and** in social-economic conditions are numerous. Only the important ones can be named here. They influence each other, but they will be handled separately.

2.1 Changes in technology

Today airborne photogrammetry is digitally. Large format digital cameras take imagery, and position and attitude sensors in the airplane are used for georeferencing of the taken imagery. All processing to digital elevation models and to orthoimages is carried out in computers and is to a large extend automatically. Topographic mapping of large areas from images is still carried out manually, but very economically and superior to any other technology. The automatic extraction of roads, houses and trees is still in a research phase, but results with automated and semi-automated methods are very promising. Close-range photogrammetry uses multiple images and self-calibrating techniques. There is no need to use stereo viewing, which has always been a big hurtle for students and newcomers to the field. The matching of conjugate points and areas is carried out by the computer, but now more accurately and more quickly. Blunders may occur and detection and removal of blunders becomes an important subject in modern photogrammetry. Many new sensors were developed. Laserscanning from the airplane and from the ground are competing with the photogrammetric method when surfaces have to be mapped. The way how a computer can recognize objects in the images developed to its own discipline: Computer vision. It is applied in robots and used in scanners in medicine. Hyperspectral scanners are applied in order to map automatically and more reliably by means of object-based classification methods. Various sensors are combined to a system and data of different sensors are used to identify changes and to map them. Various sensors are installed in unmanned vehicles and imagery can be taken from low altitudes. Remote sensing is regularly carried out from satellites and space vehicles. Ground sampling distances at civil application is down to 0.6 m, but large coverage is achieved from a 450 km altitude. Radar systems can be used day and night for mapping of areas in all weather conditions. Photogrammetry and remote sening are closely connected and form one discipline today. Efficient methods for data compression make the transfer of the data to remote places at high data rates possible. The Internet can be used as a tool for communication, computing, learning, and delivery of products. Improvements in the computer technology and software tools contribute to the possibility to obtain results automatically, in real time and with high accuracy. All these achievements are gained at the costs of considerable sophistication in the methods and tools. Knowledge of many different disciplines is necessary in order to use sensors and processing systems properly. On the other hand knowledge about digital photography and digital image processing has become general knowledge in recent years due to the fact that digital cameras became cheap and handy and amateur photography is carried out by means of digital cameras. They are nowadays even part of cell phones.

2.2 Social and economic conditions

Today we live in the time of globalization. Fortunately it is a peaceful world and with great freedom for an individual. He or she can visit, study or work in many places. Mapping tasks are carried out around the globe and in cooperation with other groups. The access to imagery and other sensor data is no longer so much restricte as it was 17 years ago in some parts of the world. Mobility, flexibility and readiness for learning new things are the requirements of the workforce in mapping and production of geo-products. Lack of resources and unemployment are still severe problems to be solved and this can be tough for some individuals. The rapidly changing technology requires high update rates and high maintenance costs for the computer systems and software packages.

3. EDUCATION AND TRAINING IN PHOTOGRAMMETRY AND REMOTE SENSING

The education and training in photogrammetry and remote sensing takes normally place at universities. But the necessary lifelong education requires also education and training outside the universities. This continuing professional development needs other approaches and will therefore be discussed separately.

3.1 Education and training in photogrammetry and Remote Sensing at universities

3.1.1 Study programmes

Photogrammetry and remote sensing is usually not a study programme itself. Education and training in these subjects are embedded in various curricula. In Central Europe and Canada has been part of Surveying Engineering or Geodesy. In recent years, with the upcoming of Global Positioning and Geographic Information Science, the study programme has been named Geomatics or Geoinformatics. Table 1 gives some examples of curricula with Photogrammetry and Remote Sensing. The content of the study programme, however, can be very different; even if it has the same name. Many European countries recently structured their five year diploma programmes in a three year Bachelor and a two year Master Degree programmes after Anglo-American example and according to the recommendations of the “Bologna Declaration” of the European Union. In Germany, for example, 41 Bachelor Programmes and 48 Master Degree programmes were created where Photogrammetry and Remote Sensing are a part of (Schiewe, 2005). The change to a two level study programme was connected with the wish for more mobility and comparability. Some of the German degree programmes are now taught in English in order to attract more foreign students and to bring the native students and teachers to higher skills in the English language. The new Master degree programme of the TU Berlin includes also Computer Vision. The many new sensors for imaging and georeferencing, and their integration into a data acquisition system require knowledge about sensors and measuring techniques. The specialization in “Measuring Science” within a study programme of Geomatics was therefore created, for example at Aalborg University. A list of all academic institutions and its programmes in Geomatics (Geodesy, Surveying, Photogrammetry, Cartography, GIS) is published in (TU Munich 2006).

3.1.2 Equipment and personnel

Beside the changes in the curriculum many new tools and systems have to be procured in order to create practical exercises for the students. Table 2 shows some of the investments at the research group of Geoinformatics at Aalborg University. Not all of the educational institutions have the resources to invest in the latest developments. The number of personnel is the other prerequisite for carrying out good education; especially if the number of students is high it may be a problem. But the number of students in engineering subjects like Geomatics currently decreases in many European universities. The reasons are different. Students at high schools seem to neglect mathematics, physics and computer science and prefer ‘soft’ subjects or subjects where high salaries or estimation can be achieved after graduation. The education at universities should be based on research. Active participation of the teachers in research projects is therefore required. Their research work has to be documented by publications in refereed journals. Supervision of PhD-students is another task of teachers at universities. Special research schools have been created in some countries. For PhD-students they organize special courses, visits of conferences and short stays at other universities.

3.1.3 Forms of education

With all the changes in technology and social-economic conditions the form of education has to be discussed. Various pedagogic models are used at universities today. The ‘problem-based and project-organized learning’, which is practised at some younger universities, is one approach. Other approaches are the ‘progressive inquiry’ and ‘integrated micro learning’. These methods will be explained in more detail. The traditional model, which is based on lectures, small exercises and a lot of examinations, needs no further explanation.

Study Programme	University	Country	Degree
Geomatics Engineering	Ohio State University The University of Melbourne Stuttgart University	USA (E) Australia (E) Germany (E)	MSc MSc MSc
Geodesy & Geoinformatics	University of Hannover	Germany	MSc
Geoinformatics	ITC	The Netherlands (E)	M, MSc
Geomatics	Aalborg University Helsinki University of Technology	Denmark Finland	MSc MSc
Remote sensing	University College London	UK (E)	MSc
Civil Engineering	Aristotle University of Thessaloniki	Greece	BSc
Photogrammetry and Geoinformatics	Stuttgart University of Applied Sciences	Germany (E)	M
Airborne Photogrammetry and Remote Sensing	Institute of Geomatics	Spain (E)	Msc
Geodesy and Geoinformation Science	TU Berlin	Germany (E)	MSc
Geodesy and Cartography	CVUT Praha	Czech Republic	MSc
Geographical Information Systems	Lund University	Sweden (E)	MSc

Table 1. Examples of curricula where Photogrammetry and Remote Sensing is taught.
MSc… Master of Science Programme, BSc…Bachelor of Science Programme, M…Master Programme, (E)… in English

The **problem-based and project-organized learning** is best characterized by means of an old Chinese proverb.

Tell me, and I will forget.
Show me, and I may remember.
Involve me, and I will understand.

Problem-based and project-organized learning (PBL) means that projects are carried out by a group of students. A problem has to be defined and solved, and the solution to the problem or the search for a solution has to be documented, presented and defended. A problem is the starting point for acquiring and integration of new knowledge.

Teachers have a different role in this type of learning; they are advisors and facilitators for the group. The evaluation of the project involves also external or internal examiners. The problem to be solved is part of a theme, and courses are given for introducing the theme and for providing an overview on the theories, methods, tools and applications. The project has to be carried out within one semester. The semester includes also some study courses which are not related to the project. At Aalborg University (AAU), for example, the students use about 50 % of their time (corresponding to 15 Credit Points in ECTS[1]) for projects (compare Figure 1).

Projects are carried out in each semester of the BSc and MSc study. Another university which uses PBL as their educational model in the Geomatics curriculum is the University of Aveiro, Portugal. (Gomes Pereira 2004). More detailed information on project-based learning is published in (Höhle, 2005).

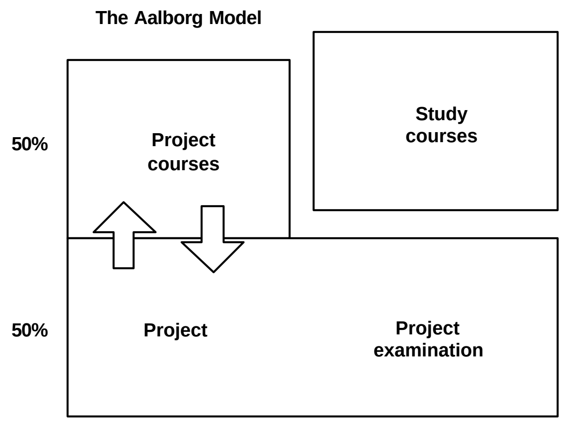

Figure 1. Problem-based and project-organized learning

At **progressive inquiry** the students take part in a research process. The students learn to inquire and investigate by means of relevant methods. The figure 2 depicts the essential elements of progressive inquiry. More detailed information can be found at (Muukkonen, H. et al.,1999).

Another approach is **Integrated Micro Learning** (IML). IML works on the basis of subdividing the learning process into small activities embedded in everyday life. Learning takes place along with professional and domestic activities and as such it is in strong contrast to "artificial" learning found in conventional course-settings. More information on this approach can be found at (Hug, 2005).

[1] One credit point in European Credit Transfer System (ECTS) is the equivalent to 30 hours of student's work.

The selection of the pedagogical model depends on the attitude of the teachers, the available resources and the maturity of the students. In the Aalborg Model, for example, the students have a very active role in their studies. There is a short distance between teacher and student – both physically and concerning the power. New knowledge and information flow both ways. The teacher is forced to update his knowledge continuously. The system is, however, vulnerable when the number of students increases. Group rooms and equipment might then be lacking.

3.1.4 Core knowledge

Due to the big changes in technology the number of subjects is substantially increased. This is also the case in many other subject of the curriculum. It is, therefore, necessary to reduce obsolete knowledge and to concentrate on core knowledge and on specialized up-to-date knowledge. At Aalborg University, for example, the education in photogrammetry starts with the 5th semester as part of the BSc Programme in Geomatics. It consists of a course and exercises which are followed by a project. The content of this basic course is summarized in Table 3 The project is carried out in groups consisting of two students each. The photogrammetric task comprises the selection of ground control, orientation of a stereopair, photogrammetric mapping, and derivation of a DEM and of an orthoimage. Furthermore, these photogrammetric products have to be compared with the map and the DEM derived by terrestrial methods **and** with the products of the mapping agencies which are stored in the geodata library of the study programme ‘Geomatics’. The knowledge in photogrammetry, map projection, surveying, and adjustment theory is examined together with the report of the project. An external censor gives marks in cooperation with two teachers. The project work has 25 CP in ECTS, the basic course in photogrammetry (lectures, small tasks and exercises) amounts to 4 CP.

Equipment	**Name**	**Number**
Stereo workstation incl. SW for mapping, DEM & Aerotriangulation	Z/I Imaging Image Station	4
Digital terrestrial camera	Kodak 14N	1
Software for calibration and mapping	Photomodeller	1
Terrestrial laser scanner incl. SW	Leica HDS 2500/3000	2
Global Positioning Systems	Leica 530, Trimble R8	4, 2
Inertia Measuring Unit	Crossbow IMU400	1
Robot total station	Trimble S6	1
Software for aerotriangulation	Bingo	3
Software for object-based classification	e-cognition	1
Software for editing DEM data	Inpho DTMaseter	1

Data (GSD [cm], m_b, number of channels)	**Name**	**Number**
Digital aerial images (6, 6700, 3)	Vexcel UltraCAM	22
Satellit imagery (61, ~67 000, 4)	Quickbird	2

Table 2. Recent investments in equipment and data for exercises and project work at AAU’s research group for GeoInformatics

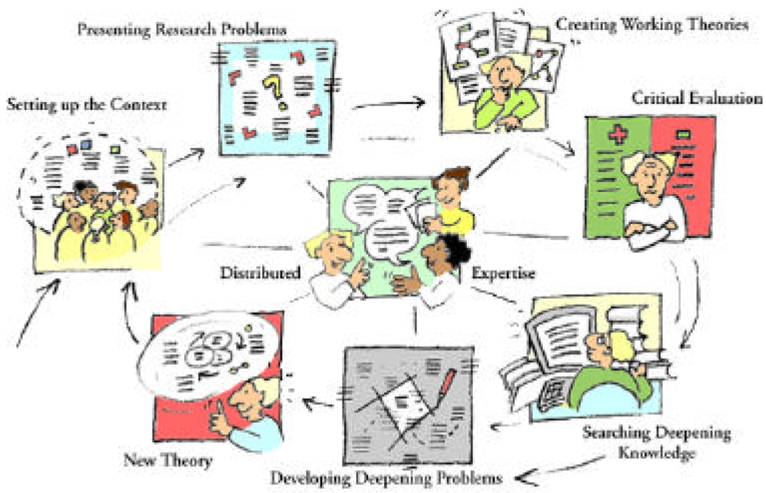

Figure 2. Elements in the learning model of ‘progressive inquiry’. Source: Muukkonen, H. et al., 1999

Lectures and small assignments
Image geometry and orientation
Stereoscopy
Rectification
Photography and scanning
Project planning, flight planning, navigation
Mathematic concepts in photogrammetry
Orthoimaging and monoplotting
Introduction into digital photogrammetry
Stereomethods and stereo workstations
Selection of control points
Introduction into aerotriangulation
Topographic mapping
DEM generation
Exercises
Measurement of parallaxes
Rectification
Relative and absolute orientation
Stereocompilation
Orthophoto production
Automatic measurement in images
Image processing
DEM generation

Table 3. Content of the course “Basic Photogrammetry” at AAU’s Bachelor’s Programme in Geomatics (Status autumn 2005).

With this core knowledge the students specialize at the MSc programme.

3.1.5 Specialization in the MSc Programme

Table 1 gives some examples of MSc Programmes which contain courses in Photogrammetry and Remote Sensing. The content differs considerably and there are also differences in the pedagogical approach. Aalborg University and the TU Berlin are used as examples.

Currently there are three specializations at AAU: Measurement Science, Spatial Information Management, and Land Management. The **specialization ‘Measurement Science’ at AAU** has two themes: ‘Positioning’ and ‘Sensor- and Data Integration’. The courses under the theme ‘Positioning’ (7^{th} semester) are Advanced Photogrammetry, Terrestrial Laserscanning, Data Libraries & Data Quality, and free study activities (‘mini-projects’) about point determination by means of terrestrial digital photogrammetry, and data collection and modelling by means of terrestrial laserscanning. Courses on Sensor Integration in Photogrammetry and Remote Sensing, Data Integration & Image Analysis, and a free study activity (‘mini project’) about Automated DTM Derivation including Quality Control are part of the education under the theme ‘Sensor- and Data Integration’ and take place in the 8^{th} semester. Table 4 shows all subjects regarding Photogrammetry and Remote Sensing of AAU’s MSc programme ‘Measurng Science’. Altogether, the students can obtain 15 ECTS credit points from courses and free study activities in the 7^{th} and 8^{th} semester in the subjects Photogrammetry, Remote Sensing and Laserscanning. The lectures are complimented by a few guest lectures, excursions, and presentations of companies.

In the 9th semester the focus is on professional development where a specific individual learning process is possible. For example, students can choose to have an internship in a company or a public institution; to study abroad at a foreign university; or to stay at Aalborg University to continue their studies. During this semester all students are connected to a virtual network, which means that they stay in contact with their fellow students and the lecturers from Aalborg University. The final semester of the MSc programme is dedicated to the production of the thesis, which takes 30 CPs.

Advanced Photogrammetry
Analytical photogrammetry
Aerotriangulation techniques
Terrestrial photogrammetry
Calibration of non-metric cameras
Industrial photogrammetry
Automation of photogrammetric processes
Terrestrial Laserscanning
Principles, instruments, methods & applications
Data Libraries and Quality of Data
Image libraries and their characteristics
Quality of DTMs and orthoimages
Sensor Integration in Photogrammetry& Remote Sensing
Imaging sensors in Photogrammetry and Remote Sensing
Platforms of sensors
Additional sensors
Direct georeferencing
Mapping from space imagery
Airborne laserscanning
Combined restitution of laserscanning and aerial images
Data Integration & Image Analysis
Operations at integrated raster data
Automated georeferencing of images
DTM&DSM production
Production of true orthoimages
Automated extraction of houses, roads, trees, etc.
Automated Quality Control of Orthoimages and DTMs.

Table 4. Photogrammetry and Remote Sensing subjects in the specialization “Measurement Science” of the MSc programme of Aalborg University.

The MSc Programme of the TU Berlin “Geodesy and Geoinformation technique” offers **specialization in “Computer Vision and Remote sensing”** with 42 CPs which are distributed over two semesters. It is supplemented with one semester of basic courses (including one course on sensor orientation and object reconstruction) and one semester for the production of a thesis (each with 30 CPs). More details on this study programme can be found at (TU Berlin 2006).

3.2 Education and training outside universities

Other education and training in Photogrammetry and Remote Sensing is carried out outside universities, for example by means of short courses, summer schools and Master degree programmes for professionals. In this way the continuing professional development (CPD) can be realized. Photogrammetry and Remote Sensing may also be integrated into high school subjects like mathematics and geography. This leads to the concept of 'Progressive learning network' (compare figure 3) and according to (Haggren 2005) the future curricula in Finland will be based on it. It means that the subjects Photogrammetry and Remote sensing are distributed over the whole lifetime of some individuals. The need to have more students in the education in Geomatics calls for marketing efforts at high schools already.

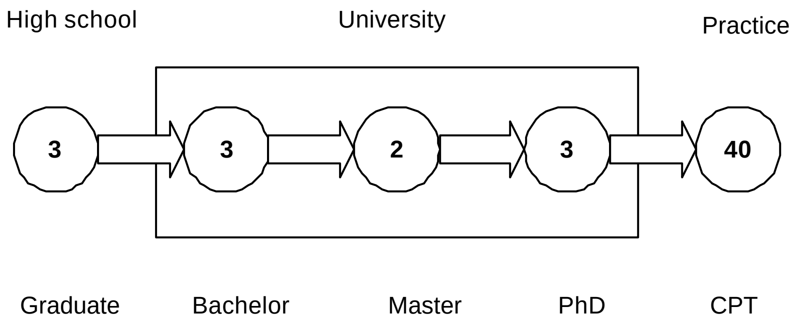

Figure 3. Life long education in Photogrammetry and Remote Sensing. The numbers stand for the number of years the studies normally last.

Organization	Subjects	Type of education
European Organization for Spatial Data Research (EuroSDR)	Photogrammetry, Remote Sensing, GIS	Short courses with introductory seminar
E-Learning Academic Network (ELAN) Niedersachsen, Germany	Photogrammetry Image processing	Short courses
ITC, The Netherlands	Remote Sensing, GIS	Short courses
GITTA, Switzerland	GIS	Short courses
Institute for Advanced Education in Geospatial Sciences, USA	GeoSpatial Information Technology	Short courses, curriculum

Table 5. E-learning courses and e-learning programmes in Photogrammetry, Remote sensing and related fields.

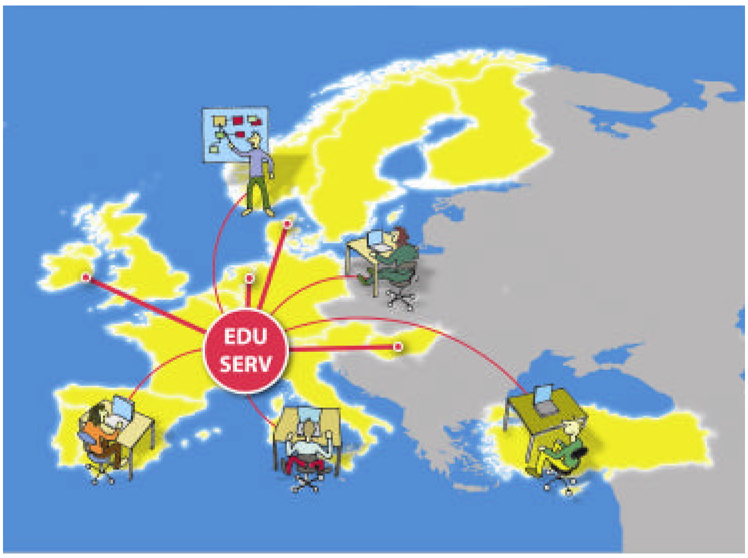

Figure 4. The educational service (Eduserv) of the European Organization for Spatial Data Research. The countries painted in brighter tones are the current member states of EuroSDR.

4. THE ROLE OF E-LEARNING

Education face to face will remain the best education or training. However, there are many reasons to use computers and the Internet in education. Today many courses in photogrammetry and related fields are offered on the Internet. Learners are sitting on remote places and study beside work and communicate with their teachers and fellow-students. At the universities e-learning is also used by the students in their group rooms or at their dormitories. Project work and work for a thesis can now be done outside the university, for example in a mapping organization. Even MSc programmes are offered as a mixture of e-learning at the home town and a few weekend seminars at the university. Companies instruct their clients how to use sophisticated hardware or software properly by means of e-learning. The learning material uses text, images, videos and sound, and a lot of interactivity. Other features for a successful e-learning are a quick feed back from the teacher or a learning system and collaborative exercises. How to design course ware for e-learning in Photogrammetry and Remote Sensing has alreadyy been presented in former ISPRS meetings, for example in (Höhle, 2004). Interactive learning programs with animation, interaction and feedback are used with success. New developments in e-learning are lectures recorded on streamed video, 3D virtual reality, games and micro learning components. The courses may use special conference and communication software packages where the course modules, discussion boards, calendar, and file exchange are integrated. Examples are First Class, Black Board or Web CT.

Many universities have now established research and/or service groups for e-learning. The production of good courseware requires many resources and good teamwork of different specialists. The carrying out of the courses including marketing requires substantial efforts as well. Table 5 shows a list of e-learning courses and e-learning programmes. It is by no means complete. The first example of Table 5 will be explained in more detail.

The **educational service of the European Organization for Spatial Data Research** carries out short courses on the Internet about the results of their research projects. A two day long seminar introduces three or four courses and e-learning of two weeks follows at their home locations (compare Figure 4). During the seminar the participants become acquainted with the teachers and to each other. The teacher can judge the prerequisites of the participants who come from different countries and different educational background. The 'distance' to the teachers is reduced and collaborative work between the participants is eased in this way. This e-learning has been carried out since 2002; four seminars and eight different e-learning courses took place. From the feedback of the participants (by means of questionnaires) it was confirmed that the combination of a short introductory seminar and e-learning at the home environment gives the participants trust, motivation, and thereby ensures good learning success.

5. QUALITY ISSUES IN EDUCATION AND TRAINING

Education at **universities** should be regularly evaluated, by students **and** by teachers. Good education should be up-to-date and based on research. Students should learn by doing. By their example how to do good research the teachers can motivate students. With the increase in knowledge and subjects the curriculum has to be divided into core knowledge and in specialized knowledge. The study should not be overloaded with details and examinations. The student has to have an active role and should be responsible for his or her education. Project work in groups will create the abilities required in practice. Professional development will increase by means of internships in a company, a public institution, or by studies at a foreign university.

Dissemination of knowledge by **e-learning** requires good educational material and communication abilities in writing. A high degree of interactivity is necessary. Short response times to questions of the students are essential. The student should experience a progress in his or her learning.

Quality management and quality control of the education are important tasks. The international organizations like ISPRS should engage themselves and give recommendations and guidelines. The comparison and rating of the specializations "Photogrammetry and Remote Sensing" at MSc programmes or of the many short courses are such tasks.

6. POSSIBLE DEVELOPMENTS IN THE FUTURE

The development in technology and social-economic conditions will go on, very likely at a higher speed. There will be many new sensors, systems and also new applications. Efforts in research and innovation become essential for the competitiveness of a national industry engaged in the production and use of spatial data. The photogrammetric community will become more connected. The resources for education will very likely be reduced due to the shrinking number of students in such technical subjects like Photogrammetry and Remote Sensing. This means that a stronger co-operation between educational institutions has to take place and, therefore, more educational networks have to be formed. The role of e-learning will increase and a global learning space will develop.

7. CONCLUSION

Education and training in Photogrammetry and related fields is changing due to new technologies and due to new social and economic conditions. In the curriculum of Geomatics also other subjects have to cope with changes and enlargements in their fields. Furthermore, the interest of young people in technical subjects and in natural sciences seems to decrease and the number of students declines. Therefore, the resources for the education in Photogrammetry are reduced in several European countries. There is nothing wrong with the subjects of Photogrammetry and Remote Sensing themselves. In this situation the core knowledge and specialization has to be defined and modularized. International cooperation and e-learning have to be organized. The advancements in Photogrammetry, Remote Sensing, Computer Vision, and Image Processing depend on good research activities. The universities should be the place of research **and** education. The governments and also the private industry should support the efforts of the universities to produce good research results and innovations and to carry out research-based education. Candidates of universities will then be able to think in new ways, to search efficiently for knowledge, methods and tools, and to manage projects in a given time frame. Problem-based and project-organized learning is a good approach to cope with such demands. The communication between people, also across borders of language and culture, will play a big role in the future and has, therefore, to be trained. The education in Photogrammetry and related fields has to use the global learning space.

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PROGRESSIVE LEARNING NETWORK, PLN

Henrik Haggr
Helsinki University of Technology, P.O.Box 1200, FIN-02015 TKK, Espoo, Finland
Henrik.Haggren@tkk.fi

Commission VI

KEY WORDS:

ABSTRACT:

Progressive Learning Network, PLN, is a model for applying the learning theory of progressive inquiry to an individual's life-long learning career. As an approach PLN was initiated during the academy Suiteproject. The model is developed in order to promote scientific research and utilize academic research knowledge and material in all phases of learning. The primary aim is to stretch the photogrammetric curriculum to the entire education line of an individual. We expect that progressive inquire is a suitable pedagogical theory for developing future photogrammetric curricula, rather than to continue with the traditional evolution model.PLN is also considered as a kind of network, where collaborative learning practices will be developed based on progressive inquiry. The network is vertically oriented along growing or aging dimension. On each level it is horizontally directed as for example our scientific and professional society. With the vertical networking our scientific community will be connected to children's learning career. According to PLN, parts of the academic activities can be associated with the primary and secondary schools or with gymnasia, if the learning model is based on theory of progressive inquiry. The network will be social and it will enhance pupilsinterest both in the subject and the common local environment, where they live. The model and network can naturally be applied to the post-doctoral or continuing professional study levels as well.The learning process of progressive inquiry follows the consecutive phases of problem solving. The concept describes the idea of a potential solution, the algorithm is a part of its analytical description, the simulation provides necessary trust on its validation, and finally, the procedure will describe the practical tooling for its realization. The tools are most probably available, like digital cameras and local orthophotographs, satellite images and maps. The necessary technology of scene reconstruction will be provided by the learning platform.In 2004, we prepared and experienced the first experiments in progressive learning with the secondary school of Maininki in Espoo. The core research group in photogrammetry was our group at TKK. The tasks were for stereo photography and imaging, and for parallax measuring. The school teachers in information technology, mathematics, physics, geography and biology did the exercises. The results were promising. However, it became evident, that the current workload of the teachers will not allow anything, which will only increase the content of the curriculum. New tasks can be adapted to individual courses only if there is an indication of positive effects to the entire learning process in the schools.In 2005, we have proceeded with our experiments jointly with Luma Centre. Luma Centre serves as the network for education, research, development and co-operation, and is coordinated by the Faculty of Science of the University of Helsinki. It is promoting teaching of biology, chemistry, geography, mathematics, physics and technology and enhancing interaction between schools, universities and business and industry. It seeks to encourage children and young people to become involved in scientific activities. The co-partners of the departments in the Faculty of Science come from education administrations, business and industry, industrial organisations, municipalities, and from the Faculty of Biosciences and the Faculty of Behavioural Sciences.

AN INTERNSHIP AMONGST MILLIONS OF POINTS

Martin Rub

Institute of Geodesy and Photogrammetry, Swiss Federal Institute of Technology (ETH) Zurich
ETH Hoenggerberg, 8093 Zurich, Switzerland -
rubm@student.ethz.ch

Commission VI

KEY WORDS: Internship, Science Transfer, Terrapoint Canada Inc. LiDAR, Photogrammetry, Operation, Processing

ABSTRACT:

During the Geomatics Engineering Course at the Federal Institute of Technology in Zurich, Switzerland, the students undertake a compulsory internship. This practical work takes place outside the Institute. The main locations for practical work are the following: engineering and planning offices, industrial and geodetic companies. This internship typically takes place during the seventh of ten terms and is required to be a minimum of four months duration. The objectives of this internship are to strengthen the practical know how and also enables the geomatics engineering students to become familiar with the professional handling of geomatic questions. The work experience is intended to promote an understanding of the general political, and economic constraints under which geomatic solutions can be developed and implemented. This is an important step to translate the knowledge into actions beyond that which was acquired during the three previous years at the university.
The ability to combine knowledge from different courses to solve a certain problem is a challenge as well as a training to develop work oriented solutions. Additionally to that, work conditions are influenced by a tight processing and delivery schedule and bring a new aspect into student's work habits.

ZUSAMMENFASSUNG:

Der Studiengang Geomatikingenieurwissenschaften an der Eidgenoessischen Technischen Hochschule in Zuerich, Schweiz beinhaltet ein obligatorisches Praktikumssemester. Dieses Praktikum wird waehrend mindestens vier Monaten ausserhalb des Institutes absolviert. Ueblicherweise wird es von den Studenten waehrend dem siebenten von zehn Semestern geplant. Die wichtigsten Arbeitgeber sind in den Bereichen der Ingenieur- und Planungsbueros, Industrie, sowie geodaetischen Privatfirmen zu finden. Schwerpunkte liegen im praktischen Arbeiten sowie beim Erlernen von professionellen und wirtschaftlichen Arbeitsvorgehen. Die Absicht ist, dass die Studenten einen Anhaltspunkt in geodaetischen und oekonomischen Anwendungen ihres zukuenftigen Berufes erhalten. Dies ist wichtig, um das waehrend den vergangenen drei Jahren erlernte Wissen an der Hochschule in Tat umzusetzten. Wissen aus verschiedenen Disziplinen muss kombiniert und zu einer einheitlichen Loesung zusammengefuehrt werden. Dies bringt einige Herausforderungen mit sich, die die Arbeitsweise des Studenten nachhaltig veraendern.
Dieses Manuskript soll einen Einblick in die grossen Vorteile aber auch Nachteile eines solchen Praktikums geben.

1. INTRODUCTION

An internship in the private industry and especially with a company located abroad presents different challenges and experiences. Before the internship can be started an extra expenditure has to be managed by the employer as well as the student. Typical issues such as the work permit as well as a requirement to obtain a social insurance number. Once these issues have been solved, new challenges take place for both parties. On one hand there is the language barrier as well as a different working mentality. These challenges provide experiences which cannot be gained at the university level.
This paper will not only focus on the challenges and experiences from an intern's point of view but also from that of the employer. Moreover, the genuine benefits and advantages of an internship will be highlighted and potential pitfalls will be investigated. Finally, conclusions will be drawn as to whether internships are worth the extra time and commitment from all view points.

2. ORGANIZING AN INTERNSHIP

2.1 Find an Internship Placement

The chair of education at the ETH Zurich makes students sensitive to the furture internship in advance. The search requirement and responsibilities to find a placement for the work term are up to the student. Students are absolutely free in finding a work place as long as it is related to geomatics engineering. Thus, the work field and the company can be chosen according to student's interests.
This particular internship comes up with some additional challenges. The negotiation with the prospective employer takes longer than for domestic jobs. Main reason might be the employer who is not familiar with the foreign education system and due to that the student's skills. Experiences have shown that the current international equalization of university education and degrees are helpful concerning comparisons and assessment. But considering degrees and a comparison of student's courses is not sufficient to allow final decisions and conclusions. That means, the prospective employer is left in the dark about the full skills of a student. The same issue appears also for the student who is not familiar with the foreign education system and thus may be left in the dark about what the employer might expect concerning skills and knowledge. Moreover, both sites have to be aware that a language barrier might be a problem during work term.

2.2 Place of the Internship

This particular internship takes place abroad at Terrapoint Canada Inc. in Ottawa. Terrapoint is well known in the LiDAR business. It has over 50 employees, offices in Houston, Calgary, and Ottawa. The employees have a different background in Engineering, Physics, Surveying, and Geodetics. It has provided more than 500 LiDAR projects and other digital mapping services for a diverse clientele for the past twenty years. During that period, Terrapoint has become the largest, most experienced LiDAR survey company in the world. The seven LiDAR systems - four in a high and three in a low range modus - have been operating in over 40 countries around the world.
The main idea of this internship is to see and become familiar with a LiDAR and photogrammetry project. To go through an entire work flow; starting from the onset until data is ready to be delivered to the client. The work flow of such a project requires contributions from many fields of work. It encompasses the project planning, data acquisition, processing, quality procedures, and the opportunity to export a high-quality product as a derivative of the laser point cloud.
Moreover, the work with LiDAR projects assume an understanding of correlations between different disciplines. On the one hand there is a talent of organizing a project in different areas, on the other hand the technical, and engineering part of planning and processing.

3. OCCUPATION DURING WORK

3.1 LiDAR Project

The first weeks of the internship encompass a training in several fields of work at Terrapoint. That gives a gross overview of what the company is doing and with the kinds of data that will be used in the next few months. The next step is an introduction to an entire LiDAR project. The co-operation from employees who have long term experiences in a relatively new business provides an outline of the difficulties and tricks of managing LiDAR projects. A data acquisition tour was taken during the initial two weeks. Once the project planning is done, the mobilization of the required equipment has to be organized. LiDAR as a airborne based system brings special safety procedures and requires a lot of preparations. Part of the training was attending the mounting of the LiDAR system and learning how its three main gauges, namely GPS, IMU and the Laser work together.
Before anything can be launched on the project site, ground work is required. First of all a GPS network is established which ensures that the planned accuracies can be ensured. Furthermore, a so called ground truthing is established which will be used as a quality control during the processing of the LiDAR data. The intern acts as system operator during several missions on the helicopter.
After a coarse field processing and an ititial quality check, data goes into a further step of the project. The office processing is responsible to bring the raw point cloud to a high-end product. This process comes up with new challenges for the intern. A couple of new software packages have to be learned. Generally, the processing of a LiDAR project can be standardized but every project comes up with different challenges. On the one hand new issues with the LiDAR system are figured out, on the other hand a processing work flow is always in a progress of improvement, software packages get more powerful, and computer are getting faster, etc. Generally, it might be the first time where an intern has to work as reliably as never before. Mistakes or problems cause directly data quality compromises and hence threaten the financial break even of a project. LiDAR missions require a proper work skills and practices during data acquisition to derive a high quality point cloud. If problems appear during a mission, issues will appear at least at one of the further processing steps.

3.2 Photogrammetry Project

Terrapoint provides its clientele with LiDAR data as well as imagery. Therefore the second half of the internship is focused on Terrapoint's photogrammetry projects. The internship is responsible for several tasks concerning photogrammetry and works alone at the beginning. To get familiar with Terrapoint's former photogrammetry projects a catalog is developed which will show the prospective clients what is possible with imagery and what might cause difficulties. The benefits and the disadvantages of photos are outlined so that every client gets an idea. The results are given in general processing steps of a photogrammetry project as well as specific targets of the company itself.
During current imagery projects, the intern is interacting with other companies which are co-operating to achieve a successful project. This brings a new aspect into student's work. A precise description of problems and targets challenges the intern. Solutions have to be checked on both sites. Questions like: Is the new solution executable and might it bring new benefits into the current work flow, have to be investigated. Furthermore, a documentation for the selected mosaicking process is written by the intern. Thus, after a few weeks the intern is integrated into a small group of prospective photo processors. The co-operation encounters a training and on-the-project training.
During the internship Terrapoint has enlarged its capability to process photo projects. This brings new tasks into the processing work flow. A totally new concept of data handling, data management and especially data backing up have to be discussed. A concept is never considered perfect until enough experience with projects can be gathered. This assumes that the processing group plans and calculates scenarios for the near future to be reliable and faster. This planning turns out to be very important because it takes effect at the very beginning of a project. At the beginning when sales people go to the clients and negotiate the proposal which directly constrain the time of processing.

4. OVERALL EXPERIENCES

4.1 Disadvantages and Difficulties

An internship in a foreign country has previously un-encountered working conditions. Initially, long discussions and uncertainties about getting a job and the required work permits face the intern. Moreover, the working term in a foreign cultural environment is very intense. Everything is conducted in English. A lot of English pertaining to the work environment is already known from studies at the university which publishes scripts in English and this, allows the students to become familiar with the technical expressions. At the beginning, one of the main issues for the intern is to follow the well defined procedures and benefits from the knowledge and experience of the colleagues. After a good introduction, several links can be done just after a couple of weeks.

4.2 Benefits and Positive Experiences

Generally, an internship changes a student's mind concerning work practices. On one hand the work has to be done in a tight schedule and has to be reliable. Mistakes usually appear sooner or later in a further on in the project process, so the work has not only to be done with great concentration; the student has to be figure out how one's work can be controlled and checked. Control

procedures might already exist in the standard processing work flow but there are still a few opportunities to do checks on your own. This controlling process can really good be linked with the methods and techniques learned at university. The university has several approaches to train the students in controlling and to become familiar with a quality oriented work environment.
An internship might be also the first time where different disciplines have to be linked and used together. Rarely are problems tied only to one field of work. Approaches for solving a problem have to be seen from different point of views as well as weighing up solutions against each other.
Another well known syndrome during exercises at the university are the projects. Usually, small projects are shared at university to train students in a particular task. This may change when working at a private company. Projects can have huge amounts concerning of data and require a much longer length of time than project assignments at the university. Therefore, problems like data management appear sooner or later once the student gets in contact with photogrammetry projects. The huge amount of data requires a very time consuming process which has to be optimized for efficient work.
An independent work experience and the exchange with people of different background in science and life experience make an internship interesting. One is faced with an environment where all of the employees have varying levels of experience and variety of different background knowledge.
Geomatics engineering is no longer a separate discipline. A successful company must have a good background of computer science. Almost all geomatic applications are based on computers and electronic tools. A good knowledge in related science makes life as geomatics engineer easier.
It is beneficial to work at least once in a foreign country to see and watch how geodetic problems are handled. For example the surveying sector in North America. It still requires a high attention concerning measurement units. Canada decided 1970 to change to the metric system. Though this is not necessarily by choice but may instead be due to the overwhelming influence of the neighboring and largely non-metricated United States that older generations are still thinking in different units. Personal experiences showed that - for coming from a metric system - more attention and imagination are required. That is especially the case for U.S. based projects where still the non-metric system is in use. Conversions and a neat and correct reporting of customary units is inevitable. Different countries have different geodetic systems. A work term encompasses experiences with different geodetic systems. For example North America are projections such as UTM and the specific State Plane are in use and these are very rarely be seen in Europe.
Another observation is have been made, that the surveying sector in Canada has a high degree of safety awareness and due to that high standards in health and security programs. Safety procedures are well defined and have to be studied by everybody who is working in the field.
After a while the challenge of a different language during an internship turns out to be an advantage. Technical problems and solutions have to be formulated in a much more compact and precise form, and reduced to the essential content. Especially writing project documentation is not encountered are an unknown field of work during study terms. Many questions and challenges occur when learning to use software tools since read and interpreting manuals typically is different in another language and many items and expressions have to be figured out.

4.21 Bottom Line An internship in the private industry can help to develop personal strategies concerning management. A graduate geomatics engineer is sooner or later confronted with the management of different resources within their company. The range of such tasks is wide and can encompass working out of technical solutions, contracting, client support, data management, human resources, etc. Working with graduate engineers give an idea of leadership issues and how to conduct a group of employees. Moreover, Terrapoint is an international operating firm which is running three branches in three different places and two different countries. This introduces new new challenges and solutions for an internal communication system and for a good work atmosphere. Sometimes team work is required with people who have never been seen before and the primary communication medium is the telephone.

5. CONCLUSIONS AND RECOMMENDATIONS

Once the decision to find an internship in a different country is made, a long time of uncertainty and discussions with different people and organizations is part of that process. Usually, several weeks pass until a company indicates an interest to hire an intern. One of the most important point to find a place for the internship is an open-minded attitude to consider each job offer. After the work placement has been selected several points have to be considered. Experiences show that the search and especially the bureaucracy to get a work permit can be very time consuming. It is recommended to search several months in advance. Nevertheless, the extra expenditure is it worthwhile and the benefits of the work experiences are huge.
Furthermore, connections to people of different sectors of geomatics engineering may help in a later work place to succeed.

6. ACKNOWLEDGEMENTS

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THE EXPERIENCE OF E-LEARNING: PROGRESS TOWARDS A NEW LEARNING PARADIGM

A. Martin [a], E. McGovern [a], K. Mooney [a], Kevin O'Rourke[b]

[a] Department of Spatial Information Sciences, Faculty of the Built Environment, Dublin Institute of Technology, Dublin, IRELAND – (audrey.martin, eugene.mcgovern, kevin.mooney)@dit.ie
[b] Learning Technology Team, Dublin Institute of Technology, Dublin, IRELAND – kevin.orourke@dit.ie

KEY WORDS: E-Learning, Learning Paradigm, On-line, Education, Teaching, Training, Spatial Information Sciences.

ABSTRACT:

This paper reviews the use of E-Learning in the spatial information science programmes of the Dublin Institute of Technology (DIT). The spatial information science programmes are placed within the context of the use of E-Learning across the Institute and this paper draws on the experiences of the DIT Learning Technology Team (LTT). The LTT has just completed the initial brief given to it by the DIT strategic planning group charged with ensuring the implementation of E-Learning as a resource in support of the change from a teacher-centred to a learner-centred paradigm.
E-Learning was first introduced in the Department of Spatial Information Sciences (formerly Geomatics) for the design and delivery of short modules for the continuing professional development (CPD) of staff in mapping organizations. Participants were generally very positive about their experience of E-Learning for CPD and identified a number of clear strengths. However, most participants reported difficulties completing assignments associated with completion of the courses. The courses were based on the principle of 'learning by doing' and, as such, required a considerable amount of assignments to be completed by participants, many of whom felt excessively challenged by their degree of difficulty.
Finally, the paper evaluates the performance of E-Learning tools in the undergraduate programmes of the Department. The cultural and pedagogical changes necessary to use E-Learning as a learning resource are happening much more slowly than the implementation of the technology might suggest. DIT students and teachers are growing more comfortable in an online environment, but are some years away from fulfilling the vision of independent online learners operating in a constructivist manner facilitated by e-moderators.

1. INTRODUCTION

The Dublin Institute of Technology (DIT) is the largest educational institution in Ireland, with more than 21,000 students engaged in programs ranging from craft training to post-doctoral research. The multi-level structure adopted by DIT incorporates a number of flexible learning models, which enable students to participate in education at different stages of their careers on either a part-time or full-time basis. DIT is also committed to lifelong learning and has a strong tradition of providing continuing professional education and development (CPD) programs to industry and professional bodies.

DIT established a Learning Technology Team (LTT) in 2002, which has just completed the initial brief given to it by the DIT strategic planning group charged with ensuring the implementation of E-Learning as a resource in support of the change from a teacher-centred to a learner-centred paradigm (O'Rourke 2005).

The Department of Spatial Information Sciences, in the Faculty of the Built Environment in DIT, provides a four-year full-time degree course in Geomatics. It also services the spatial information industry in Ireland on an annual recurring basis by providing a number of part-time programmes in Global Navigation Satellite Systems (GNSS), Geographical Information Systems (GIS) and digital cartography. Furthermore, diverse CPD modules in the spatial information sciences have been designed for specific user groups such as local authorities and government departments. The delivery of these modules, to date, has been on a block release basis whereby all students attend lectures and practical sessions in the Department of Spatial Information Sciences in Dublin. However, the rigid timetable of CPD programmes on offer has often led to accessibility difficulties for students and office downtime for employers. A new CPD program model based on the utilisation of E-Learning was, therefore, developed and piloted by the department (Mooney et. al. 2003) and Section 2 of this paper provides more detail of this undertaking.

The department has also introduced E-Learning in its undergraduate programme in Geomatics. Section 3 looks at the influencing factors that have affected the success of this initiative placing it in the context of the Irish second and third-level education system.

2. E-LEARNING FOR CPD

E-Learning was first introduced in the Department of Spatial Information Sciences (formerly Geomatics) for the design and delivery of short modules for the continuing professional development (CPD) of staff in mapping organizations. The development of a distance E-Learning course in 'Co-ordinate Reference Systems for Spatial Information' has previously been reported (Mooney & Martin 2004).

The course comprises six themes:
Theme 1 Describing position with co-ordinates
Theme 2 Defining and realising co-ordinate reference systems
Theme 3 Calculation in a two-dimensional Cartesian co-ordinate reference system
Theme 4 From local to global co-ordinate reference systems

Theme 5 Manipulating co-ordinates
Theme 6 Position in Ireland (Customisable)

Students check discussion postings and mailings on a daily basis. Course tutors give an undertaking to respond to messages within twenty-four hours. This can prove difficult to sustain particularly in the case of courses coinciding with a busy domestic workload.

Students of eLearning courses, particularly distance courses, require and expect effective feedback to problems and queries. Designers of eLearning courses, therefore, must factor sufficient time per theme for monitoring and responding to student queries.

Pilot course participants who followed the course over a six-week period covering one theme per week provided extensive feedback to the course developers. They were generally very positive about their experience of E-Learning for CPD and identified a number of clear strengths. Principal among these is the removal of barriers, relating to location and time, that might prevent a member of staff of a busy mapping organization from availing of CPD resources necessary for skills and knowledge updating or for amassing sufficient ‘CPD points’ for membership of a professional institution and career advancement.

E-Learning also offers participants a unique opportunity to gain direct access to experts in their field of work and many participants felt that valuable contacts had been established of benefit long after the course was finished. However, most participants reported difficulties completing assignments associated with completion of the courses. The courses were based on the principle of ‘learning by doing’ and, as such, required a considerable amount of assignments to be completed by participants, many of whom felt excessively challenged by their degree of difficulty.

Participant feedback also referred to the degree of interaction with the course teachers, response time to queries and the relationship between the working and learning environments.

This feedback highlights a key issue in using E-Learning for CPD. Course participants, many of whom have been working for a considerable number of years, do not seek the same outcomes from a course as an undergraduate student and do not enjoy the same amount of time for completion of tasks. For an undergraduate student, being forced to extend oneself, in searching for solutions beyond daily course content, is a necessity in developing the transferable skills needed throughout a career. A CPD student, on the other hand, requires a degree of difficulty necessary to maximize learning but not at the cost of excessive time in doing so. Designers of E-Learning courses must, therefore, ensure that course assignments are very closely related to desired learning outcomes appropriate to the target participant group - otherwise one barrier (location and access) removed by E-Learning may be replaced by another (unrealistic and inappropriate expectations).

Participants felt the learning experience was a good one provided that feedback was forthcoming from course tutors in a timely manner.

The generation of content suitable for the efficient learning of complex concepts is time consuming. In the authors’ estimation, approximately thirty hours preparation is required for one hour of student on-line study (Mooney et. al., 2003). Material must, therefore, be re-usable in other courses or educational resource. Courses should have a long ‘shelf-life’ in order that they can be used over a period long enough to recover some or all of the creation costs.

Tutorials covering complex concepts are possible through the use of communication tools provided they are well prepared and structured. However, assessments should lead to an accredited award and students should be given sufficient time to prepare submissions. Group based assignments are difficult to realise and the gain to the learning experience is marginal while grades accruing can be affected by factors other than a student’s knowledge.

The experience of the authors points to the need for a ‘template’ for the design of internationally accredited adaptable E-Learning course modules for CPD. Such a template should include a set of guidelines for best practise covering course structure, length, degree of difficulty, nature of assignments, type of interaction etc. In addition it should comprise a set of agreed assessment criteria and formats that will comply with the European Credit Transfer System (ECTS) norms.

3. UNDERGRADUATE IN-HOUSE LEARNING

The Dublin Institute of Technology (DIT) established a Learning Technology Team (LTT) during 2002 in order to manage the introduction of E-Learning across the Institute. In the three years to May 2005, the LTT has worked directly with more than 50% of DIT academic staff, and the quantity of undergraduate degree programmes making course materials available on the internet using WebCT (the E-Learning environment adopted by DIT) now exceeds 70% (O'Rourke 2005). Significantly, however, the cultural and pedagogical changes necessary to make DIT a centre of E-Learning excellence are happening much more slowly than the implementation of WebCT might suggest. For many DIT Staff members, the introduction of e-Learning means little more than using technology to distribute materials previously distributed in class, while students – although very IT literate – have shown difficulty associating Internet use with formal learning and education.

The LTT has been crucial in enabling staff members to utilise E-Learning and its role is changing from the bearers of “technology” to the providers of innovative methods for learning and teaching.

The Department of Spatial Information Sciences at the DIT offers the only undergraduate degree programme in the spatial information sciences in Ireland. The programme is of four years (eight semesters) duration. The vast majority of students enrol on this programme immediately on leaving secondary school at an average age of eighteen years, but sometimes as low as seventeen years. Most students, therefore, complete their third level education in the spatial information sciences before reaching their twenty-second birthday. This period in a student's life is one in which he/she continues to mature and there is significant variation in the ability of students to take responsibility for, and manage, their own learning. This has important consequences on the learning/teaching methods offered by the department. Initiatives have been taken in recent years to try and shift from a teaching paradigm to a learning paradigm with varying degrees of success. The introduction of problem-based-learning (Martin et. al. 2006) represents one such initiative, while the utilisation of E-Learning represents another.

The successful adoption of a learning paradigm is further influenced by an emerging trend among Irish students leaving secondary school. In recent years, students have become increasingly examination-focussed. This is due to the competitive nature of securing places in Irish third-level education. Places are offered on the basis of points scored in the secondary school leaving certificate examination. Because the Irish economy has performed strongly during the last ten years there is an expectation among most young people that they will progress to third-level education as a matter of course. It is inevitable therefore that pressure has built on second-level teachers to 'coach' students in examination techniques in order to extract the maximum points from their leaving certificate examination. Unfortunately, many students carry this approach into their third-level programmes. Many are more concerned with passing the examinations that will secure them a degree qualification than learning the subject. As a consequence such students are more comfortable in a teaching paradigm rather than one where responsibility must be taken for their own learning.

In the Department of Spatial Information Sciences, all modules of its eight-semester degree programme in Geomatics have an E-Learning module available on the DIT WebCT server. The modules are used as sources of information and a repository of course material. The use of the E-Learning environment as a source of course material can be effective if it allows classroom sessions to operate as interactive tutorials where issues are explored rather than material re-introduced. This is proving successful in some modules but difficult in others. As an institute, DIT has begun to recognise the effort involved on the part of staff members who adopt the new learning paradigm. DIT staff members are vastly experienced in their respective disciplines but may not have grown up in the Internet era. The average age of staff is between forty-five and fifty-five years. For many it has proved difficult to come to terms with on-line technology and required considerable investments of time.

Unfortunately, however, in no case is the E-Learning module yet used for self learning. Students are most comfortable while in the physical presence of a lecturer and teachers are more practiced in the ways of the physical classroom. Both are growing more comfortable in an online environment, but are some years away from fulfilling the vision of independent online learners operating in a constructivist manner facilitated by e-moderators (O'Rourke, 2005). This represents a significant challenge to the department as it strives to offer increased flexibility of choice in its modular programmes. Inevitably, as the number of available modules increases, the traditional modes of delivery associated with the teaching paradigm will become more difficult to resource. It remains to be seen if E-Learning delivers on the considerable potential it offers.

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Continuous Professional Development (CPD) for Surveyors

Shunji Murai* and Kunihiko Ono**

*Vice President, Japan Association of Surveyors: sh1939murai@nifty.com

** Director General, Japan Association of Surveyors; ono@jsurvey.jp

1-3-4 Koishikawa, Bunkyo-ku, Tokyo 112-0002, Japan

Tel: 03-3815-5751, Fax: 03-3816-6870

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ABSTRACT

Recognizing the rapid progress of surveying technologies in ITC age, the JAS initiated CPD in cooperation of 8 public corporations and 5 academic societies including JSPRS in the field of geo-informatics such as survey, photogrammetry, remote sensing, cartography, geodesy and so on. The CPD will be benefited by those who have gained higher points in terms of the evaluation by those clients who plan bidding.

JAS has received more than 3,700 surveyors who registered the CPD project in a system called "SUCCESS". The system will be provided to those central and local governments who wish to refer to the CPD points and evaluate those private companies whose surveyors joined the CPD project.

JAS is planning to provide e-learning system to those local surveyors in order to save travel time and cost by attending the tutorials normally organized in Tokyo. In 2005, the standard criteria of pointing system have been agreed, which will be also applied by other public corporations and academic societies.

INTRODUCTION

Japan Association of Surveyors (JAS) is a non-profit organization (NPO) aiming at the promotion and popularization of surveying technologies based on membership. The main activities involve the publication of the official journal of survey, capacity building of skilful surveyors through tutorials and examinations, inspection of survey instruments and survey results etc.

JAS took initiative to establish CPD Consortium for Surveyors in August 2004 in cooperation of relevant organizations such as Japan Federation of Survey and

Planning Associations, Japan Society of Phototgrammetry and Remote Sensing (JSPRS) and so on. The main points of CPD are to maintain and upgrade the skill of surveyors through tutorials and seminars, to evaluate those efforts by giving points to those registered surveyors and to let those clients be informed those companies with higher score for consideration of the selection of bidding companies.

JAS has established a computer system called "SUCCESS" by which any client can refer to the company name of which surveyors are evaluated with higher score or not.

Central and local governments start to make approach to "SUCCESS" when they plan bidding event in the field of geo-informatics.

OUTLINE OF CPD BY JAS

1) Targeted Surveyors: Ordinary members of JAS as well as the member organizations are eligible to register the CPD project
2) Learning Programs: CPD Committee will authorize those tutorials, seminars, publications and other activities which should be evaluated with specific points.
3) Registration of Points: Those registered members have to apply the certification to list up the name of individual and belonging company with those program and point, when they joined the program.
4) Disclosure of Points through SUCCESS: JAS discloses CPD point of individuals with only ID number which can be accessed by those registered members. JAS also provides those registered clients with CPD point and company name with a special password.
5) Submission of Certificate: Any registered member can obtain the certificate of CPD point.

MEMBERS OF CPD CONSORTIUM FOR SURVEYING

Eight associations and five academic societies as listed below joined the CPD Consortium for surveying.

Associations:

1) Japan Association of Surveyors (JAS)
2) Association of Precise Survey and Applied Technology (APA)
3) Japan Map Center (JMC)
4) Survey Education Center
5) Mapping Enterprises Association Japan
6) Japan Federation of Land and House Investigator's Association
7) Japan Construction Information Center (JACIC)
8) Japan Federation of Survey and Planning Associations

Academic Societies

1) Japan Society of Photogrammetry and Remote Sensing (JSPRS)
2) The Geodetic Society of Japan
3) Constitution of the Geographic Information Systems Association (GISA)
4) Japan Cartographers Association (JCA)
5) The Remote Sensing Society of Japan

(RSSJ)

BASIC PRINCIPLES OF CPD POINT

CPD Committee has approved the four basic principles for pointing in CPD.

1) Equal Opportunity: Any member can join the CPD programs, which are authorized by CPD Committee.
2) Fair Judge: The evaluation of pointing should be acceptable and agreeable.
3) Traceability: Any CPD program can be traceable with written documents.
4) Single Booking: Double booking shall not be permitted in case of jointly organized tutorials and seminars.

AUTHORIZED PROGRAMS

According to the report of CPD project as of the beginning of 2006, the following programs are authorized for CPD point.

1) Japan Association of Surveyors: 115
2) Japan Society of Photogrammetry and Remote Sensing: 9
3) The Geodetic Society of Japan: 7
4) Japan Construction Information Center: 4
5) Japan Cartographers Association: 6
6) Association of Precise Survey and Applied Technology: 5
7) Japan Cartographers Association: 6

The detail information will be available at the following web site.
http://www.jsurvey.jp/cpd/cpdmanual.html

JAS has accepted the registration from 3,734 registrants as of March 2006.

CPD POINT BY JAS

The following points are approved by CPD Committee.

1) Participation in Tutorial: 1 per hour
2) Lecturer: 3 per hour
3) Oral & Poster Presentation: 2 per paper
4) Peer reviewed paper: The first author: 5 and co-author: 2
   Technical report: The first author: 3 and co-author: 1
5) Publication of a technical book: Single author: 10 and co-author appeared in the cover page: 5. Co-author without appeared in the cover page: 2
6) Member of technical committee: Chairman: 2 and other members: 1
7) Award: Licensed Special Surveyor: 7, best paper:6, applied survey award: 4 and young author award: 3
8) Subscriber of "The Journal of Survey": 5

CPD POINT BY JSPRS

For comparison with CPD point by JAS, the following CPD points by JSPRS will be interesting.

1) Subscriber of "The Journal of Photogrammetry and Remote Sensing": 5
2) Peer reviewed paper: The first author: 5 and co-author: 2
3) Technical report: the first author: 3 and co-author:1
4) Oral presentation: 2
5) Participation in tutorial: 1 per hour

6) Lecturer of tutorial and seminar: 3 per hour
7) Publication of book: Single author: 10, co-author appeared in the cover page: 5 and co-author without appeared in the cover page: 2
8) Award: Best paper: 6, young author award: 4 and best presentation at annual or fall convention: 2

WEB ACCESS BY ORDERING ORGANIZTIONS

At this moment, the 70 ordering organizations are using the web site of "SUCCESS" for collecting information about the quality of surveyors, the CPD point, the evaluation of surveying companies etc.

Out of 70 organizations, there are 9 central governments, 26 provincial governments and 35 local governments which are given password to access the web site.

The average access number per month is about 290 hits, which totalize 5,965 accesses since July 2004.

BIDDING REQUIREMENT

As the CPD project has just started since 2004 and the accumulated points are not yet sufficient for the selection of bidders, those ordering organizations are using "SUCCESS" as supplementary information. However, it would be possible for those ordering organizations to consider the CPD points as their bidding requirements. On the other hand, JAS and other CPD Consortium Members should increase more opportunities of education and training.

As the cost of participation in CPD program for local members is much higher as compared with those living in big cities such as Tokyo and Osaka where most of CPD programs are implemented, e-learning on the base of self learning should be developed.

In 2005, JSPRS has published a CD ROM teaching material on "Applications of Geo-spatial Information" for CPD program including examination for CPD point. Such self learning system will be welcomed by those by those surveyors working in local cities.

CONCLUSIONS

1) JAS took initiatives to start CPD program for surveyors in cooperation of other 13 relevant organizations since 2004.
2) However, it will be too early to evaluate whether it is successful or not. The success depends on how much the ordering organizations will use the CPD point as the bidding requirement.
3) The necessity of CPD for surveyors has been well recognized with 3,663 registrants up to January 2006.

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CARST 1.0 AND REMOTE SENSING TRAINING AT GEOINFO LTD. IN VIETNAM

Nguyen Dinh Duong

Institute of Geography, VAST, 18 Hoang Quoc Viet Rd., Cau Giay, Hanoi, Vietnam
duong.nd@hn.vnn.vn

Commission VI

KEY WORDS: Remote Sensing, Training, Digital Image Analysis, WinASEAN, Interactive Tutorial.

ABSTRACT:

Computer Assisted Remote Sensing Training software - CARST 1.0 was developed by the GeoInfo Ltd. for hands-on training in remote sensing and GIS. The CARST 1.0 is composed of the WinASEAN 5.0 Edu, Remote Sensing Notes published by the Japan Association of Remote Sensing and GIS Work Books of Prof. Shunji Murai. The WinASEAN 5.0 Edu provides basic digital image analysis functions that can handle both one-byte and two-byte image data. Each function is explained in on-line help, which is available in English and Vietnamese version. The help file is linked to the digital books providing users deeper understanding of remote sensing and GIS background. The system is further accompanied with interactive tutorials developed by InstantDemo software that allows beginners to self-train step-by-step basic digital image analysis functions. The CARST 1.0 is being used for hands-on training in remote sensing courses organized by the company GeoInfo Ltd. in Vietnam. The training is organized in three courses: Introductory, Basic and Advanced. In the Introductory course the trainees are introduced to basic terms of remote sensing and principles of visual interpretation. Some explanations of digital image analysis are also given in this course. In the Basic course the trainees will learn basic digital image analysis functions through hands-on training using the WinASEAN software. In the Advanced course programming is focus point, which is essential for development of more complex analysis including GIS modelling. One copy of CARST 1.0 and dataset is given free of charge to each trainee to allow self-training in his own time. This paper will provide readers information of the CARST 1.0 and experience in remote sensing training by GeoInfo Ltd. in Vietnam.

1. INTRODUCTION

Capacity building is key means of successful implementation of remote sensing application. It is realized in many forms and on different levels such as university programs on remote sensing, training courses offered by space organizations or research organizations. University education provides systematic knowledge on remote sensing but does not target much on skill building. It is also usually limited to graduate or master course students. The courses organized by space agencies and research organizations are often irregular and short in duration (some days only). They target mostly on demonstration of remote sensing technology or data and some application case studies. In these courses, promotion of remote sensing is more important than practical training on data usage. In a situation when remote sensing data has become more accessible with low cost, analysis software is popular in either open source or trial ware and any modest PC can provide good environment for image analysis including high quality display of image, the number of people who really understand remote sensing and capable to process skilfully satellite image to generate practical results bringing certain benefits to the society is still limited. The application of remote sensing is still beyond a point of expectance in developing countries. There could be many reasons hidden behind but maybe one of them is a lack of sophisticated hands-on training on data analysis.

The aim of this paper is to provide information of development of the Computer Assisted Remote Sensing Training 1.0-CARST 1.0. This is a software package consisted of three components: Windows based Advanced System for Environment data ANalyis with remote sensing - WinASEAN 5.0, interactive tutorial and electronic books on remote sensing and GIS: Remote Sensing Note published by the Japanese Association of Remote Sensing (JARS), 1999 and GIS Work Book Volume 1 (Fundamental Course) and Volume 2 (Technical Course), Copyright Prof. Shunji Murai, 1999. The CARST 1.0 is being used for remote sensing training in the GeoInfo Ltd. which is a private company established as joint venture with the Department of Environmental Information Study and Analysis, Institute of Geography, Vietnam. Currently there was a quite positive response from the remote sensing user community to training program of the GeoInfo. Applicants are mainly university graduate, master course students, researchers and technical staff of space agency, mapping and remote sensing application agencies. Lectures and training are conducted mainly in after-office hours or during weekend.

2. COMPUTER ASSISTED REMOTE SENSING TRAINING PACKAGE CARST 1.0

The Computer Assisted Remote Sensing Training package has been developed by integration of three components: WinASEAN 5.0, interactive tutorial and electronic textbooks: Remote sensing note and GIS Work books. The purpose of the development is to provide trainees a user-friendly, integrated working environment, which fulfils the needs of hands-on training as well as beforehand search for explanation of advanced topics in remote sensing and GIS theory. Visual interactive tutorial is also an excellent tool for helping trainees in mastering the software by self-learning and training.

2.1 Overview on WinASEAN 5.0

WinASEAN 5.0 is the latest development version of the software package WinASEAN – Windows based Advanced System for Environmental data ANalysis with remote sensing that has been long time used for hands-on training in the framework of the Earth Observation for Tropical Ecosystem Management Seminars which had been annually organized from 1992 to 2000 by NASDA and UN ESCAP (Nguyen Dinh Duong and S. Takeuchi, 1997). The WinASEAN 5.0 is released in two versions: educational WinASEAN Edu and professional WinASEAN Pro. The only difference between two packages is that educational version can process image with size less than 2000 pixels per line and 2000 lines per image. All analysis functions are identical for both versions except that image display modules of educational version has the capability to show an image with dimension the same as of the professional one. WinASEAN 5.0 can process one byte and two byte image data.

WinASEAN 5.0 is developed based on the WinASEAN 4.0 (Nguyen Dinh Duong, 2003) and is composed of main menu and processing modules as listed below:

a) **Preprocessing**
- Data Conversion: *to import image to WinASEAN. The basic formats as BSQ, BIL and BIP are supported. The DIMAP format of SPOT5 is also accepted.*
- CD-ROM Utilities: *for reading image data stored on CD media.*
- Image Window Cutting: *for cutting a window from an image.*
- Histogram Calculation
- Image Enhancement: *Establishment of enhancement look-up table based on methods: linear stretch, histogram equalization, Gaussian stretch, logarithm and square root enhancement.*
- Image Encoding: *To encode multispectral image to a form consisted of unique pixel vectors.*
- Vegetation Index Calculation: *Computation of Normalized Differential Vegetation Index.*
- Arithmetic Operation: *To carry out arithmetic operation among spectral channels of an image. The formula is input in Fortran 77 convention.*
- Modeller: *To allow inclusion of a simple Fortran 77 code for advanced analysis. This operation can be carried out among images of the same dimension.*
- Principal Component Analysis
- Optical Image Filtering: *Optical image filtering by special filters or general filter with arbitrary size.*
- SAR Image Filtering
- Hyperspectral Transformation for Colour composite : *To create colour composite of images with number of spectral channels higher then 3.*

b) **Image Display**
- False Colour Image Display: *Display of an image by different colour combination.*
- Pseudo Colour Image Display: *Display of single image channel by level slicing.*
- Classified Image Display
- Image Display and Print: *To print an image in required scale.*

c) **Multispectral Classification**
- Training Area Selection: *To define training sample for classification.*
- Training Area Redisplay: *Redisplay of selected training samples for checking purpose.*
- Training Data Statistics Calculation
- Training Address Modification: *To modify a training address file by deletion of a class or to merge two training address files together.*
- Maximum Likelihood Classification: *Multispectral classification by maximum likelihood method.*

d) **Post Classification**
- Classified Image Filtering: *To remove isolated pixels by majority filter.*
- Area Measurement: *To compute an area occupied by each class using spatial resolution information.*
- Class Code Change and Merge: *To merge classes together or to change name of a class.*

e) **Geometric Correction**
- Ground Control Point Selection: *To define ground control points by using maps or GPS measurement.*
- Image Control Point Selection: *To define image control points on master image.*
- Coefficient Computation and Resampling: *To compute geometric correction coefficients according to the selected GCP or ICP.*
- Image Mosaicking: *To create mosaic of georeferenced images.*
- Image Ortho-rectification by Regression: *Ortho rectification of image by using DEM and regression method.*

f) **Change Analysis**
- Plural Image Display: *Display of multi-temporal images in colour composite.*
- Generation of Change Matrix: *To establish change matrix of two classified images.*
- Visualization of the Change Matrix: *Visualization of the change matrix.*
- Masking by Two CLS Images: *To suppress some classes in one classified image by mask in the other one.*

g) **Bird's Eye View**
- DEM Data Conversion: *To import DEM to WinASEAN format.*
- Bird's Eye View Generation: *To develop BEV image by using DEM and ortho-rectified image.*
- Bird's Eye View Image Display
- BEV Image Sequence Generation: *To create a series of BEV in different azimuth and depression angles.*
- BEV Image Sequence Display

h) Image Overlay

To overlay two images for change analysis study.

i) Utilities
- File Information: *To retrieve basic information of an image.*
- Conversion of MIF to CLS: *To carry out vector to raster conversion. Supported vector format is MapInfo MIF. Raster format is WinASEAN classified image.*
- Geometric Correction of MIF and DXF files: *To carry out geometric correction of vector data in MIF and DXF formats.*
- Shading Optical Image: *To develop a shaded image of DEM according to time and Julian day of satellite observation to assist geometric correction of an image in case of unavailability of topographical maps or difficulty in GCP selection.*
- Shading SAR Image: *To simulate SAR image by using DEM and satellite orbit parameters for geometric correction of SAR image.*

j) Help:
On-line help integrated with interactive tutorial and electronics books on remote sensing and GIS.

Detail description of WinASEAN including information on algorithm can be found in WinASEAN help. WinASEAN user interface and processing flows were designed and developed primarily for training and education purposes. However, the system can be used for practical use due to well-developed algorithm, which allows high performance of data analysis.

2.2 Some Unique Functions of WinASEAN

WinASEAN covers basic digital image analysis functions. However, there are some unique functions that are not available even in commercial packages. In this paper, the author would like to highlight two functions: Hyperspectral transformation for colour composite: colour composite module for image with number of spectral channels larger than 3 and Modeller: real time modelling tool by programming in Fortran 77 language.

2.2.1 Hyperspectral Transformation for Colour Composite

The conventional methodology for colour composite generation of multispectral images is to assign three spectral channels to three principal colour red, green or blue respectively. In case the number of spectral channels of an image is greater then 3, only three-channel subset of the image can be visualized at one time. In order to display more information in the visualised image, principle component analysis technique could be applied to bring most image information into the first three components and using these components to generate colour composite. Disadvantages of this technique are that colour tone of the objects is not stable and there is still some image information in the higher components not showed in the final image. A special technique called as Hyperspectral Transformation for Colour Composite – HTCC has been developed by the author. This technique is based on transformation of multispectral image data from n spectral channels to three-component space using conic vector space (Nguyen Dinh Duong, 2000). The transformation is done by the following equation:

$$\begin{bmatrix} a_1 & . & . & . & a_n \\ b_1 & . & . & . & b_n \\ c_1 & . & . & . & c_n \end{bmatrix} \times \begin{pmatrix} p_1 \\ . \\ . \\ . \\ p_n \end{pmatrix} = \begin{pmatrix} p_1' & p_2' & p_3' \end{pmatrix}$$

Where p_i is original image digital count and p'_i is transformed value. The coefficients a_1, a_n, b_1, b_n, c_1, c_n can be computed using different transformation model. For the case of 4 channel image data, the transformation is done by the following equation:

$$\begin{bmatrix} -0.866025 & +0.000000 & +0.866025 & +0.000000 \\ +0.000000 & +0.866025 & +0.000000 & -0.866025 \\ +0.500000 & +0.500000 & +0.500000 & +0.500000 \end{bmatrix} \times \begin{pmatrix} p_1 \\ p_2 \\ p_3 \\ p_4 \end{pmatrix} = \begin{pmatrix} p_1' \\ p_2' \\ p_3' \end{pmatrix}$$

Because the transformed components are in achromatic space so it is necessary to convert them to IHS and RGB space for colour visualization. The conversion can be done by any of common IHS-RGB algorithms. The new colour composite provides more information than any of the conventional ones. The visualized image is an excellent tool for vegetation study and water and infrastructure mapping. Conversion of transformed components p'_i into I, H, S system is done by formulas:

$$I = \sqrt{p_1'^2 + p_2'^2 + p_3'^2} \qquad S = Arc\tan\left(\frac{\sqrt{p_1'^2 + p_2'^2}}{p_3'}\right)$$

$$H = Arc\tan\left|\frac{p'_2}{p'_1}\right|$$

Example of colour composite for the TM image data with 6 visible spectral channels is given on the figure 1. HTCC image is given on the figure 1b (right), while 1a (left) shows the standard false colour composite.

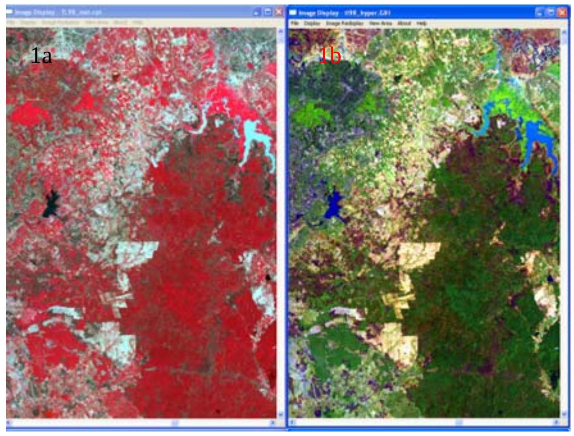

Figure 1. Standard false colour composite of Landsat TM data (left) and HTCC image (right)

Thanks to presence of short wave infrared information the hyperspectral transformation colour composite become clearer with higher contrast, better separation between bare land and turbid water body.

2.2.2 Modeller and on-line Programming

Modeller was developed in integration of Open Watcom Fortran 77 compiler 1.4 with WinASEAN. The Modeller module is composed of two parts: executable file developed by the Microsoft Visual C++ 6.0 and Fortran PoweStation 4.0 and Dynamic link library DLL file created during execution time. The DLL part is compiled and linked by the Open Watcom Fortran 1.4. This mechanism allows user to integrate a Fortran program input by the user to create a new special function for image analysis.

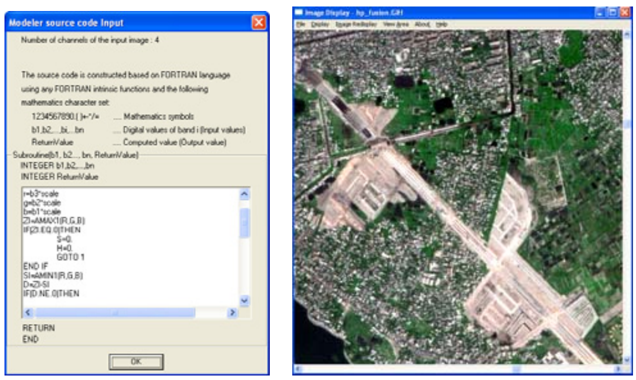

Figure 2. Input window of the Modeller and SPOT5 pan-sharpened image by the Modeller

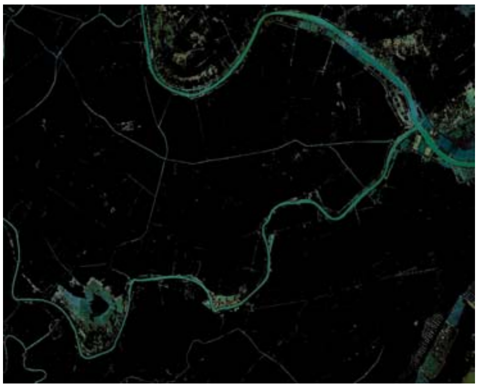

Figure 3. Extraction of hydrographical features by Modeller

Modeller can be used as key module for GIS modelling and analysis. Many advanced analysis as data fusion, reclassification using DEM and GIS data could be realized with Modeller. On the Figure 2 is an example of Modeller Fortran code input window and SPOT5 pan-sharpened image by Modeller. The Figure 3 shows extraction of hydrographical features by spectral pattern analysis algorithm programmed in Modeller.

1.1 Help and Interactive Tutorial

Training under guideline of instructors is common in practice. However, self-training is quite important for better understanding and building sophisticated skill in data analysis. The self-training now is better organized with help system of WinASEAN 5.0. The WinASEAN 5.0 Help system is composed of three parts: the Help and user manual in html format, interactive tutorial developed by using the InstantDemo software with video file in the ShockWave format and the electronic books Remote Sensing Note and GIS Work Books.

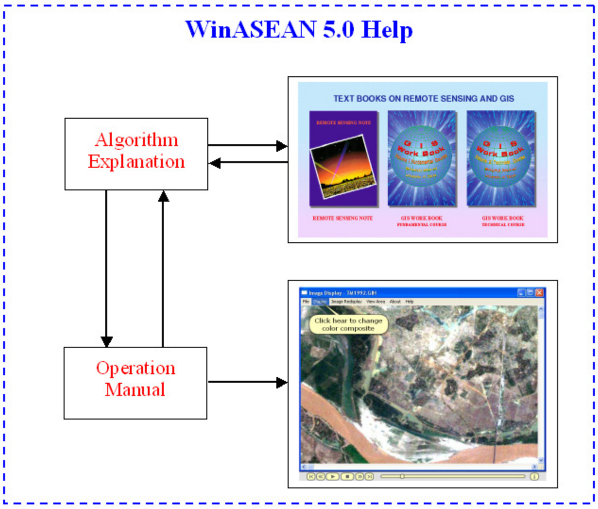

Figure 4. Structure of WinASEAN 5.0 Help system

Help for each function in WinASEAN is organized in two parts: algorithm explanation and operation manual. The concept of the help system is explained on the Figure 4. Algorithm explanation window is linked to textbooks on remote sensing and GIS for deeper algorithm description. For better navigation in help system, remote sensing and GIS textbooks are opened in separate windows. The operation manual is integrated with interactive tutorial that is available in ShockWave video format for each menu. The Windows system will automatically notify user for updating Flash tool if it is not yet installed.

Figure 5. Interactive tutorial in ShockWave format

In the WinASEAN 4.0, steps of each operation were recorded by SnagIt software to create video demonstration file, which can be playback by Windows Media player to show how to operate each function. Disadvantages of this method is the video files are too large in size and also there was no possibility for interaction between trainee and the software. The InstantDemo software of the NetPlay has been used in WinASEAN 5.0 to overcome these obstacles. The InstantDemo provide high quality video file in ShockWave format, which is quite small in size. There is plenty of video editing function including making annotation in form of Bubble talk, duplicating frames and inserting pause points (hot spots).

2. REMOTE SENSING TRAINING AT GEOINFO LTD. IN VIETNAM

GeoInfo Ltd. is a private company operating in the field of geoinformatics. GeoInfo has been established as join venture in that the Department of Environmental Information Study and Analysis, Institute of Geography is the main partner in remote sensing and GIS. Training in remote sensing and GIS is one of common activities of the company. Remote sensing training is organized in three courses: Introductory, Basic and Advanced courses. Participants are mainly graduate students, master and doctoral course students, researchers and staff of space agency and remote sensing application institutions in Vietnam. Lectures are organized mostly outside working hours in evening time or during weekends. The contents of the courses focus on data analysis skill development. However, some explanations on remote sensing theory are still available in the courses but kept on minimal level. WinASEAN Edu version and dataset is provided to each trainee to offer self-training in their own time. To ensure high quality for the training, number of participants is limited to 12 and one computer is shared by two trainees.

2.1 The Introductory Course

The Introductory course is organized in four lectures. Each lecture is 150 minutes long. In this course the trainees are explained about fundamentals of remote sensing, the principle of visual interpretation and how to read false colour composite image. Contents of the course is given below:

Lecture 1	Fundamentals of remote sensing
Lecture 2	Introduction into digital image analysis

Lecture 3 Introduction into WinASEAN, colour composite of multispectral image, spectral characteristics of land cover.
Lecture 4 Steps in visual image interpretation, training in visual image interpretation.

2.2 The Basic Course

In this course trainees have the opportunities to practise with basic digital image analysis operation starting from image data import to multispectral classification. The course is broken down into the following 10 lectures.

Lecture 1 Common remote sensing data format, image display, histogram computation, optical image enhancement and filtering.
Lecture 2 Geometric correction: principles.
Lecture 3 Geometric correction: image to maps registration.
Lecture 4 Multispectral image classification by maximum likelihood method.
Lecture 5, 6 Multispectral classification: practice.
Lecture 7 Arithmetic operation, vegetation index, level slicing. Post classification operations.
Lecture 8 Principle component analysis. Hyperspectral transformation for colour composite.
Lecture 9 Change analysis: visual detection and overlay operation. Change detection map.
Lecture 10 Change analysis: continue. Introduction to content in the Advanced course.

2.3 The Advanced Course

The advanced course aims to provide trainees advanced analysis and integrated practical application. Applicants for this course are selected among professional staff of remote sensing application agencies, researchers and doctoral course students. Requirement for admission is that applicant should have participated the Basic course and have some experiences in remote sensing application. The course is organized in 20 lectures as follow:

Lecture 1 Introduction to DEM and 3D image display.
Lecture 2 Introduction to Fortran programming.
Lecture 3 Modeller – Advanced analysis module.
Lecture 4 Combination of GIS information to support multispectral classification, vector to raster conversion.
Lecture 5 Advanced multispectral classification.
Lecture 6 Classification using colour matching.
Lecture 7 Data fusion.
Lecture 8 Microwave remote sensing.
Lecture 9 Advanced geometric correction. Image to image registration, multi-sensor image overlay.
Lecture 10 Combination of optical and microwave data for land cover study.
Lecture 11,12 Land cover mapping using optical and microwave data
Lecture 13 Spectral pattern analysis: vegetation cover extraction.
Lecture 14 Spectral pattern analysis: water body and hydro graphic features extraction.
Lecture 15 Spectral pattern analysis: barren land extraction.
Lecture 16 Image mosaicking, virtual reality visualization.
Lecture 17 Introduction to other image analysis software as: MultiSpec, PCI, ENVI and ERDAS Imagine.
Lecture 18 Practice with PCI software.
Lecture 19 Practice with ENVI software.
Lecture 20 Practice with ERDAS Imagine software.

Participants from the following organizations have attended training:

- Ministry of Natural Resource and Environment, MONRE.
- Institute for Land administration research, MONRE.
- Ministry of Agriculture and Rural Development.
- Mapping agency, Ministry of Defence.
- Colleague of Military Technology.
- Hanoi University of Mining and Geology.
- University of Forestry.
- University of Agriculture.
- Institute of Mechanics, VAST.
- Vietnam-Russian Tropical Technology Center.

Figure 6. Remote sensing training at the GeoInfo Ltd.

3. FUTURE DEVELOPMENT

There is a plan to develop CARST 2.0, wich will have the same concept as of the CARST 1.0 except that WinASEAN will be of version 6.0. The upgrading of WinASEAN bases on adding the following new functions:

- Time series remote sensing data analysis functions including: ground truth database management, classification of land cover by time series satellite data by spectral pattern analysis method.
- Export of WinASEAN image data to generic binary format.

4. CONCLUSIONS

The CARST 1.0 is an initiative of the author to develop a comprehensive environment and practical tools for remote sensing training and education. The concept of integration of WinASEAN 5.0, interactive tutorial and textbooks on remote sensing and GIS seems very useful for both beginners and advanced users. The curriculum of training presented in this paper is just the first trial and it will be improved gradually to satisfy the needs from user community. While CARST 1.0 with WinASEAN Edu is free, the version with WinASEAN Pro is provided with low charge in an effort to cover expenditure on software development, maintenance and Web service. After one year of conducting training at GeoInfo Ltd. some lessons could be drawn as follow:

- Capacity building is key issue for developing countries including Vietnam.
- Academic education on remote sensing in Vietnam lacks sophisticated hands-on training and practice.
- Remote sensing training curriculum in GeoInfo targets to fill gaps between theory and practice.
- The training at GeoInfo are useful complement to various university remote sensing program including distance e-learning courses.

ACKNOWLEDGEMENT

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Developed of A Computer Aided Instruction (CAI) package in remote sensing educational

Sultan AlSultan [1], H. S. Lim [2], M. Z. MatJafri[2], K. Abdullah[2]

[1]Qassim University, College of Computer Sciences & Information Technology, Saudi Arabia
Tel: +966600050 ext. 4098 Mobile: + 966 50 489 0977
http://www.commission7.isprs.org/wg7/
E-mail: computer_305@yahoo.com

[2]School of Physics, Universiti Sains Malaysia, Minden 11800 Penang, Malaysia.
Tel: +604-6533888, Fax: +604-6579150
E-mail: hslim111@yahoo.com.sg,
mjafri@usm.my, khirudd@usm.my

Commission VI

KEY WORDS: CAI, remote sensing eduction, Macromedia Flash and SWiSH Max.

Abstract

Computer Aided Instruction (CAI) is an application of computer in implementating instructions. It is an integration of software and hardware. A variety of software has been used to build up CAI packages such as Macromedia Director MX, Macromedia Flash and SWiSH Max. In this study, Macromedia Flash was used to make this CAI package. The aim of this remote sensing education project is to create a CAI package entitled remote sensing processing and to develope of international cooperation and capacity building on remote sensing education collaboration between Universiti Sains Malaysia (USM) in Malaysia and AlQassim University in Saudi Arabia. In this study, all the information is presented by implementating the CAI package. The knowledge of the digital image processing can easily reacquired by using CAI package. The main objective of study is to introduce a fundamental of this digital image and a few common methods to process a digital image which have a very wide range of application in our modern world. This CAI package is very useful to those who are interested to continue their studies or research in the fields of remote sensing. The package is also particularly designed to ensure all the users to understand the information easily compared to other learning materials in markets. The intergration of latest educational technology such as personal digital assistants (PDA) provides an opportunity to promote student centered learning was discuss in this study. For the conclusion, this CAI package can play an important role as an alternative material to all users in the near future.

1. Introduction

Acronym for computer-based training (CBT), a type of education in which the student learns by executing special training programs on a computer. CBT is especially effective for training people to use computer applications because the CBT program can be integrated with the applications so that students can practice using the application as they learn.

Historically, CBTs growth has been hampered by the enormous resources required: human resources to create a CBT program and hardware resources needed to run it. However, the increase in PC computing power, and especially the growing prevalence of computers equipped with CD-ROMs, is making CBT a more viable option for corporations and individuals alike. Many PC applications now come with some modest form of CBT, often called a tutorial (Webopedia). "Computer-assisted instruction" (CAI) refers to instruction or remediation presented on a computer. Many educational computer programs are available online and from computer stores and textbook companies. They enhance teacher instruction in several ways.

Computer programs are interactive and can illustrate a concept through attractive animation, sound, and demonstration. They allow students to progress at their own pace and work individually or problem solve in a group. Computers provide immediate feedback, letting students know whether their answer is correct. If the answer is not correct, the program shows students how to correctly answer the question. Computers offer a different type of activity and a change of pace from teacher-led or group instruction.

Computer-assisted instruction improves instruction for students with disabilities because students receive immediate feedback and do not continue to practice the wrong skills. Many computer programs can move through instruction at the student's pace and keep track of the student's errors and progress. Computers capture the students' attention because the programs are interactive and engage the students' spirit of competitiveness to increase their scores. Also, computer-assisted instruction moves at the students' pace and usually does not move ahead until they have mastered the skill. Programs provide differentiated lessons to challenge students who are at risk, average, or gifted (The Access Center).

CAI package was an interaction media play an important role in computer context act as a teacher. CAI package can provide a more stability presentation. Audience can obtain the message and information in dynamic form through CAI package. CAI package will be present in various computer interfaces either in two or three dimension. CAI package also present in good visual looking with nice graphic and animation. CAI package also can included hundred of note in a small right package. The main objective of this study is to introduce a fundamental of this digital image and a few common methods to process a digital image which have a very wide range of application in our modern world.

Personal Digital Assistants (PDAs) such as Palm Pilots and Pocket PCs are handheld computers that serve as an organizer of personal and professional information. PDAs are now being broadly accepted in a variety of educational settings. PDAs come with software that allows educators and students to perform a range of tasks, including synchronizing data with desktop or laptop computers, accessing e-mail, managing appointments and course assignments. PDAs have been used to augment and supplant computers in classrooms because they are readily available, inexpensive, and easy for educators to use (Ray, 2002). PDAs are effective classroom organizational tools for educators. Student can use the PDA as an education tool for learning with this developed CAI package.

2. Software and Hardware

Our packages are developed on the Microsoft Window platform. For this study, a personal computer with Intel Pentium 4 Processor with Hyper-Threading technology - 3.0GHz, Microsoft Window XP in the Engineering Laboratory, School of Physics, Universiti Sains Malaysia, Malaysia was used. The software we used for generating CAI package was Macromedia Flash and supported by some other computer software like Adobe Photoshop and Sound Forge. Adobe Photo was used for graphic and picture editing and Sound Forge was used for sound editing.

3. What is remote sensing

Remote sensing is a technique for collecting information about the earth without touching the surface using sensors placed on a platform at a distance from it. The major applications of remote sensing include environmental pollution, urban planning, and earth management. We have to understanding the basic concept of electromagnetic waves well enough to apply remote sensing techniques in our studies. We classify electromagnetic energy by its wavelength. This electromagnetic radiation give an energy source to illuminate the target except the sensed energy is being emitted by the target.

There are two types of remote sensors: active and passive. Passive remote sensors detect reflected energy from the sun back to the sensor; they do not emit energy itself. But active sensors can emit energy or provide its own source of energy and detect the reflected energy back from the target.

There are two types of remotely sensed data: airborne and space-borne. Airborne images are captured using sensors placed on aircraft platform while space-borne images are captured using sensors placed on a satellite platform. Remotely sensed data began with the traditional black and white aerial photography and followed by colour photography. However hyperspectral airborne or space-borne images are readily available nowadays. We use both the multispectral space-borne digital images in our studies. The major advantage of using remote sensing data is that we can produce the final output as maps of the Earth's surface phenomena being studied.

4. Development of International Cooperation and Capacity Building between USM and QU in Remote Sensing Education

Focus had been mad of the development of international cooperation and capacity building on five remote sensing education applications for our research joint activities, including technology transfer and training between Univerisiti Sains Malaysia (USM) in Malaysia and AlQassim University in Saudi Arabia.

1. Land surface temperature
2. Land cover / Land use mapping
3. Changes detection
4. Air quality mapping
5. Land surface temperature and urban heat island.

Research collaboration between USM and AlQassim University has established and many research articles have been published either in journal or conference proceedings such as:

1. Estimation of seasonal agricultural vegetation coverage for two seasons over AlQassim, Saudi Arabia
2. Environmental impact assessment and evaluation of the land cover features from Landsat TM and SPOT over Makkah Almukaramah in Hajj Season
3. Land surface temperature estimation over Palestine and Mediterranean.
4. Urban heat island evaluation over Makkah and Madinah by remote sensing.
5. Area estimation from Landsat TM data over Makkah.

5. Methodology

Firstly, the computer must be installed with the Macromedia Flash MX software. To begin, open Macromedia Flash MX. The screen shown below here will be presented (Fig. 1).

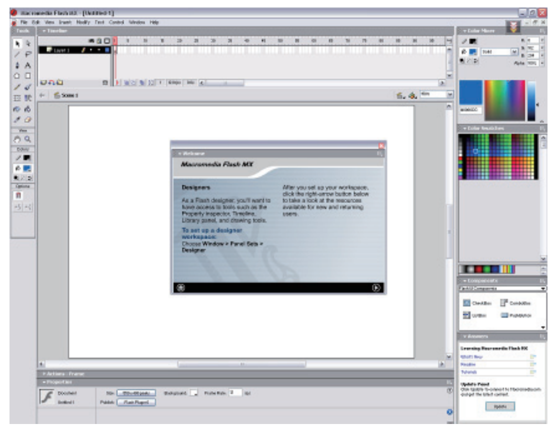


Fig. 1. Main screen of Macromedia Flash MX.

To create a new document, click Flash Document. The screen shown here appears (Fig. 2):

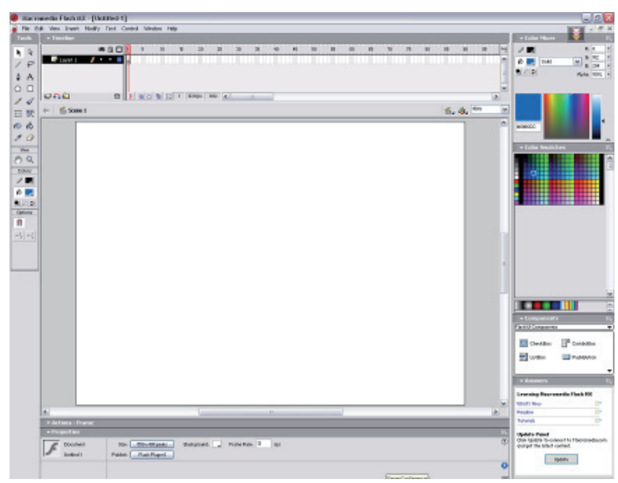


Fig. 2 New document in the Macromedia Flash MX.

The upper left corner of the screen displays the Tools palette, which contains tools to create or modify graphics and text. We can select a tool by clicking on it. Tool modifiers for the selected tool display below the Tools palette. We use modifiers to set tool options. The Timeline appears in the upper portion of the screen. We use the Timeline to lay out the sequence of your movie. The Stage displays in the center of the screen. We create our movie on the Stage. We set these properties in the Movie Properties dialog box. To set the properties for the movie:

1. Choose *Modify* > *Document* from the menu. The Document Properties dialog box opens (Fig. 3).

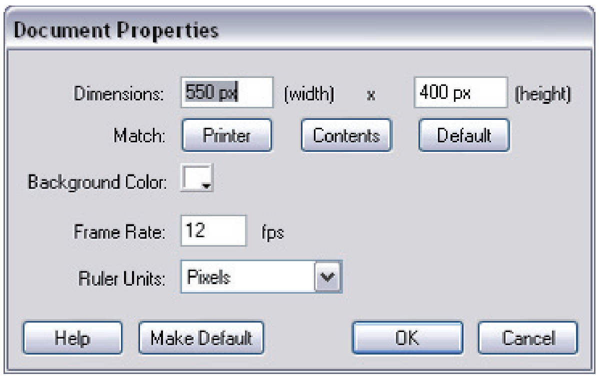


Fig. 3. The document properties dialog box.

In the Macromedia Flash MX, the entire cast members that we want to use have to be imported into Library. The timeline or the scope for the Macromedia Flash MX was formed from the layer as a location for the sprite cast member. The length of the CAI package can change with the frame on the layer in the timeline function. If your timeline window is not open, press (Ctrl+Alt+T). Select the first frame. Import the picture or change a subject onto stage, upon which you would want to implement motion Tween. Now select your object on the stage and press F8 to convert this image to a Symbol. Convert to Symbol window will pop-up. Name your Symbol what ever you like. Select Graphic behavior and press OK. Right now your Symbol is in frame1 of Layer1 (Fig. 4). Select frame 20 and press F8 to insert a new keyframe.

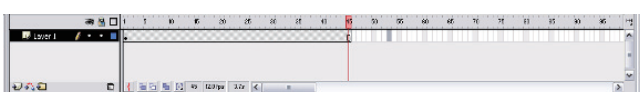


Fig. 4.Layer of Macromedia Flash MX.

Besides that, we can change the effect for the picture. Such as we can click the button of modify – Transform – Scale – Rotate to rotate our picture. In this case, we just need to identify the scale and the rotate degree.

We also can insert an image, convert it to a button, and add a URL to it so it becomes a link. First, we need to import an image that will become a button. We also can create our own symbol as our button using Macromedia Flash MX. The image will be saved in the Library. Second select the image with the Arrow tool and convert the image to a symbol. Next we need to right click on the image and choose Actions from the pop-up menu. Then enter a full URL in the URL field (like http://www.CAIPackage.com) and choose the target in the Window field that want to link.

We also can insert the sound into our CAI package. We just need to import a sound file into our CAI package. Finally, we just click on Controls and play or just press Ctrl+Enter to view our animation. We also can embed this CAI package in HTML pages by using Macromedia Flash MX.

6. CAI Package

Macromedia Flash was used in this study to generate a media interaction in animation format. Macromedia Flash was a powerful tool to produce animation. All the information presented by this CAI package was the basic theoretical of remote sensing and some information on the research articles carried out between Universiti Sains Malaysia (USM) and AlQassim University.

Firstly, all the information regarding the basic theoretical of remote sensing and the research collaboration between Universiti Sains Malaysia (USM) and AlQassim University was gathering for this CAI package. After that, Adobe Photoshop was used for picture and graphic editing. Adobe Photoshop software is the professional image-editing standard and leader of the Photoshop digital imaging line. Groundbreaking creative tools help achieve extraordinary results.

Macromedia Flash was use to create all graphics presentation in animation format. Macromedia Flash is the industry's most advanced authoring environment for creating interactive websites, digital experiences and mobile content. Finally, sound edition was performed and included into the CAI package.

Sound Forge software was used in this purpose. Sound Forge software is the professional's choice for audio editing, recording, effects processing, streaming content creation, and more. Now, Sony Media Software introduces Sound Forge Audio Studio - an easy-to-use home version of professional program. Fig. 5 shows some frame of research between USM and AlQassim University in this CAI package. Fig. 6 (a and b) shows the location of Malaysia and Saudi Arabia. Fig. 7 shows the research collaboration between Universiti Sains Malaysia (USM) and AlQassim University. Fig. 8 shows the results produced by the research collaboration between Universiti Sains Malaysia (USM) and AlQassim University of land cover change. Fig. 9 shows the raw satellite images of Mina, Arafah and AlHaram. Fig. 10 shows the heritage of the Desert.

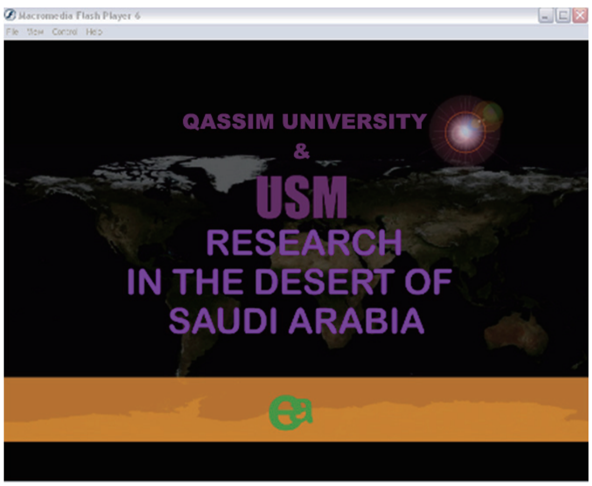
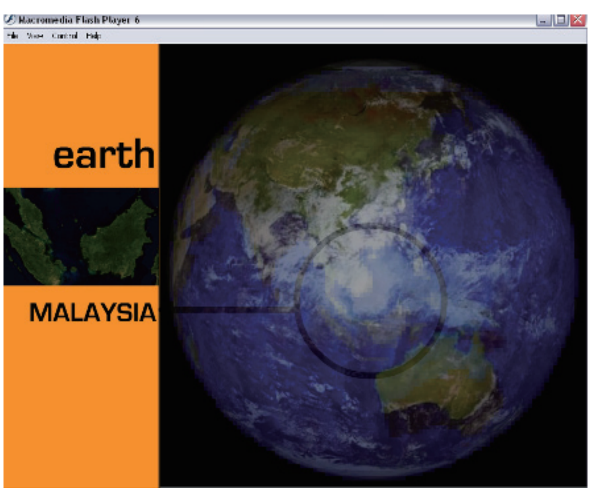
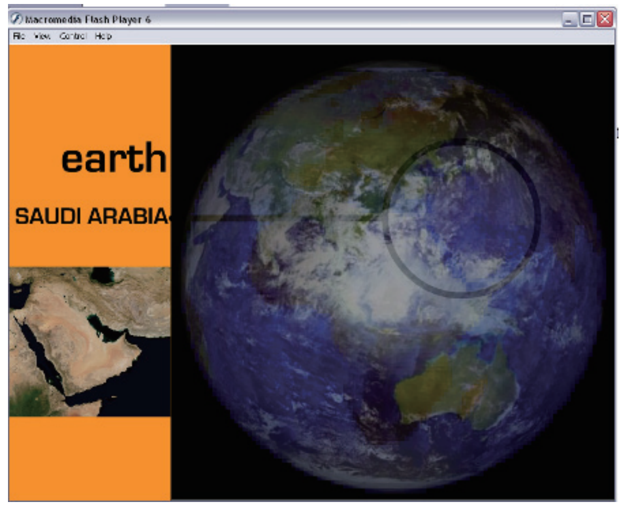


Fig. 5. Research between USM and AlQassim University in this CAI package.



(a)



(b)

Fig. 6. The location of Malaysia (a) and Saudi Arabia (b).

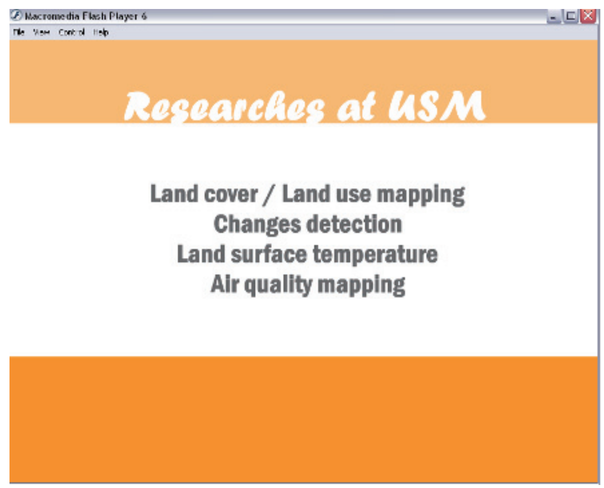


Fig. 7. The research collaboration between Universiti Sains Malaysia (USM) and AlQassim University.

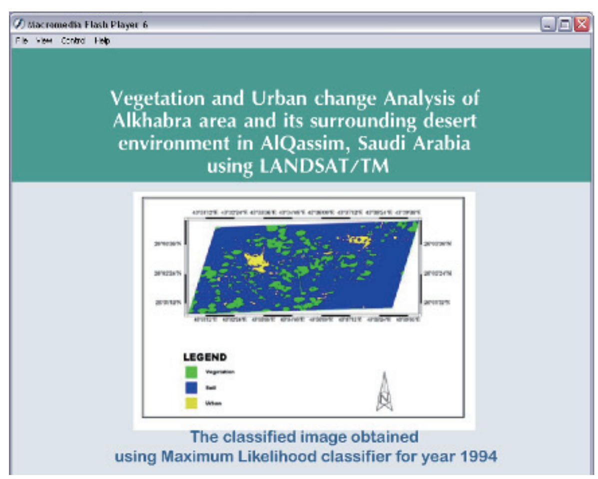


Fig. 8. The land cover change produced by the research collaboration between Universiti Sains Malaysia (USM) and AlQassim University

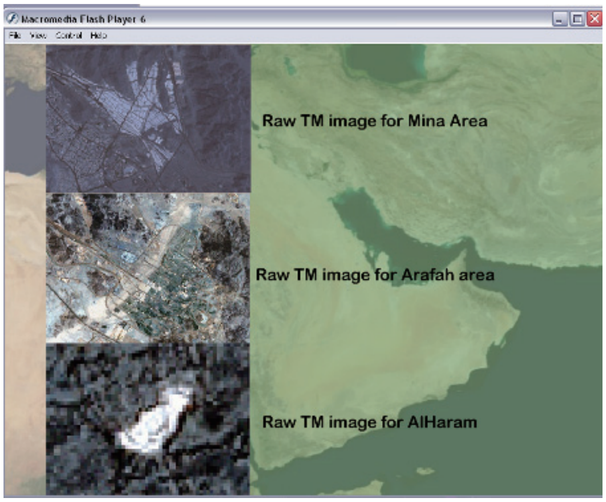


Fig. 9. shows the raw satellite images of Mina, Arafah and AlHaram.

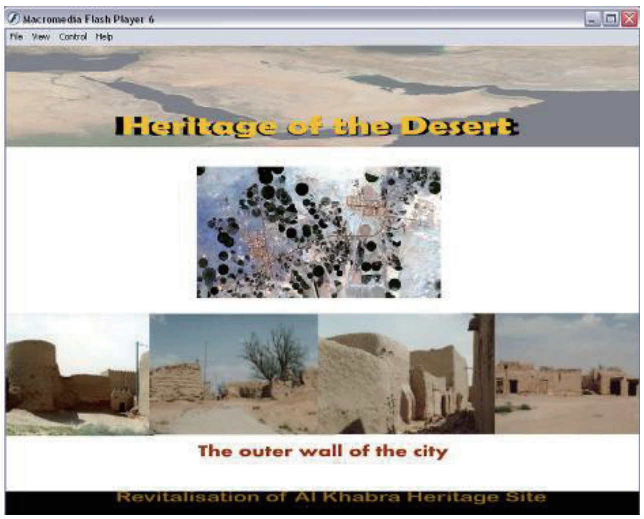


Fig. 10. The heritage of the Desert.

With this CAI package and the latest technology nowadays, such as PDA, student can access this CAI package and learning through PDA anywhere. PDA can quickly take over the classroom as a portable learning tool, allowing anywhere, anytime access to speeches, audiobooks, and lectures. We can build a paperless environmental using the latest technology like PDA. At the same time, we also can use PDA for daily assignments such as reading, word processing, wireless internet access and laboratory analysis. Besides that, publishers are beginning to offer electronic versions of their textbooks. So, we also can use PDA to access the e-books. Advanced technology should be proposed and use in the education activity. We also can edit and update our information in a short time.

This developed CAI package also can upload into web, so public people that who interested can access through the web. With the latest technology, we can develop and make technology transfer in remote sensing for environmental management or application. We also can provide wider education in photogrammetry and remote sensing with the latest technology such as wireless internet access. We also can make useful of this CAI package to include more research activities proposals that we can joint research including technology transfer and training with international institution. So, we can build a collaboration networking connections with international institution in the field of photogrammetry and remote sensing.

7. Conclusion

This CAI package was successfully developed to provide useful information on basic theoretical of remote sensing and the research articles between Universiti Sains Malaysia (USM) and AlQassim University in animation format. This CAI package has the advantage compared to traditional hardcopy output. This CAI package provides more flexible, easily and interesting way to get information. CAI package was playing an important role as an alternative material to all users in the near future.

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LOW-COST VIRTUAL REALITY VIEWER AS AN INTRODUCTORY TOOL FOR LEARNING REMOTE SENSING IMAGE PROCESSING

Shoji Takeuchi[a], Yoshinari Oguro[a], and Nguyen Dinh Duong[b]

[a] Dept. of Environmental Information Studies, Hiroshima Institute of Technology, 2-1-1, Miyake, Saeki-ku, Hiroshima 731-5193, Japan - sh-take@cc.it-hiroshima.ac.jp, yoguro@cc.it-hiroshima.ac.jp
[b] Dept. of Environmental Information Study and Analysis, Institute of Geography, Vietnamese Academy of Science and Technology, 18 Hoang Quoc Viet Rd., Cau Giay, Hanoi, Vietnam - duong.nd@hn.vnn.vn

Commission VI

KEY WORDS: Bird's Eye View Image, DEM, Geometric Correction, Dynamic Display, Self-Practice

ABSTRACT:

The authors developed a set of image processing tool named as Low-cost Virtual Reality Viewer (LVR-View) as an introductory tool for learning remote sensing image processing by extending WinASEAN (Advanced System for Environmental ANalysis for Windows) software package. WinASEAN was developed to promote remote sensing applications by offering a public-domain image analysis software. The LVR-View software is aimed to realize movie-like dynamic display of bird's eye view (BEV) image sequences generated by an extended WinASEAN BEV generator. The software is available in standard PCs for student use, and therefore, students can execute and experience LVR-View by using their own PCs. It is expected that these experiences lead them to the interest on remote sensing and the understanding of the roles of some fundamental image processing techniques and the effectiveness of the combined use of satellite images and geographical data.

1. INTRODUCTION

Nowadays, a personal computer is one of the most fundamental tools for the learning in the university. In the Department of Environmental Information Studies of Hiroshima Institute of Technology (HIT), all students have their own note PCs when they enter the university and they can continue to use the PCs during they learn the curriculum. There are two lectures and one practice on remote sensing technology (Earth Observation System, Earth Observation Data Analysis, and Practice on Earth Observation Data Analysis) and two seminars (Freshman and Specialized Seminar) in the curriculum. Considering such opportunities for PC utilization, some additional and attractive image processing tools usable with their own PCs might be a great help to increase their motivations for learning remote sensing image processing technology through the curriculum.

For the purpose mentioned above, the authors developed a set of image processing tools for Low-cost Virtual Reality Viewer (LVR-View) by extending bird's eye view (BEV) image generator of WinASEAN (Advanced System for Environmental ANalysis for Windows). WinASEAN was developed to promote remote sensing applications by offering public-domain image analysis software (Nguyen and Takeuchi, 1997). The LVR-View software is aimed to realize movie-like dynamic display of BEV image sequences generated by an extended WinASEAN BEV generator. The software is available in standard PCs for student use with Windows 98, 2000 or XP, and therefore, it is expected to use for three dimensional scene analyses as an introductory tool for increasing the interest to remote sensing and for understanding the effect by the combination of satellite images and geographical data.

2. FUNCTIONS OF LVR-VIEW

2.1 Outline

The main functions of LVR-View are as follows;

(1) To generate bird's eye view (BEV) image sequences by combining satellite images with digital elevation model (DEM). The image sequences consist of jpeg image files with sequence numbers indicating spatial relationships about view positions among all of the generated BEV images.

(2) To display the BEV image sequences dynamically with the movement to different view positions as well as zooming, shrinking and scrolling functions.

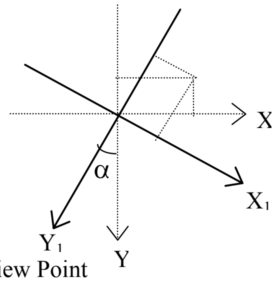
In addition, it is necessary to overlay satellite images onto DEM data before generating BEV image sequences. We prepared an additional function for generating reference images for geometric correction of satellite images, that is, for generating *shaded images* from the DEM in the test site. After generating the shaded images just when the target satellite images are acquired, students can perform geometric correction of target satellite images using geometric correction menu of WinASEAN without referring any topographical maps.

2.2 BEV Image Generation

Bird' eye view (BEV) images are generated by a satellite image like Landsat/TM or ETM+ combined with a digital elevation model (DEM), both of which should be geometrically overlaid each other. The principle of BEV image generation is shown in Figure 1.

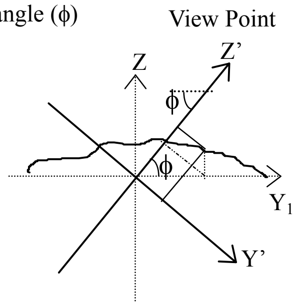
(1) Transformation by azimuth angle (α)

$$X_1 = X\cos\alpha + Y\sin\alpha$$
$$Y_1 = -X\sin\alpha + Y\cos\alpha$$



(2) Transformation by depression angle (ϕ)

$$X' = X_1 = X\cos\alpha + Y\sin\alpha$$
$$Y' = Y_1\sin\phi - Z\cos\phi = (-X\sin\alpha + Y\cos\alpha)\sin\phi - Z\cos\phi$$
$$Z' = Y_1\cos\phi + Z\sin\phi = (-X\sin\alpha + Y\cos\alpha)\cos\phi + Z\sin\phi$$



(3) Transformation from parallel to central projection

$$(Y'' - Y') : Z' = Y'' : d$$
$$\therefore\ Y'' = Y'd / (d - Z')$$
$$(X'' - X') : Z' = X'' : d$$
$$\therefore\ X'' = X'd / (d - Z')$$

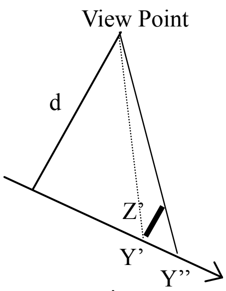


Figure 1. Principle of BEV image generation

In Figure 1, three parameters, azimuth angle (α), depression angle (ϕ), and distance (d), are required to assign to generate a BEV image. In WinASEAN BEV generator, students can assign any values for these three parameters, and after that they can check the result of BEV image generation quickly in the same menu. Figure 2 shows an example of BEV images of Hiroshima-City generated from Landsat-7/ETM+ image and 50 meters mesh DEM issued by Geographical Survey Institute of Japan (GSI).

2.3 BEV Image Viewer

Although students can view the BEV images quickly after assigning necessary parameters, it still takes several seconds at least for generating one BEV image with the PCs for student use, and this means that at the moment true virtual reality cannot be realized with their own PCs. Therefore, a special image viewer was developed for dynamic display of BEV images which are previously generated by BEV generator of WinASEAN.

First the BEV generator of WinASEAN was extended to generate a set of BEV images (BEV image sequences) which consist of jpeg image files with the numbered file names corresponding to the values for azimuth and depression angles. Actually the numbered file names consist of five-digit numbers, first two-digit represents depression angle values and next three-digit represents azimuth angle values. The ranges and intervals for azimuth and depression angles are specified when BEV image sequences are generated.

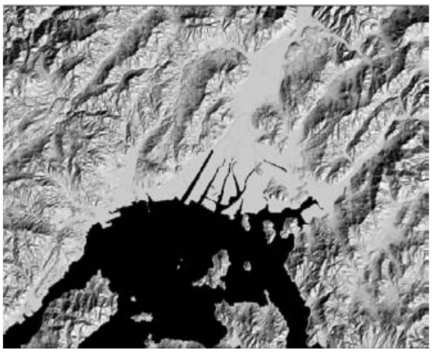
Figure 2. An example of BEV images of Hiroshima City. In this BEV image, ground height values are enhanced two times.

Then a special BEV image viewer was developed to display the BEV image sequences according to the number sequences. The number sequences are controlled by keyboard (←↑→↓) or mouse movement. Therefore, students can experience movie-like dynamic display of BEV images with the operation of keyboard or mouse. Of course, a large number of BEV images are required for smooth movement in the BEV image viewer, that is, the intervals for azimuth and depression angles should be small (a few degrees) to generate a large number of images, usually more than one thousand images. Some optional functions for zooming, shrinking, and scrolling are also available in the BEV image viewer.

2.4 Geometric Correction Using Shaded Image

The pre-processing of satellite images, namely the geometric correction of satellite images, is required to realize BEV image generation. This process is actually the most difficulty for the beginners of remote sensing image processing. In the regular practice on earth observation data analysis, the geometric correction has been conducted with the digital map issued by GSI. However, one digital map consists of 1 to 25,000 scale topographical map, and much higher resolution (al least two or three meters) than that for satellite images is required to select GCPs from the digital map and thus the data volume of the digital map becomes very large. For example, if we want to generate BEV images of Hiroshima City shown in Figure 2, we need to select GCPs from the map image with the volume more than 400 MB. This means actual difficulty to perfom efficient geometric correction with the PCs for student use.

In order to realize more efficient processing for geometric correction, we chose the alternative approach with *shaded images* which are generated from DEM and reflect the shaded conditions just for the time of satellite observation (Takeuchi and Oguro, 2002). Figure 3 shows the shaded image for Landsat-7/ETM+ image acquired on April 10, 2003, and the geomerically corrected ETM+ image by using the shaded image as a reference. As the size of a shaded image is equal to that of the original DEM image, the geometric correction process becomes a simple process, that is, overlaying of the satellite image onto the shaded image by extracting appropriate image to image tie point pairs.



Shaded image for ETM+ image

Geometrically corrected ETM+ image

Figure 3. Shaded image and geometrically corrected image for Landsat-7/ETM+ data acquired on April 10,2003.

3. SELF-PRACTICE ON LVR-VIEW

3.1 Time for Self-Practice on LVR-View

In the Department of Environmental Information Studies of HIT, the practice on earth observation data analysis is held in the former semester of third-year. This practice consists of three kinds of fundamental subjects, geometric correction of satellite images, multi-spectral image analysis by vegetation index and maximum likelihood classification, and surface temperature extraction from a thermal-band image.

At the moment, the practice on LVR-View is held in the later semester after above regular practice for the students belonging to the author's seminar, because at least the basic concept for geometric correction is necessary for the self-practice on LVR-View. However in near future, LVR-View might be possible to be included as one of the subjects of the regular practice. In addition, in the freshman seminar, which is held in the former semester of first-year, a brief demonstration of LVR-View, that is, the experience of LVR-View by pre-generated BEV image sequences with their own PCs, is presented to students.

3.2 Method for Self-Practice on LVR-View

Figure 4 shows the data processing flow for the self-practice on LVR-View by students with their own PCs. Students should complete the practice by themselves, although some auxiliary information, data specifications of satellite images and DEM, observation date of the satellite image, and the principle for the generation of shaded images etc., is presented by text or Word documents.

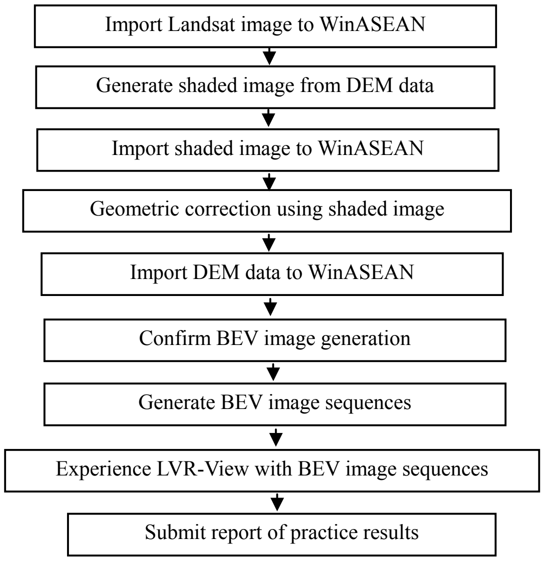


Figure 4. Data processing flow for self-practice on LVR-View.

Figure 5. A scene of self-practice on LVR-View with their own PCs in a seminar room.

As it takes rather long time (several hours) for generating BEV image sequences, it is difficult to execute every practice in the regular scheduled period at the moment and therefore they need to complete the practice as their home works. However, in near future, it will be possible to complete total practice in a scheduled period according to the grade-up of computation power of PCs. Figure 5 shows a scene for self-practice by students with their own PCs. In addition, students should use the special software for generating shaded images at the moment. This software might be included as one of the menus of WinASEAN to execute more efficient geometric correction in near future.

3.3 Effect of Practice on LVR-View

The geometric correction is one of the most fundamental image processing techniques necessary for various practical applications of satellite images. However, generally this procedure needs patience especially for the beginners. LVR-View possibly offers the importance and effect of the geometric correction due to its attractive result. In addition, LVR-View suggests the effect of the combination of satellite images and auxiliary GIS data. The understanding for the importance and the effect of the geometric correction and the combined use of satellite images with GIS data might be a great help to lead students to the research on remote sensing image analysis in their graduation theses.

4. LVR-VIEW AS A TOOL FOR RESEARCH

Originally LVR-View was developed as an educational tool for the learning of remote sensing image processing and analysis. However, this system might be possible to use as a tool for the research too. Figure 6 shows the flow chart of a research for the analysis on the topographical conditions of urbanized areas by the combined use of multi-temporal satellite images and DEM (Takeuchi and Oguro, 2003). Figure 7 shows one of the results by this study in Hiroshima and Sendai City. The figures in Figure 7 indicate the occupation rates of slope-classes in newly urbanized areas in both cities. The slope-classes are obtained from the slope angles computed from DEM by dividing them in 5 degrees interval.

The result in Figure 7 means that the slope conditions for newly urbanized areas are much more severe in Hiroshima than in Sendai, because the rate for urbanized areas developed in steep slope is much higher in Hiroshima than in Sendai. Figure 8 shows the examples of the results by LVR-View, in which BEV image sequences are generated in both cities by using *same parameters* for BEV image generation. Therefore, the difference of the topographical conditions in two cities is easily understandable by Figure 8. Actually Figure 8 is only one scene by LVR-View, and the difference can be recognized in more realistic manner by the experience of real LVR-View.

5. CONCLUSION

The authors developed a set of image processing tools for Low-cost Virtual Reality Viewer (LVR-View) as an introductory tool for the learning of remote sensing image processing and analysis. The most attractive point is that students can execute and experience LVR-View by using their own PCs. It is expected that these experiences lead them to the interest to remote sensing and the understanding of the role of some fundamental image processing techniques and the effectiveness of the combined use of satellite images and GIS. In near future, more powerful tool should be developed to realize more attractive event on remote sensing image analysis and application.

ACKNOWLEDGEMENT

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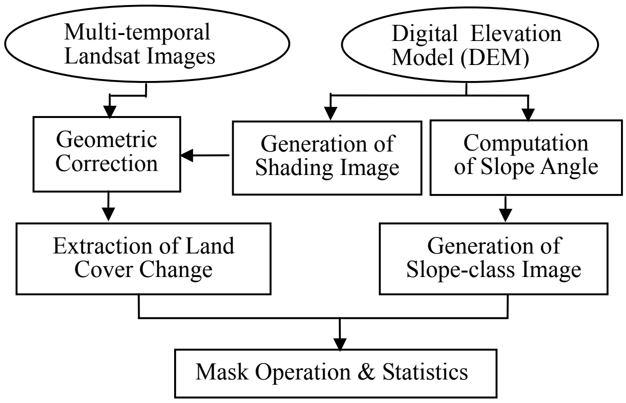

Figure 6. Flow chart of the research for the analysis on the topographical conditions of urbanized areas.

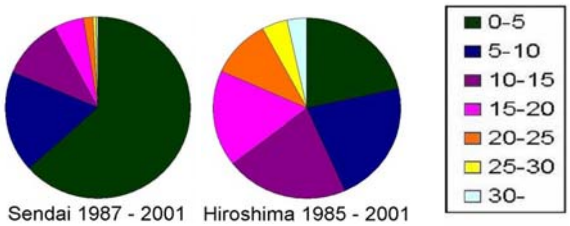

Figure 7. Occupation rates of slope-classes in newly urbanized areas in Sendai and Hiroshima City.

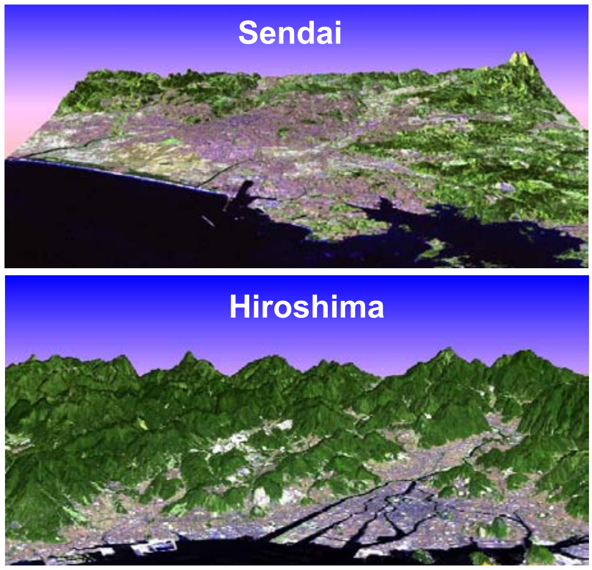

Figure 8. Examples from LVR-View in Sendai and Hiroshima City. Above two BEV images are generated with the same values for depression angles and with three times enhancement of ground height values.

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RS-FUN FOR SHARING EDUCATIONAL MATERIALS ON REMOTE SENSING

Kohei CHO[a], Atsushi KOMAKI[a], Tsunekazu CHUJO[b] Takashi TADA[b]

[a]Department of Network and Computer Engineering, Tokai University,
2-28-4, Tomigaya, Shibuya-ku, Tokyo 151-0063, JAPAN
cho@yoyogi.ycc.u-tokai.ac.jp
[b]Triple-I
2-9-13-102, , Tomigaya, Shibuya-ku, Tokyo 151-0063, JAPAN

Commission VI

KEY WORDS: eLearning, Flash, Web, Training, Edutainment, Jigsaw Puzzle

ABSTRACT:

The authors are developing educational material package for remote sensing called RS-fun with Macromedia Flash software. RS-fun is developed under the concept of "edutainment"(education + entertainment). RS-fun is a kind of Q&A game on the Web. Users can learn about the basic concept of remote sensing with some fun. In this study we propose a procedure for developing and sharing RS-fun with other scientists and educators. Four international teams are planed to be set up for developing and sharing RS-fun. The four teams are Development Team(Team-D) , Scenario Team(Team-S), Evaluation Team(Team-E), and Translation Team(Team-T). Team-D develops modules of RS-fun by using Macromedia Flash. Team-S produces scenarios and/or images to be used in making new modules. Team-E evaluates scenarios and produced materials, and makes suggestions to Team-S or Team-D if necessary. Team-T translates the texts of completed RS-fun package to various languages if needed. The educational material developed in this framework will be open to public through web. The international framework of RS-fun may expand the possibility of developing educational software for remote sensing.

1. INTRODUCTION

1.1 Types of educational materials on Internet

Nowadays, various universities, research institutions etc. are developing educational materials on remote sensing. Many of them are open to public via Internet. Those materials can be classified into four types. The first type is textbook type material. "Remote Sensing Tutorial" of NASA/GSFC(Nicholas Short, 2006) and "Fundamentals of Remote Sensing" of CCRS(2006) are good examples of the textbook type material. The beginners can learn about remote sensing like reading a book. The hypertext function is one of the advantages of this type of material. The second type is power point/slide type material. Not a few university professors are uploading their power point type teaching materials on their web site to support their students, and some of them are also open to public. Though user can not expect detailed explanation in slide type materials, visualized figures and compact explanations are sometimes much understandable than detailed explanation. The Department of Geomatics at the University of Melbourne is providing many good lecture slides on remote sensing at their web site for the students to down load(2002). The third type is lesson plan type material. "An Introduction to Remote Sensing" of Science NetLinks(2002) is a good example. This type of material is mainly prepared to help teachers to learn how to teach remote sensing to their students. The fourth type is interactive game type material. Graphical and interactive operations are realized in this type of materials using Java and/or Macromedia flash technologies. "What on Earth" of NASA(2003) is an good example. Like playing a game, user can learn about remote sensing with some fun. The RS-fun(Cho, 2004) described in this paper is categorized in this type of material.

1.2 Proposal

So, various kinds of educational materials on remote sensing are on the Internet. However, since most of them are developed independently, the concept, target users, and levels of them are quite different from each other. The themes and items covered with each educational material are also limited. In order to share know how, experiences, and ideas of making good educational materials on remote sensing among international scientists and educators, setting up of some procedure or framework for cooperation is necessary.
Among the above four types of educational materials on Internet, the interactive game type materials have strong advantages against traditional educational materials. However, since the development of this type of material takes time, the number of the materials of this type for remote sensing is still limited. The authors have been developing interactive educational material for remote sensing called RS-fun with Macromedia Flash software. RS-fun is a kind of Q&A game on the Web, and allows users to learn about the basic concept of remote sensing with some fun. In this paper, the procedure for developing and sharing RS-fun for remote sensing education is proposed.

2. RS-FUN

2.1 Developing Concept

The target users of RS-fun are beginners of remote sensing, including high school or lower grade students who do not know much about remote sensing. In order to interest high school or lower grade school students, the authors decided to introduce the concept of “edutainment: education and entertainment” for developing a new educational material on the Internet. But, this does not mean RS-fun is for kids. The interactive operation does not only interests students but also allow them to check the level of their understanding.

2.2 System Configuration

RS-fun is a software package installed on a web server to allow users to access via Internet with web browsers. Macromedia Flash is used as the authoring tool to provide interactive operations with various visual effects to make users feel more like playing computer games. In order to utilize Flash functions, users have to install free software Flash player to their browsers before using RS-fun. RS-fun mainly consists of three modules which are Q&A Module, Jigsaw puzzle Module and Database Module (see Figure 1).

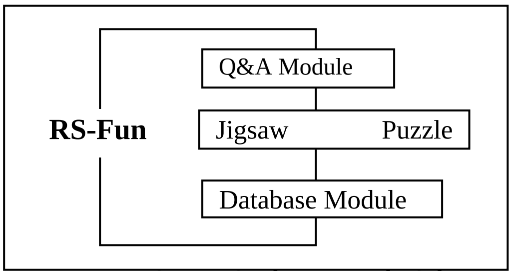
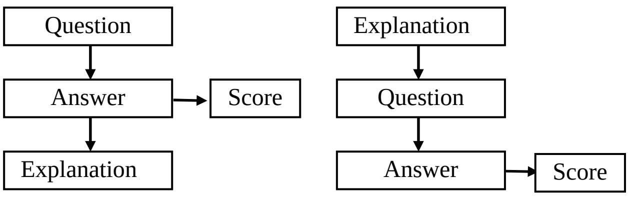


Figure 1. System Configuration of RS-fun

2.3 Q&A Module

2.3.1 Basic Procedure of Q&A

In the Q&A type educational materials, there are mainly two procedures as shown on Figure 2. One is “Explanation-after-Q&A” and the other is “Explanation-before-Q&A”.
In the “Explanation-after-Q&A” procedure, some questions on a certain topic are asked first, and then answer and explanation about the concept will be followed. In this procedure, question will raise user’s curiosity about the topic and motivation to read the explanation will be increased. But, on the other hand, the score of the Q&A does not reflect the level of their study achievement.



(a) Explanation-after-Q&A (b) Explanation-before-Q&A
Figure 2. Procedure of Q&A

In the “Explanation-before-Q&A” procedure, the concept of a certain topic such as “reflectance” is explained first, and then questions about the topic will be asked. Since the answer of the question is usually included in the explanation, the user can check their understanding about the explanation of the topic, and the score of the result will reflect the level of their study achievement. But, on the other hand, in this procedure, users sometimes have to read the explanation without their interest on the topic.
Since RS-fun is prepared for the beginners who are interested in remote sensing, we decided to mainly use the former procedure.

2.3.2 Operational Procedure of Q&A Module

Figure 3 shows the operation procedure of Q&A Module. The Q&A Module consists of a series of sessions. Each session deals with one particular topic on remote sensing such as “Spectral reflectance” or “False color composite”. At first, a user selects a session and starts reading the text explaining the topic of the session. Figure 4 shows an example. In the top of this session, concept of remote sensing is explained (See Figure 4(a)). After reading the explanation, users have to do an exercise. In this case, the user has to select a right answer from the three alternatives. According to the user’s answer, the message “WRONG!” or “CORRECT!” would be displayed on the screen as shown on Figure 4(b) and (c). If the answer was wrong, the user can read the explanation and try the exercise again if he/her wanted. In this way the user can check his/her understanding of the session. After finishing one session, user can move on to the following sessions one by one.

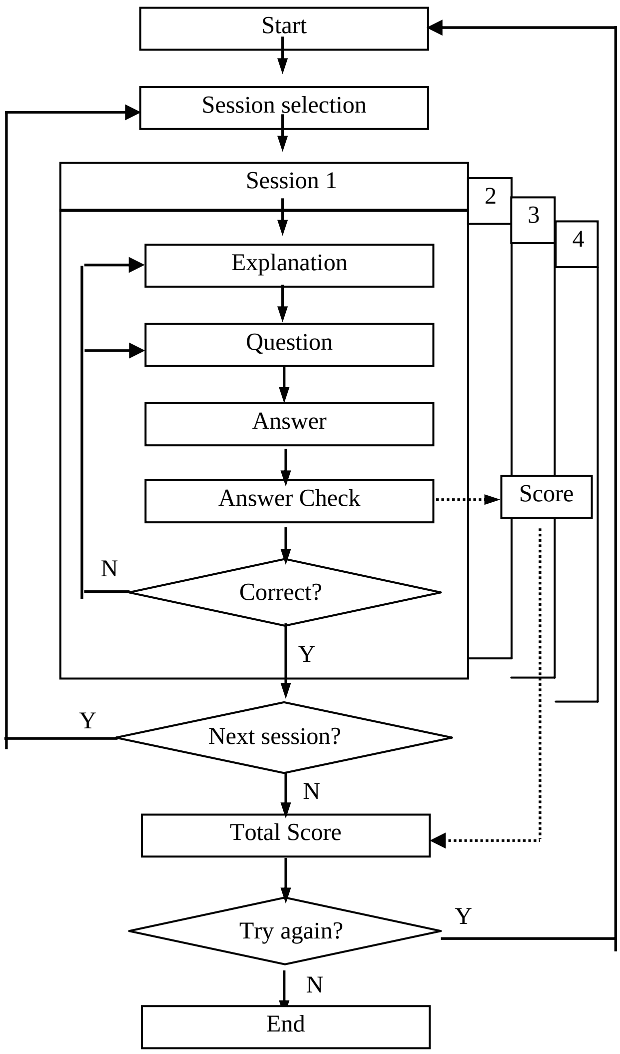
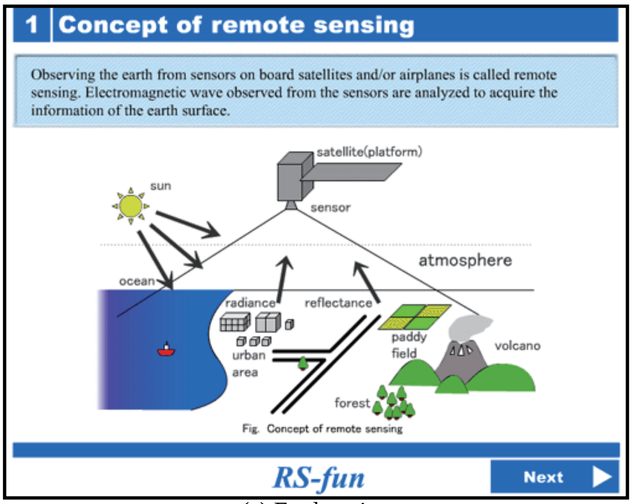
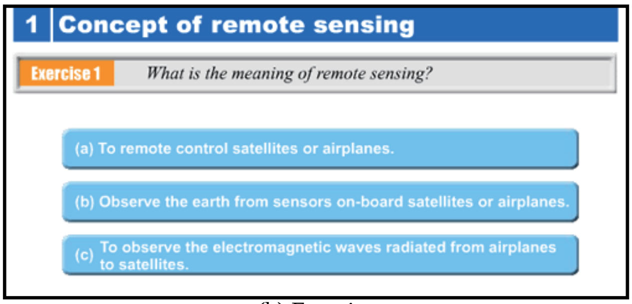


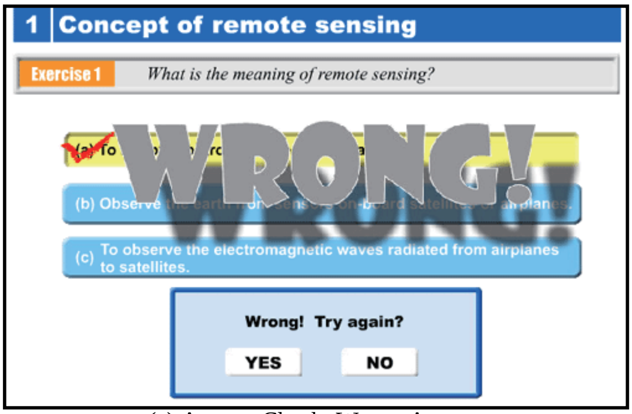
Figure 3, Operation Procedure of Q&A Module



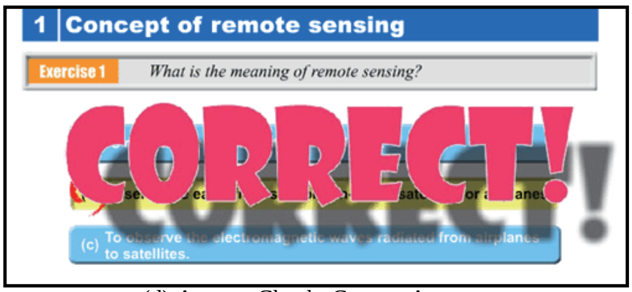
(a) Explanation



(b) Exercise



(c) Answer Check: Wrong Answer



(d) Answer Check: Correct Answer

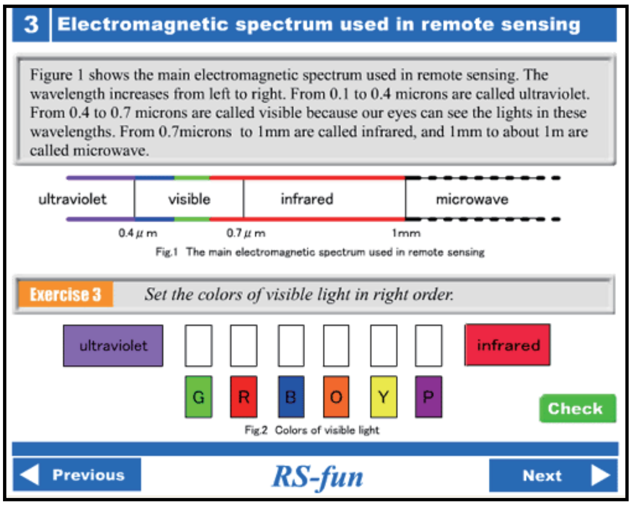
Figure 4. Graphical operation examples of Q&A Module.

2.3.3 Unique Features

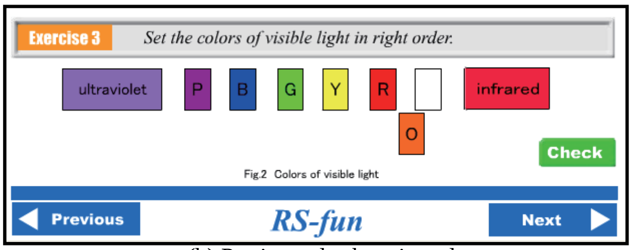
In order to make Q&A Modules attractive to users, several unique features are considered when composing each material of RS-fun.

(1) Graphical Operation

As shown on Figure 4, the multiple choice exercise is one of the most common types of exercises used in these kinds of interactive educational materials. However, this type of exercise does not have big difference with traditional textbook exercises. In RS-fun, graphical operations are enhanced to attract users. Figure 5 shows such an example. This session explains about electromagnetic spectrum used in remote sensing. In the exercise, a user has to move the color bars in right order. Since user can freely move or swap each color bars, the user feel more like playing a game than doing an exercise.



(a) Explanation and exercise

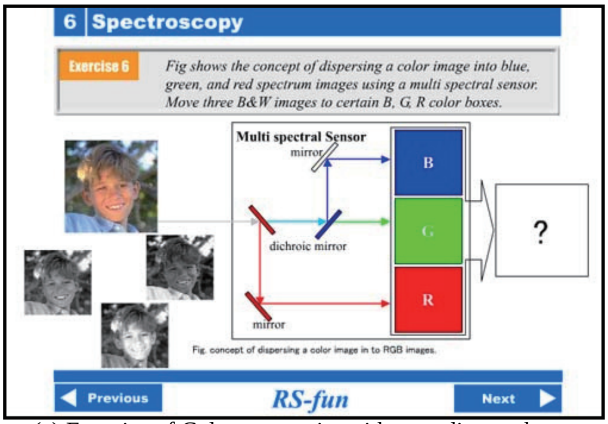


(b) Putting color bars in order

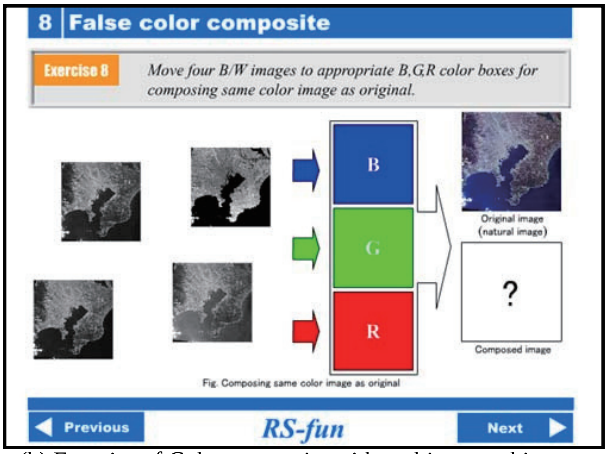
Figure 5. Graphical Operation example used in exercises.

(2) Simplification and materialization

For explaining certain concept, simplification is quite useful. However, once the concept is understood, it is very important to learn more about the reality. Figure 5 shows such an example. Color composite is one of the most basic and important techniques one has to learn in remote sensing. However, understanding the meaning of color composite using remotely sensed multi-spectral images is not easy. In RS-fun, a photo of a boy is used to understand the concept of RGB color composite(See Figure 6(a)). If each image is not set in right order, the composite color image of the boy does not become same as the original. This is much understandable than using satellite images. However, once the concept is understood, the user moves to the next step where false color composite images are produced from multi-spectral images (See Figure 6(b)). Because of the graphical operation, users are more likely to enjoy answering to each question.



(a) Exercise of Color composite with an ordinary photo



(b) Exercise of Color composite with multi-spectral images

Figure 6. Simplification and materialization

(3) Score

According to the user's answer, the message "CORRECT!" or "WRONG!" pops up on the screen as shown on Fig. 3. This flashy action gives users strong motivation for answering correctly. Each time user answers a right answer to each questions, one point is given to the user. When the user comes to the end of the sessions, the total score will be displayed on the screen (see Figure 7). Like a game, the score will be a good motivation for trying RS-fun again to improve his/her understanding of remote sensing

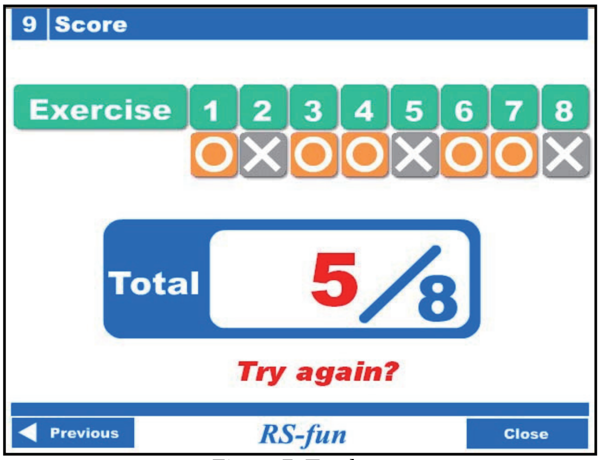


Figure 7. Total score

2.4 Jigsaw Puzzle Module

The Jigsaw Puzzle Module contains a series of digital jigsaw puzzle of satellite images such as of Landsat/TM, JERS-1/SAR, Terra/MODIS, IKONOS. The jigsaw puzzles are not prepared only for fun but also to give good chance for the beginners to carefully look at satellite images.

2.4.1 Operation Procedure

Figure 8 shows a jigsaw puzzle of MODIS image of the sea ice area of the Okhotsk Sea. When a user starts to "play" the puzzle, the satellite image is divided in to 5 x 5pieces and shuffled. The user has to move each piece to right place to re-construct the original image. By pushing the NAVI button, the original image is displayed in light colors, which help the user to find the right place to put each piece.

2.4.2 Unique Features

(1) Timekeeping

In order to make user's satisfaction, the lapsed time is displayed in the bottom of the jigsaw puzzle (see Figure 8). This will force users to try again and again to improve their time for completion. Through several times of trials, users are likely to be used to the satellite image and recognize the detailed patterns of the image with some enjoyment.

(2) Data base linkage

Satellite and sensor names displayed in the jigsaw puzzle screen are hyper linked to the Database Module (see next session). When users click the name of the satellite or sensor placed next to the puzzle image, the detailed information will be displayed on the screen. These information help users to understand about the specifications of the satellite and the sensor of the image.

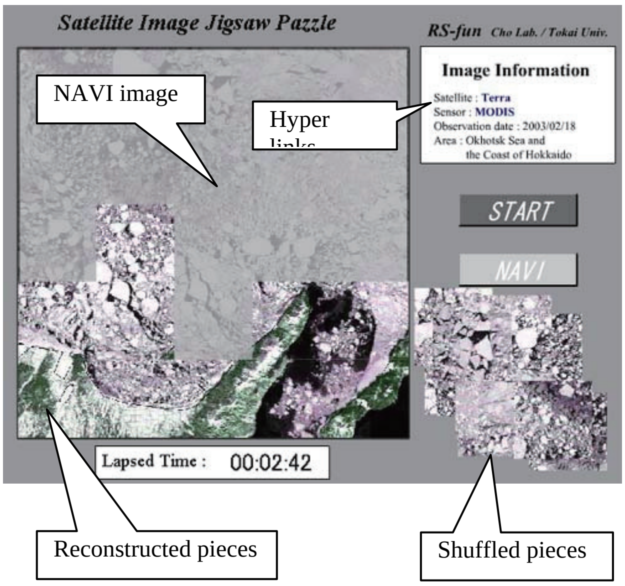


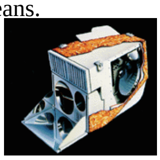
Figure 8. Jigsaw puzzle of MODIS image of sea ice area

2.5 Database Module

Database Module consists of various information related to remote sensing. Important key words such as “electromagnetic wave”, “satellite”, and “platform” in the Q&A Module as well as in the Jigsaw Puzzle Module are hyper linked to the database Module, so the user can learn more details on certain subject. Figure 9 shows a part of the MODIS sensor information stored in the Database Module. We plan to expand the database from time to time.

MODIS（Moderate Resolution Imaging Spectrometer）

[Outline]
MODIS is a 36-band multi-spectral radiometer aboard the Terra and Aqua satellites of NASA. MODIS data are being used to derive products ranging from vegetation, land surface cover, and ocean chlorophyll fluorescence to cloud and aerosol properties, fire occurrence, snow cover on the land, and sea ice cover on the oceans.



[Sensor Specifications]
Satellite : Terra, Aqua
Orbit：Sun synchronous,
Altitude:705km,
Equator crossing time: 10:30AM(Terra), 1:30 PM(Aqua)
Swath：2,330km
Spatial resolution：
250m (Wavelength：0.620 - 0.876µm, Band:1-2)
500m (Wavelength：0.459 - 2.155µm, Band:3-7)
1,000m (Wavelength：0.405 - 14.385µm, Band:8-36)
Planned lifetime: six years

< Related Links >
NASA(MODIS Web) :
http://modis.gsfc.nasa.gov/about/specs.html
MODIS reception at Tokai University :
http://www.tric.u-tokai.ac.jp/rsite/r1/modis/modis.html

Figure 9. Information example stored in the DataBase Module

3. PROCEDURE FOR SHARING EDUCATIONAL MATERIALS

So far, the concept of RS-fun is well accepted by the user community. However, RS-fun is still a small package for education. In order to share know how, experiences, and ideas of making good educational materials on remote sensing among international scientists and educators, setting up of some procedure or framework for cooperation is necessary. The authors would like to propose the following procedure for developing and sharing RS-fun with other scientists and educators.

3.1 Setting up of Teams

Total of four teams are planed to be set up for developing and sharing RS-fun. The four teams are Development Team (Team-D) , Scenario Team (Team-S), Evaluation Team (Team-E), and Translation Team (Team-T). Team-D members have the ability to develop some sessions of Q&A Modules of RS-fun by themselves using Macromedia Flash. Team-S members do not develop sessions by themselves, but produce scenarios and/or images to be used in making new sessions. Since good scenario is the key for making a good educational material, this team needs experienced educators and scientists from various application fields. Team-E members evaluate scenarios and produced materials, and make suggestions to Team-S or Team-D if necessary. So far, the texts of RS-fun are prepared in English and in Japanese. Team-T translates the original RS-fun to certain language. Figure 10 shows the relationship of the four teams and users. To keep the quality and concept of RS-fun, Team-E finally decides to include a new material to RS-fun or not. Members of each team are not concrete, and can belong to plural numbers of teams.

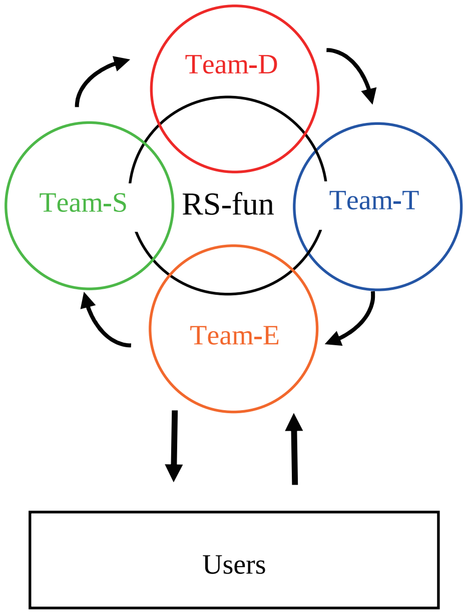


Figure 10. Relationships of Teams for RS-fun development

3.2 Development procedure

(1) Q&A Module

Firstly, Team-S produces certain scenarios of new sessions. The scenarios are reviewed by Team-E, and some modification to the scenarios will be applied by Team-S or Team-E if necessary. The information on important keywords will also be collected. When scenarios are ready, Team-D starts to develop actual sessions. The developed sessions are reviewed by Team-E, and feedback goes to Team-D for improvement. The prototype of a session of Q&A module will be provided to the team members. So, if a member has Macromedia Flash software, one can develop a new session of RS-fun by one’s self. The authors are planning to modularise each session so that teachers can sort out sessions and decide the order of sessions according his/her lecture plan.

(2) Jigsaw Puzzle Module

Team-S collects certain remote sensing images and additional information on the images for jigsaw puzzle production. The information should include image explanation, map, name and specification of platform/sensor. Since the authors have developed software for making jigsaw puzzle from an original image, the making of jigsaw puzzle itself is quite simple and automatic. Team-D will make the jigsaw puzzle after receiving images and related information from Team-S.

(3) Database Module

After accepting scenarios and information on jigsaw puzzle images from Team-S, Team-D starts to produce data base files in html format. Those files are linked from Q&A Module and/or Jigsaw Puzzle Module.

3.3 Dissemination

After the evaluation by Team-E, the new materials are added to previous RS-fun on the web server to allow users to access via Internet. The initial version of RS-fun is accessible at the following site
http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/RS-fun/index.html.
The copy of the products will also be provided off line to the team members according to their request.

3.4 Copyright

All the contributors will be clearly indicated on the web site of RS-fun. In general, the copyrights of the materials remain to RS-fun team. However, for particular images or graphs etc., the copyright may remain to the person or organization that provided them.

4. Conclusion

The concept of a remote sensing education software package RS-fun was explained in details in this paper. The interactive operation of RS-fun allows beginners including high school or lower grade students to learn about remote sensing with some fun. In order to expand the role of RS-fun, procedures for developing and sharing RS-fun with other scientists and educators were proposed in this paper. We already have received intentions from several scientists. For example, Dr. Sultan Hasan AlSultan of Qassim University of Saudi Arabia has started to translate RS-fun texts into Arabic. The authors are pleased to cooperate with those who are interested in developing, improving, and using RS-fun for education.

Acknowledgment

The authors would like to thank MEXT for supporting a part of budget for developing RS-fun for environmental education.

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BUILDING CAPACITY IN GEO-INFORMATION HANDLING: ADDRESSING DIVERSIFIED NEEDS

Sjaak Beerens
Director External Affairs
International Institute for Geo-Information Science and Earth Observation - ITC
P.O. Box 6, 7500 AA Enschede, the Netherlands
E-mail: beerens@itc.nl

Commission VI, Working Group VI/3

KEY WORDS: Capacity building, geo-information, development cooperation, partnerships

ABSTRACT:
Developments in the Geo-Information Sector across the world have far-reaching implications for the professional GI-organisations operating in that sector. In terms of capacity and capability requirements these developments imply that GI-organisations not only require technically and scientifically skilled and knowledgeable personnel but also capability to formulate business strategies, manage complex processes and design GEO-ICT infrastructures. These diverse needs in turn imply a diversified approach of building capacity in science and skills at different level and with different modalities and delivery mechanisms tailored to accommodate specific requirements. Regular providers of capacity building either universities or specialised training institutes are therefore challenged to combine scientific excellence with professional expertise in both GI and knowledge transfer. ITC has managed to realise such a capability. The developing world is well on its way in developing its own capability to provide education and training in geo-information handling. In doing so, however, they should be aware of the requirements that relevant capacity building programmes, which address the diversified needs of GI-organisations programmes entail. Equal level partnerships with universities and professional training institutions in the Western world, experienced with and equipped for capacity building for geo-information handling, could well contribute to the ultimate goal of realising the Millennium Development Goals (MDGs).

1. INTRODUCTION

The lack of capacity in developing countries is considered one of the main constraints hampering the realisation of the Millennium Development Goals (Morgan et al, 2005). This also applies to many professional organisations involved in the provision and/or use of geo-information such as surveying and mapping agencies and resource management agencies (hence referred to here as GI-organisations). These organisations play, or are supposed to play, a crucial role in the management of space and resources which in turn comprises an integral and essential pre-condition for realising the MDG's. The management of space and resources requires the interaction between different stakeholders in society; i.e. public, private and government sector. These interactions require a good understanding of these spatial processes and the exchange of geo-information and geo-information processes and which should be provided through so-called local, national and even international spatial data infrastructures (SDIs).

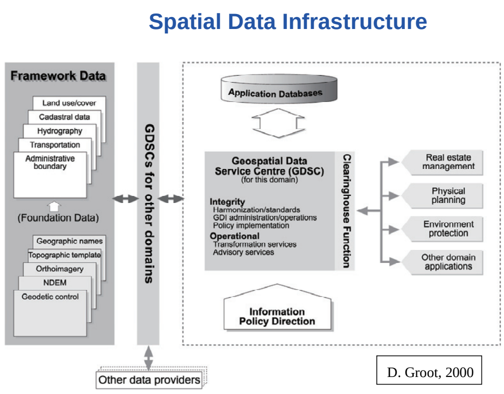

Figure 1. Spatial Data Infrastructure (Groot, R & J. McLaughlin, 2000)

2. OBJECTIVES

The requirements imposed on professional GI-organisations to deal with their changing role have far reaching implications for the type of capacity that they require. In this paper some thoughts are shared on:

- the developments that professional GI-organisations face in their operating environment;
- the various repercussions these changes have for the capacity required by these organisations;
- theoretical frameworks for capacity building in organisational environments;
- the implications for the way this capacity is to be built and to be maintained; and finally;
- the consecutive implications for the role of capacity building organisations such as ITC.

3. GI SECTOR DEVELOPMENTS

3.1 General developments

Spatial Data Infrastructures (SDIs) have the potential to provide the proper frameworks for sustainable development of space and resources. The development of these infrastructures requires that the relative positions of the public and private sector have to be clarified. New specifications and regulations are required for the ownership, the management and sharing of geo-information. The concepts of framework data and core data have to be reformulated for a geo-information community that is no longer map-oriented. Legal and policy issues have to be taken care of. Professionals, policy and decision makers slowly learn to understand these problems, but are still far from solving them. Government has two roles in this context: it is one of the players in the decision making about the management op space and it should provide legislation and regulation for the development of SDIs.

Professional organisations involved in the provision and/or use of geo-information such as surveying and mapping agencies and resource management agencies (e.g. planning units, water boards but also municipalities), are faced with drastic changes in their operating environment, related to:

a) the speed of developments in the Geo-ICT technology and architecture applied by these organisations, with consequent requirements in the management of operations;
b) the institutional environment in which they operate and which confronts them with other providers, resulting in competition, e.g. from private sector providers; general government policies regarding outsourcing and cost recovery; and empowerment of users and clients in the products and services;
c) globalization of information requirements increasing the need for harmonization and standardization of information both in terms of process and context.

Hence professional geo-information organisations need to adjust their organisational structure, ICT architecture and their associated strategies to meet the challenges and even be ahead of change in their technological and business environment.

3.2 Settings, domains and levels

The issues professional GI-organisations face can be described under the headings setting, domains and levels:

Setting

In terms of setting a distinction can be made between:

- Internally organisations have to deal with Business strategy, organisational infrastructure, GEO-ICT Strategy and GEO-ICT architecture
- Externally they phase a business environment and a GEO-ICT environment

Domains

In terms of domains a distinction can be made between the:

- Business domain comprising a business strategy and organisational infrastructure
- GEO-ICT domain comprising the GEO-ICT Strategy and the GEO-ICT Architecture

Levels

In terms of levels a distinction can be made between the:

- Strategic level, covering both business and GEO-ICT, and
- Operational level, consisting of organisational infrastructure and GEO-ICT architecture.

3.3 Principle questions

Professional GI organisations are continuously confronted with questions that they were not used to in the past such as:

Business strategy:

- Which products and services to be provided?
- Which strategic alliances/joint ventures to pursue?
- Which pricing, quality, VA services to apply?

Organisational infrastructure:

- Which organisational design, roles and reporting relations?
- Which production processes for key activities?
- Which knowledge, skills and expertise is required?

GEO-ICT strategy:

- Which types/range of GEO-ICT systems are in the market?
- Which system reliability, connectivity etc. to pursue?

GEO-ICT architecture:

- Which workflows for data acquisition, processing, storage, presentation and dissemination?
- Which data model to apply?
- Which Information System to apply?
- How to build and maintain the information system?

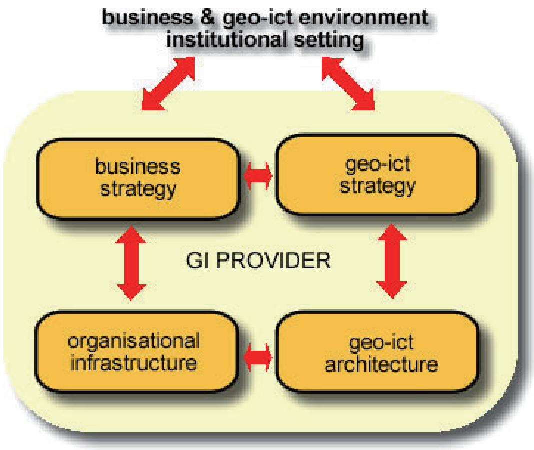

Figure 2. The operational environment of GI-organisations (Georgiadou and Kuma, 2002 / Kraak, 2005)

4. CAPACITY REQUIREMENTS

4.1 Changing roles, changing capacity requirements

The changing role of professional organisations engaged in the provision, dissemination or use of geo-information for general development purposes has also repercussions for the skills and knowledge of their staff. Apart from technological and conceptual developments in the knowledge field geo-information, we observe a drive for privatization, cost recovery and competition from an emerging private sector. These developments require GI organisations to avail of the human resources that not only have the technical skills and conceptual knowledge but who are also able to deal with the various management aspects associated to a competitive demand-driven environment.

In the (recent) past professional mapmakers had a central role with respect to spatial information production, they were especially involved in the provision of framework data and topographic core data. They were mainly geodesists, cartographers, surveyors and photogrammetrists. In the seventies and eighties a new remote sensing and GIS community evolved which consisted in the early days of interested experts from other fields, mainly the various surveying disciplines, and pioneering amateurs who obtained their skills by training and through experience.

Governments are to create an “enabling environment” for the use of geo-information through (Westerhof and Reeves, 2004):

- Proper legislation on ownership and transfer of data;
- Political stability and consistency;
- Good governance including fighting of corruption, ensuring civil rights and public safety
- Creating an infrastructure and capacity, including organisations handling and delivering data and services and the expertise to do so.

How can governments, policy and decision makers be convinced about the importance of the geo-information sector. Or phrased otherwise: “How good is the sector at convincing governments about the need for geo-information?” Progress is being made but we a stage where the sector is a participant in government budget discussions by default has certainly not yet been reached. How did this come about?

4.2 The economics of geo-information

An appropriate way of convincing policy and decision makers is by calculating for them the financial and economic gains from using remote sensing and geo-information in their work. How good are we at doing that? That's where most GI-specialists have a problem since not many have been educated or trained to make financial and economic calculations. Yes, perhaps to develop and apply formulas and algorithms but not to do the economics. How good are the geo-information professionals in economics? It would not be surprising if they have heard about cost-benefit analysis but not how to calculate it, let at all an internal rate of return.

An example of such an economic exercise is provided by the benefits of geo-scientific mapping in Australia. Financial-economic calculations done in the early 90's of the last century revealed that an annual investment by the Australian government of some A$ 65 million in federal and state geo-scientific mapping underpins an activity that generates A$ 28 billion in export earnings and raises A$ 5.1 billion in taxes and royalties for government (Richards, 1993).

Another, more recent example is the Feasibility Study for the Thailand National Spatial Data Infrastructure (ESRI et al, 2004). That study concludes that a National SDI for Thailand would provide the economy a net benefit of $ 732 million, while the net return on investment over a 5 and 8 year period would be a staggering 470% and 111% respectively.

One would think that such figures should be adequately convincing to governments to provide the enabling environment for geo-scientific mapping. But what about the various other applications such as land administration, disaster mitigation and biodiversity conservation to mention just a few.

4.3 Capacity in numbers

In terms of numbers, considerable work still needs to be done. To my knowledge, apart from a limited number of specific studies, that assessment has never been made. Such an assessment is also very difficult to make as it depends on a range of aspects including economic development level, population and labour force.

Take, the Netherlands: With a population of 17 000 000, an employment force of about 6 million and a GDP/capita of $ 24 000 the geo-information sector amounts to about 50 000 people (CGI and Ministry of Economic Affairs, 2003). It gradually approaches the employment of agricultural sector in the Netherlands, which has some 100,000 people engaged.

5. THEORETICAL FRAMEWORKS

5.1 Definitions

Before embarking on the issue of strengthening GI-organisations in their ability to perform and achieve specified objectives a moment of reflection is required to look into some theoretical aspects of capacity building of GI-organisations.

As observed in previous chapters, the developments with which the GI-Sector is being confronted require an organisation not only to avail of human resources that have the technological skills, scientific knowledge and professional values required to address these developments but also a capability to deal with the various management aspects to operate within and contribute to institutional setting and policy issues.

"Capacity" is therefore more than having staff with appropriate technical and scientific skills and knowledge. Hence "capacity building" is more than "education". *Education*, directed at human resources development, i.e. the supply of technical skills and professional values is only one component of capacity building (Georgiadou and Groot, 2002).

Where a proper organisational and institutional environment is lacking, as is the case in many developing countries, organisational and institutional strengthening form the two major other components of capacity building.

Capacity building aims at improving the ability of entire organisations to perform agreed tasks, either singly or in co-operation with others.

Capacity building comprises three interrelated activities closely linked to the requirements that professional geo-information organisations are confronted with:

1. *Human resources development*, directed at the provision of scientific, technical and professional personnel;
2. *Organisational strengthening,* aimed at strengthening the management capacity of organisations in embedding new technological ICT solutions and strategic decision making;
3. *Institutional strengthening*, aimed at enhancing the capacity of organisations to develop business and geo-information and communication technologies and to negotiate appropriate mandates and modus operandi as well as legal and regulatory frameworks within new operating conditions.

A fourth component of capacity, that is infrastructure, hardware and software, is not considered her as that is more as a result of an organisation properly negotiating its mandate and its tasks and the way it is being managed.

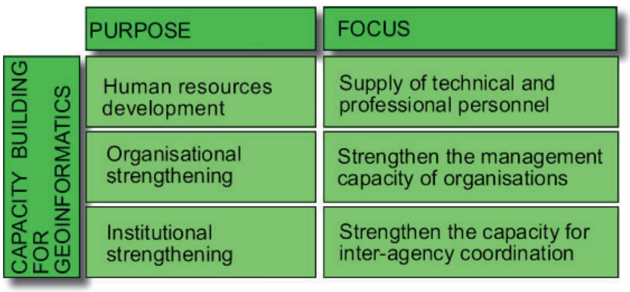

Figure 3. Components of capacity building (Courtesy Georgiadou and Groot, 2002 / Kraak, 2005)

Capacity development, i.e. change is generally looked upon very much from an exogenous perspective, i.e. efforts by external parties, i.e. both donors/funding agencies as well as actual providers to increase capabilities of individuals and organisations in the developing countries.

Although it is not the intention of this paper to elaborate on the theoretical frameworks of organisational capacity building in much detail, it is important to note that apart from exogenous factors there are many endogenous factors influencing organisational capacities – the process of change from the perspective of those undergoing the change.

For this purpose Morgan et all (2005) have developed a framework with a core comprising interconnected dynamics of capacities, change and performance, shaped by four other factors, i.e. external context, stakeholders, and internal features and resources

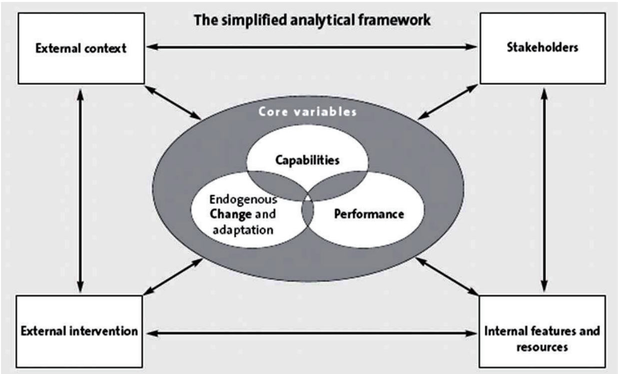

Figure 4. Simplified analytical framework for analyzing organisational capacities (Morgan 2003)

This framework provides an appropriate basis to look at organisations as organic creations and capacity as almost ecology, considering organisations as part of a complex network of other actors – a capacity ecosystem (Morgan, 2004).

6. CAPACITY BUILDING IMPLICATIONS

6.1 Requirements in terms of process and context

Nowadays the GI-community consists increasingly of highly educated professionals. These professionals can be divided in three major categories:

1. Experts and managers in the field of spatial information handling (or specialists in certain aspects of this field),
2. Users of geo-information; and
3. Decision makers and policy makers, who are developing the required legislation and institutional arrangements.

Their education and training requires carefully designed curricula, programs and courses based on the mature paradigms of geo-information science and its related disciplines. The design should also be based on a proper understanding of the contexts in which geo-information is produced and used and of the role that the different types of professionals play in this field (Molenaar, 2004).

These observations imply that capacity building in the context of geo-information provision should be put high on the agenda of the international GI-community and a dedicated effort is required to identify the needs for education. In this respect we should consider the actual processes for geo-information provision in relation to the three categories of roles that experts, identified here above, play in this context.

On should therefore look at spatial data handling from two perspectives (see Figure 5 from Molenaar and Kraak, 2000 / Kraak 2005):

a) *The process structure* for geo-information production with the stages of data acquisition, storage and retrieval, processing and presentation and dissemination and use;
b) These processes can be seen in *different contexts*. There is the context of the applied technology with the aspects of sensor systems, the systems and methods for information extraction from images and the systems and methods for information storage and retrieval and dissemination. But these information production processes can also be seen in the context of the application domains. These cover a wide variety of fields, such as land administration, natural resources management, disaster mitigation, etc. Other contexts are the information flow management with its organisational aspects and also the institutional and policy issues

PROCESS / CONTEXT	data acquisition	storage & retrieval	processing & presentation	dissemination & use
application domain				
technology				
information management				
institutional setting & policy				

Figure 5. The different aspects of geo-information handling processes and contextual perspectives from which these processes can be considered (Molenaar and Kraak, 2000 / Kraak 2005)

Professionals operating in the field of geo-spatial data infrastructure are aware of this fact. On the other hand the fact that the application domains cover a wide variety of fields, such as land registration and administration, natural resources management, disaster mitigation, etc., implies that specialisation (although within an interdisciplinary context) will be required for professionals to keep up to date with the state of the art in their field of expertise. These apparently conflicting criteria for the education of professionals and scientists in geo-informatics require a careful focusing and design of educational programs. Not all requirements can be fulfilled by one single program, one should rather think of a coherent family of education programs to educate the members of the future geo-informatics community.

6.2 Requirements in terms of delivery modes

Besides process and context of educational and training programmes, current needs have also changed in terms of delivery modes. Since 1950 ITC has concentrated its efforts on postgraduate programmes leading to either a diploma or degree. These programmes were offered as full-time, long-term and residential activities in the Netherlands. Over the years adjustments were made to accommodate changing requirements.

Anticipating the changing environment already for some years, ITC has some years ago embarked on changing its course more drastically than ever in the past. Its educational programmes were adjusted to pay more attention to aspects of context, i.e. information management, institutional setting and policy. A modular system was introduced, with all programmes/specialisations consisting of three weeks modules, all starting at the same time. This system, which includes elective modules, allows course participants to select the topics that best fit their individual professional requirements.

Most GI-organisations nowadays avail of expertise at diploma and MSc level and are in need of other formats to meet their capacity needs at different levels. Apart from the level of the education/training, i.e. degree, diploma, certificate other aspects are becoming important in the delivery. The duration of the activity is an important aspect as employers do not want to see there staff absent for too long. There is also increasing interest in part-time rather than full-time attendance (occasionally requiring spreading the programme over a longer period. The residency requirement, i.e. the requirement to be personally present at the premises of the provider is occasionally considered a limitation increasing the demand for distance education modalities. In response to these rapidly changing requirements, ITC has developed a flexible capacity building programme in terms of level, duration, spread over time and residency requirement.

Level	*Duration (month)s*	*Full/Part-time*	*Location: Res/Comb/DE*
PhD	36 – 42	FT&PT	Res/Comb
MSc	18	FT&PT	Res/Comb/DE
Master	12	FT	Res/Comb/DE
Diploma	9	FT	Res/Comb/DE
Certificate	0.75 - 3	FT	Res/Comb/DE
Tailor-made	diverse	FT&PT	Res/Comb/DE
Seminars		FT	Resident
Advisory services: diverse		-	-

Table 1 Delivery modes ITC Capacity Building Programme

6.3 Partnerships in capacity building

The developing world is well on its way in developing its own capability to provide education and training in geo-information handling. International donor policy directed at capacity building activities to take place increasingly in the recipient countries has contributed significantly to that development. This local capacity very much meets the wishes of local employers and local and national governments to have economical education and training within their own borders. In doing so, however, they should be aware of the requirements that relevant capacity building programmes, which address the diversified needs of GI-organisations programmes entail.

In order to address these developments ITC has embarked on establishing equal level partnerships with universities and professional training institutions to jointly build capacity in geo-information handling for national and regional organisations. To that end ITC strives at entering in tripartite relations with professional organisations to tailor services to the specific organisational needs.

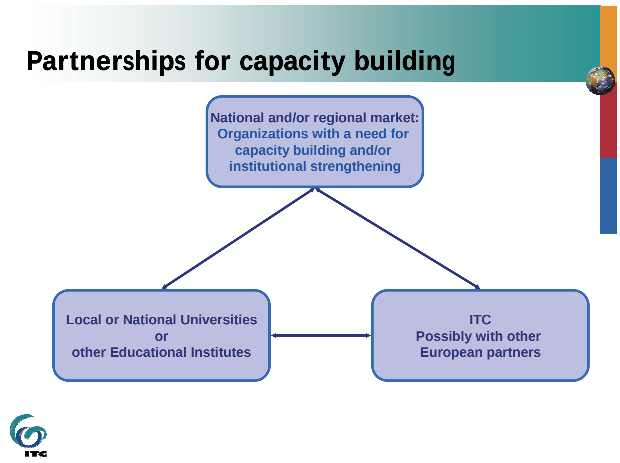

Figure 6. ITC tri-partite relation in capacity building

A major element of ITC's current strategy towards partnerships in service provision is based on joint educational programmes collaboration with qualified partner organisations in other countries. The aim for the coming years is some 20 partnerships. At this moment there are operational joint educational degree programmes in China, Philippines, India, Iran, Tanzania, Nigeria, Ghana, Mexico and Bolivia. Others are operational within the Netherlands and within Europe.

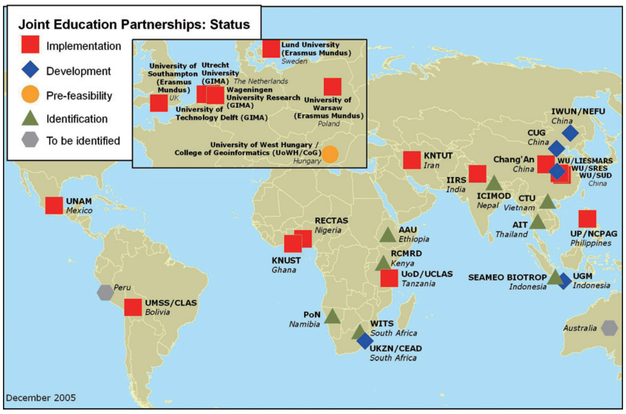

Figure 7. ITC Joint Education Partnerships (December 2005)

These joint degree programmes are not limited to exchanging students, allowing them to do part of their study in their home country and part at ITC in The Netherlands. It also involves the exchange of staff for quality assurance purposes, not only ITC staff visiting partner organisations but also the other way around, with staff of partner organisations to supervise students while studying at ITC.

Apart from joint degree programmes, ITC is expanding the programmes with joint short courses and joint courses tailored to the need of individual organisations. Moreover joint advisory services and joint research complement the human resources development activities both with partner organisations as well as professional client organisations.

6.4 Sustainable partnerships

Whatever attempts are made to strengthen local capacity building institutions, proper attention should be paid to the sustainability of such initiatives.

A distinction is made here in this context between academic, institutional and financial sustainability (Beerens, 2004).

Of particular importance in this respect concerns the "*academic sustainability*" of a capacity building programme. This refers to the capability to continuously upgrade its contents in correspondence with the requirements as defined by developments in the environment and society at large. This generally requires such a capacity building programme to be embedded in a research environment. For that purpose ITC's current joint educational and training activities are gradually being embedded in a system of joint research.

CONCLUSIONS

Developments in the GI Sector across the world have far-reaching implications for the professional GI-organisations operating in that sector. In terms of capacity and capability requirements these developments imply that GI-organisations not only require technically and scientifically skilled and knowledgeable personnel but also capability to formulate business strategies and manage complex processes and GEO-ICT infrastructures.

This in turn sets requirements on the design of capacity building programmes which goes much further than regular education and training but includes management and institutional expertise through research and advisory services.

The developing world is well on its way in developing its own capability to provide education and training in remote sensing and GIS applications, geo-informatics in short. That capability has been built up during the course of many years, much of it with the support of western institutions in the framework of Official Development Assistance.

The desire of developing countries to have their own capability to build capacity for its GI organisations is a most appropriate one befitting the principles and spirit of national governments and donor agencies. In doing so, however, these organisations should be aware that:

- Capacity requirements exceed technical and scientific skills and knowledge, dealing with both the process and context components of geo-information handling;
- They include managerial skills as well expertise in the development and negotiation of appropriate mandates and modus operandi as well as appropriate (new) institutional, legal and regulatory frameworks;
- This in turn has implications for the way such capacity is built, as traditional education and training in technical and scientific knowledge and skills is insufficient;
- Professional advisory services and research are equally important aspects.

All this has implications as well for the universities and institutions in the western world that have thus far contributed to building capacity in geo-information handling elsewhere. Apart from the fact that their educational programmes should address the increasing demand for flexibility in academic degree programmes and respond to the need for more demand-driven and tailor-made training, delivery modes have to be adjusted.

ITC, a major player in this field is rapidly accommodating to these developments and is adjusting its delivery mode by entering into partnerships with universities and institutions to provide joint capacity building programmes, whereby most of the activities take place in the home countries of the GI-professionals.

This set-up turns out to be much more cost efficient and effective:

- Calculations by ITC for its programmes have revealed that from the perspective of the individual course participant (or sponsor) joint programmes (at the same quality level as full programmes at ITC) may be up to 65% cheaper.
- From the perspective of the Dutch Government as a development cooperation donor, joint educational programmes may be up to even 75% cheaper compared to having them done entirely in the Netherlands.

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APPLICATION OF GLOBAL GEOGRAPHIC FRAMEWORK DATA FOR EDUCATION －GLOBAL MAP－

H. Koshimizu[a], H. Maruyama[a], S. Sakabe[a], J. Kisanuki[a], T. Nagayama[a], S. Kayaba[a], M. Abe[a], N. Kishimoto[a], T. Okatani[b]

[a] Geographical Survey Institute, 1 Kitasato, Tsukuba Ibaraki, Japan sec@iscgm.org
[b] Ministry of Land, Infrastructure and Transport, 2-1-3 Kasumigaseki, Chiyoda Tokyo, Japan

KEY WORDS: Global Map, Framework data, National Mapping Organizations, ISCGM, Application Strategy, Education

ABSTRACT:

Global Mapping project intends to develop and update global digital framework geoinformation under the cooperation of National Mapping Organizations (NMOs) of all over the world. The project seeks to develop global geographic framework data to contribute to solving global environmental problems and realising sustainable development. In spite of the serious efforts made for promoting the project, it has not gained recognition by the public. In view of the importance of publication, the Ministry of Land, Infrastructure and Transport (MLIT) set up a Committee on Application Strategy for Global Maps in 2003. In a plan developed in 2004 by this committee, six projects were proposed as appropriate activities to publicize the applications of Global Map. Among others, "Global Map School" is considered to be the most practicable. The "Global Map School" is a project to apply Global Map to educational field. Execution of this project is expected to become a touchstone for the successful application of geographic information developed by using remote sensing and other technologies, in international communication in education.

1. INTRODUCTION

The Global Mapping project intends to develop and update global digital framework geoinformation under the cooperation of National Mapping Organizations (NMOs) of all over the world. The project seeks to develop global geographic framework data to contribute to solving global environmental problems and realising sustainable development. In spite of the serious efforts made for promoting the project, Global Map has not gained recognition by the public, therefore, further efforts for the publication is indispensable to make Global Map into a real contributor.

Firstly, this paper summarizes establishment and development of the Global Mapping project, then introduces efforts to publicize Global Map, and at last introduces a project of Global Map application in educational field.

2. ESTABLISHMENT AND DEVELOPMENT OF GLOBAL MAPPING PROJECT

2.1 Background of Global Mapping Project

The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, 1992, adopted Agenda 21 as a programme for addressing global environmental challenges and setting out measures to be implemented. Agenda 21 states that the availability of geographical information is critical for environmental decision making (Agenda21. 40. a).

It has been recognized that global geoinformation framework is needed for solving global environmental problems. To this end, the Global Mapping project intends to develop this framework named as "Global Map" under international cooperation. The concept of the Global Mapping project was first advocated in 1992 by the Ministry of Construction (now reorganized as the Ministry of Land, Infrastructure and Transport: MLIT) and the Geographical Survey Institute (GSI) of Japan, in response to growing concern about global environment and as a contribution from mapping and surveying sector.

Primary objective of the Global Mapping project is to contribute to solving global environmental problems and realization of sustainable development through the provision of base framework geographic dataset. The Global Map data are developed by NMOs in accordance with the common data specifications. In order to promote and implement the Global Mapping project, the International Steering Committee for Global Mapping (ISCGM) was set up in 1996 and GSI of Japan serves as its secretariat since its inception.

As of March 2006, 160 countries and regions that cover 91% of land area of the Earth participate in the project. Among them, data of 22 countries have been completed. These data are downloadable freely for non-commercial use through the Internet from ISCGM website at http://www.iscgm.org/. (See Figure 1.)

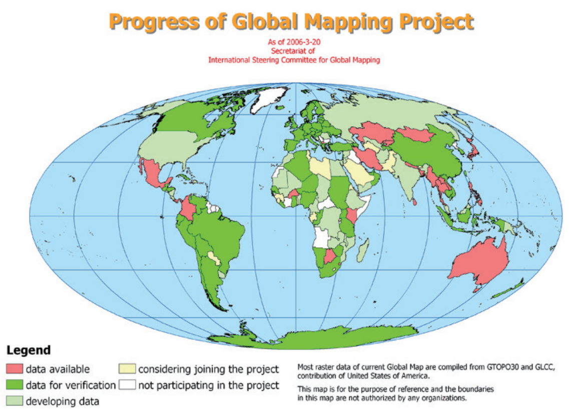

Figure 1. Progress of Global Mapping Project

2.2 Promoting Body of the Global Mapping Project – ISCGM-

The primary purpose of ISCGM is to examine measures for facilitating Global Map data development, with a view to better implement MEAS (Multilateral Environmental Agreements), mitigate natural disasters and encourage economic growth within the context of sustainable development.

ISCGM consists of twenty members (as of March 2006) who represent NMOs and regional geographic information organizations; namely, Antarctica (SCAR), Australia, Bangladesh, Canada, China, Europe (EuroGeographics), France, India, Iran, Japan, Kenya, Republic of Korea, Malaysia, Mexico, New Zealand, Niger, South Africa, United Kingdom and United States of America (in alphabetical order). The committee is currently chaired by Professor D. R. F. Taylor of Carlton University, Canada.

ISCGM has held its meetings nearly once a year at places all around the world. The Twelfth ISCGM Meeting was held in Cairo, Egypt in 2005. It has 4 Working Groups. Working Group 2 deals with specifications of Global Map and Working Group 4 works on global raster data development.

2.3 Outline of Global Map Data

Global Map is digital global spatio-temporal data in the following format:
1) In 1km resolution (at 1:1,000,000 scale)
2) Covering the whole land area of the globe with consistent specification
3) Composed of 8 layers (shown in Figure 2. and 3.)

For 1), the specifications define accuracy of Global Map data as follows:
"For horizontal accuracy, 90% of points will be within ±2km of their actual location. In the case of data obtained from satellite images, the maximum error is less than or equal to 0.5km. Vertical accuracy is notionally ±150 metres for 90% of points. This figure may need to be reviewed once the data are available, as sources to this accuracy may not be available in areas of high relief."

For 2), everyone can see the features and attributes that are included in the Global Map Specifications on the Global Map Website (http://www.iscgm.org/).

For 3), Global Map data consist of following 8 layers:
a) Transportation (i.e. Railroad, Road…)
b) Boundary (i.e. Political Boundary, Coast Line…)
c) Drainage (i.e. Water Course, Inland Water…)
d) Population Centers (Built-up Area, Miscellaneous Population…)
e) Elevation
f) Vegetation
g) Land Cover
h) Land Use.

The former four layers are vector data and the latter four layers are in raster format. Everyone can download the data freely for non-commercial use through the Global Map Website mentioned above.

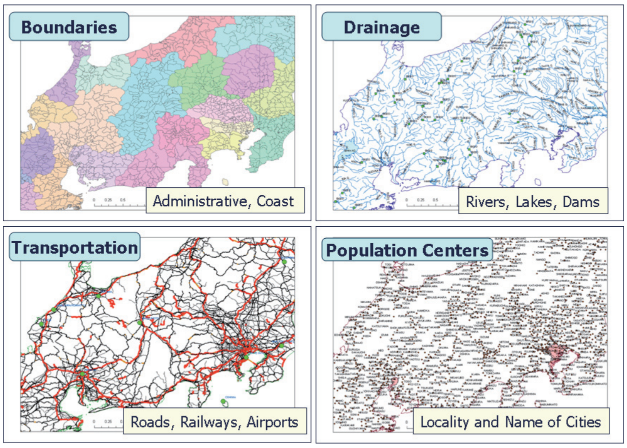

Figure 2. Contents of vector layers

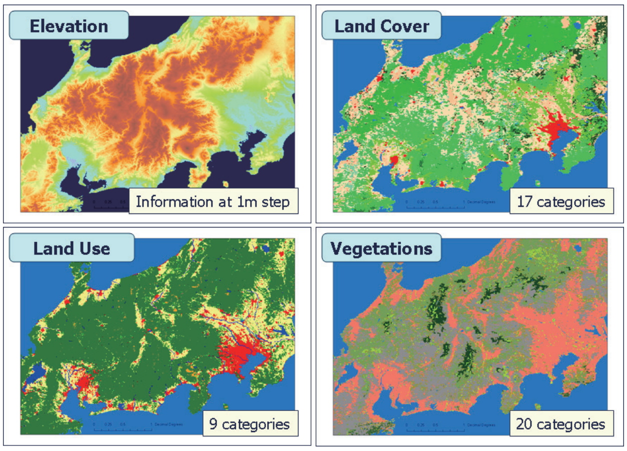

Figure 3. Contents of raster layers

These data are produced mainly from existing geographic information, such as topographical maps, earth observation data and satellite imagery with remote sensing technology, combined with analysis of existing data (Figure 4.).

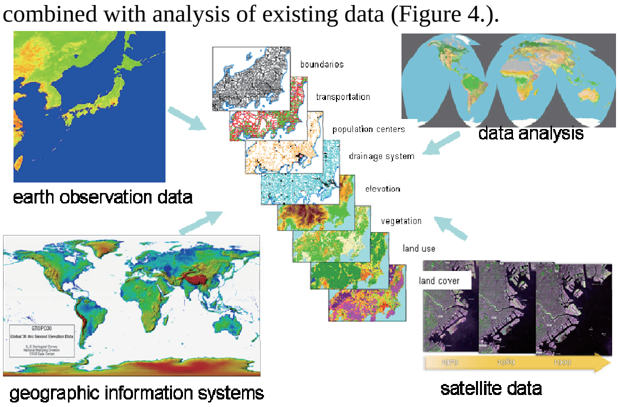

Figure 4. Best use of technologies for developing Global Map

Although Global Map data are expected to contribute to solving various global problems through their applications, only few applications are recognized by now as Global Mapping project is not well known to the public.

In the next chapter, we are going to mention about efforts for publicizing the project.

3. EFFORTS TO PUBLICIZE GLOBAL MAPPING PROJECT

Efforts to publicize Global Map are crucial to enhance the applications to make Global Map contribute to solving various global problems. These efforts need to be made both internationally and domestically. This paper deals with undertakings mainly in Japan, because they can be applied to other countries.

3.1 Establishment of "the Committee on Application Strategy for Global Maps"

In view of the importance of publication, MLIT organized a Committee on Application Strategy for Global Maps in 2003 chaired by Emeritus Prof. Yoshio Tsukio, University of Tokyo.

This is a national committee consists of distinguished national experts in various fields, such as geographic information, education, environment, and mass media.

The objective of this committee is to formulate an application strategy to gain more recognition of Global Maps and to promote practical application in Japan as well as in global community.

Through four meetings held in 2003 – 2004, various application plans were proposed and discussed. Then Application Strategy for Global Maps was formulated in September 2004.

The contents of the strategy are as follows:
1) Basic concepts of the application strategy for Global Maps
2) Proposed plans for the application strategy for Global Maps
- Execution of pioneering application plans -
3) Proposed plans for the application strategy for Global Maps
- General improvement on application -

At 1), The strategy mentions about the outline of Global Mapping project, considerable merits and problems of the project, concepts and directions for the publicity, proposed applications in line with the publicity of the project and solution of current problems, and relationship among proposed strategies.

At 2), The strategy proposes plans for developing application. The plans are divided into two main branches, a plan for information sharing and model plans for application.
For the information sharing, development of portal site is proposed. The purpose of this portal site is to share outcomes of Global Map applications. The portal site aims at promoting further applications of Global Map data through collecting various outcomes of Global Map applications and sharing them.
For the model applications, following six plans are proposed:
a) Cooperation with Other International Projects
In cooperation with other international research projects including environmental field and by integrating various geographic information, Global Map provides a base map for analysing various problems. Outcomes of these research works will be released.
Through the application of Global Map to environmental field, which is considered to be the most important area for Global Map applications, Global Map can really contribute to solving environmental problems, and thus gains recognition that the data are indispensable for researches and policy making aiming to solve such problems.
b) Regional Disaster Prevention Maps
In cooperation with other organizations which have information on disaster prevention, an Internet site is developed to effectively supply information on disaster prevention. This site will be used for the planning of disaster prevention by national and local governments.
In cooperation with various organizations as well, it is expected that specifications for disaster information databases, which is planned to be developed, will be harmonized with Global Map Specifications.
c) Global Map School
By communicating with both domestic and foreign schools, a scheme for learning will be developed through an exchange of mutual ideas in a global perspective. Through this learning, an international understanding among students will be improved. This plan could be a valuable tool for international exchange in educational field.
d) World History Observed through Global Map
A digital map that can be used for researching and studying world history in an easy manner is made by Global Map and related materials. People can grasp world history, such as historical change of international boundaries and the relationship of historical events in various areas at the same era, visually by mapping various historical events on the digital map.
e) My Global Map Contest
Contests that employ Global Map data as their sources are executed. Through the utilization of Global Map data by many users, publicity of Global Map will be improved and arising new applications.
f) Flight Navigation / Global Sightseeing Map Developed by Everyone
A "Flight Navigation" aiming at learning the earth is developed. By improving this tool, a sightseeing information sharing service can be developed with users' participation.

At 3), The strategy proposed plans for general improvement in application. These plans aim at promoting applications by improving current situations of Global Map data supply. Proposed plans are as follows:
a) Expansion of Coverage of Global Map Data
It is needed to achieve participation from the whole world; improve data development of Global Map; realize integrated utilization of both land and ocean data; and strengthen system of international promotion.
b) Improvement in Data Utilization
It is needed to establish portal site; improve data format; support users; and develop an environment that enables utilization of maps besides original Global Maps (1:1,000,000).
c) Establishment of Promoting System for Easier Applications
Commercial use of Global Map data is considered to be a breakthrough at present, however, such use requires permissions of all the countries included in the Global Map to be used. It is needed to improve this situation to accelerate applications of Global Map.

Every plan shown in this document will play an important role for improving utilizations and applications of Global Map data. We are going to explain, among others, "Global Map School" that is planned to be executed soon as one of the most effective plans for promoting applications of Global Map data.

4. MODEL APPLICATION "GLOBAL MAP SCHOOL"

As mentioned above, "Global Map School" is considered to be one of the most feasible applications. This application aims at:

"By communicating with both domestic and foreign schools, a scheme for learning will be developed through an exchange of mutual ideas in a global perspective. Through this learning, an international understanding among students will be improved. This plan could be a valuable tool for international exchange in educational field."

"Global Map School" project is executed according to the following process (also shown in Figure 5.):

a) At first, discussion theme has to be decided. Then, Global Map data, application tool and data related to discussion theme will be provided to model schools. With these tools, all the model schools will create maps according to the same theme.
b) Second, ideas among model schools will be exchanged through e-mail and bulletin boards prepared on the Internet environment. Every student and teacher can see the outcomes from other model schools by uploading the results of learning in text or image files.
c) Then, at an event of exchanging the knowledge, students of each model school will exchange their understanding through teleconference system.

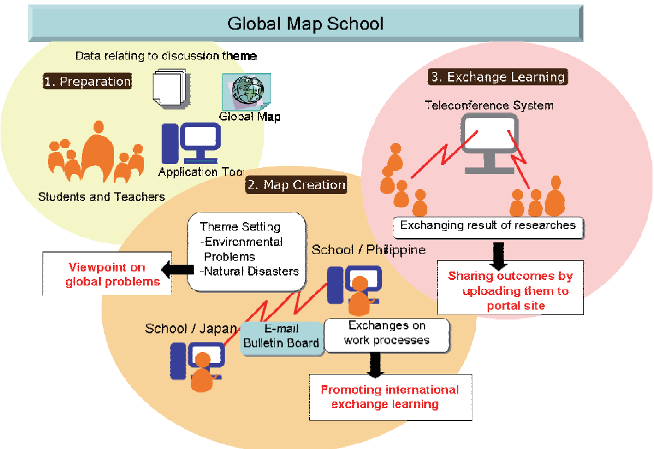

Figure 5. Process of "Global Mapping School" project

Actually, the first "Global Mapping School" project is in progress. Currently, a certain school in Japan and in the Philippine are due to join in this project as model schools. The first event to exchange learning will be scheduled in this September.

Although this attempt might be a simple case study for applying geographic information in the educational field, we hope that the project will be executed as a touchstone for the application of geographic information developed by remote sensing and other technologies, in international communication in education.

5. CONCLUSION

Global Mapping project is a worldwide project with 160 participating NMOs. The project has already released Global Map data of 22 countries. A lot of efforts have been made for promoting the project, however, the project is not so well known to the public.

In view of the importance of publicity, MLIT organized a Committee on Application Strategy for Global Maps in 2003. In a plan developed in 2004 by this committee, six projects were proposed as appropriate activities for applications of Global Map.

"Global Map School" is a project to apply Global Map to educational field as it was considered to be the most practicable. It is expected that the project could become a touchstone for application of geographic information developed by remote sensing and other technologies, in international communication in education.

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GEOMATIC EDUCATION IN MALAYSIA: TIME TO DO SOME REALIGNMENT

Azmi Hassan and Mustafa Din Subari
Center for Technology Policy & International Studies (CENTEPIS)
Universiti Teknologi Malaysia
Jalan Semarak 54100 Kuala Lumpur
MALAYSIA
azmih@citycampus.utm.my

KEY WORDS: Geomatic, Education, Patent, GNSS.

ABSTRACT

This paper identifies GNSS education and training program under Geomatic field of study. GNSS education programs is evaluated vis-à-vis new-products. Data on Geomatic knowledge generation in the era of the GNSS derivatives over the 1975 – 2003 period are examined. The emerging trends and patterns; in particular for selected Asian nations will be dissected in detail. The knowledge indicator used in this study is the patent ownership against the background of emergence of new core technologies and innovations in the field of GNSS. Looking at the dismal performance of Geomatic professionals in terms of innovative activities in most part of Asian and Malaysia in particular, is it there is something that holding up these professionals from doing so? With our universities and numerous polytechnics offering Geomatic program, more is expected from them. Is it a problem of lack or inadequacy of skills? Or is it these professionals are too busy and being narrowly focused on doing something else?

1.0 INTRODUCTION

Global Navigation Satellite Systems (GNSS) are Radio navigation system that utilizes orbiting satellites as their reference stations. The USA's NAVSTAR Global Positioning System (GPS), and the Russia's GLONASS, are the two core GNSS systems currently in service. Galileo is the European Union's equivalence, which is planned to be in operation only in the year 2008. GNSS are used for a wide variety of applications by many different users. Besides the military, end users fall into several sectors. GNSS offers two main services, namely location-based. The main applications of GNSS are navigation on land, sea, air and space. With the advent of sophisticated carrier phase processing, surveying and mapping applications was developed. Other GNSS applications are timing and scientific. Domestic GNSS users vary within these applications, with surveying and mapping communities in the lead since the pre-GPS era. Navigation users on the other hand are emerging quite strongly. Education and training programs in GNSS is no doubt an important element in this emergence.

There seems to be numerous GNSS education and training programs around locally, with government's institutions and agencies taking the lead. Private industries such as GNSS vendors are also running specialized short courses, specifically hardware and software specific. Those taking the courses come from a huge variety of backgrounds - environmentalists, people working in local and central government, utility companies, the military and non-governmental organizations. And there seem to be about hundreds of different GNSS and related textbooks.

Yet, despite all this, GNSS education and training is astonishingly lacking behind and - in our view - is mostly stuck on historical tramlines. Since the emergence of GPS in the middle 1980's and lately GNSS, there has been a shortage of skills in its use at several levels. Most educators were of the view that the technical complexity of GNSS operations and their sophisticated implementation requirements made the design and development of GNSS difficult to understand.

2.0 BACKGROUND

In Malaysia, GNSS education and training programs appears under Geomatic field of study. Geomatic study primarily entered university curricula in the mid-1980s, although there are notable exceptions such as at the UTM which commenced its undergraduate program a decade before in the early 1970s.

Teaching of Geomatic through the 1990's continued to follow a largely conventional path with lectures on theory plus practical exercises using either the latest technology from the major vendors (such as Ashtech and Trimble) or more commonly through the use of more simplified PC-based, university-developed software products.

Since those early years, UTM, USM, UPM and UiTM have now established graduate programs in Geomatic, while individual service subjects have also been made widely available for students. However, there is now an increasing trend towards the recognition of Geomatic technology as a discipline in its own right, and complete programs are becoming available at the undergraduate and graduate level. Examples from UTM include: the Bachelor of Geomatic Engineering.

The current Geomatic undergraduate degree administered by the Department of Geomatics at the UTM is the Bachelor of Geomatic Engineering - a four-year professional course of study that meets the requirements of the Institution of Surveyors, Malaysia. The degree originally had its foundations in land surveying and mapping science, but in recent years has moved into the wider domain of Geomatic field. Nonetheless, it is still fundamentally a professional engineering degree structured around the requirements of the professional bodies and licensing authorities that accredit it.

However, the Geomatic engineering discipline has rapidly expanded over the last decade—to the extent that the geographic component of information technology has now become a major global growth area. Indeed, annual worldwide expenditure in this field (in terms of software, hardware, training and data) is estimated to grow tremendously. Thus, the demand for qualified graduates in this area is becoming more acute than ever before, and is certainly greater than the demand for graduates from the Department's mainstream professional engineering degree.

Today there are only few government organizations that do not utilize satellite-positioning technology in some way for managing their data and assets, and for aiding many of their strategic decisions. Furthermore, GNSS is now accepted as a mainstream technology within local government and utilities, particularly for managing infrastructure, and these systems are also a key tool for the majority of environmental and natural resource management agencies.

While the B. Sc. Geomatic Engineering degree has moved a long way towards helping to meet the shortfall in human capital in the GNSS industry, it is still constrained by its need to serve the land surveying and engineering professions, yet the rapidly growing locational information industry is continuing to demand at a greater heights.

3.0 GNSS EDUCATION

Generally, what is required in programs of GNSS education are topics covering understanding of the GNSS system, its capability and limitations, extent of applications, and other associated or related topics. These could be achieved through taught modules as well as hands-on sessions (Walter, 2002 and Merry, 2002).

Within the understanding of the GNSS systems, discussions could be made on the system architecture and working principles, hardware and operations. For example, users should understand that GNSS are radio navigation systems which uses satellites to transmit the navigation signals to its users. The satellites however are passive devices. It only re-transmitting back whatever information uploaded to its memory. The system is actually governed by a network of Ground Control Stations which maintains and defined the reference datum, as well as tracking the satellites to determine its orbital motion. The users on the other hand requires a suitable receiver to receive signals from the satellites to obtained its services. GNSS offers at least three services, namely location-based services (LBS), precise timing and military/scientific. For the LBS, users need to receive at least signal from four satellites and using a triliteration formula within the receiver's firmware, to compute its position with respect to the reference datum of specific system. For the precise timing applications, a single satellite is what is needed to give time accurate to about a millisecond. Signals of GNSS could also be used for scientific purposes, such as for the monitoring of the Total electron Content (TEC) of the atmosphere (Walter, 2003).

Users also need to know capabilities and limitations of GNSS. On a basic mode user operation, GNSS could give positioning accuracy to within several tenths of meters and height determinations to about three times as worse. On a differential mode (D-GNSS), a significant improvement could be achieved, with positioning accuracy to 2-3 meters only and height to about 5-7 meters. With the use of carrier-phase data of the transmitted signals, a more sophisticated receiver as well as rigorous data processing algorithm, user could determine their position up to couple centimeters and height to about several centimeters. Limitations to GNSS services are mainly things that interrupts the operation of its system, such as the delay in the propagation path of the signal caused by the atmosphere, signal blockage such as by dense tree foliage and structures such as building walls and tunnels. For sure, GNSS signals could not travels in water. GNSS need a reasonable area of open sky, to enable the receiver receiving its signal. GNSS signals could also be interrupted by other signal transmissions from such as radio and cellular services tower.

Users have to be aware that at least two of the existing GNSS, namely the GPS and GLONASS are military navigation system, hence having a dual-service signals, military and civilian. By this virtue, military usage of these systems takes precedent over the civilian usage. By default also, military services is of several fold better than the civilian services.

3.0 GNSS EDUCATION PROGRAMS IN MALAYSIA

GNSS education and training programs in Malaysia can be grouped into formal education programs, short-courses and other programs.

3.1 Formal GNSS Education Programs

Formal GNSS education programs are carried out through taught course and research, leading to an academic award.

Universiti Teknologi Malaysia (UTM) is probably the only local university offering taught courses in GNSS. Masters in Science (Satellite Navigation) contains subjects such as Navstar GPS, GPS Navigation, Navigation Systems, and Intelligent Transportation System. While Masters in Science (Satellite Surveying) contains subjects of GPS Surveying, GPS Geodesy, GPS Navigation, and GPS Applications in Surveying and GIS. Two other programs, Masters in Science (Geomatic Engineering) and Masters in Science (Hydrographis Surveying) contain a couple of GNSS related subjects (FKSG, 2003).

UTM is also teaching several GNSS subjects in their Bachelor Degree of Geomatic Engineering, namely GPS Surveying, Satellite Navigation, and Hydrographic Positioning Systems. Post Graduate program through research works related to GNSS are also offered in areas of Satellite Navigation, Satellite Surveying, Geomatic Engineering, Hydrographic Surveying.

Universiti Putra Malaysia (UPM) teaches subject of Satellite Surveying in their Bachelor of Civil Engineering as well as subject of GPS in their Masters of Engineering (Remote Sensing and GIS) (Mansor, 2004). Universiti Teknologi Mara (UiTM) are teaching topics of GNSS in subjects such as Physical and Satellite

Geodesy, Geodetic Surveying, and Hydrography, under their Bachelor of Surveying Sciences and Geomatic, as well as subject of Geodetic Surveying under their Diploma of Geomatic Science program (Rosdi, 2004). Universiti Teknologi Petronas (UTP) teaches topics of GNSS in subject Geomatic under their Bachelor of Civil Engineering, while Akademi Laut Malaysia (ALAM) also teaches topics of GNSS in their subject of Electronic Navigation Aids (ENA) (Matori, 2004). Universiti Sains Malaysia (USM) is also teaching GNSS and related topics in their Bachelor of Civil Engineering program (W. Ismail, 2004).

3.2 Short-Courses

Institutions mentioned earlier under item 3.1 also from time to time offers short courses in GNSS and related topics. Apart from that Institut Tanah dan Ukur Negara (INSTUN), under the Jabatan Ukur dan Pemetaan Malaysia (JUPEM) also offers short courses in GNSS and related topics, which is mainly for their own staff in-house HRD programs. These courses are mainly focused on subjects or topics. The other parties that offers short-courses, which on the other hand focuses on instrumentations – hardwares and softwares – are GNSS related local vendors.

3.3 Other GNSS Education Programs

Local institutions also organize seminars and meetings on GNSS and related field. Such meetings are (just to mentioned several of them, for example);

1. UNOOSA The first regional workshop was held in Malaysia in August 2001 for countries in Asia and the Pacific
2. International Symposium and Exhibition on Geoinformation series, started 2002 - current
3. National Seminar on Geoinformation, started 1997 – 2001
4. National Seminar on GNSS Applications, started 2004.

4.0 THE NEW GEOMATIC & GNSS ERA

In this era of the so-called GNSS era, knowledge and innovation is considered as a crucial input in the industrialization and development of any nations. The GNSS economy is strongly influenced by the liberalization of international trade system worldwide where emphasis is given to competitiveness. With this scenario, the importance of knowledge as a factor determining the growth of nations is critically important. Malaysia, as a developing nation, sourced out its quest for high-tech knowledge from abroad, especially in the early stages of her development.

But the New Economy changed how businesses are conducted and the new rules of the game require speed, flexibility and innovation. A metal casting firm uses computer-aided manufacturing technology to cut cost, time and energy. A farmer who sows genetically altered seed and drives a tractor navigate by the GPS satellites. Or a toy manufacturer that uses the Internet to take orders from customers all over around the world. The New Economy gives birth to industry giants such as the Apple Computers from Steve Job’s and Steve Wozniak’s garage and Dell Computers from the trunk of Michael Dell’s car. A nation’s economic success will increasingly be determined by how effectively they can spur technological innovation, entrepreneurship, education, specialized skills, and the transition of all organizations—public and private—from bureaucratic hierarchies to learning networks.

5.0 GENERAL TRENDS IN GEOMATIC KNOWLEDGE GENERATION

It is well known fact that the innovative activity which, is the primary source of knowledge generation, concentrated only in a number of developed nations. Within these developed nations, these activities are only concentrated and dominated by only a small number of corporations.

In developing nations, the primary mode of promoting technology advances is through technology acquisition. However, in this new era of economy, the focus is on innovation and the creation of new technology and higher value-added activities by increasing basic and applied research. Malaysia, for example in the early years of its development has placed its primary emphasis on technology acquisition. As its per capita income increases, Malaysia is putting in place major fundamental research & development programs in the public and private sectors in an attempt to attain world leadership in key areas.

Table 1 shows two indicators of innovative activity for key Asian nations. These two indicators cover both knowledge 'inputs' as well as 'output'. R&D expenditures are considered the ‘input’ indicator of the innovative activity. The knowledge output indicator considered in this study is patents obtained by inventors from different nations at the US Patent and Trademark Office over the past 25 years period (1975-2000). There are other forms of knowledge generation activities such as copyright and trade secret. However, because patenting is the primary form of intellectual property protection, patent data are considered to be the most available, objective and qualitative measure of knowledge output. Thus, a nation's patenting activity is an indicator of the strength of its research enterprise and technological strengths, both overall and in particular fields of technology.

The table reveals that an extreme form of knowledge generation concentration with just three nations of Asia, which account for the bulk of all innovative activities in Asia. This top three nation’s of Asia, that is Japan, Taiwan and South Korea account for as much as 80% of Asia resources spent on R&D activity annually. In terms of knowledge output, the same top three nations have the most number of patents issued. They account nearly 98% of the knowledge output in terms of patents taken out in the US. Hence, the concentration in terms of knowledge output is even more uneven than for the knowledge inputs. But the obvious trend is that the control over knowledge is directly related to the amount of fund allocated to its R&D. Malaysia for example, allocated only 0.20% of its GDP for R&D purposes and this is reflected in the number of patents awarded for the past 25 year period, which amounted to only a meager 384 patents. The trend shows that Japan is way ahead in their innovation activities with a total of 426, 702 patents issued to them.

Besides the patenting activity defined by a nation of the inventor in all type of sectors, trends were also analyzed by the number of patents issued that are related to the Geomatic field. Keywords related to this field such as GPS, GNSS, mapping, remote sensing, triangulation, spatial, and photogrammetry are among others that are used in the definition. Table 2 shows the number of patents produced for the Geomatic field for a period from 1982 to 2001.

Nation	GDP 1999 (US $Billion)	R&D Expenditure as % of GDP (1998)	US Patents Taken (1975-2000)
Japan	4,357.7	2.90	426,702
China	991.2	0.69	1393
South Korea	406.9	2.68	19,935
India	440.5	0.67	1127
Taiwan	288.6	1.98	31968
Indonesia	151.9	0.09	153
Thailand	125.3	0.17	238
Malaysia	78.9	0.20	384
Hong Kong	158.6	0.25	4316
Singapore	84.9	1.79	1406
Philippines	76.5	0.08	228

Table 1: General Trend in Knowledge Generation in Asia

Period/ Country	1982-1986	1987-1991	1992-1996	1997-2001	Total
Japan	3	7	117	108	235
China	2	10	1	1	14
South Korea	0	1	3	5	9
India	0	0	0	2	2
Taiwan	0	1	5	14	20
Indonesia	0	0	0	0	0
Thailand	0	0	0	0	0
Malaysia	0	0	0	0	0
Hong Kong	0	0	2	1	3
Singapore	0	0	2	1	3
Philippines	0	0	0	0	0
Others	413	667	1058	1018	3156

Table 2: Number of Patents Produced for the Geomatic Field

Table 2 shows that Japan still leads in their patenting activities with a total of 235 Geomatic patents issued for the 20-year period. And this is followed by South Korea, Taiwan and China. Out of the total 3442 Geomatic patents issued by the U.S. Patent and Trademark Office, only 286 or 8% originates from the Asian countries. The remainder of the 92% of the patents mostly originates either from North America or Europe. The numbers shows that there is lack of innovative activities amongst the Geomatic professionals in the Asian region compared to their North American or European counterparts. What is more disturbing is that Malaysia, which boasted four higher education institutions (UTM, UPM, UiTM and USM) that offered Geomatic program does not possessed a single patent in the Geomatic sector. Ironically Singapore, which the number of Geomatic professionals is far less than that of Malaysia has already produced three patents that are related to the Geomatic sector.

To make a definitive comparison on the innovation activities of Geomatic sector to other sectors, data for five different sectors are compiled and tabulated for selected Asian nations. The sectors concerned are Advanced Materials, Automotive, Health, ICT and Transport. Table 3 shows the patents count of major Asian nations. The table is based on the indicators computed for the same four five-year periods: 1982-1986, 1987-1991, 1992-1996 and 1997-2001.

The table shows that Japan leads in all sectors in terms of the number of patents issued. But the technological capabilities of Korea and Taiwan are budding, with their growing strength most evident in the advanced materials and ICT sectors. In the transportation sector, Korea and Taiwan are showing steadily growing strength. On the other sides, three Asian nations of Malaysia, Hong Kong and Singapore do not have enough patenting activities in any of these five sectors to be identified as emerging competitors. Singapore for example allocated nearly 1.79 % of its GDP for R&D purposes and these percentage points is comparable to Korea or Taiwan, but still lags behind. The most probable reason for this trend is that these three nations lack what is called the indigenous R&D capability. For the most part, manufacturing and industrial development are currently supported by R&D done elsewhere.

Comparing the number of patents generated by Geomatic professionals with the other five sectors shows a very disturbing trend. Lets take Japan for example, leaders both in the number of Geomatic patents and number of all types of patents for Asian nation. For the 20-year period, Japan has produced a total of 235 patents related to Geomatic sector. Among the five sectors, transport shows the least number of patents produced that is 5213 patents. Therefore, when compared to the weakest link of the five sectors, Geomatic still pale behind considering the number of patents produced.

Even though Malaysia dose not produce a single patent in Geomatic field, but all the other five sectors have some form of innovative activities in terms of the number of patents. The problem of lack of innovative activity is not only confined to Malaysia alone, but also to all other Asian nations as shown both in Table 2 and 3. The lack of innovative activities it seems is not confined to a particular nation but to the Geomatic professionals itself.

6.0 CONCLUSIONS

Looking at the dismal performance of Geomatic professionals in terms of innovative activities in most part of Asian and Malaysia in particular, is it there is something that holding up these professionals from doing so? With our universities and numerous polytechnics offering Geomatic program, more is expected from them. Is it a problem of lack or inadequacy of skills? Or is it these professionals are too busy and being narrowly focused on doing something else?

Malaysian business are generally doing well, in large measure, as a result of our national investments in science and technology, and the innovation and competitiveness they yield. In this perpetual marathon that is global competition, now is the appropriate time to strengthen our effort into bringing the Geomatic field to greater heights. We must prepareourselves to seize new GNSS sector opportunities and create fertile ground for economic growth.

The world's GNSS sector is undergoing a fundamental transformation where revolutionary technological advances such as powerful personal computers; high-speed telecommunications and the Internet are the root cause of it. The sudden transformation of GNSS changed how Geomatic business is conducted and the new rules of the game require speed, flexibility and innovation. Geomatic studies need not be in the frenetic action of the cutting edge but revolves their organizing work around high technology. The Geomatic in the arena of GNSS derivatives holds vast potential for extending the technology-driven economic growth of a nation.

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Sector	**Advanced Material**					**Automotive**					**Health**					**ICT**					**Transport**					Total
Country	**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		
China	0	2	4	6	(12)	0	10	7	16	(33)	1	16	38	45	(100)	2	21	36	56	(115)	1	2	3	6	(12)	**272**
Hong Kong	0	1	1	1	(3)	1	2	3	3	(9)	1	4	12	17	(34)	7	7	26	32	(72)	1	1	2	3	(7)	**115**
India	0	2	6	6	(14)	0	0	3	4	(7)	11	15	57	65	(148)	1	4	41	49	(95)	0	0	3	9	(12)	**276**
Japan	46	1329	1862	3053	(6290)	2058	3754	3217	4326	(13355)	1497	2510	3008	3867	(10882)	7012	16208	25015	45924	(94159)	432	1215	1560	2006	(5213)	**129899**
Malaysia	0	0	0	1	(1)	1	0	0	2	(3)	0	0	2	2	(4)	2	4	10	15	(31)	0	0	2	4	(6)	**45**
Singapore	0	2	3	7	(12)	1	0	0	1	(2)	0	0	3	5	(8)	1	8	82	127	(218)	0	1	0	1	(2)	**242**
S. Korea	1	3	57	65	(126)	2	27	72	103	(204)	5	12	74	92	(183)	4	224	1629	3429	(5286)	0	7	38	65	(110)	**5549**
Taiwan	1	9	45	83	(138)	15	109	204	326	(654)	4	8	34	101	(147)	12	113	1007	1743	(2875)	1	22	39	47	(109)	**3923**

Note: Number in brackets is the total of each sector.

Table 3: Patent Counts of Other Sectors for Selected Asian Countries.

ACTIVITIES TOWARDS DISSEMINATION OF GEOGRAPHIC INFORMATION IN MACEDONIA

K. Yamada [a], K. Tsuda [a]

[a] Kokusai Kogyo Co., Ltd., Sanban-cho 5, Chiyoda-ku,, Tokyo, Japan
keiji_yamada@kkc.co.jp
kaoru_tsuda@kkc.co.jp

KEY WORDS: Developing Countries, Environment, Mapping, Cooperation, Education

ABSTRACT:

We report the result of an environmental thematic map contest for elementary and junior high school students and a map dissemination forum aiming for geographic information popularization in Former Yugoslav Republic of Macedonia. These activities were conducted as a part of 1:25,000 national spatial data infrastructure (NSDI) project of Macedonia funded by Japan International Cooperation Agency (JICA). The project consists of the establishment of NSDI, technology transfer training for surveying and mapping of NSDI and disseminating geographic information. Until today, maps and geographic information were of no interest or use to people in Macedonia. The reasons being that maps were not available to the public before independence, relatively expensive, inconvenient to purchase, and not used in academic activities. It is a must to increase the number of users and to be acknowledged by the public in order to realize the sustainable development of NSDI and wide use of GIS which will contribute to economical development. In the study, we aimed to enhance the future use of maps and geographic information by offering the opportunities to enjoy their use and to understand the benefit of them. It is a known fact that a top-down approach for promoting the use of geographic information using IT technology towards the whole society is effective. However it was also realized from this study that such continuous grass-roots activities are as well the effective approach.

1. INTRODUCTION

With the commission of the Japan international Cooperation Agency (hereinafter referred to as JICA), in April 2004 we began the “Study for Establishment of State Base Map” in the Former Yugoslav Republic of Macedonia (hereinafter referred to as Macedonia) (Population of approximately 2 Million). The main activities of this study are to establish a National Topographic Map of approximately 14,000km2 (1:25,000 scale) within the whole area of Macedonia (area of 25,713 sqkm2), transfer technology to the Governmental Survey Institute and disseminate geographical information. The study period is approximately 3 years.

The investment and effectiveness of Official Development Assistance (ODA) is evaluated objectively. It is expected that the establishment of National Topographic Maps will become the foundation for various succeeding development aid and after completion will have a wide scope of practical uses.

This article reports how National Topographic Maps widely recognize the social infrastructure, and explains the geographical information dissemination activities which aimed to promote wide-spread use of these Topographic Maps. We will also make special mention of the reception of this grass-root activity Environmental Thematic Map Contest and Map Forum which had never been experienced previously.

2. GEOGRAPHICAL INFORMATION ISSUES IN MACEDONIA

When the Former Yugoslav Commonwealth was a Republic, Macedonia’s Topographic Maps were controlled as classified information and ordinary citizens had no knowledge of them at all.

Despite geographical information being presented to the public after independence, until now there has been hardly any use of it. The following tables 1-6 show the status of utilization of Geographical Information for Macedonia, neighbouring countries as well as Japan according to an inquiry survey.

Scale \ Country	Japan	Slovenia	Hungary	Czech	Macedonia
1:25,000	1986 - 2005	1993 - 1999	1976 - 2002	2004	1971 - 1972
The oldest maps currently sold	1986	1970	1976	1971	1944

Table 1. Production Year of Topographic Maps

Scale \ Country	Japan	Slovenia	Hungary	Czech	Macedonia
1:25,000	1.9	3.0	6.4	1.7	144

(in Euro)

Table 2. Price of Topographic maps (paper map)

Country / Place	Japan	Slovenia	Hungary	Czech	Macedonia
Government Office	Map Center, Head Quarters	1	138	9	1
Others	1600 book store & Agents	Book stores	N/A	N/A	N/A

Table 3. Places to Purchase Topographic maps

Country / Info Type	Japan	Slovenia	Hungary	Czech	Macedonia
Order of Geo-information through web-site	Yes	Yes	Yes	Yes	-
Free Download of Thematic Maps	Yes	Yes	-	-	-
Free Download of Topographic Maps	Yes	-	-	-	-

Table 4. Web-service by Survey and Mapping Organization

Country	Japan	Slovenia	Hungary	Czech	Macedonia
Waiting Time	5 min.	5 min.	5 min.	5 min.	5 Days

Table 5. Waiting Time for Purchasing Maps

Country	Japan	Slovenia	Hungary	Czech	Macedonia
1:25,000 Printed maps	1,308,000	8,000	15,000	28,694	46

Table 6. Number of Maps sold in 2004

Due to reasons such as information being outdated, expensive and the troublesome purchasing procedure, only 46 maps were sold throughout the whole country in the space of 1 year. We, the study team were strongly concerned that the new National Topographic Maps that we produced would not be effectively used and that the implementation of the constructed maps would not be utilized.

Furthermore, according to an interview confirming that there was a lack of formal education on topics such as Macedonia's domestic industry, the environment, geography, etc we thought that in future we would not see an increase in the number of potential map users.

3. GEOGRAPHICAL INFORMATION DISSEMINATION ACTIVITIES

3.1 Plan for Geographical Information Dissemination Activities

Using the clarification of the current status of the utilization of geographical information and the issues as a start point, we carried out a plan concerning activities for the dissemination of geographical information in order for the National Topographic Maps and geographical information developed by this project to be continuously utilized.

The afore-mentioned status of the use of geographical information is not simply the case for Macedonia. The establishment of National Topographic maps is one of the many cases which have to be considered for Official Development Assistance. For that reason it can be said that it is not a versatile process for the solution. This project intended to combine the collective efforts of various disseminating activities in order to produce results.

Firstly, mass communication and the internet were used to release the information to the general public. The details are shown in table 7.

Activities	Description	
News Letter	Project information is released on the internet through a Survey Institute's website	
News Paper	An article introducing the project is released in major newspapers	
Television	The project is introduced on State owned channels	
TV Comedy-show	Televised as a comedy by a famous comedians	

Table 7. Activities through mass-media

The benefits of releasing information to the general public this way are that it is cheap and has a wide spectrum. However the disadvantage is that it is difficult to realize its effectiveness. For this reason we also planned our dissemination activities focusing on respondents who have never experienced a grass-roots movement previously. This article reports on the activity of the Environmental Map Contest and the Map Forum.

3.2 Environmental Map Contest

3.2.1 Outline: In recent years there have been various map contests held in Japan. Most of these contests utilize high interest techniques concerning maps and map contents.

The aims of the Environmental Map Contest, as part of the dissemination of geographical information, are for the children to become familiar with maps and to learn about their surrounding environment. It is hoped that the geographical information will be used in education and will lead to future potential geographical information users or the cultivation of technical experts in this field.

The application period ran from October 2004 until early February 2005 and the exhibition and awards ceremony was held of the 18^{th} of February. The subject area Prilep (Population 70,000) is a major urban area in the heart of Macedonia and the subjects were 5^{th} year (age 8) to 8^{th} year (age 11) students who are studying geography in one of the 7 schools for elementary education (8 grades).

3.2.2 Idea and Method: The ideas and techniques were drawn from a publication by the Environmental Map Education Research Society in Asahikawashi city, Hokkaido, Japan, entitled “Making maps of the environment around us” (hereinafter ”Environmental Map Manual”), as well as the Environmental Map Exhibition carried out at Tamashi City Government Office in Tokyo. As this was the first time an environment related contest was carried out in Macedonia and it was also the first time for JICA to carry out this kind of event on the topic of geographical information, the references of the environmental map contests held in Japan were widely consulted.

3.2.3 Hearing: Firstly the Environment Manual was read carefully, it had to be adapted to meet Macedonia’s country conditions then the manual had to be translated into Macedonian. After that we carried out a hearing with geography teachers and the Ministry of Education confirming whether or not there were admissible grounds for such as event, what problems would arise at the time of implementation and whether or not they would collaborate. Fortunately we were able to affirm that we would receive full cooperation from the schools and the Ministry of Education.

3.2.4 Problems: On another front, implementation problems arose. All of the schools had seldom budgeted for educational materials. It was discovered that because photocopiers and examination papers were not supplied, a fee was collected from students when they sat examinations.

Therefore the study team distributed 70 sets (total 350 sets) of Topographic Map making kits (containing A1 size drawing paper, A3 size notebooks for use during field study, colour pencils, crayons and markers) to each of the 7 subject schools. In addition we distributed extra copies of essential papers such as registers of participants, name tags to stick on their work; and the schools had no obligation to fund the preparations.

Moreover, the schools did not have topographic maps or aerial photographs so in order to help them prepare and plan the creation of environmental maps we provided them with aerial photographs which the study team had taken in July 2004.

3.2.5 Presentation: Taking into account the possibility that presenting teachers with translated manuals and posters is not going to effectively communicate the object to students, for 50 classes we carried out 10-30 minute presentations including introducing Japan. At that time we distributed a large number of pamphlets entitled “Holding of the Environmental Map Contest” and “Why are JICA supporting the creation of maps?”. As a result, the presentation activities encouraged the teacher’s efforts and led to an increase in output.

3.2.6 Result: After the Environmental Map production period, they were collected and evaluated. We first expected 10 maps from each school, a total of 70 maps, and 350 participants. However the results far exceeded our expectations, with 276 maps and 1109 participants.

The selection of the exceptional maps was carried out by the study team, Ministry of Education, Cadastral and Survey Institute and a local television channel. For the 5th year to the 8th year students a total of 19 prizes for things like each outstanding map, creativity etc were awarded from the selection parties. In addition a special prize was awarded to the school that produced the largest number of maps. The selection criteria were also in accordance to the Environmental Manual.

On the maps we could see an abundance of litter In addition, we could see subjects of various measures such as maps surveying local tobacco cultivating areas, maps plotting the location of traffic accidents, surveys of households with pets, the activity of stray dogs, free spaces in car parks etc.

3.2.7 Exhibition and Awards Ceremony: The exhibition was held on the 18^{th} of February over a period of 5 hours and approximately 2000 people attended. Furthermore, 200 people attended the awards ceremony that evening.

The students who received the outstanding individual award and group award were asked to give a presentation about things such as the reason for their selected topic, difficulties they faced when carrying out the survey and things they discovered. The students that this contest was aimed at had mostly never taken part in contests and the parents and relatives of the commended children watched proudly and warmly hugged the students.

Figure 1. The Environmental Map Content Presentation

Figure 2. The Environmental Map Content Exhibition

Figure 3. The Environmental Map Contest Awards Ceremony

3.3 Map Forum

With the aim of disseminating the project results and the Geographic Information, "New Era of Mapping in Macedonia" was held focusing on government agencies, relation to education, public institutions such as electricity and water suppliers, private companies, international organizations and aid agencies from each nation. The program of the forum is laid out in table 8.

Approximately 200 people attended the forum and there was active discussion. For the users it was an opportunity to become acquainted with the latest information and for the maintenance side it became an opportunity to hear first-hand the needs of the users.

Based on the needs of the users and advanced reports regarding the surrounding countries, the Cadastral and Survey Institute declared that hereafter they had a concrete plan to establish maps for Geographic information, sales plans and carry out organization control reforms.

Topics	Contents
The history of Macedonia's maps	Introduction to the transition of establishing Topographic Maps
The current status of Topographic Map selling	Introduction to the current status of selling Topographic Maps and organization of issues
The required Geographic Information and the service	The arrangement of the required data and service
The application of new Geographic Information.	Introduction by a technical expert as to examples of how Geographic Information can be used
Macedonia's GIS	Introduction to examples of how Geographic Information can be utilized for the case of Private GIS companies
The current status of Geographic Information of the neighbouring countries (Czech Republic, Hungary)	Introduction to the statistics for Topographic Map sales and utilization in the neighbouring countries.
Geographic Information Society in Japan	Introduction of Spatial data use utilization in Car Navigation Systems in the case of Japan
Improvement of the Acreage and Survey Agency's Geographic Information Service	Using the results of the discussion to organize the necessary points for improvement

Table 8. Topics of Map Forum

Figure 4. Map Forum

4. CONCLUSION

Using this project as an example, for National Topographic Map Establishment projects under ODA, regardless of area or country, most of the data lifecycles have common issues (Figure 5). According to the study results at the hearing, it was realized that these issues are inter-related. For this reason it is expected that when one issue is resolved, it should have a favourable impact on the other issues.

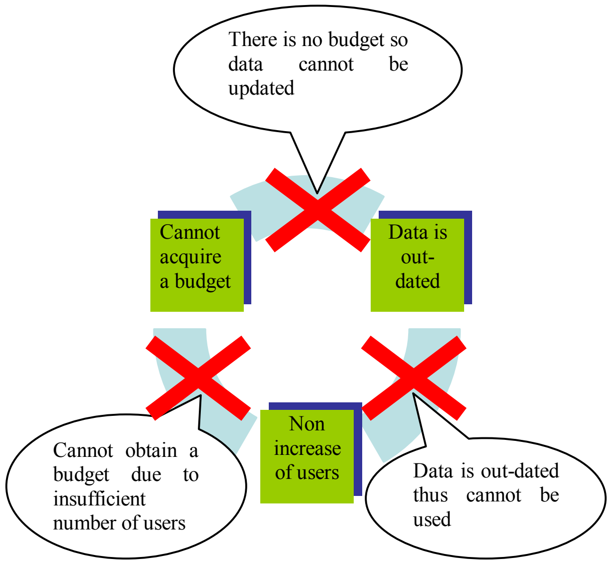

Figure 5. Problems on Data Life Cycle

The activities of this article intended to use various techniques and implement a relatively low budget to resolve the "Non Increase of Users" issue.

As we had no previous experience carrying out grass-roots activities like Environmental Map contests and Map Forums, we were concerned about the operation and results. We were particularly concerned about the level of interest that the children, who are unfamiliar with maps, would have for the Environmental Map Contest. Moreover the winter season had a lot of snowfall so we were also concerned about whether or not the children would be able to go outside for the study.

Consequently, our hopes for a certain level of findings in this initiative were realized. In terms of the Environmental Map Contest, we received an unexpectedly high number of participants and a high degree of interest. With the support of the Ministry of Education and the teachers, this event was a huge success for the child subjects who had hardly taken part in contests. We hope that by using Geographic Information in basic education it will raise interests and will be an impetus to produce future technical experts. From the active discussion at the Map Forum we were able to accumulate the user demands for the release of Geographic Information and their needs. Among these ideas the Cadastral and Survey Institute will have the information which will be very useful in creating an establishment plan, and fixing a budget for the basic creation materials.

It is difficult to link the results of the initiative with results such as the immediate increase in map sales. However we would like to think of one of the techniques to activate the development of Geographic Information and the utilization life-cycle (Figure 6).

The materials for this Environmental map Contest were provided by the study team but if backing can be obtained from all sides then this project could be adapted for any project on other developing countries. We realized that the creation of environmental maps is an extremely effective way of creating interest in maps and the surrounding environment. After the support from JICA ended, the Ministry of Education and Map Establishment Agency became the main bodies and the new issue is how to arrange a plan for the sustainable operation with their collective efforts.

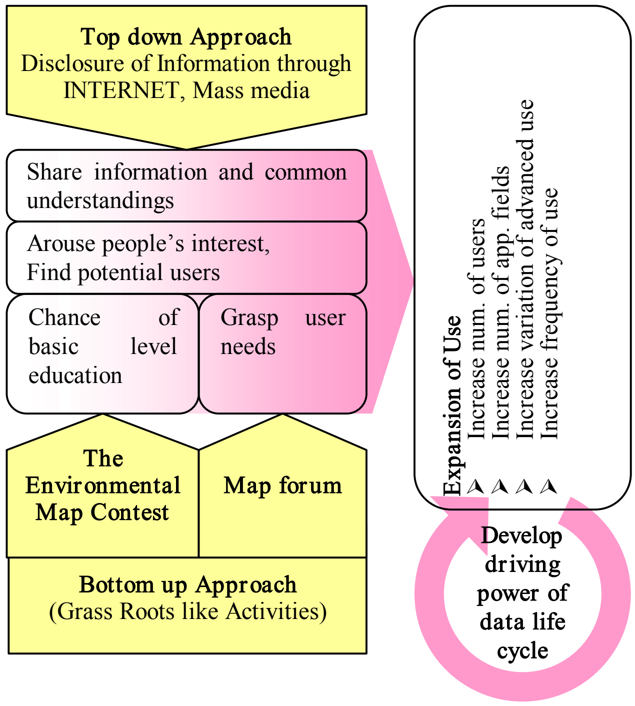

Figure 6. Conceptual scheme of disseminations

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ACKNOWLEDGEMENTS

The results were also released in Japan when the outstanding maps from the Environmental map Contest were displayed this year at the "Maps of the Environment around us Exhibition" in Asahikawashi. We would like to express our gratitude to Mr Onodera of the Environmental Map Education Research Society for the valuable advice and data he provided.

E-LEARNING COURSES FOR GIS AND REMOTE SENSING IN GERMANY STATUS AND PERSPECTIVES

Gerhard Koenig [a], Jochen Schiewe [b]

[a] Institute for Geodesy and Geoinformation Science, Technical University of Berlin, Germany
gerhard.koenig@tu-berlin.de
[b] Institute for Geoinformatics and Remote Sensing, University of Osnabrueck, Germany
jschiewe@igf.uni-osnabrueck.de

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KEY WORDS: Education, Online learning, E-learning, Training, Web based, Multimedia

ABSTRACT:

E-learning can play a vital role in providing suitable and effective learning environments to enhance the knowledge and skills of students. The paper will begin with an analysis of the recent e-learning activities of the German GIS and RS market. The main projects are introduced, benefits and problems are discussed.

In conclusion, one can see that a huge number of valuable e-learning materials has been developed, most of them in joint efforts which have led to fruitful and welcome cooperation among universities. However, also some problems can be identified which may be grouped into the aspects distribution, pedagogy and strategic organisation and will be outlined in this paper.

The question how to minimise problems and maximise e-learning's impact plays a major role. Several recommendations will be discussed which may help authors to provide stimulating and interactive learning environments which will be sustainably used in future.

1. INTRODUCTION

Education is getting into the focus of politics and the German society after the results of so called PISA studies (Programme for International Student Assessment), invoked by the OECD, were published. In theses tests the performance of the educational systems of 41 participating states were compared by screening the skills of fifteen year-old school pupils in the areas of mathematics, reading and sciences. The results increased sensitivity that equality of educational opportunity has to be strengthened in all levels of education. Discussions led to the demand for a structural change also in the area of tertiary education. To meet the challenges in a continuously changing world especially in the technical disciplines and to compete in our globalised environment, modern educational flexible and easily updatable tools must be introduced in order to meet the increasing international requirements. Quality and competitiveness of universities will play an even more important role in near future. Also a wider variety of educational offers for lifelong learning have to be implemented to fit the customers' needs.

Moreover, German universities are faced with other great challenges in the near future. Predictions forecast a continuous increase of students, resulting in a rapidly growing demand for college places, training capacity and a broader variety of courses. Faced up to national and international competition and confronted with stagnating budget the university management has to find new ways to supply the demand, even improving quality and quantity of education. Promised benefits of e-learning, such as economic, organisational and pedagogical advantages, have forced higher education institutes to test and implement some form of e-learning. Large sums of money have been spent by national and local governments, by university administration and by engaged institutes on the many aspects of designing, developing, facilitating and managing e-learning at a higher level. A major breakthrough was achieved in 2001 when the German Ministry for Education and Research (BMBF) and the European Union (EU) encouraged several project teams to develop advanced e-learning material. Their work resulted in a number of highly interactive e-learning modules that involve learners in topics within geoinformation science, remote sensing, cartography and surveying.

2. GIS AND RS E-LEARNING ACTIVITIES

The following section will give an exemplary overview on e-learning activities in the GIS and remote sensing domain, considering the fact that the list is not exhaustive.

2.1 eduGI.LA2

In July 2003 a network for GI Science Education - Latin-America was established. The partners come from Brasil, Mexico, Chile, Spain, Portugal and Germany (University Muenster). The network is supported by ALFA (América Latina - Formación Académica), a programme of cooperation amongst higher education institutions of the European Union and Latin America.

Main targets of the projects are an increased mobility of students (Masters and PhD levels), an exchange of teachers (professors and research assistants), a harmonization of curricular contents and an enhanced research cooperation.

Within this network several e-learning courses were established (http://www.edugi.net/eduGI.LA2). In this context the University Muenster successfully organized a summer school course ‘Introduction to Digital Cartography’ (Figure 1).

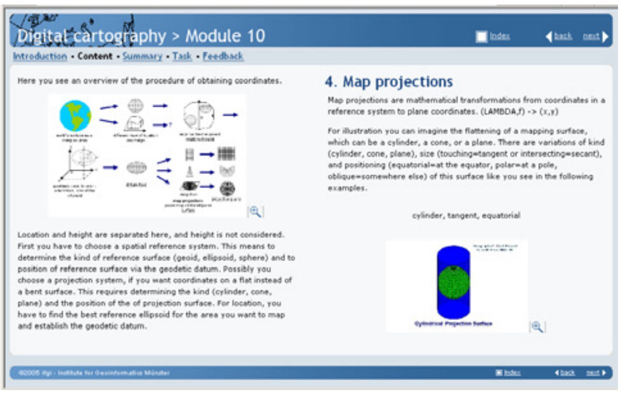

Figure 1: Digital Cartography – University Muenster

Students learn how to create thematic maps by using modern visualization techniques. The course explains how specific user requirements and demands on thematic maps can be fulfilled by a modern interpretation of classical cartographic theories.

Web-design and navigation is based on the development of geoinformation.net, which is described below.

Access to the teaching materials is limited to course participants.

2.2 ELAN - Virtual Landscape

The project ‘Virtual Landscape’ is part of the joint project “E-Learning-Academic Network” (ELAN), a network of e-learning courses covering different disciplines funded by the state of Lower Saxony, Germany. Access is also limited to course participants.

The idea of this project is to represent the landscape virtually in order to provide an intuitive entry point for studying the landscape, its genesis, the spatial processes occurring on it, but also models for describing and analysing it (Katterfeld 2005). The project consists of three main components: a virtual landscape, learning material related to it, as well as modules in terms of applications or scenarios.

Virtual Landscape follows the action-oriented and blended learning concept. For example, students can study the planning process necessary for routing a railway line. Lectures give detailed information and an introduction into the task. A map exercise is carried out within a hands-on seminar where students solve a complex task by running through the different stages of decision making: from analysing data according to their relevance for a planned project, discussing about alternatives unto forming the decision. The planning process will be exercised within the Virtual Landscape. For this the spatial base (maps etc. - Figure 2) and thematic data (e.g. different soil parameters, water protection areas, areas of biotope protection etc.) are provided. Tools for exploring and analysing data are supplied in the web-based environment. For visualisation and analysis 2D and 3D-views are provided.

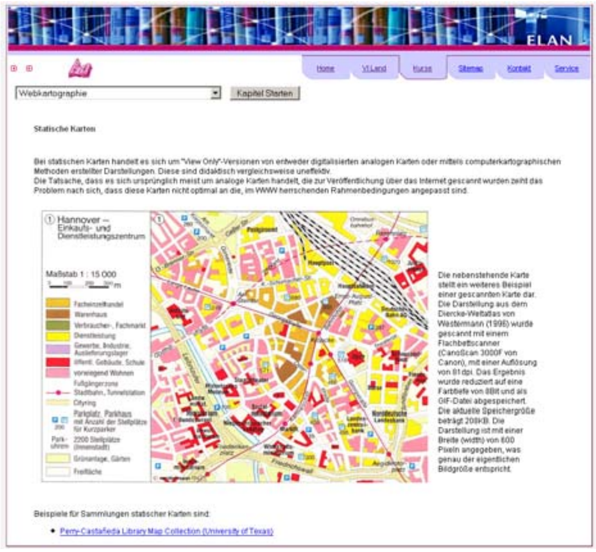

Figure 2: Virtual Landscape – University Hannover

The target group for using the developed e-learning-environment are students in Earth Sciences, such as geodesy, geoinformatics, geography, environmental studies, landscape planning as well as students of applied computer science.

2.3 ELITE@TUB

ELITE@TUB (E-Learning in Tertiary Education at Technical University Berlin) is based on developments initiated by members of the Department of Photogrammetry. It uses web-supplemented information for the lectures as well as additional input for exam preparations. Access to the complete set of materials is free.

Central idea of the tutorial is to offer students learning material dependent on individual pre-knowledge and skills (Koenig 2004). This is achieved by introducing a database concept. For each content and questions page a degree of difficulty is allocated and stored as metadata. On the other side, students’ knowledge is measured during the learning phase continuously which allows adjustment of the tutorial to the students individually.

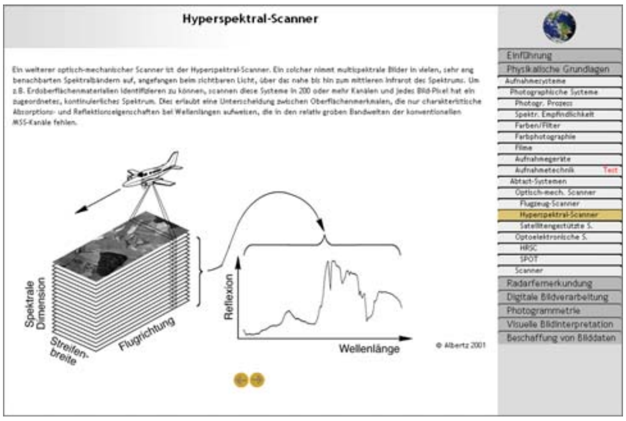

Figure 3: ELITE@TUB – Technical University Berlin

The training course splits into seven different modules, covering photogrammetric and remote sensing relevant topics. So far, the modules are addressed to German students only. With the introduction of the international Master’s course ‘Geodesy and Geoinformation Science’ a redesign of the tutorial is in progress, based on the European Credit Transfer System (ECTS), translating the modules into English, which will allow future students to deal more extensively with remote sensing and GIS topics.

2.4 FerGI

The FerGI (Fernstudienmaterialien Geoinformatik) project started in October 2003. FerGI is a cooperative project of the center of excellence in geoinformatics in Lower Saxony (GiN) and the e-learning network VIA Online. The GiN partners – four institutes from the University Hanover, the University Osnabrueck and the University of Applied Sciences in Oldenburg are developping the contents whereas VIA Online, represented by the University Hildesheim gives didactic support (Krüger 2005). Usage of the materials is free.

The aim of the three years lasting project is to produce and evaluate 20 e-learning modules, mainly concentrating on special geomatics topics. The content is divided into small compact modules (with ECTS points from 0.5 to 3) guaranteeing a better content exchange and a greater acceptance amongst GI lecturers. The contents of the modules will be given in German and / or in English.

The FerGI modules impart knowledge on GIS base data acquisition, spatial data management, data analysis and presentation. Bejond more theoretical modules, building a solid basic education, also application-oriented modules are implemented, deepening learners’ practical experience. The module “Laser Scanning Systems” (Figure 4) was introduced successfully in the CATCON competition during the ISPRS symposium in Istanbul.

Figure 4: FerGI-online – University Osnabrueck

2.5 geoinformation.net

One of the most successful developments was sponsored by BMBF: *geoinformation.net*. geoinformation.net was developed in a consortium of nine university institutes from the areas of geodesy, geography, computer science, spatial planning and pedagogy. It comprises 14 coordinated, but self-contained learning modules. Modules are designed to enhance face-to-face teaching, but can also be used by students for preparation and follow-up work (Dörschlag 2005). Access to the materials is free.

For each learning module two versions are available: one version is optimised for supporting lecturers in classes, the other version is for Internet use. This version complements and enhances content of course transparencies with additional text, points out correlations and interconnections and provides tests and exercises.

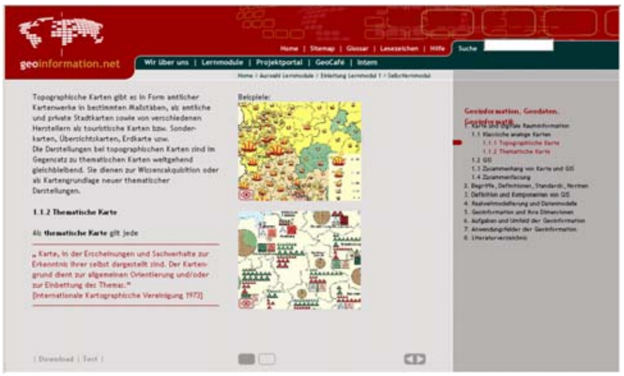

Figure 5: geoinformation.net – University Bonn

Designed for re-use, all transparencies are stored in a ‘transparencies pool’ as HTML-files. With the help of a so called ‘Lecture Builder’ lecturers have access to the pool and can adapt and group transparencies for their individual courses. Adding own transparencies is also supported.

In terms of didactics problem-based motivation and active forms of learning are mainly focused on. In addition, the ‘GeoCafé’ provides a geo-algorithm-IDE based on a geo-relevant, Java-like programming language. Algorithms and data structures can be visualised online (GeoJava). Works on GeoCafé are still in progress. Last but not least, the communication component ‘GeoChat’ facilitates learning in groups.

2.6 gimolus

During the BMBF-funded project phase, the gimolus group (partner: Universities Stuttgart, Wuerzburg, Duisburg and Oldenburg) developed learning modules for different disciplines in environmental science (Müller 2004). Usage is limited to members of the participating universities.

The gimolus learning portal is based on a combination of XML-data modules, XSL-transformations, WebGIS- and database usage as well as serverside interpreted PHP- and Java-elements. The ‘virtual landscape’ is the central concept for combining learning modules, based on real geodata covering the south-west region of Germany.

Dataset-geometries and attribute data are stored in a MS-SQLServer database, managed via ESRI's ArcSDE. This geo-database holds different dataset levels, matching the needs of the different thematical topics of the gimolus participants. The data is used in exercises as basis for interactive model-calculations and visualisations via ESRI's Arc Internet

Mapserver (ArcIMS). Tasks range from simple exercises that can be easily worked on in 20 minutes up to complex problems demanding one or two hours of concentrated work depending on the individual approach. Modules feature different technologies and software from Flash and Excel, web-based geoinformation systems, to models based on Java, JavaScript, Visual Basic, Pascal or PHP (often directly linked up to geoinformation systems). The following subjects are dealt with:

- model evaluation
- hydrological modelling techniques
- models of population dynamics
- habitat modelling with logistic regression
- erosion modelling
- strategies of collecting samples
- evaluation models in landscape planning
- Finite-Difference methods
- network analyses
- geodetic methods of measurement
- basics of working with geoinformation systems

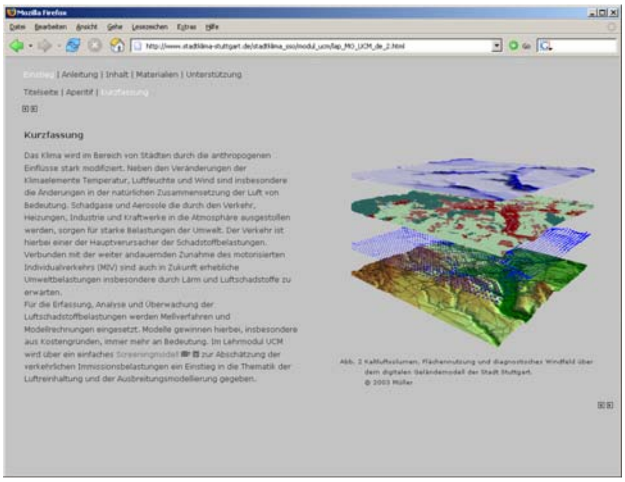

Figure 6: gimolus – University Stuttgart

Communication between students and lecturer via e-mail or module specific discussion-boards is also part of the system.

2.7 WEBGEO

WEBGEO combines multimedia-based, web-based teaching and learning modules. These modules impart basic knowledge of topics in physical geography, such as climatology, geomorphology, pedology, vegetation and animal geography, and hydrology. Students who are interested in these topics have free access.

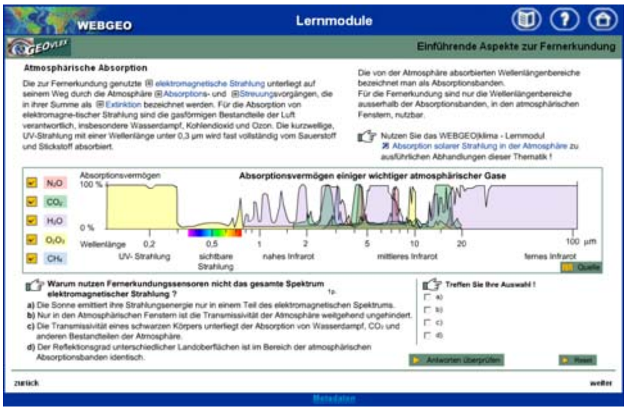

Figure 7: WEBGEO – University Halle

Modules allow for visualisation of typical geo-processes, preparations and interactive orientation in terms of virtual excursions and for model calculations of typical geographical processes depending on interactive user-defined parameters.

Learning modules in WEBGEO are created in line with the concept of networked, systemic learning. This allows acquisition of physical-geographical knowledge by employing knowledge strategies that aim at understanding and solving problems. This approach will lead away from acquiring isolated special knowledge towards developing ecological thinking and understanding instead. Special subject modules, methodical modules, tasks and characteristics of the information network are designed and linked to each other, guiding learners to solve a problem successfully.

Teaching and learning materials are presented in the form of networked basic learning modules, so called 'basic learning objects'. Modules can be easily maintained and updated as well as reused and adapted to different target groups and teaching contexts. Based on the smallest possible learning units, WEBGEO develops combined concepts of modularisation that are appropriate to present large and even cross-subject contents in a way conducive to learning.

Table 1 gives a recapitulating overview of e-learning modules features just now presented.

Synonym	Internet Address	Topics	Lang	Techniques	Partner
eduGI.LA2	www.edugi.net/eduGI.LA2	digital cartography	e	XML, PDF, PowerPoint	Münster
ELAN	portal.l3s.uni-hannover.de	web cartography	g	HTML, PHP	Hannover, Braunschweig
ELITE@TUB	www.igg.tu-berlin.de/elite	remote sensing, photogrammetry, (GIS)	g / (e)	HTML, PHP, Flash, Servlets	Berlin
FerGI	www.fergi-online.de	GIS, remote sensing, photogrammetry, cartography	g / e	HTML, Flash, PDF	Osnabrück, Hannover, Oldenburg, Hildesheim
geoinformation.net	www.geoinformation.net	GIS, cartography, remote sensing	g	XML, PDF, PowerPoint	Bonn, Karlsruhe, TU-München, LMU-München, Uni BW München, Münster, Potsdam
gimolus	www.gimolus.de	GIS, hydrology	g / e	XML, PDF, Flash, ArcIMS	Stuttgart, Würzburg, Duisburg, Oldenburg
WEBGEO	www.webgeo.de	physical geography, remote sensing	g	XML, HTML, Flash	Freiburg, Halle; Frankfurt/M, Trier, Heidelberg

Table 1: e-learning modules – overview, 9.4.2006 (g: German, e: English)

3. CHALLENGES

It can be concluded that a huge number of valuable e-Learning material has been developed, most of them in joint efforts which have led to fruitful and welcome cooperation among universities. However, also some problems can be identified which hinder the acceptance of the e-learning idea. These problems can be grouped into the aspects distribution, pedagogy and strategic organisation.

3.1 Distribution problems

Although e-learning is offered by most institutes, acceptance is still moderate. This may have several reasons and depends on the individual situation at the universities. But in general, e-learning is too often scattered within and across institutions and has limited visibility. Another reason is the content itself. In the eyes of lecturers courses seem only partly usable, because the own curriculum follows a broader or shorter, a more or less mathematical or application oriented approach. As a result the modules don't fit the individual needs. Of course problems with digital rights often hinder adoption, and also there may be discontent with the practical implementation as e-learning modules suffer from interoperability problems which prevent from using third party material.

3.2 Pedagogical aspects

Although in most projects pedagogues are involved in the process of course development and project evaluation, a general scepticism about the e-learning approach and the pedagogic value can be noticed. Indeed, there is no value added, if courses follow the tendency to imitate existing ways of learning rather than transforming and using content differently, applying accepted pedagogical approaches such as collaboration or constructivism. Up to now, e-learning mostly supplements rather than replaces classroom-based teaching. Face-to-face classroom teaching still remains central, and even the blended learning approach is insufficiently adopted.

On the other hand, collaboration techniques are not attractive to students in small institutes. Direct access to lectures is preferred over forums or chat rooms. These techniques are only suitable for distance learning or in the post education market supporting life long learning.

3.3 Strategic organisational challenges

Project support often caused overlapping development of proprietary management systems to fit assumed needs. Meanwhile, commercial learning management systems (LMS), which are found too dear or open source LMS (future, maintenance too insecure) are rarely used. Also, the fear to be dependant on a LMS which complicates a platform change and causes dispensable work is a major argument. But to the authors' opinion e-learning benefits from LMS because they handle administrative functions, provide tracking and reporting, offer assessments and report test scores, and measure learner competencies. Moreover LMS give e-learning modules an unique, area-wide visibility and corporate design.

The most severe constraint is that continuous operation and maintenance are still a major problem. The survival of projects depends on staffing after financial support by project initiators stopped. Today, most universities can not ensure the essential sustainability.

4. RECOMMENDATIONS

Several recommendations will be given in this section, which refer to various organisational levels. Starting from bottom-up, authors of future materials and systems should consider the following:

- Learning technologies are supposed to be designed to work within established open standards. Large pieces of content should split into smaller modules (learning objects) to facilitate and increase material re-use and sharing.
- New didactical and learner oriented approaches have to be applied. It is advisable to create constructivist learning spaces that include interactive and personalised student oriented features. To be successful with e-learning, experimental learning, project learning, action-oriented learning and experience based learning approaches should be considered during course development.
- As for the management of copyright of digital content (DRM), there is a need to develop a system which is simple enough for content creators to understand and use. At the same time, it must of course provide proper legal protection of digital content rights and be technically well designed and robust (European Commission 2005).

But even more important several actions on the respective university level have to be made:

- E-learning is successful only if a binding strategic concept for the whole university exists. University administration must propagate, support and bundle individual activities.
- In consequence, universities have to build centres for multimedia in education and research. They must be responsible for setting up and maintaining the e-learning infrastructure, consisting of servers, development environments, authoring tools, content management systems (CMS) and LMS.
- Well trained media competence is a must! Media-centres have to distribute their knowledge offering training courses to interested university employees, giving support in creating animations and producing complex visualisations but also giving pedagogical advice. Of course, computer scientists, software engineers, graphic artists, designers, and pedagogues have to be on the team to meet the demands.

Finally, a set of actions on an across-university level are recommended:

- Coordination of initiatives and projects bringing together people with different background will reinforce e-learning activities. Partnerships are a key characteristic of e-learning that could help institutes to share knowledge and good practice and will help to avoid duplication of work.
- E-learning modules have to be peer-reviewed or comply with a quality assurance process, which will provide confidence and strengthen the acceptance. For further education and training a certification should be aspired.
- A good marketing strategy will help to make e-learning visible and known.

5. CONCLUSIONS AND OUTLOOK

In Germany new chances for e-learning activities are caused by the changeover from the single-track Diploma courses to the Bachelor/Master system. It is the hope that this transition forces some of the mentioned actions on university level. Since it seems to be unrealistic that single universities will be able to guarantee sustainable maintenance of e-learning courses and updates of course contents, across-university cooperation is essential. One possibility to achieve a broader cooperation is tested in Switzerland: the Swiss GIS e-learning project GITTA (Fisler 2005) has released their basic level lessons and case studies as open content under the Creative Commons license. Free use, copy, distribution, translation of the lessons is accepted as long as it is not for commercial use. As a community project GITTA coordinators are looking for partners who are willing to contribute to project activities.

In Germany, cooperation of the main course developers will be realised in a project proposal *geo-kiosk* which is currently submitted to the Federal Ministry of Education and Research (Schiewe 2005). Within this project, e-learning materials and services in the field of geoinformatics, remote sensing and geography will be integrated, additional services such as translations or migration to LMS will be offered, which hopefully will lead to the use of e-learning as a flexible and standard teaching format in the near future.

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TOWARDS A SUSTAINABLE E-LEARNING SOLUTION FOR GI-EDUCATION

Antje KRUEGER [a] , Thomas BRINKHOFF [a], Beata GRENDUS [b]

[a] Institute for Applied Photogrammetry and Geoinformation (IAPG), FH Oldenburg/Ostfriesland/Wilhelmshaven (University of Applied Sciences), Ofener Str. 16/19, D-26121 Oldenburg, GERMANY – antje.krueger@fh-oldenburg, thomas.brinkhoff@fh-oldenburg.de

[b] Institute for Geoinformatics and Remote Sensing (IGF), University Osnabrueck, Kolpingstr. 7, 49074 Osnabrueck, GERMANY – bgrendus@fzg.uni-osnabrueck.de

Commission VI

KEY WORDS: eLearning, GIS, geoinformatics, online learning, learning management systems, training, education

ABSTRACT:

Computer aided learning, also known as eLearning, plays a decisive role for technology-orientated subjects with a high innovation rate and it is an indispensable aid to support the process of lifelong learning. Within the past years, many universities discovered the advantages of eLearning such as offering flexibility in learning, keeping the content up-to-date easily and having the possibility to integrate multimedia methods to visualize learning content. A large number of eLearning projects at universities have come into being, which often are financially supported by governments. However past has shown that funded projects often have difficulties to be effective and independent after the time of funding. This paper tries to give some ideas about finding sustainable solutions for forthcoming or still existing eLearning projects considering as example the FerGI-project in Germany (FerGI = Fernstudienmaterialien Geoinformatik, engl.: distance learning material for geoinformatics). Conceptional and didactical issues as well as technical aspects provide the basis for this approach. Furthermore, we will introduce the project briefly, present first evaluation results and future strategies.

1. INTRODUCTION

Knowledge nowadays continuously increases and underlies significant changes. Some disciplines – especially the ones closely connected to technology like GI Sciences – are extremely “short-living”. Some years ago, eLearning was expected to take the challenge of this development and to modernise learning and teaching methods. Today we must revise this judgement: Often eLearning can be seen merely as a very useful support for conventional learning processes, but not as substitute. Nevertheless, this trend brought up various promising eLearning projects. Many of them had been or still are developed at universities or other educational institutes as confirmed in an online survey about existing eLearning initiatives in Germany (see chapter 4). After an enthusiastic start and a successful finish of those funded projects, the question for sustainability is often answered either too late or not sufficiently enough. In consequence, after the time of funding the produced contents can not be maintained or further developed. That again means the content will be not up-to-date after a fairly short time. FerGI, the latest eLearning-project for GI-Sciences in Germany, tries to avoid that development by having a solid conceptional fundament and by detecting future strategies to establish a sustainable solution.

2. THE FERGI-PROJECT

FerGI started in October 2003 and will finish by the end of 2006. During those 3 years, 22 small and compact eLearning modules will be produced, which do not reflect the whole GI-curriculum, but concentrate on special GI-topics with high topicality. The contents of the modules will be given in German and / or English.

FerGI is a cooperative project of the Center of Excellence in Geoinformatics in Lower Saxony (GiN) and the eLearning network VIA Online. The GiN partners – five institutes from the University of Hanover, the University of Osnabrueck and the University of Applied Sciences in Oldenburg will develop the contents whereas VIA Online, represented by the University of Hildesheim gives didactic support. More information about FerGI can be found at http://www.fergi-online.de.

Each module belongs to one of these 5 topics:

- Spatial data capturing,
- Spatial data management,
- Spatial analysis,
- Spatial data presentation,
- GI-applications

Figure 1 depicts all FerGI-modules (light coloured modules have been not completed yet).

Figure 1. Modules in FerGI.

3. CONCEPTIONAL ISSUES

3.1 Project aims and target group

Intensively dealing with conceptual and didactical issues definitely has a huge impact on the success of eLearning. Key factors within this aspect are to define the project aims and to carefully analyse the target group. In the end, both must be adjusted to each other. At first glance, this work seems to be trivial, but questions about needs, precognition and requirements of the target group are often not answered very easily. It is a complex venture, which demands professional action considering experiences from past projects and learn from their mistakes. The conception of a computer aided learning environment in general needs much more rigid planning than the conception of face-to-face learning, since the flexibility and spontaneity of the teaching person should be reflected in the computer based learning system.

Analysing the target group means to know learners motivation, their pre-knowledge and learning habits. Certainly this can not be done for each individual, but for groups of people. There are two different kinds of motivation to deal with the learning content. On the one hand students like to learn because they are interested in the subject. In this case the module should contain substantial information, allow flexibility in the learning path and vary in the presentation of content to keep curiosity. On the other hand the motivation can be target orientated, e.g. the expected acquisition of a certificate. This requires incentives in the beginning of the module such as explain learning targets, present the material in the same scheme and divide it into small units. Tests as feedback for the learning progress are absolutely essential in this context. Judging the motivation of learners incorrectly would certainly discourage students (Kerres, 1998).

Since the target group in the FerGI-project is comparatively inhomogeneous, the second scenario was chosen. So it was possible to offer FerGI-modules to students of geoinformatics, geodesy, geography and environmental sciences as well as to participants of further education programs. Using the modules for further education, each course starts with an introductory event, where participants get to know each other and finishes with a summary in a final event. In between there are self-study parts, occasional events for asking questions and workshops.

FerGI´s main project target is to produce small units within each module, in order to guarantee exchangeability with other educational institutions and reusability in general. Modules can be easily altered, restructured and maintained, which has a very positive effect on economic efficiency and sustainability.

3.2 Content in general and layout

The careful choice of teaching material is of central importance and greatly influences the quality of the material. Since the modules are accessed via internet, the material should be less storage consuming to avoid waiting times and interruptions in the learning flow.

Another factor often underestimated is the degree of acceptance of the interface, also known as "look and feel". Common symbols and colours should be used in order to keep the clarity and enable the user to work intuitively with the interface without spending too much time on getting used to it. Figure 2 depicts an example.

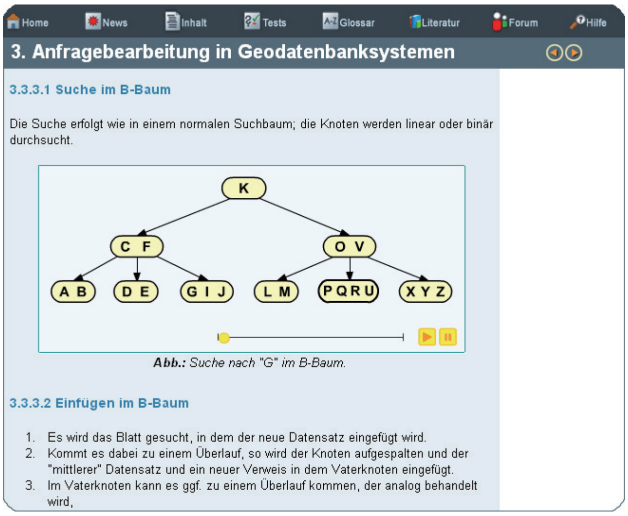

Figure 2. Layout of a FerGI-module.

3.3 Interaction and Communication

eLearning development showed that blended learning, as a combination of long-distance learning and face-to-face learning, is more effective than pure eLearning. The larger the self-study component, the more interactive parts must be involved. Interactivity is in general the most important aspect, and even more in online learning environments compared to conventional lectures and books. FerGI also integrated animations for explaining contents that are difficult to learn. By using them, the time of learning can be shortened and the comprehension can be increased. Since it is fairly time consuming and costly to produce animations, it is advisable to analyse deeply the effectiveness of using animations. Sometimes a single picture can express the same content as good as an animation, but producing it is much faster and therefore cheaper.

Interaction can also be reached by using special tools and applets that are strongly integrated into the learning issue. The more general such a tool, the more often it can be applied within different courses. Figure 3 shows an example of a Java applet for demonstrating different models of topological relationships.

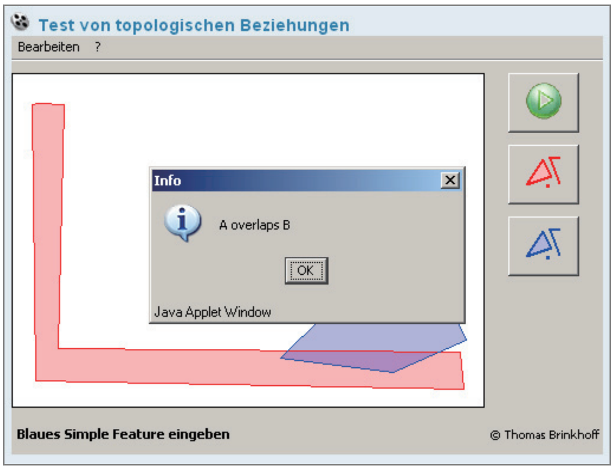

Figure 3. A Java applet for testing topological relations between geometries as an example for interaction.

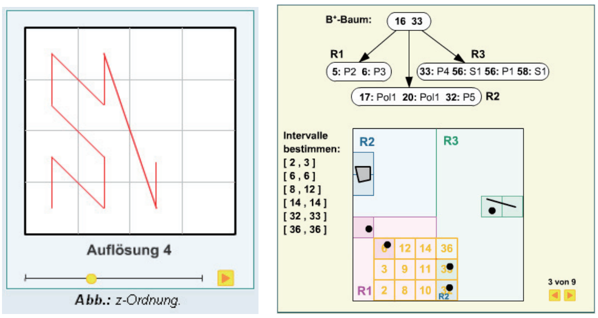

Figure 4. Examples for animations.

Learning in general is a social process, which requires communication between lecturer and student as well as between student and student to give feedback in learning progress. Therefore, suitable communication models must be developed in computer aided learning environments to stop isolated learning and to simulate the social dynamics of learning groups, including conventional face-to-face learning situations with their short feedback times. This is essential for the success of eLearning, but demands a high consumption of time resources (Strobl, 2004). In order to achieve that goal, FerGI offers forums where learners and teachers can exchange opinions, ask questions and give feedback to each other. Furthermore, interposed questions (see figure 5) within the learning material can be discussed in those forums.

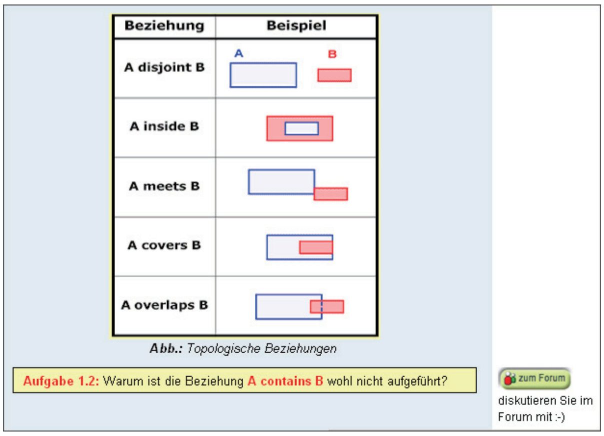

Figure 5. Example for interposed questions with the request of using the forum to discuss.

3.4 Tests and exercises

Life-long learning demands a high frequency change between gaining new expertise, using it, and solving problems (Strobl, 2004). Therefore, learning material should be particularly coupled with practical exercises. This step motivates learners over a longer period of time and consolidates gained knowledge. Besides students are able to judge their progress and define areas of their knowledge which requires more work.

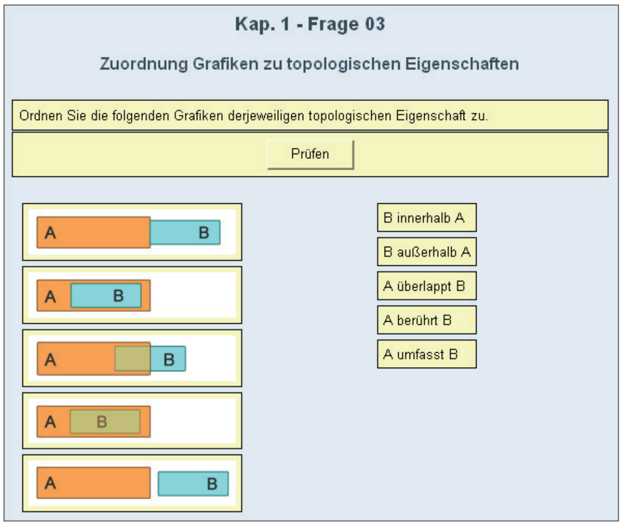

Figure 6. Hot Potatoes™ questions (part of the module "Geodatabase Systems").

FerGI uses the Hot Potatoes™ for performing tests (see http://hotpot.uvic.ca). This software offers various different question types for automatic corrected tests. Hot Potatoes is free for non-profit use, provided that the Hot Potatoe questions are freely accessible to everybody in the internet. The produced questions are compatible with FerGI´s favoured Open Source learning system Moodle (see http://moodle.org).

FerGI also uses certain tools for exercises such as the Spatial Database Viewer shown in figure 7. This tool (Brinkhoff, 2005) is a web-based interface for visualization of spatial tables, complex attributes and metadata using Oracle Spatial or PostGIS on the top of PostgreSQL. The tool is intensively used by the FerGI-modules “Spatial Database Systems” and "Object-relational Database Systems".

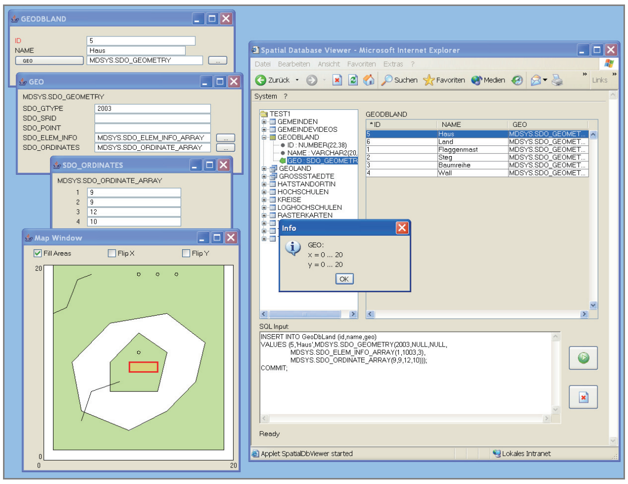

Figure 7. Spatial Database Viewer.

4. TECHNICAL ISSUES

Many projects in the past focused highly on the technical development of the learning environment and neglected didactical aspects. Others decided to take an already existing learning system, but finding the appropriate one to fulfil the didactical aims is often highly time-consuming. Standard techniques, which are reliable in functionality and usability, should be used, so that didactical aspects can be concentrated on and technical aspects take a back seat (Kerres, 1998).

FerGI-modules run as a stand-alone HTML Version, but it can be easily integrated into learning management systems as well – STUD.IP/Illias and Moodle had been successfully tested so far.

Another fundamental aspect concerning sustainability is to build up courses in a way that content modification can be executed rapidly and not necessarily by the person who developed the content. In this context XML-based techniques and standards in general are often mentioned. Indeed, complex XML schemas can be used perfectly for structuring and transforming content but complicate the content development. Therefore FerGI has chosen HTML in connection with Cascading Style Sheets (CSS). The advantage of HTML is that editing the content is less time consuming and requires less skills. Furthermore, our experiences have shown that such an approach allows an easy transfer to mobile devises like PDAs (see figure 8). Especially for modules about mobile data capturing this possibility is very reasonable. Such integration of eLearning content also means to adapt to customers’ needs and to be competitive.

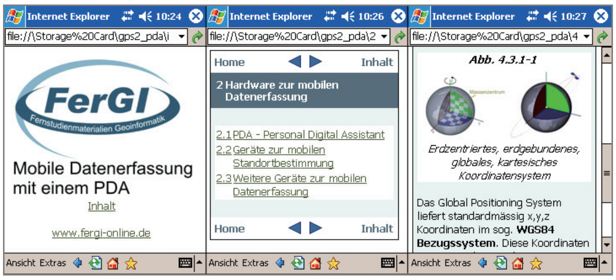

Figure 8. Version for mobile devices like PDA.

5. USERS AND EVALUATION

Since June 2005 all completed FerGI-modules are available free of charge. Only an online-registration is required. This resource has been used by 308 persons so far, from which 25% of them are directly or indirectly connected to the institutes and universities participating in the FerGI-project. Those are for example, students, lecturers or other staff members. Another 25% corresponds to users from schools or other universities, and 50%, the largest part, corresponds to users from business and administration areas outside universities or schools. Those numbers were not expected and considering the fact that the project is not yet finished, they also might express the particular need for such offers. Another important aspect is to have a good marketing concept to transfer the information about the project to potential users. An online survey carried out by FerGI in co-operation with the Bernhard Harzer Verlag, a publishing house specialized on GI-topics in Germany, showed that many simple or complex eLearning offers in the GIS field already exist (see http://www.gin-online.de/elearning), but their marketing is not well developed. Although the high number of projects indicates that eLarning is experiencing an important development, the heterogeneity of these projects and their users may negatively influence its clarity. A central access point to the projects is missing. Thus, the market potential is not exploited, yet. FerGIs follow-up project “geo-kiosk” will try to raise transparency and bundle the GI eLearning projects in Germany. More information about “geo-kiosk” can be found in the passage about “future strategies”.

All users of FerGI-modules are requested to evaluate the modules using an online questionnaire. Evaluation is an essential instrument for quality assurance, which has an impact on the acceptance, too. Since it is advisable to activate several channels of evaluation, FerGI also uses expert opinions from other lecturers of the partner universities as well as of other institutions. The tendency of those evaluations especially amongst students is relatively clear. The wish for blended learning and not pure eLearning is very often mentioned as well as the claim for more interactive elements, examples, tests and interposed questions. More support services are also often demanded, e.g., if the content is not clear enough or if users need help with solving certain problems within exercises.

6. FUTURE STRATEGIES

In the already mentioned online survey about existing eLearning initiatives, we found that 75% of all listed projects had been developed at universities with the aid of public funding. As reported in the beginning, the lack of sustainability did not allow maintenance and further development of the learning material after the time of funding. Possible problems might be the excessive effort on searching for a suitable learning management system, and the technical challenge concerning the implementation of contents. Besides, there is a deficit of experience and expertise to formulate a successful business model in connection with marketing strategies and related legal issues. Another possible problem is that up to now universities cannot act as self-regulated business companies.

Having mentioned learning management systems the licence costs should be considered, unless an Open Source system has been chosen. FerGI´s experiences with learning systems show that Moodle, as such an Open Source system, is a very powerful tool to build effective learning environments. The latest evaluation study on behalf of the Austrian Federal Ministry for education, research and culture (Kristöfl, 2005) gives some interesting details about the functionality of Moodle in comparison with other learning systems.

FerGI took steps towards a sustainable solution by integrating FerGI-modules into existing successful programs like the GIS-CombiCourse (http://www.igf.uni-osnabrueck.de/kurse) at the University of Osnabrueck to create a GIS-CombiPlusCourse. The usual GIS-CombiCourse contains one week of conventional face-to-face-lectures and eight weeks of practical exercises with online-support. The GIS-CombiPlusCourse is basically the GIS-CombiCourse with an extra FerGI-module for the students to work with. This extra enables the learner to receive a certificate at the end of the course.

Another approach is to use FerGI-modules for GEOWIN (http://www.igf.uni-osnabrueck.de/geowin) the GIS further education program for small and medium-sized enterprises (SMEs) in Lower Saxony. The target of GEOWIN is to offer SMEs a cost-effective and tailor-made possibility of further education in GIS within 18 weeks of blended learning with FerGI-modules. Again, there will be a certificate in the end of a successfully completed GEOWIN-course. GEOWIN is also a funded project.

A similar approach is taken by the project "Further Education in Geoinformatics" at the University of Applied Sciences in Oldenburg (http://www.fh-oow.de/institute/iapg/projekte/geoinf_weiterbildung). This EU-funded project offers (among others) an eLearning course about object-relational and spatial database systems that is based on FerGI-modules and finishes the eLearning phase with a one-day workshop for all participants in Oldenburg.

Last but not least, there could be the follow-up project, the geo-kiosk (http://www.geo-kiosk.com), which is intended to bundle the largest eLearning-projects for geoinformatics and geography in Germany: FerGI (University of Osnabrueck), geoinformation.net (University of Bonn), gimolus (University of Stuttgart) and Webgeo (University of Freiburg) to build an effective marketing concept and a service portal for technical, organizing, didactical and economical services for high-quality eLearning-material. Although geo-kiosk has not been yet approved, it is scheduled to start approximately in July 2006.

7. CONCLUSIONS

In this paper, we presented ideas concerning the conceptional, didactical and methodical design as well as the technical issues for developing eLearning-modules, with emphasis on the example of FerGI. Some evaluation results of completed FerGI modules and an overview of existing users had been given. We also identified some problems that often occur after the time of funding and tried to find ways towards a sustainable solution for eLearning projects.

8. ACKNOWLEDGEMENTS

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INTEROPERABLE LEARNING ENVIRONMENTS IN GEOSCIENCES – A VIRTUAL LEARNING LANDSCAPE

C. Katterfeld*, V. Paelke

Institute of Cartography and Geoinformatics, University of Hanover, Germany
{christiane.katterfeld|volker.paelke}@ikg.uni-hannover.de

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ABSTRACT:

E-Learning has reached the geosciences as well as many other subjects. As in other domains E-Learning has produced high prospects for teaching geosciences in the first instance. Many major research and development projects have been carried out and developers now have a clear understanding of what is possible with which amount of effort. From the technical point of view the implementation of E-Learning functionality has been quite successful. However, from experience we have also learned that conceptual and didactical considerations are very important for the effective employment of E-Learning tools. From the didactical point of view constructionist learning theory fits most of the E-Learning demands. As a consequence action-orientated approaches should be implemented which require high proportions of interaction functionalities. In our case we think of a Virtual Learning Landscape as a data-based interaction environment.
The successful design and implementation of a Virtual Learning Landscape leads to challenges both on the content related conceptual side and the technical implementation side. We aim to address these challenges by providing support for interoperability both on the content and implementation side.
Planning and implementing functionality-intense environments is quite resource consuming. Furthermore, such environments are mostly applied to a certain application and/ or a certain area and are thus restricted to a special application or become obsolete after some time.
This paper describes our approach for building interoperable learning environments. This includes the technical as well as the conceptual side. By focusing on interoperability we want to address different aspects. First, that technically complex architectures or programs may be used repeatedly for different learning scenarios, different datasets or even with different content. Second, that in terms of web-based architectures, the interoperability idea has almost reached the state of standards, although practical adoption still remains limited in many parts. The Open Geospatial Consortium (OGC) has suggested suitable standards for web-based data delivery in the geospatial context. We want to make use of these developments and integrate these technical ideas into E-Learning environments. This paper describes, how established standards like the Web Feature Server (WFS), the Web Map Server (WMS) and the Web 3D Server (W3DS) may be used to provide the data for a Virtual Learning Landscape in an interoperable way.
Conceptual interoperability is another key idea that we address. When different learning contents shall be provided within the same learning environment without much re-construction of the application, we need an interoperable way to formulate the content as well as the concepts of how to teach the task. Ontologies are currently used in many fields to express or define objects, concepts and relations between them. We examine if (and how) ontologies may possibly used to express learning content and introduce the idea of establishing an "EduOntology" for distinct learning issues.

1. INRODUCTION

The great potential has turned E-Learning into a well-discussed issue during the last decade.
Benefits of E-Learning include:

- flexibility of learning with respect to time and space,
- adaptation to individual interest and previous knowledge,
- interactivity and dynamics,
- more effective presentation through multimedia,
- providing access to complex domains, incorporating interaction and simulation for features that are not accessible in the real world,
- increased motivation (cp. educational gaming, edutainment),
- support for different learning styles and learner types, i.e. variety in the conceptual design of materials,
- access to distributed data,
- world-wide availability of education on highly specialised subjects and
- establishing of learning-communities that overcome the isolation of traditional distance education.

With these benefits in mind we give an overview of the situation of E-Learning in geosciences and will deduce the challenges of E-Learning environments especially for this field of application in the first chapter.
To particularize some challenges we will focus on the issues of 3D visualization and interactivity. As the main point we then expound ideas of interoperability and standardization in the technical sense as well as in the contextual sense.

2. LEARNING ENVIRONMENTS IN GEOSCIENCES

Symptomatic for learning in the geosciences is the fact, that many relevant aspects are distributed in the real world.

Teaching those is e.g. covered in field trips, where interaction with the real environments is typically not possible due to environment size, need for reversibility of actions as well as cost and time constraints.

Virtual environments may counter that problem by providing the learners with interaction possibilities to develop an intuitive understanding of a subject. However, the practical application of virtual environments for such purposes is currently hindered by technological constraints as well as the high cost of content production.

Hence much E-Learning content in Geosciences has been produced as web-based "lecture-note"-like materials. Examples of those impressing collections are e.g. geoinformation.net [1] (Germany), GITTA[2] (Switzerland) or the e-Map Scholar[3] (UK). While these collections provide a huge amount of information and many interactive assets they remain rather text-loaded and do not fully use the potentials of the WWW. To create valuable E-Learning experiences and justify the cost of web-based teaching methods beyond initial research projects will require adequate use of the special features offered by the WWW in the future.

Utilization of extended technical but also conceptual approaches are even more needed because geosciences (i.e. geodata-based learning) demand for a special way to present data and information and provide special interaction tools. Thus e.g. the term *learning environment* may be understood literally because a presentation of a natural environment can be provided. We will here speak of a "Virtual Landscape" to emphasize the natural environment as the matter of learning. This implies issues like e.g.:

– requirements of using "real" geographic data (with all its features like e.g. projection, scale etc.) to simulate the "real" environment,
– requirement to integrate data from different sources,
– enabling of reasonable interaction with the geometric, but also thematic level of the geodata and
– possibly incorporating further simulation and / or multimedia techniques to convey special kinds of information (e.g. a process with temporal aspects inherent).

These requirements give a strong argument for the use of the WWW as a means for education.

Some projects have already attempted to go beyond lecture notes and implemented such interactive, explorative learning environments using WWW and multimedia potentials. Examples for such an approach include:

Virtual Field Course (Dykes et al., 1999): The Virtual Field Course (VFC) [4] – carried out at the University of Leicester / UK – was undertaken to address the use of virtual environments and information technology in teaching fieldwork for geologists, biologists, geographers, planners and architects.

Ocean Science Learning Environment "Virtual Big Beef Creek" (Campbell et al., 2002): A collaborative three-dimensional online learning environment for ocean-scientists was provided by the University of Washington. The environment enables users to navigate through a data-rich representation of an estuary on Washington's State's Olympic Peninsula. The learning environment should prepare users for a fieldtrip. Another goal was to provide an online repository for geo-referenced data obtained through fieldwork.

Gimolus (Müller, M., 2004): gimolus [5] provides learning materials for students from environmental science using a complex web-architecture that is largely based on commercial products. Using terminal-client students can log on to an application server that provides GIS 2D-data and software. Using a wide variety of data from distinct area learners can carry out exploration and analysis for several relevant issues within the same area.

These projects give an impression of how the implementation of a learning environment based on geodata-use could look like. Apart from the requirement for the use of web-based learning facilities, another point of view to motivate web-based learning environments in geosciences should be taken up as well: The Spatial Data Infrastructure (SDI) has become a big task in the field of geoinformatics. Much work has been carried out – in first instance – from the technical side. Standards and services have been developed and are – more or less – successfully implemented and accepted. However, practical adoption is much slower than initially expected. Location Based Services[6] (LBS) on Mobile Phones and PDAs provide a wide variety of applications that can benefit from SDI. These include online map-services (e.g. city maps, aerial images, historical maps etc.). Information systems with possibly restricted access, like property search or tools for public participation in planning processes are other applications that base on the technical principles of SDI. While these use cases are well examined they do not yet produce the expected amount of economic impact. The establishment and acceptance of further applications is needed to enhance the use of web-based geodata delivery. Learning environments could be one of such a use case.

3. CHALLENGES OF 3D LEARNING ENVIRONMENTS FOR THE GEOSCIENCES

The projects introduced in the former section illustrate – representative for others – the great possibilities both for virtual reality-based as well as "just" 2D-data-based learning environments. Due to the fact that some of the learning material is not accessible at the moment, it must be concluded that sustainability of complex E-Learning environments remains a big issue. Another issue is the fact that many projects are restricted to either a certain task and / or a certain area. This restricts their application and hence sometimes not legitimates the cost of implementation. Here interoperability (i.e. implementation of standardized interfaces) could provide a solution. The problem of sustainability could probably be addressed in this way as well. Concerning the technical requirements the standards for a web-based-(geo)-data architecture may be derived from the SDI-development and – if necessary – adjusted to the learning application.

Due to the need of an advanced environment, 3D visualisation and simulation are techniques to incorporate. Standards and "best-practice"-examples exist. However, their application for learning is – in most cases – still at an experimental state.

These issues have to converge in the step of (conceptual and technical) scenario-design. Such a scenario-design must provide theory and tools for expressing and implementing the learning objective, particular learning procedures and the learner's interaction possibilities. The special challenge of scenario-design is the requirement of a standardized approach. This is a

1 www.geoinformation.net
2 www.gitta.info/
3 http://edina.ac.uk/projects/mapscholar/index.html
4 http://www.geog.le.ac.uk/vfc/index.html
5 http://www.ilpoe.uni-stuttgart.de/cgi/caya/index.php?id=3&loc=en
6 (cp. e.g. Gartner, 2003)

difficult task due to the need of abstraction and standardization of conceptual issues. Those conceptual standards still have to be developed. Our current work aims to contribute to this.
Finally the individual requirements in terms of previous knowledge, specific user interests, as well as preferences for special data presentation or interaction techniques could (and should) be met by "individualization". Individualization is another quite challenging issue and of high importance to improve usability and acceptance of E-learning environments. While our standard-based approach has been designed with user specific customization in mind a detail discussion of the topic is beyond the scope of this paper.

The challenges in terms of standardized web-based education in geosciences are:

- sustainability,
- interoperability (use of SDI-standards),
- 3D visualization and simulation,
- interactivity with geodata (application of constructionist learning approaches),
- scenario design and
- individualization.

Within this paper we want to emphasize two aspects. On the one hand we will focus on 3D visualization and interactivity to facilitate the constructivist (i.e. explorative) learning approach. On the other hand we want to look at an interoperable way of scenario design. This point includes interoperability issues in terms of techniques and concepts.

4. 3D-VISUALIZATION

The value of visualization in 3D and perspective presentation in terms of effective communication of spatial content has been generally motivated by many authors, e.g. MacEachren et al. (1999), Verbree et al. (1999), Petschek & Lange (2004), Tiede & Blaschke (2005).
Learning systems targeting environmental phenomena can benefit from the inclusion of 3D content and presentation because of:

- vivid presentation of geo-spatial information,
- immediate visibility and better understanding of results and
- removal of forced abstraction and indirection. (Abstraction is not inefficient in every case. However it is desirable not to be restricted by technology, but be guided by didactical arguments. Flexible change between realism and abstraction may possibly help to bridge between both dimensions.)

While these factors have been the driving force for the development of 3D GIS, 3D city models and the proliferation of 3D visualisation in geosciences in general they can be especially useful in E-Learning for learners because they allow to establish a more direct correspondence to physical reality.
Web-examples of implementations of such environments for learning purposes are e.g. CNN's visualization of a hurricane[7] or the "Nerve Garden"[8] (Damer et al., 1998). These examples show what is technically possible. However, most existing virtual environments stress the aspects of exploring the space and thus act – in case of the display of geodata – "just" as a multidimensional variation of a traditional (topographic) map. Very few of such environments have integrated the textual dimension in terms of additional learning contents.
Two ways are possible to meet that requirement: The first is to *provide* explicit information into the scene, which may then be detected and learned by exploration and interaction. Secondly there is the potential to give the learner the possibility to *gain* (explicit, but also implicit) information by providing interaction / exploration as well as analysis tools.
Systems, offering sophisticated analysis functions for 3D data can be referred to as "3D-GIS". Such software provides useful tools to explore and analyze 3D data but is not especially designed to support learning. The knowledge of how to work with the system and the data must be brought into the process by the intelligent user of the software. Integration of feedback or instructional knowledge etc. is not envisioned.
Approaches to encounter that lack will be suggested in the chapter about contextual interoperability. While many issues in effective application of 3D in education (in geosciences) still have to be solved, the general value has been demonstrated successfully in existing prototypes and further development in concepts is required.

5. INTERACTIVITY

Most action-orientated systems are based upon the constructionist learning method, which is build upon the idea that reality may not be considered as external. Therefore, every learner has to build his knowledge structure by himself starting from his own needs and previous knowledge. Riedl & Schelten (2002) reason that learning without execution of actions remains at the state of a mere mental action and therefore stays distant from real acting.
General theses on constructivism may be summarised as follows (Reich, 1998):

- Didactics should no longer be a theory of mapping, memory and real reconstruction of knowledge and reality, but a constructionist environment of individual learning in reality.
- Didactics becomes an open process of contextual and relational mediation.
- It is not longer considered helpful to prescribe a certain way of teaching or learning, resp. but allow the learner to go his own way of knowledge construction.

The E-Learning pioneer Papert emphasised the constructivist (vs. instructionist) idea by saying: "Well, *teaching* is important, but *learning* is much more important". Papert's constructionist approach relies on the computer for realization.
As stated above interactivity and interaction are essential characteristics of constructionist learning systems. It therefore seems to be worth, to closely look on these terms.
The term interaction comes from social sciences, where it is defined as interplay between two people. "Interactivity" is used in computer science to describe the interdependency between computer and human. In learning programs interactivity constitutes the user's possibility to control and intervene into the system (individually).
Strzebkowski & Kleeberg (2002) distinguish interaction for controlling a (learning) application (e.g. navigation and dialogs) and didactical interactions (e.g. activities for presentation of

7 http://www.cnn.com/SPECIALS/multimedia/vrml/hurricane/
8 http://www.karenmarcelo.org/ng/siggraph/

Interaction	Description of Interaction	Impact on the Learning Process
Interaction with the Data Representation		
Lighting	Illumination changes	low
Viewpoint ("camera")	Perspective changes	medium
Orientation of Data	Perspective changes	medium
Zoom-in/ Zoom-out & Rescaling	Level of Detail of data changes	high
Remapping Symbols	Clarification of quantitative and qualitative information as well as semantics	low
Interaction with Geometric and Textual Dimensions		
Navigation	Free movement to any perspective/ attribute data is enabled	high
Fly-Throughs	Bird's eye view is applied to have different perspectives	medium
Toggling	Views on data may be changed	medium
Sorting or Re-expression	Inter-Relationship of values is made clear	high
Interaction with the aim of Comparison		
Multiple Views	Comparison of different areas and/ or different representations	high
Combining Data Layers	Synopsis of different data	high
Window Juxtaposition	Synopsis of different data	medium
Linking	Synopsis of different data	high
Interaction with the Data		
Database Querying & Data Mining	Data Analysis by different techniques	high
Filtering	Data Analysis: Excluding data	high
Highlighting	Data Analysis: Including data	high
Computer-Based Mapping comprising analytical capabilities	Data Analysis: Manipulation, Management, Analysis, Linking of selected Data with external Information, Graphic Redesign	high

Table 1. Preliminary Taxonomy of Interactivity in Geovisualisation (Crampton, 2002). The types are listed according to their (ascending) functional complexity.

information, edit-functions for presented content and possibilities to edit the database). When stressing the distinction between controlling / navigation and textual, possibly didactical interaction, it is helpful to define distinct terms for both ways of interplay. Hence it may be stated, that in terms of software use, interactivity refers to the navigation and application control. Interaction in contrast stands for the interplay with content (Schulmeister, 2002).

To avoid confusion about the terms "interactivity" and "interaction" we adopt this definition for this chapter, in which "interactivity" refers to user actions outside the actual learning content and "interaction" is limited to learner actions within the educational content.

While the provision of interaction facilities in learning processes are generally assumed as an important advantage of E-Learning environments the number of studies to support this claim is still limited. Works about interactivity in geosciences have so far often concentrated on interactivity (navigation in geodata sets) and system control, e.g. in Mach (2005) or Oster (2005). However, initial work to understand the impact and effectiveness of interaction with geodata has been done as well. First approaches tried to categorize content related interactions in a sort of taxonomy or typology. Suggestions were done by Asche & Herrman (1994), Monmonier (1994), Buja et al. (1996) and Crampton (2002).

Due to the variety of definitions Crampton (2002) gives his definition as 'least common denominator' by saying that "[Interactivity is defined as] a system that changes its visual data display in response to user input."

Some years ago some authors added qualitative information (e.g. on effectiveness) into the taxonomies and thus established classification systems. The development of such a categorization of kinds of interaction is motivated by Buja et al. (1996) by saying: „It is useful to develop a taxonomy for data visualization, not only because it brings order to disjointed techniques, but because it clarifies and interprets ideas and purposes behind techniques. In addition, a taxonomy may trigger the imagination to dream up new and as yet undiscovered techniques." We may extend this reasoning by stating that such taxonomy (cp. Tab. 1) may provide a good structure. Efficiency information in terms of suitability for learning is added.

A discussion on the effectiveness of different forms of interaction has been conducted by MacEachren (1995). However, the demand for a final method to assess the quality and effectiveness of geovisualization was mentioned by Slocum et al. (2001). This situation has not yet changed. Hence the powerfulness of any interaction type may until now only be depicted in a subjective ordinal ranking. However a taxonomy gives the interface designer at least a first impression to assess the usefulness of a special interaction means and thus support designers in the systematic exploration of the available options.

In our virtual landscape we build on these results to provide appropriate interaction functions to facilitate effective learning. Of course the introduced theory on interaction may as well be helpful for the adoption to other environments, like e.g. use cases in the context of Location Based Services, Desktop VR for the WWW or immersive VR environments.

6. THE CONCEPT OF VIRTUAL LEARNING LANDSCAPES

"Hands-on"-learning in geosciences has been hindered in the past both by the difficulty of information access and the lack of implementation of interaction concepts with textual data and thus the impossibility of experimentation. Direct access to information from real-world environments is impossible in most learning situations (except excursions). Abstracted information collections like maps and GIS have traditionally been the main means of work. While it is practically impossible to observe the results of "what-if" – experiments in reality and in traditional maps, GIS may be used in this way. Virtual landscapes take this approach a step further and utilise a perspective 3D representation of a physical environment that is augmented with learning information. Users of the virtual landscape can:

- explore information directly by navigation in the virtual landscape using 3D representations to establish a close link to spatial reality,
- see the results of analysis operation directly in their spatial context,
- manipulate features in the landscape to directly observe the impact of changes, thus enabling "hands-on" learning and be guided by additional annotations or illustration techniques to ensure a productive experience.

7. INTEROPERABILITY

7.1 Technical Interoperability

Learning environments – especially when based on visualisation of landscapes – are very expensive to build. Usually concepts for special scenarios are elaborated. This work is done manually, because the adjustment to the special needs of a learner and a teacher can only be yielded when optimizing a concept. However in many cases the technical implementation will be carried out individually as well. This means that a 3D landscape model for the study area is build. Possibly further thematic data and possibilities for interaction are integrated. This usually requires a big programming effort. The environment then may also just be applied for one special application.

In other fields of applications the same problem is tried to be solved by standardization and toolbox-like systems with standardized components. E.g. for web-based geographical information systems a standardisation process has taken place over the last decade. The Open Geospatial Consortium[9] (OGC) develops technical standards, e.g. in the field of web-based 3D-data presentation. Two specifications in that domain are at the state of discussion papers at the OGC at the moment. One is the Web Terrain Service (WTS)(OGC, 2001). The specification envisions the display of maps in perspective views. The problem of that system is that just raster images will be generated. However, different layers of raster images can not be overlaid. Interaction with and navigation in the WTS is not possible either (Kolbe, 2004; OCG, 2001). An important feature thus is missing. Hence there was another development, the Web 3D Service (W3DS)(OGC, 2005). In comparison to the WTS the W3DS combines all objects in a scenegraph before rendering, which is finally handled by a client, rendering the scene based on the scenegraph description.

We showed in Katterfeld & Sester (2005) how these standards might be applied to provide a technical framework to provide data and functionalities for virtual learning landscapes. However such an environment should be extended to better suit learning- and teaching needs. The required extensions concern primarily the task of interactivity and providing learning information.

7.2 Contextual Interoperability

The importance to integrate content in a learning environment is obvious. Also, the value of interaction was discussed in one of the former sections. But how to integrate those information in an "on-demand"-environment? How to implement such content requirements?

We aim to answer these in our work. Our ideas aim at providing standardized and hence exchangeable descriptions of the content to be learnt as well as standardized descriptions of the kind of interaction needed to convey distinct information effectively. These descriptions can be seen as kind of learning-augmentation. These augmentations could be used in different technical and conceptual versions of a learning system as long as the interfaces are well defined and supported across platforms. In terms of this contextual interoperability we are working on a way to structure the learning information in a kind of "EduOntology". We also want to consider effectiveness of ways of interaction with geodata.

An Ontology is a collection of information and hence represents a part of the reality (a so-called "domain") in a structured way as well as the relationship between the objects in machine-readable form. Within our work we create "Task Ontologies" for special learning scenarios.

We want to test the hypothesis that learning information may be deployed interoperable and thus more effective when expressed in a standardized way. Ontologies are a well-known means to structure information and it has to be tested until which level of

Prototype Scenario

The process of planning a railway line requires a set of steps. The student first will be asked to choose the right work steps from a list of options and put them in the right order. The list will be only accepted when the steps were put in the right order. Then the learner has to carry out these steps within the virtual landscape-learning environment. For that appropriate data is provided. The choice of data was done by a tutor who compiled the learning scenario before. (For advanced students the access to the data services could be provided. Thus the choice of data would be a single working step.)

The learner then will carry out the working steps, e.g. exploring the area by using interaction tools of the environment (e.g. pan, zoom, fly, comments/ links on mouse over, etc.) as well as simple analysis tools (e.g. select by attribute, etc.). For analysis the learner had next to assign sensibility indices to every land use type. Based on that areas with lowest sensibility against the intervention are to be calculated. Different weights to the subject of protection have to be assigned to express a valuation of protection needs. For that some basic analysis tools (attribute-based assignment of values and calculation of the total value for ever object) must be provided. Further on the student should calculate buffers to analyse the range of the effects of noise. For that a tool for calculating buffers must be provided. (If the student is interested to learn more about the buffer operation he may switch to a text-based course, where GIS operations are introduced.) Based on the buffer a resistance value can be assigned to areas still much affected by the noise.

Overlaying areas and calculating their resistance should enable learners to identify the respective values of possible routes. Possibly intersected areas have to be investigated in terms of the need of compensation actions. Areas of compensation must be roughly digitized and assigned by attributes about further measures.

The result must be cartographically visualized in the virtual landscape (i.e. the possibility to change graphic variables must be given) and the course of the route may be explored in the perspective view. The final (perspective) map and some verbal evaluation on the route and problems involved in the solution must be submitted as result of the task.

A discussion of the results will be part of a course where every student has actually to be physically present. The commented outcomes will stay available online to be a base for issue-based discussion for the course in the next year.

Figure 1: Prototype Szenario

[9] www.opengeospatial.org

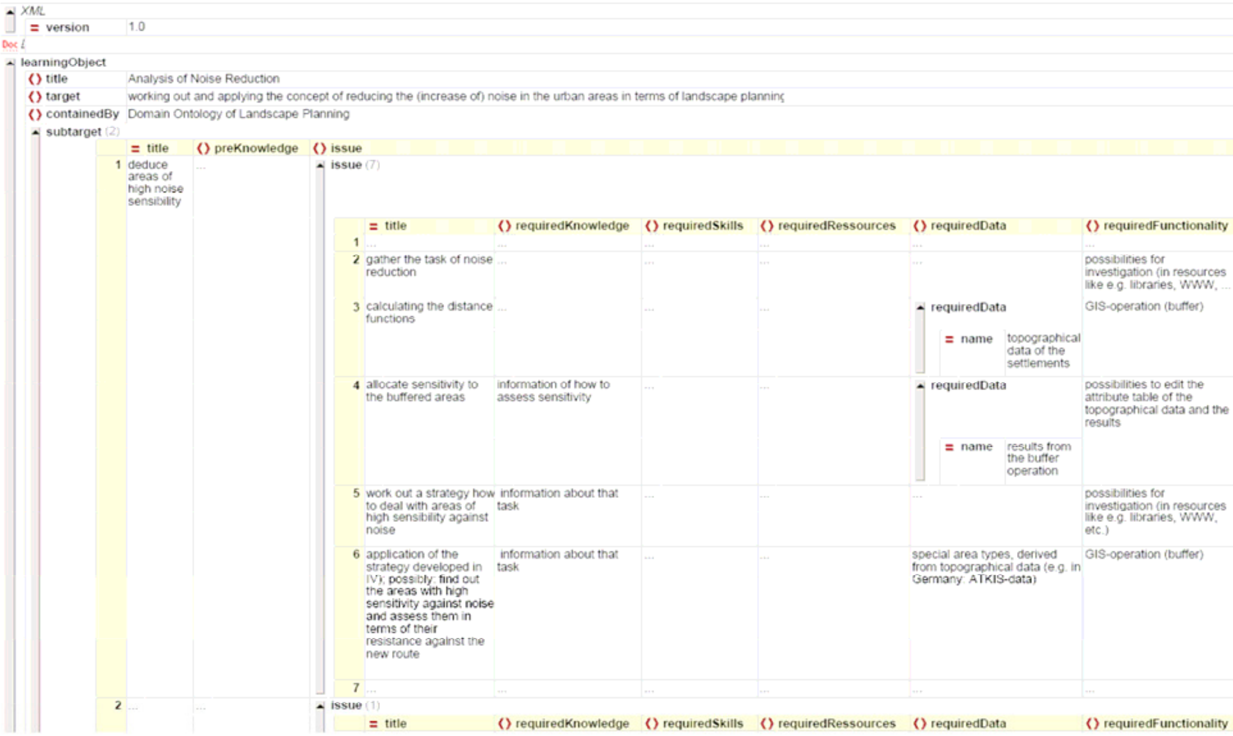

Figure 2. Example of an extract from a domain ontology

<u>Interaction with the Data Representation</u>
…
Orientation of Data
degree of interaction: *medium*
efficiency: *medium*
info: -
Zoom-in/ Zoom-out
degree of interaction: *low*
efficiency: *high*
info: -
Rescaling
degree of interaction: *low*
efficiency: *high*
info: *information on scales, generalisieration etc.*
Remapping of Symbols
degree of interaction: *medium*
efficiency: *low*
info: *information on cartographic issues*
....

<u>Interaction with the Data</u>
…
Database Queries & DataMining
degree of interaction: *high*
efficiency: *high*
info: *information on databases, databasequeries and data mining*
Filtering (Excluding)
degree of interaction: *high*
efficiency: *high*
info: -
…
<u>GIS-Operations</u>
…
Clip
degree of interaction: *low*
efficiency: *high*
info: -
Buffer
degree of interaction: *high*
efficiency: *medium*
info: *information on buffering algorithms*

Figure 3. Extract from the Interaction Dictionary

complexity ontologies remain applicable. Otherwise other frameworks for structuring information (possibly e.g. databases etc.) have to be found.
We are working on a case study, wherein students of the landscape planning subject should use the virtual landscape to learn how to plan a railway line. A possible scenario, how the work within the virtual landscape could look like given in Fig. 1. Our task ontology is derived from text analyses (based on the text in Fig. 1), a method suggested and applied e.g. by Kuhn (2001). It itemizes the whole process into single working steps and assigns further information to every working step.

Such further information is:

- working target (the aim of the distinct action in relation to the learning target),
- overall learning target of the working step (i.e. what the learner is supposed to learn with that action),
- ascertained action,
- data needed,
- metainformation needed,
- software functionalities needed and
- possible feedback.

Enhancing the ontology with these information we derive another ontology, which we will call the first-level EduOntology. Such an Ontology could be regarded as script for a learning scenario. Fig. 2 gives an insight how such a scheme could look like.

The second important aspect to incorporate with the domain ontology to derive a mature EduOntology is the evaluation of interaction types in terms of effectiveness for the use with distinct geodata in distinct situations. Approaches to categorize ways of interaction were introduced before.

Based on these taxonomies we establish a so-called 'Interaction Dictionary', which provides for the interaction types attributes on the degree of interaction, the efficiency in terms of acquisition of knowledge and the information a learner should possibly know about this type of interaction. The last point became necessary, because we also understand more complex processes of gaining knowledge as interaction as well. Here e.g. a complex GIS-analysis could be regarded as one interaction. In that case it might be useful to learn more about that functionality, which mostly incorporates different steps, some of them containing algorithms, which's understanding is important for evaluating the results. However this point is very difficult to realize, because the learner should not be confronted with intransparent learning information when he is looking for an answer to a distinct question. The provision of information according to the users needs is another problem to deal with when aiming to improve such a learning environment.

Fig. 3 gives some examples how the Interaction Dictionary could look like. The assignment of the attributes to the interaction types is based upon our experiences. However to quantify and improve the propositions some systematic user tests would be necessary.

The most interesting point now is the incorporation of the Interaction Dictionary into the EduOntology on the one hand and the (automated) transfer of the mature EduOntology into a learning environment, i.e. into software on the other hand. One case could be, e.g. the notion of a buffer – given as a functionality in the first-level EduOntology – would automatically be related to the description in the Interaction Dictionary (which could also be extended with technical information of the buffer operation, as well as the necessary parameters) and derive the suitability of this operation for the current environment, scenario or issue. This issue is subject to further work. At the moment the findings provide principles for designers to mind when implementing learning environment more or less manually. However it would be desirable to develop tools which are able to use such information (e.g. formalized in XML or in the Web Ontology Language, OWL) for semi-automatical or finally automatical implementation of learning environments.

8. SUMMARY

In this paper we discussed the development of learning environments for geosciences in a broad and overall way. We gave an overview of the situation of geodata-based learning and made clear what chances but also challenges exist. We introduced technical standards and identified ways to use those standards for the development of learning environments. We further discussed the contextual side of learning environments extensively. Here we have provided a proposal of how a kind of standardization of structuring learning information could be reached. For that we incorporated and hence investigated the task of interaction.

It could be summarized that E-Learning is valuable, but still has to be improved in terms of applying visualization and interactivity to accommodate distinct learning scenarios and special user demands. We suggested applying structured instructions how to design learning scenarios by developing an EduOntology. However, we are aware that much work remains to be done until those structures can be operationalized successfully. Thus further efforts are needed for the investigation of effectiveness and impact of different interactivity types, for expressing learning scenarios and domain knowledge in a structured way as well as for the operationlization of those structures for software use. The description of learning scenarios in an EduOntology also provides the opportunity to adapt the presentation to a specific learning context (user, knowledge, hardware, environment), an aspect that we have not addressed in this paper and that we aim to explore in the future.

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Multi-usable courseware for flexible and demand-driven education at ITC

Drs. G.T.M. ten Dam
ITC, International Institute for Geo-information Science and Earth Observation,
Hengelosestraat 99 7500AA Enschede, The Netherlands
tendam@itc.nl

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Remote Sensing, Spatial Information Sciences, Teaching, Training, Multimedia, On-line, Tasks, Courseware

ABSTRACT:

The paper describes the change in education at ITC, from fully face-to-face via the use of an electronic learning environment towards online learning and all possible combinations of face-to-face and distance learning. The didactic approach has changed as well. The paper describes how ITC is working on this enormous change by the development of multi-usable, on-line courseware and tries to deal with related issues that have come on our way of change. These issues include the selection of the basic instructional design of multi-usable courseware, accreditation of flexible and joint courses, copyrights on educational materials, selection of standard geo-software for teaching and instructional design and technical support and training for lecturers. The first results show that indeed one set of courseware can be used in different modalities. Well prepared reading materials and exercises plus guidance during the course are the most crucial for effective online teaching, the use of multimedia is less crucial. ITC staff is not yet fully prepared for a change of working style and preparation of materials long before the course will be run. The time needed for the development of multi-usable courseware is underestimated.

RECENT CHANGES

ITC is an Institute for International Education in the Netherlands. It specializes in Geographic Information Systems and Remote Sensing and their application in various fields. ITC's mission is capacity building in countries that are technologically and/or economically less developed. This is done through research, education and consulting. ITC has expertise in the entire chain in geo-information handling, from data acquisition to dissemination to use in different application fields as well as the context and organizational setting in which geo-information management takes place.
Until recently ITC's main educational activities were under- and postgraduate courses at different levels (Certificate, undergraduate and postgraduate Diploma, Master degree and Master of Science degree) offered at ITC and contract teaching in the context of institutional development in less developed countries. All courses were offered face-to-face by ITC staff. This has changed rapidly over the last few years. Our target group and their training needs are rapidly changing. New target groups have been reached. New delivery mechanisms, allowing for part-time and distance education, have been introduced. Joint courses are offered with partners in both LDC and western countries. The educational program has become more flexible and more demand-driven.
In order to survive in an ever increasingly competitive world the variety of ITC's educational products must and will increase further:

- First of all a comprehensive education and training programme will be maintained at ITC.
  The demand driven strategy and definition applied for capacity building, imply attention to both scientific and professional requirements. This means that both a scientific MSc and a professional Master course will be maintained.
- In addition the education programme will include (postgraduate and regular) diploma courses, short courses ranging from 3 weeks to 3 months, tailor-made courses on demand as commercial products and refresher courses. The focus will change to more and higher specialized short courses and tailor made contract education as core business of ITC rather than supplementary service.
- More delivery modes: Next to full-time face-to-face study at ITC, the flexibility for the participants in terms of pace of study and location will increase; part-time study, distance education, joint courses in the region (see next bullet), etc.
- Linked to the academic degree courses delivered in Enschede, ITC will enhance its policy of joint educational programmes, building on the capacity that has been created over the past 40 years in ITC's target countries. ITC aims for 2009 to have 20 operational partnerships in delivering joint educational programmes.
- Next to the traditional target groups from developing countries, ITC will offer courses to Dutch and other European participants.

According to ITC's Strategic Plan (ITC, 2004) not only the number of modalities offered will increase, also the output per modality must increase considerably. Only the output of academic degree programmes at ITC is expected to decrease. The input of all other modalities must increase considerably: regular diploma and short courses at ITC, courses for Dutch and European participants, joint courses, refresher courses, distance education and contract education and training.

These modalities and output have to be realized with the same or slightly fewer resources, both staff time and finances. This has asked for a new format for educational materials and for a new educational approach.

ITC'S AIM: FLEXIBILITY FOR STAFF AND CLIENTS

ITC aims at what many Australian universities have already realised: online courses with online materials that can be taken by participants the way that suit them best; on campus at ITC or at the premises of ITC's partners, as distance course or any combination of these two. The courses can be taken in fulltime mode, part-time or spread over a longer period.
These online courses offer flexibility to the participants and also to the lecturers. The teaching can be done in different ways, by staff at one location, shared by staff at different locations and even with input from experts all over the world.
Also in contract teaching the same flexibility is possible, depending on the wishes of the client. Combinations of face-to-face block teaching and distance learning plus online after care are possible.
In all its delivery methods, ITC wants to continue what most participants mention as ITC's strongest points in education: practice oriented courses in combination with extended support and guidance by experts in geo-information and in the application field of the participant. This starting point has clear consequences for the type of distance courses that ITC will offer that excludes stand-alone packages.

For ITC this aim means an enormous change. We are changing from fully face-to-face via the use of an electronic learning environment towards online learning and all possible combinations of face-to-face and distance learning. The didactic approach has to change as well. This paper will describe how ITC is working on this change and the problems (most of these existed already but have become much more urgent to solve in an e-environment) that constantly come on our way of change.

PROJECT ORGANISATION

The scope of the change and the consequences for the organisation require a powerful project organisation. The Steering group, chaired by the rector of the ITC (that shows the importance of e-learning for ITC), takes decisions on policy, priorities and work plans. The project group prepares and implements the work plans and monitors each courseware development project. The actual development of each courseware package and distance course is done by an development team and is run as a project. The terms of reference and the responsibilities of the project manager are clearly described.

MAIN STEPS

Use of an electronic learning environment

In 2001 ITC introduced an electronic learning environment in its courses at ITC. By now all materials in all modules are available online, easily accessible for participants. Easy for the colleagues to find out what is done in other modules and easy for archiving and re-use next year. The main purpose of this environment is, however, that it allows combining face-to-face and online learning and fully distance education. For ITC the introduction of the electronic learning environments is the first step towards blended and distance education and distant support to joint courses.

Development of multi-usable courseware[1]

ITC is now working hard on the next step, the development of multi-usable courseware.
The modalities and combinations of content will increase but the content itself will not necessarily change. This allows for re-use of content and consequently also re-use of courseware. ITC's current courseware is mainly developed for face-to-face teaching at ITC. Re-use in other modules requires labour-intensive re-development. When the same courseware must be used by staff of partner institutes in joint courses, the transfer of the expertise of the lecturer is labour-intensive. When the same courseware is used for distance education, adaptation or re-development of the courseware is needed.
ITC needs courseware that can be used in different modalities. This requires that the courseware is suitable for online delivery and that it is less lecturer-dependent. More than in face-to-face course materials expertise of the lecturer that is needed for regulation of the learning process, guidance of the exercises and provision of feedback must be integrated in the courseware. A lecturer manual must be available.

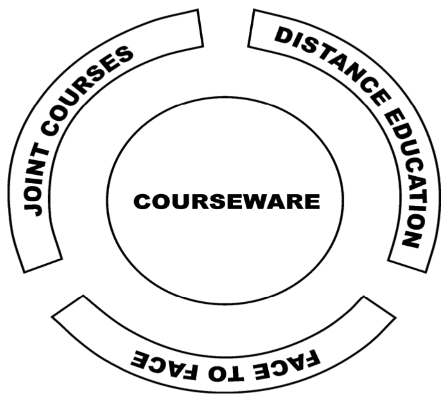

Figure: multi-usable courseware

[1] Work definition courseware: Courseware is the structured set of all teaching and learning materials of a module, made available in the electronic learning environment. These materials include: literature, lecture notes, slides, assignments and data, standard help and feedback, discussion items, example exams, assessment criteria, assessment form, and if needed the teacher manual.

The new courseware will be available in the electronic learning environment and will be the same in all modalities. The guidance provided by the lecturer will differ per modality (but will be prepared as much as possible and integrated in the courseware; e.g. FAQ, example results of exercises, help to participants for foreseen problems):

- In face-to-face courses at ITC: The lecturer will complement the courseware with face-to-face tutoring, supporting lectures or question hours and supervision of practical exercises.
- In joint courses: Lecturers of the partner institute can rather easily use the low lecturer-intensive courseware to offer the module. The lecturers can add additional face-to-face components similar to what the ITC lecturer can do in face-to-face courses at ITC. Whenever necessary an ITC lecturer can provide additional online support to the lecturers or co-tutor the participants directly.
- In distance education: The tutoring is done online, using the communication functionalities in the electronic learning environment and other ICT.

To help the lecturers to make the shift to multi-usable courseware they are asked to design and develop courseware for distance courses. If the courseware is suitable for DE it will also be suitable, with a few of the above smaller additions, for use in face-to-face courses and joint courses. In this paper we will therefore mainly talk about distance courses and online courseware but this will include use of the same courseware in joint courses and in face to-face courses at ITC.

Task based learning

ITC developed several stand-alone distance course packages in the past. However, experience with development of courseware suitable for online teaching and online tutoring was limited. After study of several distance courses offered by other institutes, ITC has chosen for task based learning (DU, 2004) as basic instructional design of the online courseware. Modules are divided in tasks in which theory and practice are integrated. Each task has to result in a deliverable or product that is posted in the discussion board. Fellow-participants and/or the lecturer can discuss the results or provide the feedback. The deliverable allows the lecturer to keep track of participant progress and to check whether the participant has understood the content. To give the participants a feeling of belonging to the course and the course group e.g. a video to introduce the course and the course staff is added and communication between participants and participants and staff in the discussion board is stimulated.
This task based approach could also be an answer to results of evaluations of face-to-face courses at ITC that show that although participants are still satisfied with the content of the courses, the number of remarks and complaints about the teaching approach, which is not seen as suitable for adult education, increases. To offer more effective education and to stay competitive a change in didactic approach from teacher-centred to student-centred is needed. The leading principle for the design of modules should change (further) from the best teaching methods and sequence for the lecturer to the optimum learning process for the participants. Modules that consist of one or a series of learning units (tasks, assignments, projects) could realise that goal.

Learning units and tutoring

The key question to answer in the design process of module courseware will be: What learning units (Karjalainen, 2004), tasks, assignments or projects, must be done by participants and in what order to guide participants from their starting level to the required end-level of the module?
Every learning unit consists of a description of the end product, the way the participant should get there (path, steps, materials that have to be used, etc.), learning materials, communication between participants and/or between participants and staff during the learning unit, and the feedback that will be provided on the end-product.

This learning unit approach allows for several didactical approaches, from fully closed to fully open assignments, and from heavily teacher regulated education to individual learning paths and high levels of student independence. Although several newly (re-) developed modules might start with relatively closed learning units, all modules will gradually offer more choices for participants and more individual learning paths. The role of the lecturer will more and more change from teacher to tutor.

RELATED ISSUES

Learning Content Management System: Less lecturer-dependent courseware as described above will lead to more efficiency in the execution of the same modules in different modalities. Efficiency of ITC's education can be increased further by sharing courseware components and learning units between different modules. Therefore a Learning Content Management System (LCMS) is essential. An LCMS can make existing or newly developed courseware accessible and re-use more likely. The best granularity (learning units and/or components of learning units) of the content in the LCMS will need special attention. A special working group will be appointed to advise how ITC can best manage its learning content as well as all other documents that ITC produces.

Accreditation: The current accreditation of ITC's degree courses is based on the organisation and face-to-face delivery of the courses that are fully taught at ITC's premises in Enschede. ITC's distance courses and joint courses are not (yet) accredited. ITC intends to base the quality (that meets the requirements of the Dutch accreditation organisation NVAO) of ITC's courses and modules on the distance education modality. In that scenario the face-to-face activities that are added in courses at ITC and in joint courses abroad are seen as extra service to the participants on top of the standard minimum delivery quality.

Copy rights on educational materials: Courseware development, an LCMS and re-use of materials by others require a clear and well implemented policy on copy rights. The Dutch and international law has always been quite clear about copy rights on research output, but the rights on education materials required a (subjective) interpretation of the law. Some lecturers refused to put their materials in the electronic learning environment since they feared that colleagues would use and even change their materials without proper acknowledgement. (It has indeed happened several times that materials of colleagues were used in contract teaching without mentioning the name of the original author.)
ITC is developing copyright rules for internal use, stating that ITC has the commercial rights of all education materials but that the intellectual rights are of the author. Colleagues can use the materials and add new components but they are not allowed to change.

Geo-software: Also essential for courseware development and re-use of courseware is a selection of standard geo-software packages that ITC will use in its courses, to avoid that many software-specific versions (and regular updates to new versions of the SW) of exercises have to be made. The IT department is working on such selection.
Another issue is what software to use in distance courses. Can you expect that the participants will pay for commercial packages for use in a short course? Can you expect that they have already access to it? The solution that ITC has chosen is that for the basic courses in GIS and Remote sensing use is made of free software like ILWIS that is produced by ITC in house or free or almost free temporary (student) licences like for ERDAS and ArcGIS. For the more advanced distance courses access to the commercial software that is used in the course is an entry requirement (training participants who will not have access to the software after the course has finished is not very useful).

Support for staff: Developing student-centred e-learning and courseware is a new task for lecturers of ITC and of partners for joint education. They need training and on-the-job support. For efficient development of effective courseware both didactical and multimedia/technical expertise next to content expertise are needed. Three experts should closely work together. The didactical expertise in courseware development is limited within ITC. The instructional designers take further training as well. The multimedia and technical expertise is scattered over the building and grouping this is important to share expertise and to make it better accessible. The old idea of a multimedia support group might be a good option.
Also training is needed for the delivery of online courses, online tutoring and provision of feedback. ITC is developing a whole range of courses and workshops: refresher workshops on the use of the electronic learning environment, courseware design, online tutoring, online group work and audio- and video- communication and courses in the use of multimedia. Next to these courses and workshops ITC organises education seminars where staff can present their experiences with course ware development and online and distance courses.

FIRST EXPERIENCES

- ITC has re-developed courseware for a few modules. A few distance courses are developed and offered. The student results with the new courseware in distance courses and in face-to-face courses at ITC are positive. In the meantime ITC has learned a lot. Especially the planning of the courseware development stage and the organisation of the course delivery can be improved.
Until now we have been working on re-design of existing modules. In the new UPM and GIM courses the new modules will directly be developed as multi-usable courseware.
- The time planned to re-develop a module into distance education format or courseware was usually not enough. It would have been sufficient for the re-development but lecturers spent much of the available time on improvement of the materials. Materials that would have been good enough for another face-to-face run are not considered as good enough for inclusion in a package that will become standard for a few years.
- Lecturers tend to spend a lot of energy on labour-intensive transformation of the lectures into e-lectures to present and explain to the participants what they would explain in class in face-to-face courses. Slide shows enhanced with animations and other multimedia are popular, also video lectures are used often. Animations, audio and video are powerful tools for explanation of concepts and to bring real-life into the course. At least a few participants per animation have indicated that it was very helpful for their learning process. Nevertheless participants have clearly indicated that not these fancy additions but the quality of the reading materials, well prepared exercises and the guidance offered by the lecturer during the course are the most crucial. This has lead to the recommendation to the development teams to develop the readings and exercises and prepare the feedback first and then spend the remaining time on add-ons, adding new ones every year.
- Lecturers and project managers tend to underestimate the time needed for the delivery of the course and especially the guidance during their first distance course. Provision of feedback does take much time and in the design of the exercise the time needed for proper feedback is not sufficiently taken into account. This usually changes after one run.
- Distance education and courseware development require a change of working style. Courses and materials have to be prepared long before the course is run and staff has to work in teams. Both do not match well with the current working style of ITC’s lecturers. This might also explain why the current practice to make one of the lecturers project leader of the development team does not always work well.

- The new style of teaching will change and has already changed the content of the work of ITC's lecturers. They will have to spend more time on the development and maintenance of courseware, more time on online guidance and feedback and less time on face-to-face teaching at ITC or abroad. The lecturers' tasks and consequently required skills have diversified further. Whether staff will like to do all these tasks themselves or that they will prefer specialization is not yet clear.

CONCLUSIONS

The use of the same courseware set in different modalities is indeed possible. The first student results are positive. Staff has already experienced the power of good online courseware; in distance courses and for easy transfer of the teaching task to partner institutes in joint courses.

The statement in the conference brochure is only partly supported: "The highly integrated multimedia technologies of e-learning are rapidly changing the style of education."
ITC's style of education is indeed rapidly changing; from fully face-to-face education to different kinds of combinations of face-to-face and online learning, from face-to-face approaches to e-learning and from face-to-face based materials to highly flexible courseware. For this change the introduction of an electronic learning environment was crucial. But more advanced multimedia technologies play only a minor role. Although high-tech technologies are an essential component of the content of ITC's courses, the high-tech multimedia are not the key for success in the delivery of ITC's courses, neither in face-to-face or in distance courses.

ITC is well on its way from a mainly face-to-face to a flexible education institute that is constantly adapting its courses and can deliver education products on demand. The way is long and challenging and includes dealing with problems that we had not foreseen. But the first results show that we are heading in the right direction.

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This paper is based on the work of ITC lecturers who have been willing to experiment with the development of courseware and on the experiences of students who studied and were taught with the newly developed courseware. I am grateful for their effort and their willingness to share their experiences and opinions with me.

INDONESIA CONTRIBUTIONS IN ALOS PROJECT

Fahmi AMHAR
National Coordinating Agency for Surveys & Mapping
Jl. Jakarta-Bogor Km. 46 Cibinong 16911 – Indonesia
telp. /fax. : ++62 21 8790 1254
email: famhar@telkom.net, famhar@yahoo.com

Commission VI

KEYWORDS: International Cooperation, Technology Transfer, Topographic Map Production, ALOS.

ABSTRACT:

International Cooperation and Technology Transfer will be well done by Indonesia participation in ALOS Project through some research topics. Highlighted in this paper is preparation to research in topographic map production using ALOS data, which should contribute to the know-how of ALOS integrated mapping system. Three experiments will be taken to benchmark the ALOS data, so that some technological and financial effort of ALOS data-usage will be well known. The first experiment is topomap production of rural area of Bogor using PRISM and AVNIR. The second experiment should be topomap production and 3D-city model generation of the Jakarta metropolitan area using PRISM, AVNIR and PALSAR data. The third experiment should be topomap production in cloudy jungle and mountainous area in for East Kalimantan and Papua using AVNIR and PALSAR. A complete workflow and working schedule will be also presented.

1. INTRODUCTION TO ALOS PROJECT

The mapping satellite ALOS of Japan is launched on January 24, 2006. The ALOS mission has three sensors in single platform: Panchromatic Remote-sensing Instruments for Stereo Mapping (PRISM), to measure precise land elevation, Advanced Visible and Near Infrared Radiometer type 2 (AVNIR-2), which observes what covers land surfaces, and Phased Array type L-band Synthetic Aperture Radar (PALSAR), which enables day-and-night and all-weather land observation

Since two years before, JAXA has invited Indonesia to participate in the research using coming ALOS data. The National Institute of Aeronautics and Space of The Republic of Indonesia (LAPAN) is the liaison for JAXA and coordinator for the whole Indonesian partners. LAPAN is recently responsible for all remote sensing technology. Table 1 shows the participating institutes and their research topics:

The research topic carried out by BAKOSURTANAL is the most challenged one since it will be the comprehensive test for the main purposes of ALOS, i.e. mapping! Mapping or map updating, especially in rapid physical developed metropolitan with a lot of buildings or in ever-cloudy forest area, is always complicated, expensive, and the suitable technology is not always available. ALOS with combination of several sensors shall answer the challenges. In the other side, the capacity of integrated platform for several sensors in ALOS should be tested comprehensively, especially in topographic map production with more concerned in geometrical aspect.

	Participating Institutes	Research Topics
1	Indonesian soil research Institute (ISORI), Soil and Agroclimate R&D, Ministry of Agriculture	Assessment of Land Degradation and Mass Movement using ALOS Satellite Data
2	Geology Development and Research Center, Ministry of Energy and Mineral Natural Resources	Modeling For Natural Resources Mapping
3	National Coordinating Agency for Surveying and Mapping (BAKOSURTANAL)	Topographic Map Production using ALOS Data; Benchmark test in urban area of Jakarta, rural area of Bogor and cloudy-forest area of Kalimantan/Papua
4	Center for Remote Sensing and Ocean Sciences (CreSos)	Development of Algorithms for Coastal Zone Management and Vessels Monitoring using ALOS Data
5	Regional Development Study Center, Bogor Agriculture University and GIS & RS Center of Aceh Syiah Kuala University	Land Use, Land Cover and Terrain Changes in Nanggroe Aceh Darussalam, Indonesia
6	Center for Forestry Mapping, Ministry of Forestry	Application of ALOS Satellite Imagery for Indonesian Forest Resources Monitoring

Table 1. Participating Institutes and their research topics

2. TOPOGRAPHIC MAP PRODUCTION

Three experiments will be taken to benchmark the ALOS data, so that some technological and financial effort of ALOS data-usage will be well known.

Benchmark sites will be rural area of Bogor, urban area of Jakarta, and selected forest area of East Kalimantan or Papua. In these areas there are some data to compare: topographic map, GPS ground control point and some aerial photographs.

The first experiment should be taken for Bogor area. The big area of Bogor is in larger part rural and the water-catchment's area of the capital Jakarta with a midsize city in its center. PRISM and AVNIR data should give an up-to-date topographic map of scale 1:25.000, which accuracy could be comparable to one made at year 2000 based on 1:30.000 aerial photograph added with some SPOT-image and field survey. The area is a good representation of typical Indonesian mixture (mountainous area – plain area, midsize city and rural area). The test result will give the recommendation about the usage of ALOS for typical middle scale topographic map production.

2.1. Topomap of Typical Rural Area

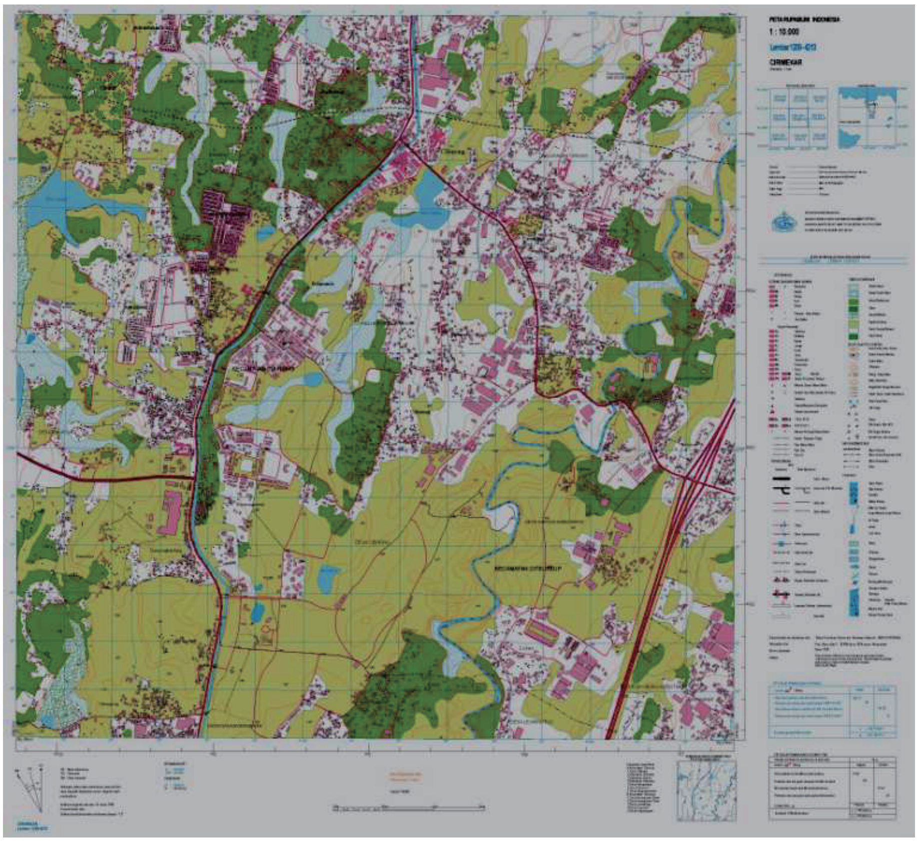


Fig. 1. Typical Indonesian topographic map made by photogrammetry
(© Bakosurtanal)

2.2. Topomap & 3D-City Model of Metropolitan Area

The second experiment should be taken for Jakarta area. This Indonesians capital has a lot of skyscrapers and dense settlement, which is growing rapidly. The city has also coastal area, which is in change. An up-to-date map of scale 1:25.000 should be made using PRISM and AVNIR. The new 3D-city model should be also made using PRISM and PALSAR data. We will compare these two sensors, and compare also with the old 3D-city model made by analytical photogrammetry. The capacity of AVNIR data to detect the material of the objects should be tested. The 3D-model has broadly application, e.g. cellular telecommunication planning, environmental study and fire-protection optimation.

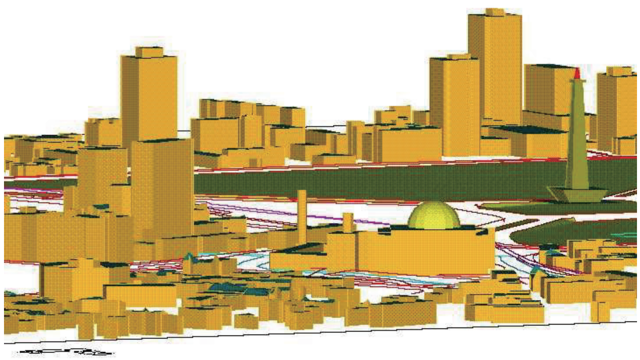


Fig. 2. Prototype of 3D city model made by photogrammetry
(© Bakosurtanal)

2.3. Topomap of Cloudy, Forest and Mountainous Area

The third experiment should be production of topographic map 1:50.000 for a selected area in East Kalimantan and/or Papua where the larger area are dominated by forest and the sky is oftener cloudy. In East Kalimantan, the benchmark could be the existing topographic maps made by photogrammetry and additional data from airborne interferometric SAR, SRTM, LANDSAT-TM and ASTER. In Papua, the benchmark could be only DEM of SRTM or older map produced by Indonesian Army (DITTOP-AD). The area is a good representation of ever-cloudy area. East Kalimantan (Berau County) would be good representation of jungle in plain and marsh area, while Papua (Timika County) is good representation of jungle in mountainous area. In all test area, there are enough GPS Ground Control Points already. Definitive area should be selected after a complete path-row-index of ALOS received.

3. METHODS

The hypotheses of the research should be: (1) ALOS data can be used to the objective with certain requirements; (2) The accuracy is nearly closed the benchmark data.

Topographic map will be made by using PRISM + AVNIR (for Bogor & Jakarta 1:25.000) and by using PALSAR + AVNIR (for Berau and Timika 1:50.000). A softcopy photogrammetry system will be used to processed PRISM and PALSAR data to generate the Digital Terrain Model (DTM). The DTM will be used further to generate the contour line. For 3D-city modeling, the DTM will be further modeled to generate the solid raster 3D-building model. This model is later compared with rasterized existing 3D-city model (in vector format)

The other part of topographic map (layer river, coastline, roads, settlement and vegetation) will be vectorized from AVNIR data. For land cover, a previous unsupervised classification could improve the process. The combination of this planimetric detail and contour line built the manuscript map. For the real map, addition information for administrative boundaries, building identifications, street classes and geographical names must be collected from field check or authoritative institution, but for this research unnecessary.

The general approach is in the following flowchart:

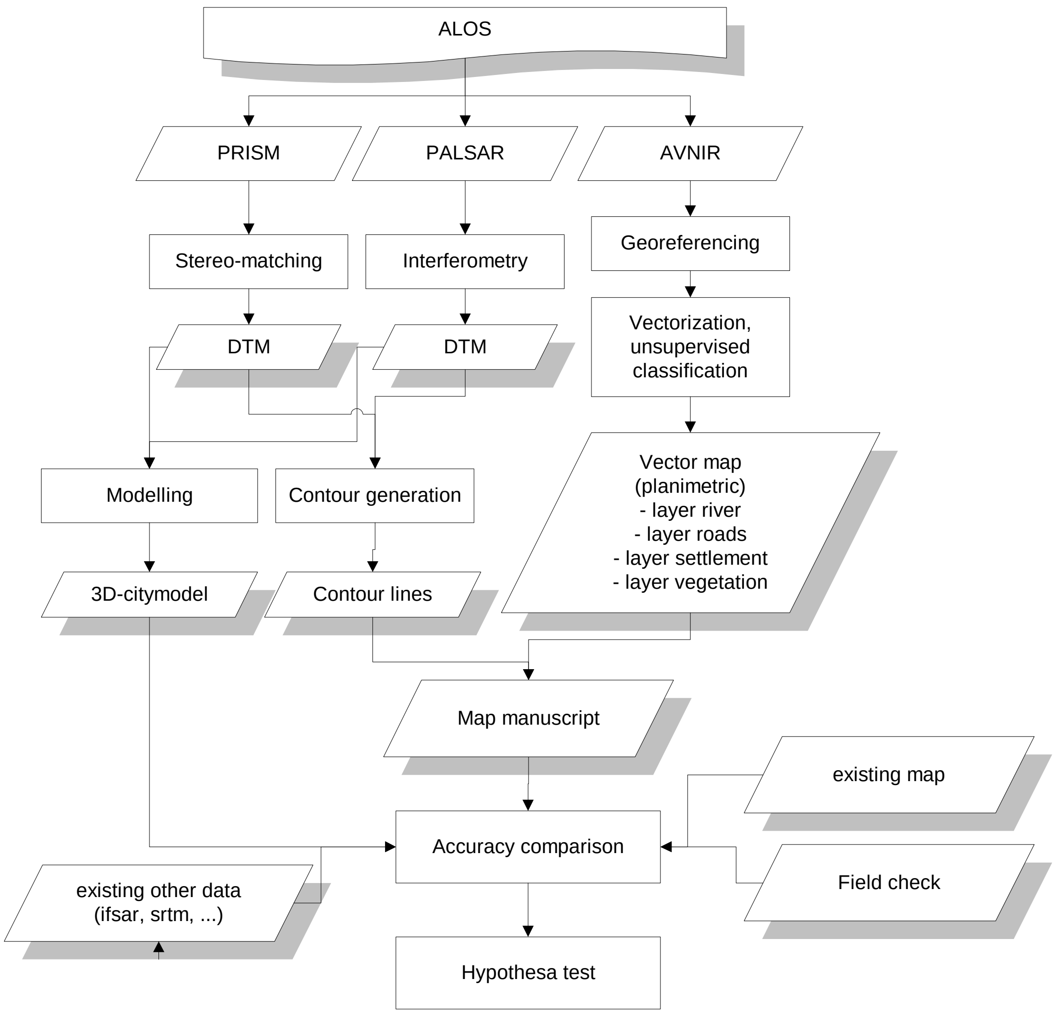


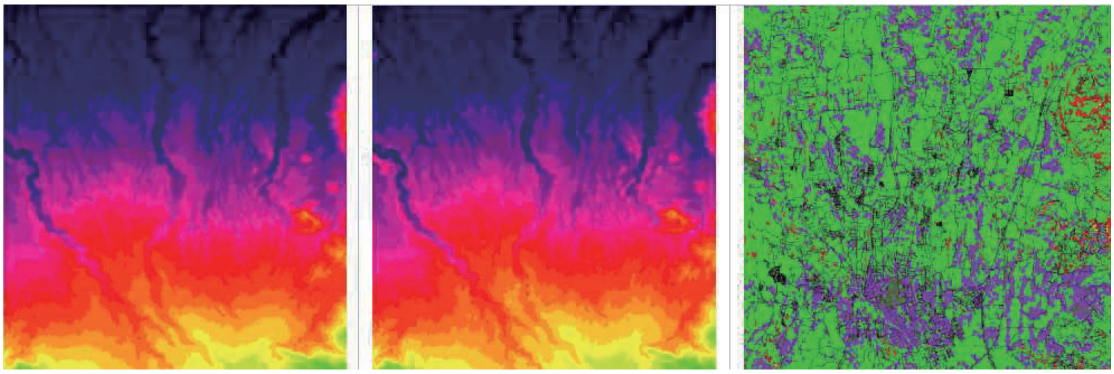
Fig. 3. Flowchart of the research method

4. DATA BENCHMARKING

Lastly, the result could be benchmarked with the existing map and with the reality (in case that there is change in nature). Twenty good distributed objects location would be selected and tested. The result would be classified as "good" if the 90% of the objects have the differences less than 0.2 mm to the map scale (horizontal) and 0.3 of the contour interval (vertical). For DEM, a comprehensive benchmarking will be done using DEM-subtraction. The figures-4 show a test done for benchmarking of DEM from Interferometric SAR data to DEM from photogrammetry.

Benchmark will be also done for the working efforts, manpower, time and costs. Production line with ALOS should be not only technologically possible but also economically feasible.

The research will contribute to the geospatial world about the benefit of ALOS data. For the area of research: In Bogor, planer (agriculture, environment and hydrology) will have an up-to-date map, which should support the function of Bogor as buffer area of Jakarta. In Jakarta, planer (urban planer, cellular telecom planer) will have an up-to-date map and 3D-city model which reduce the cost of all building-project. In East Kalimantan or Papua, planer (regional, forest, mining, environment) will have an up-to-date spatial data – partially for first time, especially in the area where cloudy will be "never" opened.



a. DEM of Interferometric SAR b. DEM of Photogrammetry c. Difference DEM (overlaid with vectors)

Fig. 4. Comparison of DEM (here in color coding)

The project is projected for three years with one-year preparation (2005), depend on the availability of the real ALOS data (after succeed with simulated data), the progress in data processing and the condition for field check. Part of work phases will be done sequentially, and part others will be done in parallel. Fig 5 is the tentative schedule up to 2008.

Workphase	
Preparation:	2005
Workshop / training	Early 2006
Data collecting & processing of simulated data	Early 2006
Data collecting (real ALOS data)	Late 2006
Data collecting (benchmark data)	Late 2006
DEM processing (stereo matching PRISM)	Early 2007
DEM processing (interferometry PALSAR)	Early 2007
DEM processing (DEM editing)	Mid 2007
DEM processing (contour generation)	Mid 2007
DEM procesing (3D City Modeling)	Late 2007
Georeferencing of AVNIR	Mid 2007
Unsuspervised classification AVNIR	Mid 2007
Vectorization avnir	Mid 2007
Map manuscript production	Late 2007
Comparation with field data	Early 2008

Fig. 5. Tentative Schedule up to 2008

CONCLUSION

The research will give the geospatial world the real experience and know-how of using ALOS data in topographical map production and other usages. The project should be good example for International cooperation and technology transfer, which significantly contribute to the photogrammetry and remote sensing society.

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UNDERSTANDING AND TEACHING FOR REGIONAL DIFFERENCES OF AGRICULTURE USING SATELLITE DATA

Genya SAITO, Makoto HANAYAMA and Kazumasa OSAWA

Graduate School of Agricultural Science, Tohoku University
1-1,Tsutsumidori Amamiya-machi Aoba-ku, Sendai, 981-8555, JAPAN
genya@bios.tohoku.ac.jp

Commission VI

KEY WORDS: Agriculture Field, Regional Difference, Paddy Field, Field Size, Remote Sensing

ABSTRACT:

Remote Sensing Laboratory, Field Science Center, Graduate School of Agriculture Science, Tohoku University starts at April 2004. For studies and education at the laboratory we are now developing the system of remote sensing and GIS. Our system consists of ordinary PCs, one digitizer and one color laser printer. The PCs are assembled by us for the optimal performance and the low cost. Gigabit LAN connects each PC, and one PC is used as file server to store common data such as maps, remote sensing images and GIS data. The file server has RAID system for safety storage from HD trouble. We use ARC/GIS as GIS software and many kinds of Remote Sensing software such as, ERDAS/Imagine, ENVI, eCognition, PG-Steamer and SILCAST. Using the developing system, we are understanding and teaching for regional differences of agriculture with the interpretation of satellite data analysis. Earth Remote Sensing Data Analysis Center (ERSDAC) made the Home Pages of Terra/ASTER Image Web Library 3 “The Major Airport of the World.” http://www.Ersdac.or.jp/ASTERimage3/library_E.html. First, we check the Airport Data to use agricultural understanding for the world. Almost major airport is located in rural area and surrounded with agriculture field. To survey the agriculture field adjacent to the major airport has almost the same condition of human activities. The images are same size and display about 18km X 14km. We can easily understand field size and surrounding conditions. We study seven airports as follows, 1. Tokyo Narita Airport (NRT), Japan, 2. Taipei Chiang kai Shek International Airport (TPE), Taiwan, 3. Bangkok International Airport (BKK), Thailand, 4. Riyadh King Khalid International Airport (RUH), Saudi Arabia, 5. Charles de Gaulle Airport (CDG), Paris, France, 6. Vienna International Airport (VIE), Austria, 7. Denver International Airport (DEN), CO, USA. At the area of Tokyo Narita Airport, there are many golf courses, big urban area and small size of agricultural fields. At Taipei Airport area are almost same as Tokyo Narita Airport area and there are many ponds for irrigations. Bangkok Airport area also has golf courses and many ponds for irrigation water. Riyadh Airport area is quite different from others, and there are large bare soils and small agriculture fields with irrigation and circle shape. Paris Airport area and Vienna Airport area are almost agricultural fields and there are vegetated field and bare soil fields because of crop rotation. Denver Airport area consists of almost agriculture fields and each field size is very large. The advantages of ASTER data are as follows, 1. High-resolution and large swath, 2. Large wavelength and many bands, 3. High-revel of geographical location, 4. Stereo pair images, 5. High performance data searching system, 6. High speed data delivery system, 7. Cheap price, 8. Seven years observation and large volume archive. A kind of project “Determination of Local Characteristics at Global Agriculture Using Archive ASTER Data” was started at middle of November 2005. We establish data processing system and get some results. Paddy rice fields analysis was started at first, we analyze 1) the Shonai Plains in Japan, 2) the Yangtze River delta in Middle-East China, 3) Mekong Delta in South Vietnam, 4) North-east Thai Plaines, Thailand, 5) Sacrament Valley, California, USA. The results of this studies are as follows, 1) Using ASTER images, we can easily understand agricultural characteristics of each local area. 2) ASTER data are high accuracy for location, and the accuracy is suitable for global study without the fine topographical maps, 3) By five years observation of ASTER, there is huge numbers of ASTER scenes, but not enough volumes for cloud free data for seasonal analysis. It means that follow-on program of ASTER is necessary, 4) We need not only paddy field, but also all crop fields and all area, 5) The studies are necessary to international corroboration.

1. INTRODUCTION

Recently, the importance of terrestrial and marine field sciences might be realized in many courtiers including Japan, and remote sensing and GIS are powerful tools for the study. For this reason, Remote Sensing Laboratory, Field Science Center, Graduate School of Agriculture Science, Tohoku University in Japan started at April 2004, and at the time, there was nothing about Remote Sensing and Geographical Information System (GIS) tools [1]. First, we developed analytical system for the remote sensing and GIS using hand made PCs at the lowest cost.

In 1983, Dr. Joji IISAKA etc. published the beautiful color book named “World Agricultural Surveyed from Space” using LANDSAT/MSS images. Unfortunately it was written in Japanese, if it had been written in English, it would be the famous book in the world. More than 20 years from the publication, we hope to renew the book using Terra/ASTER data. ERSDAC made the HP of ASTER Image Web Library 3 “The Major Airport of the World.” http://www.Ersdac.or.jp/ASTER image3/library_E.html. Next, we check the Airport Data to use agricultural understanding for the world; At last we used Archive ASTER Data and analyzed the data for the purpose.

2. DEVELOPMENTS REMOTE SENSING SYSTEM USING GIS

For studies and educations at the laboratory, we developed the system of remote sensing and GIS. Our system consists of hand made PCs, one digitizer, one color laser printer and one scanner, and outline is listed Fig. 1. We assemble the PCs for the optimal performance and the lowest cost. A gigabit LAN connects each PC, and one PC is used for file server to store common data such as maps, remote sensing images, and GIS data. The file server has RAID system for safety storage from HD trouble. Main-use software is ArcGIS and ERDAS/Imagine and we use them jointly with floating licenses. Multi-Spec, eCognition, PG-Steamer of remote sensing software were already installed on some PCs and we hope some more software such as ENVI and ER-Mapper will be installed.
Our System has seven desktop PCs and two laptop PCs that connected Gigabit LAN using Hub in our room and 100-mega bps LAN to outside. Each desktop PC has 1.8 – 2.8 GHz CPU, 1 – 2 GB random access memory, high performance graphic board, and 100-200 GB hard disk. Our laboratory has two staffs, eight students, and some visitor scientists and/or students. Four desktop PCs were almost personal use; and these PCs can use Erdas/Imagine and ARC/GIS by floating license system. One desktop PC is a data server using RAID system and two desktop PCs for the use of more difficult analysis of remote sensing and GIS with high level performance and special analysis software, and manages the floating license.

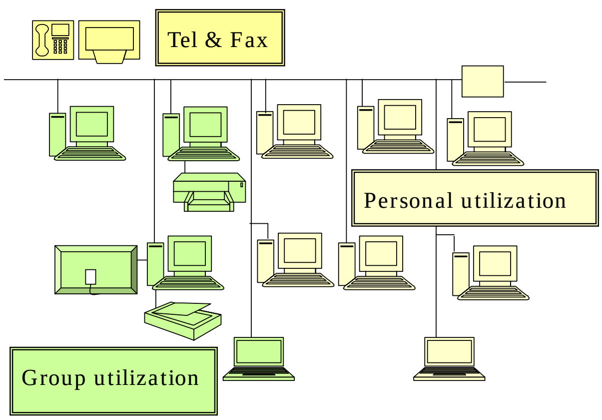

Fig. 1 Developing system of Remote Sensing Laboratory, Field Science Center, Graduate School of Agriculture Science, Tohoku University

3. AGRICULTURAL UNDERSTANDING FOR THE WORLD USING "THE MAJOR AIRPORT OF THE WORLD

Presently, remote sensing applications for agriculture are progressing and two books were published in Japan and Greek (Remote Sensing Society of Japan, 2003, and OECD, 2004). We would like to promote the interest in understanding agriculture using remote sensing techniques. ERSDAC made the Home Pages of Terra/ASTER Image for major airport is located in rural area and surrounding agriculture field. To survey the agriculture field adjacent to the major airport is almost the same condition of human activities. The images are same size and display about 18km X 14km. We can easily understand field size and surrounding conditions.

1. Tokyo Narita Airport (NRT), Japan
2. Taipei Chiang kai Shek International Airport TPE), Taiwan
3. Bangkok International Airport (BKK), Thailand
4. Riyadh King Khalid International Airport (RUH), Saudi Arabia
5. Charles de Gaulle Airport (CDG), Paris, France
6. Vienna International Airport (VIE), Austria
7. Denver International Airport (DEN), CO, USA

At the area of Tokyo Narita Airport, there are many golf courses, big urban area, and small size of agricultural fields. At Taipei Airport area are almost same as Tokyo Narita Airport area and there are many ponds for irrigations. Bangkok Airport area also has golf courses and many ponds for irrigation water. Riyadh Airport area is quite different from others, and there are large bare soils and small agriculture fields with irrigation and circle shape. Paris Airport area and Vienna Airport area are almost agricultural fields and there are vegetated field and bare soil fields because of crop rotation. Denver Airport area consists of almost agriculture fields and each field sizes are very large.

Fig. 2 ASTER images of main international airport made by ERSDAC
Upper: Tokyo Narita Airport (NRT), Japan
Lower: Denver International Airport (DEN), CO, USA

4. IMAGE INTERPRETATION OF ARCHIVE ASTER DATA

We want to more precision understanding of the local characteristics using ASTER data. First we check the advantages of ASTER data, and the results are as follows,

1. High-resolution and the large swath
2. Large wavelength and many bands
3. High-revel of geographical location
4. Stereo pair images
5. High performance data searching system
6. High speed data delivery system
7. Cheap price
8. Large volume archive by seven years observation

A kind of project "Determination of Local Characteristics at Global Agriculture Using Archive ASTER Data" was started at middle of November 2005. We establish data processing system and get some results. The procedure is listed in Fig. 3. At first, we survey target and request the data at level 1A data for analyses using ASTER Ground Data System (GDS). Next, The level 1 data are processed to ortho image of ENVI format with UTM coordination and made to Digital Elevation Model (DEM). At last, we use the data for understanding localities of agriculture using package software such as ENVI, Erdas/Imagine, and PG-Steamer.

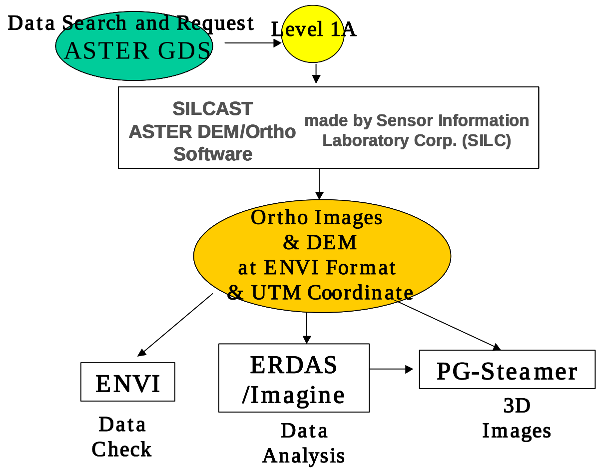

Fig. 4 Data processing procedure and using software

Paddy rice fields analysis was started at first, we analyze four areas in Asia and one area in America, as follows;

1) The Shonai Plains in Japan,
2) The Yangtze River delta in Middle-East China,
3) Mekong Delta in South Vietnam,
4) North-east Thai Plaines, Thailand,
5) Sacrament Valley, California, USA.

The results of the Shonai Plains in Japan are listed in Fig. 5, and that of Sacrament (Central) Valley, California, USA are listed in Fig.6. We perform almost same procedure to Yangtze River delta in Middle-East China, Mekong Delta in South Vietnam, and North-east Thai Plaines, Thailand. The results of five areas are listed in Table 1.

The Shonai Plains is typical paddy fields area in Japan, and has well-developed irrigation and drainage systems. The Yangtze River delta in Middle-East China is the famous paddy fields area at global. The area of Mekong Delta in South Vietnam and Northeast Thai Plaines are famous to produce exporting rice. At the area, there is enough temperature, but limitation of rice growth is water. Northeast Thai Plaines have severe dry season, and at the season, rice cannot grow. Mekong Delta area is attached South China Sea and has a big river. At the area, rice grows not only in rainy season but also dry season. Sacrament Valley, California, USA is also very famous commercial rice producing area. At the area each paddy field size is almost ten times larger than Japanese large paddy felid. We can easily understand that it is very difficult to make the rice at same cost in Japan and USA.

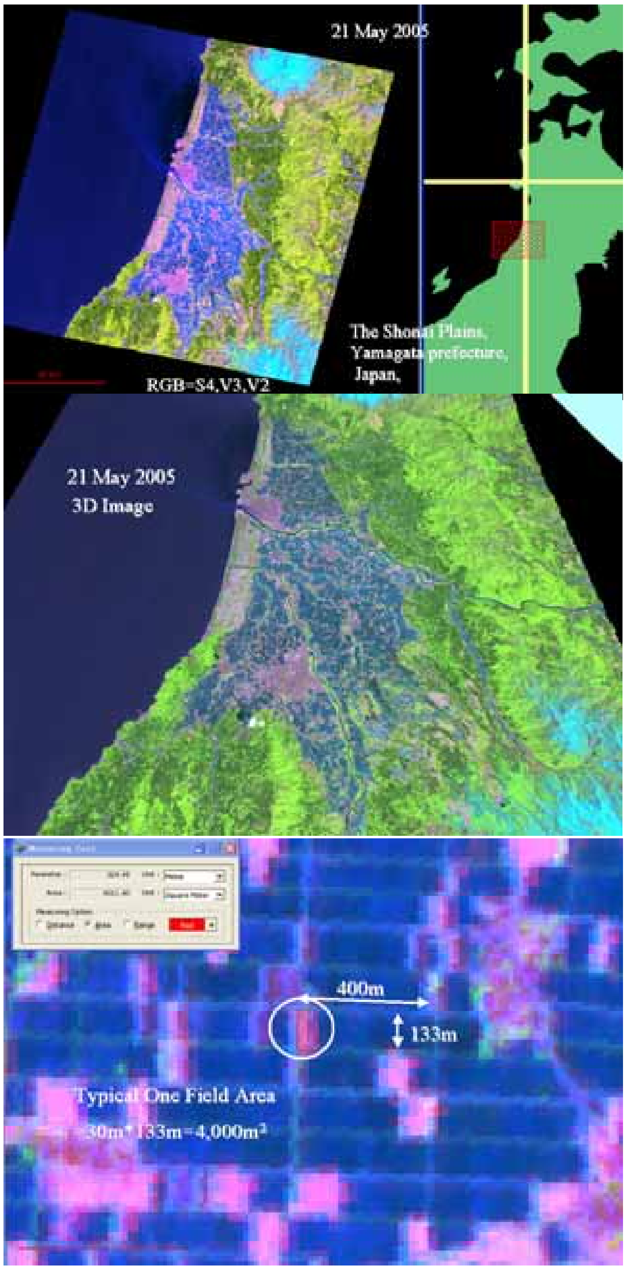

Fig. 5 Paddy fields of the Shonai Plains in Japan
Upper: Total scene of ASTER data and the map of location
Middle: 3D image of the Shonai Plains
Lower: Field size of the Plains

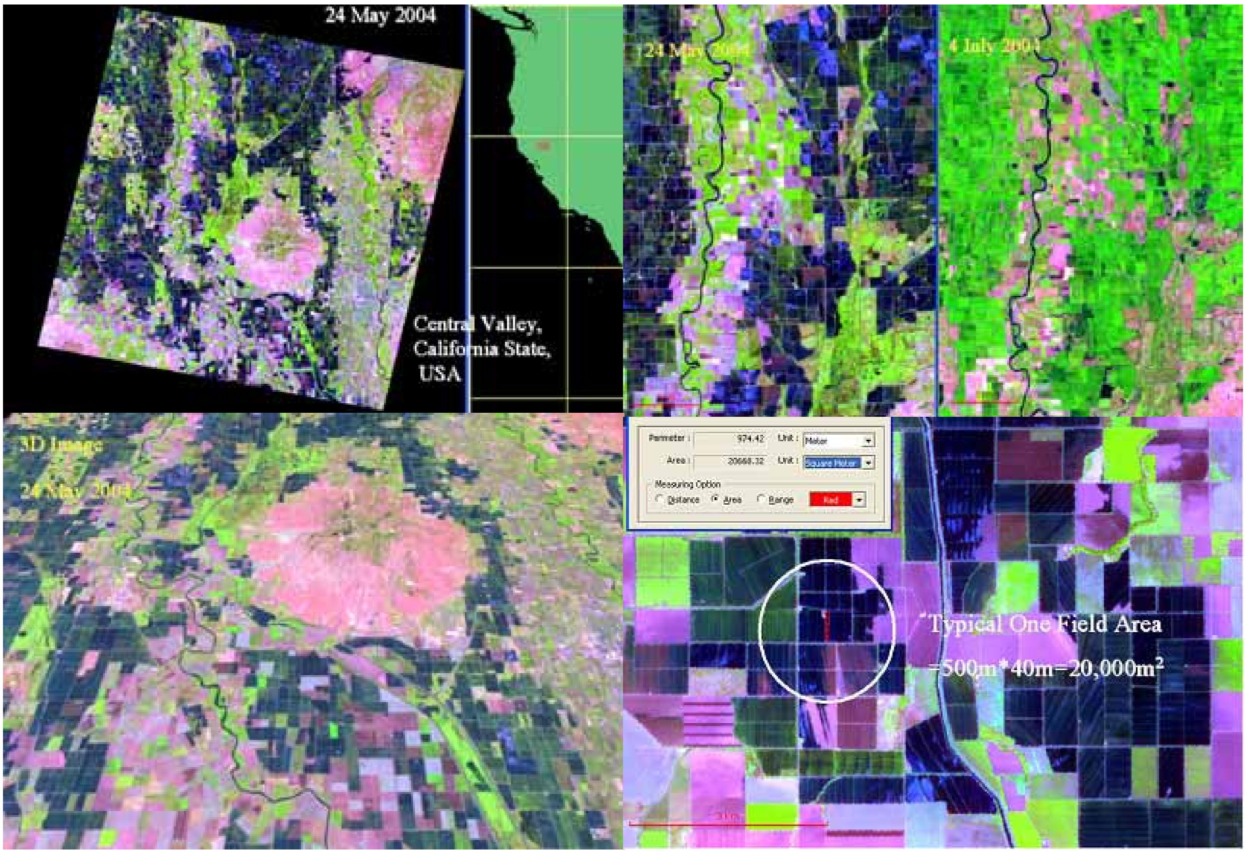

Fig. 6 Paddy fields of the Sacrament Valley, California, USA
Upper left: Total scene of ASTER data and the map of location Upper right: The images of in May and July
Lower left: 3D image of the Valley, California, USA Lower left: Field size of the valley

Table 1 Characteristics of Each Paddy Field

	Regional Topography	Growing Season	Field Size	Field Shape
Shonai, Japan	Mountainous	Summer	Middle	All Rectangle
MW-China China	Almost Flat	Summer	Middle	Half Irregular Half Rectangle
NE-Thai, Thailand	Very Flat	Rainy	Small	Almost Irregular Same Rectangle
Mekong Delta, Vietnam	Very Flat	Rainy	Mainly Small Minority Large	Rectangle
California USA	Almost Flat	Summer	Large	Almost Rectangle Same Irregular

5. CONCLUSIONS

The study of “Determination of Local Characteristics at Global Agriculture Using Archive ASTER Data” is developing and we have some results until now. The conclusions of the study at now are as follows,

1) Using ASTER images, we can easily understand agricultural characteristics of each local area.
2) ASTER data are high accuracy for location, and the accuracy is suitable for global study without the fine topographical maps.
3) By five years observation of ASTER, there is huge numbers of ASTER scenes, but not enough volumes for cloud free data for seasonal analysis. It means that follow-on program of ASTER is necessary.
4) We need not only paddy field, but also all crop fields and all area.
5) The studies are necessary to international corroboration.

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A COMPARISON OF FIVE POTENTIAL EVAPOTRANSPIRATION METHODS AND RELATIONSHIP TO NDVI FOR REGIONAL USE IN THE MONGOLIAN GRASSLAND

S. Tuya[a], J.Batbayar[b], K. Kajiwara[c], Y. Honda[d]

[a,c,d]Centre for Environmental Remote Sensing of Chiba University, 1-33 Yayoi-cho, Inage-ku, Chiba, 263-8522 JAPAN
s.tuya@ceres.cr.chiba-u.ac.jp
[b] Atmospheric Physics Division, University of Science and Technology, Ulaanbaatar, Mongolia
tchbayar@yahoo.com

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KEY WORDS: potential evaptoranspiration, NDVI, Mongolian grassland

ABSTRACT:

Potential evapotranspiration (PET) is an important parameter of water budgets at different spatial scales and is a critical variable for understanding regional biological processes. It is often an important variable in estimating actual evapotranspiration (AET) in rainfall-runoff and ecosystem modelling. However, PET is defined in different ways in the literature and quantitative estimation of PET with existing mathematical formulas produces inconsistent results. The objectives of this study are to contrast five commonly used PET methods and quantify the 10 days PET of selected 3 meteorological stations in the Mongolian grassland. The temperature based (Hargreaves-Samani), combination Penman-Monteith method (FAO56-PM), radiation based (Makkink, and Priestley-Taylor) and Mass transfer based (Dalton aerodynamic) PET methods are compared. Also we examined temporal responses of remotely sensed NDVI to evapotranspiration during a four years period (2001-2004). 10 days NDVI values for Mongolian grassland region were calculated using National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) NDVI images. The study found that PET values calculated from the five methods were correlated with correlation coefficient 0.60 to 1.0. However, showed that PET values from different methods were significantly different from each other. Greater differences were found among the Dalton aerodynamic PET method than other four PET methods. In general, the combination Penman-Monteith method (FAO56-PM) and Hargreaves-Samani method performed better than the other PET methods in the Mongolian grassland. Based on the criteria of availability of input data and correlations with ground measurement ET values, the Hargreaves-Samani and combination Penman-Monteith methods (FAO56-PM) are recommended for regional applications in the Mongolian grasslands.

1. INTRODUCTION

Although several variations of the definition exist, potential evapotranspiration (PET) can be generally defined as the amount of water that could evaporate and transpire from a vegetated landscape without restrictions other than the atmospheric demand (Thornthwaite, 1948; Penman, 1948; Jensen *et al.*, 1990). There exist a multitude of methods for the estimation of potential evapotranspiration *ET* and free water evaporation E, which can be grouped into five categories: (1) water budget (e.g. Guitjens, 1982), (2) mass-transfer (e.g. Harbeck, 1962), (3) combination (e.g. Penman, 1948), (4) radiation (e.g. Priestley and Taylor, 1972), and (5) temperature-based (e.g. Thornthwaite, 1948; Blaney-Criddle, 1950). The availability of many equations for determining evaporation, the wide range of data types needed, and the wide range of expertise needed to use the various equations correctly make it difficult to select the most appropriate evaporation method for a given study. The objectives of this study are to: (1) contrast five commonly used PET methods that have potential to be incorporated into regional scale hydrologic modelling in global change studies, and (2) quantify PET across the climatic gradient of the Mongolian grassland and to examine of NDVI influence on ET under different climatic seasons. In previous studies shows the high values of evaporative fraction are related with were vegetated area, low values corresponding to bare soil and sparsely vegetated in arid and semi arid region of Mongolia. Tuya .S et al (2003). This paper reports finally, the overall applicability of the selected methods is examined and their predictive ability for the study region is discussed.

2. THE STUDY AREA AND DATA

In this study include grassland-steppe region of Mongolia. The area covers between the latitudes of $45^{0}00'$N and $50^{0}00'$N and the longitudes $96^{0}00'$E and $118^{0}00'$E. The range of this study area is considered on (Figure1). The Mongolian steppe grasslands have strong continental climate characterized by rainfall (from 100 to 350 mm) occurring mostly during the warmer months of June, July and August. The growing season is short, generally from 80 to 100 d. The climate data we used in this study 10 days (from 2001 to 2003) by selected 3 grassland meteorological stations. This study used NOAA AVHRR 8km 10 days Maximum Value Composite NDVI images also during 2001-2003 years.

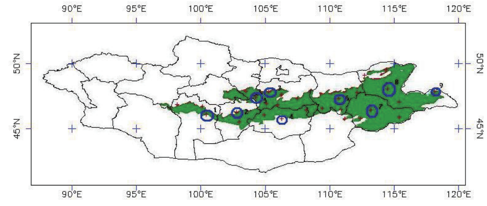

Figure 1. The study area with 3 selected grassland meteorological stations

3. METHODS

3.1 Penman-Monteith method

The FAO Penman-Monteith method for calculating reference (potential) evapotranspiration *ET* can be expressed as (Allen *et al*., 1998):

$$ET = \frac{0.408\Delta(R_n - G) + \gamma(\frac{900}{T+273})U_2(e_s - e_a)}{\Delta + \gamma(1+0.34U_2)} \quad (1)$$

where e_s= saturated vapor pressure at air temperature (Pa)
e_a= actial vapor pressure (Pa)
T= air temperature
Δ = slope of the saturation vapor pressure-temperature curve at the mean temperature (kPa $^oC^{-1}$)
γ = the psychrometric constant (kPa $^oC^{-1}$)
U_2 = the wind speed measured at 2m height (sm^{-1})
Rn = Net radiation ($MJm^{-2}d^{-1}$)
G = Soil heat flux ($MJm^{-2}d^{-1}$)

3.2 Hargreaves-Samani method

The original Hargreaves method (1985) for calculating ET_0 is based on only mean daily maximum and mean daily minimum temperature:

$$ET_0 = 0.0023*0.408RA*(Tavg + 17.8)*TD^{0.5} \quad (2)$$

where RA= extraterrestrial radiation expressed in (MJ m^{-2} day^{-1}), Tavg = average daily temperature (^{0}.C) defined as the average of the mean daily maximum and mean daily minimum temperature
TD= the temperature range, computed as the difference between mean daily maximum and mean daily minimum temperature. The constant 0.408 is used to convert the radiation to evaporation equivalents in mm. RA can be obtained from tables (Hargreaves 1994), equations (Allen et al. 1998). The two other parameters, 0.0023 and 17.8, were obtained by Hargreaves et al. (1985) by fitting measured ET0 values to Equation (1).

3.3 Priestley-Taylor method.

The PET is estimated as (Jensen et al., 1990):

$$\lambda PET = \alpha \frac{\Delta}{\Delta + \gamma}(Rn - G) \quad (3)$$

where PET = Daily PET in mm/day
λ = Latent heat of vaporization in MJ/kg
α = calibration constant = 1.26
Δ = Slope of the saturation vapor pressure-temperature curve in kPa/^{o}C.
γ = Psychrometric constant kPa/^{o}C.
Rn = Net radiation in $MJ.m^{-2}.day^{-1}$.
G= Heat flux density to the ground in $MJ.m^{-2}.day^{-1}$.
It can be estimated as (Jensen et al.,1990):

$$G = 4.2\frac{(T_{i+1} - T_{i-1})}{\Delta t} = -4.2\frac{(T_{i+1} - T_{i-1})}{\Delta t} \quad (4)$$

where T_i = Mean air temperature in ^{o}C for the period i.
Δ t = The difference of time days between two periods.

3.4 Makkink method

$$PET = 0.25 * (\Delta/(\Delta + \gamma) * R_s - 0.12 \quad (5)$$

where R_s = daily solar radiation, Mj/m^2/day
Δ = slope of the saturation vapor pressure curve
γ = psychrometric constant

3.5 Dalton mass-transfer method

The mass-transfer method is one of the oldest methods (Dalton, 1802) and is still an attractive method for estimating free water surface evaporation because of its simplicity and reasonable accuracy. The mass-transfer methods are based on the Dalton equation, which for free water surface can be written as:

$$E=f(u)(e_s-e_a) \quad (6)$$

where f(u) = wind function
e_s= the vapour pressure at the evaporating surface (kPa),
e_a = the vapour pressure of the atmosphere above (kPa)

4. RESULTS AND DISCUSSION

The in this comparative study, 10 days evapotranspiration from Penman-Monteith method (Equation (1)) and other four empirical methods, i.e., Equations (2), (3), (5), and (6), respectively, was computed with their original constant values involved in each equation. The Pearson correlation coefficients were calculated the values ranged from 0.60 to 1.00. Among these correlation coefficients at the selected 3 sites, the Hargreaves-Samani and Makkink PET methods had the highest value (R =0.99), while the Dalton mass transfer PET method had the lowest values (< = 0.94) with other methods (Tables 2, 3 and 4). Across the 3 sites, greater differences were found radiation based Priestley-Taylor method than other methods (Figures 2, 3 and 4). The PET values predicted by the Penman-Monteith, Hargreaves-Samani and Makkink methods were found to be similar in magnitude, especially for the Hargreaves-Samani and Penman-Monteith methods, which had a correlation coefficient of 0.98-0.99 between the two. A visual comparison shows (Figures 2, 3 and 4) that the value of α = 1.26 in Priestley-Taylor method seemed too high and Dalton mass-transfer method predicted the lowest PET values for the region. The Penman-Monteith, Hargreaves-Samani and Makkink methods worked quite well original values of the constants and were close to the mean estimates for all methods. Table 1. Showed NDVI strongly related with Hargreaves-Samani method than other PET methods in study area.

Site	Penman-Monteith	Hargreaves-Samani	Priestley-Taylor	Makkink	Dalton mass-transfer
Orkhon	0.730816	0.787776	0.750304	0.78695	0.64241
Choibalsan	0.796604	0.832108	0.751744	0.789816	0.820321
Khalkhgol	0.632252	0.696918	0.624473	0.663762	0.647883

Table 1. Correlation coefficients between NDVI and selected five PET methods (2001-2003).

PET Methods	Penman-Monteith	Hargreaves-Samani	Priestley-Taylor	Makkink	Dalton mass-transfer
Penman-Monteith	1.000	0.975	0.970	0.976	0.879
Hargreaves-Samani	0.975	1.000	0.988	0.997	0.910
Priestley-Taylor	0.970	0.988	1.000	0.993	0.897
Makkink	0.976	0.997	0.993	1.000	0.900
Dalton mass-transfer	0.879	0.910	0.897	0.900	1.000

Table 2. Pearson correlation coefficients among five PET methods (site #1. Orkhon 2001-2003)

PET Methods	Penman-Monteith	Hargreaves-Samani	Priestley-Taylor	Makkink	Dalton mass-transfer
Penman-Monteith	1	0.974287	0.951688	0.969568	0.905842
Hargreaves-Samani	0.974287	1	0.980319	0.989528	0.946947
Priestley-Taylor	0.951688	0.980319	1	0.992723	0.923984
Makkink	0.969568	0.989528	0.992723	1	0.943299
Dalton mass-transfer	0.905842	0.946947	0.923984	0.943299	1

Table 3. Pearson correlation coefficients among five PET methods (site #2. Choibalsan 2001-2003)

PET Methods	Penman-Monteith	Hargreaves-Samani	Priestley-Taylor	Makkink	Dalton mass-transfer
Penman-Monteith	1	0.969711	0.945138	0.969171	0.937889
Hargreaves-Samani	0.969711	1	0.983113	0.994686	0.951346
Priestley-Taylor	0.945138	0.983113	1	0.991641	0.935391
Makkink	0.969171	0.994686	0.991641	1	0.948193
Dalton mass-transfer	0.937889	0.951346	0.935391	0.948193	1

Table 4. Pearson correlation coefficients among five PET methods (site #3. Khalkhgol 2001-2003)

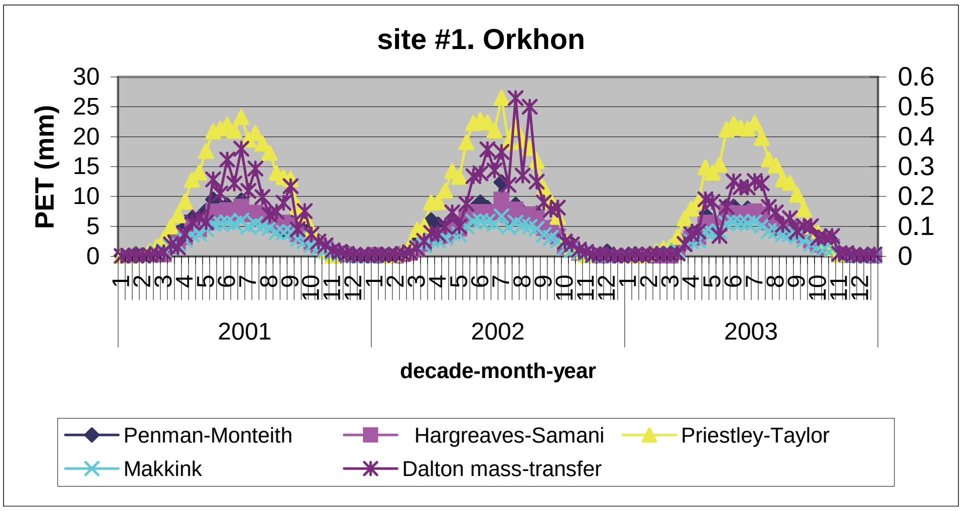

Figure 2. Comparison of 10 days PET by five methods at the meteorological station Orkhon

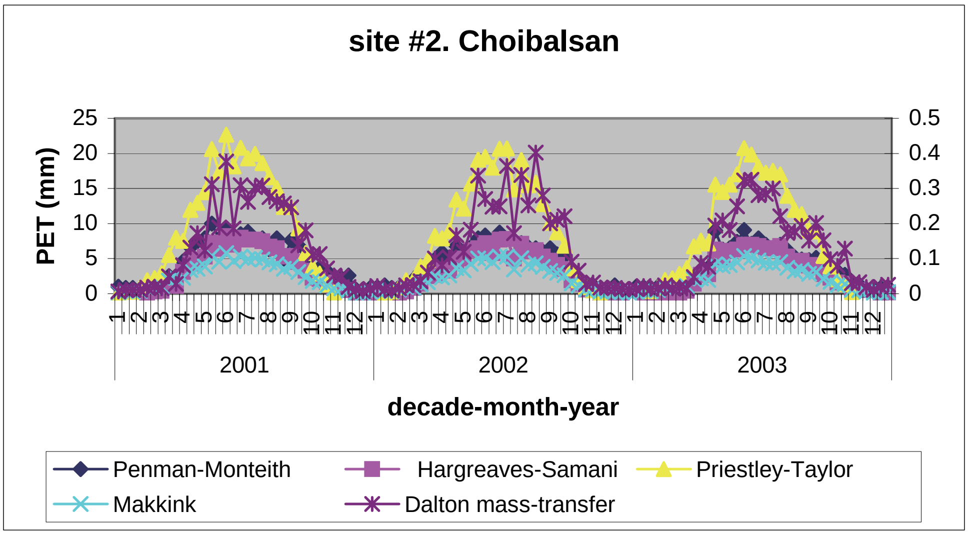

Figure 3. Comparison of 10 days PET by five methods at the meteorological station Choibalsan.

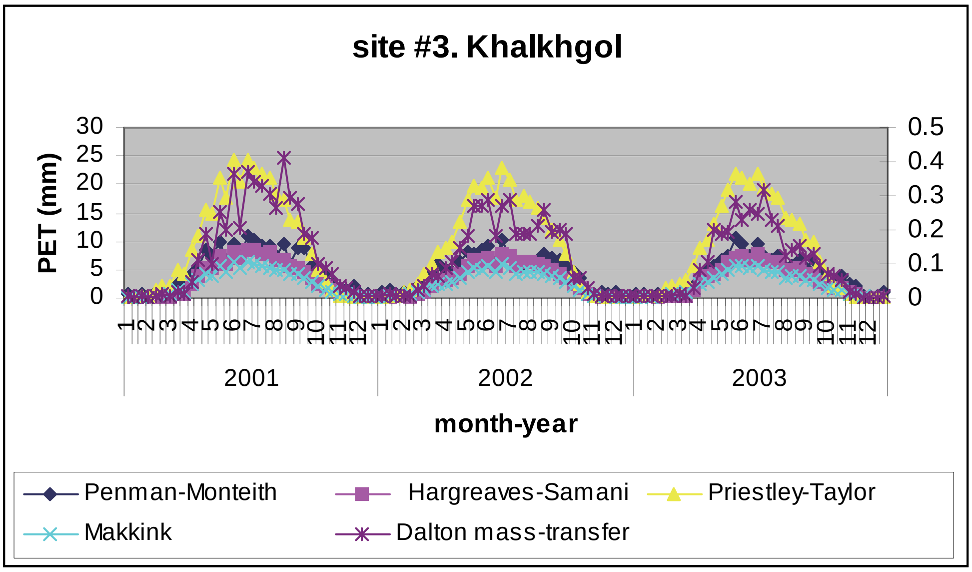

Figure 4. Comparison of 10 days PET by five methods at the meteorological station Khalkhgol.

5. CONCLUSIONS

This study suggested that PET is difficult to estimate accurately. The commonly used PET methods for this comparison study showing differences PET across the Mongolian grassland. The Priestley-Taylor method gave the highest and Dalton mass transfer lowest PET estimates in the study region. This suggests that careful calibration and verification efforts are needed when applying the Priestley-Taylor and Dalton mass transfer PET methods for this region. The Hargreaves-Samani PET method worked well under the semi-arid conditions in Mongolian grassland. However, the results of the present study suggest that this method may not be appropriate humid regions of Mongolia. We conclude that the temperature based Hargreaves-Samani method is better than the other methods in this study region. Otherwise, the Makkink and Penman-Monteith methods could be used in the dry arid and semi arid region. The Priestley-Taylor method developed for warm humid climate condition.

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SATELLITE IMAGES OF AIR POLLUTANTS AND LAND COVER FOR ENVIRONMENTAL EDUCATION AND DISASTER PREVENTION

Naoko IINO [a,] , Kisei KINOSHITA [b] and Chikara KANAGAKI [c, d]

[a] Department of Mechanical Engineering, Kagoshima University, Kagoshima 890-0065, JAPAN - iino@mech.kagoshima-u.ac.jp
[b] Research and Development Center, Kagoshima University, Kagoshima 890-0065, JAPAN - kisei@rdc.kagoshima-u.ac.jp
[c] Goshoura-Kita Junior-high school, Amakusa, Kumamoto 866-0302, JAPAN -
[d] Center for Educational Research and Development, Kagoshima University, Kagoshima 890-0065, JAPAN - chikara@edu.kagoshima-u.ac.jp

KEY WORDS: Atmosphere, Pollution, Vegetation, Volcanoes, Hazards, Imagery, Database

ABSTRACT:

We studied the behavior of air pollutants such as volcanic gas and Asian dust by using satellite remote sensing data and ground observations. In addition, we studied some natural disasters occurred in Kyushu, such as earthquakes, floods, and forest fires by using satellite images. In order to publicize these research results for non-specialists and to archive the analyzed satellite images together with related data, the results have been provided through the Internet as the Satellite Image Network Group in Kagoshima (SiNG Kagoshima) website since 1996. In this report, we describe the SiNG Kagoshima contents in conjunction with the research results, references, related studies, websites, and the educational or social contributions.

1. INTRODUCTION

In Kyushu, southern Japan, there are many active volcanoes such as Aso, Sakurajima, Suwanosejima, Unzen, and so on. Furthermore, the location near the Chinese continent causes in atmospheric environmental deterioration by long-range transport of air pollutants, such as Asian dust and acid substances from the continent. In addition, Japan is affected by typhoons in summer every year and also flood disasters occur occasionally. Therefore, it is very important to provide information on these phenomena by means of explicit photographs and images with concise explanation for environmental education and disaster prevention.

We are investigating the behavior of air pollutants such as volcanic clouds and Asian dust by using meteorological satellite data, Visible and Infrared Spin-Scan Radiometer (VISSR) data from the fifth Japanese Geostationary Meteorological Satellite (GMS-5) and Advanced Very High Resolution Radiometer (AVHRR) data from the National Oceanic and Atmospheric Administration (NOAA) polar orbiting satellites, and ground observations. In addition, we studied some natural disasters, such as an earthquake in 1997 at northwestern area in Kagoshima Prefecture and a heavy flood in August 1993 in Kagoshima City by using Landsat images.

In order to contribute to environmental education and disaster prevention, and to archive the analyzed satellite images together with related data, the results have been provided through the Internet as the Satellite Image Network Group in Kagoshima (SiNG Kagoshima) website since 1996. In this report, we describe the SiNG Kagoshima contents in conjunction with research results, references, related studies and websites. We also discuss the educational or social contributions that were obtained from these contents.

2. SING KAGOSHIMA

2.1 Contents and Members

Figure 1 shows the SiNG Kagoshima top-page, http://arist.edu.kagoshima-u.ac.jp/sing/index-e.htm. It provides 19 contents of research results, explanation and image database for education and disaster prevention as follows.

A. MOS/MESSR Images of Volcanoes and Ash Clouds in Kyushu, Japan
B. Mt. Sakurajima and Ash Clouds observed by JERS-1
C. Thermal Images of Kyushu Island in the Nighttime Observation by LANDSAT
D. NOAA Thermal Images of Kroshio (Black Current) and the Sea around Kyushu
E. Comparison of the Brightness Temperature between the Data of LANDSAT and NOAA at Low Temperatures
F. Topographies of South-West Japan, Kyushu, and North-West Part of Kagoshima in Relation to Recent Earthquakes
G. Analysis of Satellite Images of Eruption Clouds from Sakurajima Volcano
H. NOAA Images of Volcanic Clouds in Kyushu, Japan
I. Mt. Yakushima observed from the Space
J. Kagoshima 1993 flooding analysis by using Landsat data
K. Satellite Analysis of Asian Dust Events.
L. Livers and the open sea water
M. Satellite images of volcanic clouds from Miyake-jima in 2000
N. A forest fire analysis using Landsat/TM data
O. Satellite images of Miyake-jima plumes 2001
P. Satellite images of Miyake-jima plumes 2002
Q. Satellite images of Miyake-jima plumes 2003
R. Satellite images of Miyake-jima plumes 2004
S. MODIS Database of Volcanic Eruptions in the Western Pacific

Figure 1. SiNG top page

Most of them are displayed in English version, with the exceptions SiNG-D, F, H-L and N in Japanese only. In SiNG-K of Asian dust page, there is also a page in Chinese. SiNG Kagoshima was originally composed of two sectors, Public and Education. The Public sector is described as above. The SiNG Education sector was constructed to provide the Landsat/TM data in reduced format with its viewer. It developed into a system to perform the 3D presentation of satellite images in real time motion, and separated into an independent page, SiPSE (Kinoshita et al., 2006).

The SiNG Kagoshima top page is at Physics Department, Faculty of Education, Kagoshima University, and some of the contents are linked to websites at other institutions. The SiNG Kagoshima members providing research results and collaborating research consist of Kagoshima University, Daiichi University, the Kagoshima Prefectural Institute of Environmental Science, the Foundation of Kagoshima Environmental Research and Service, and so on.

2.2 Outline of the Contents

The main study theme in the SiNG Kagoshima is the volcano located in the Western Pacific. The topography of the volcanoes in Kyushu such as Aso, Unzen and Sakurajima, and their volcanic clouds seen in satellite images, are presented in SiNG-A, B, and G pages with the explanation of each image. Typical image of each page is shown in Figure 2. In addition, the study results for Miyakejima volcano in Izu Islands near Tokyo are demonstrated in SiNG-M and O-R. At these pages, the volcanic clouds and SO_2 concentrations at the volcano observed from the 2000 Miyakejima eruption to 2004 are displayed as a separated page for each year. SiNG-S shows typical eruption clouds taken by the Moderate Resolution Imaging Spectroradiometer (MODIS) images of volcanoes located in Tokyo, Darwin and Washington VAAC areas. Typical color composite NOAA images of volcanic clouds at volcanoes in Kyushu in 1980s - 1990s are displayed in SiNG-H. Details and related studies are discussed in Section 3.

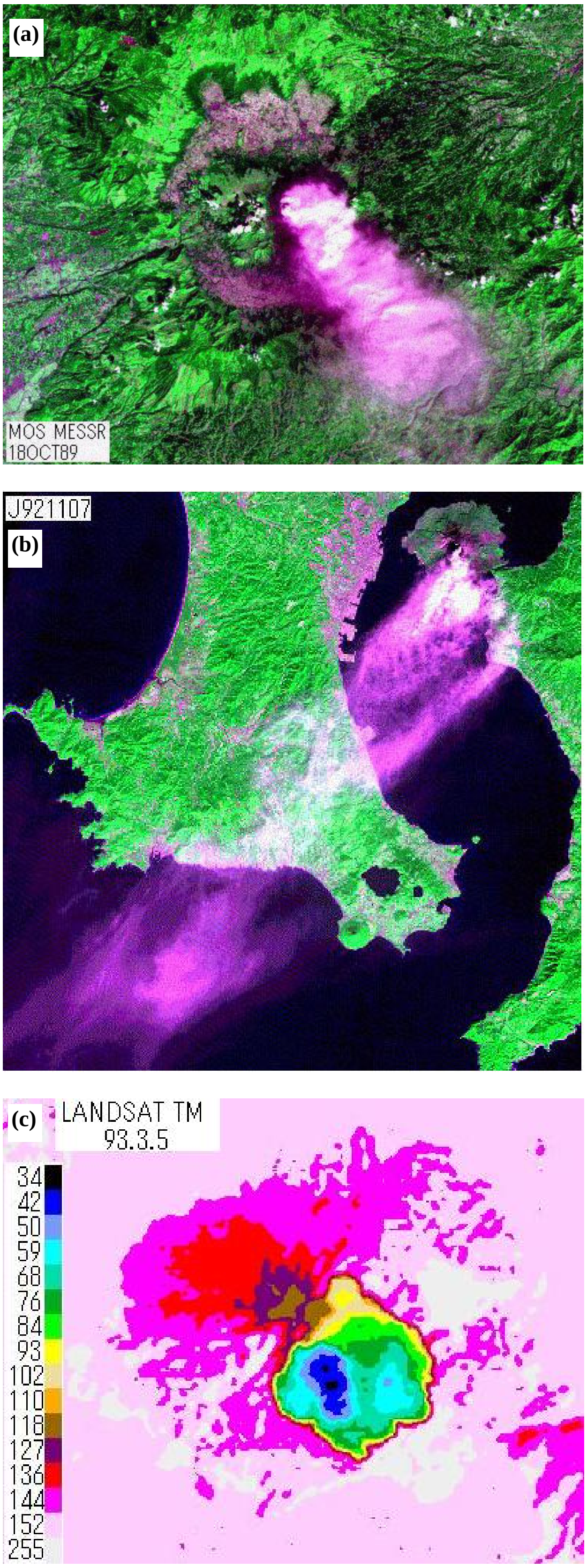

Figure 2. Typical images of volcanic ash clouds in Kyushu

As for atmospheric phenomena, Asian dust transport analysis using satellite data is shown in SiNG-K. The resultant NOAA and GMS images from 1997 are archived as a yearly database. The general explanation page about the transport of Asian dust is also provided in Japanese and in Chinese versions of SiNG-K. Details and related studies are described in Section 3.

Typical thermal images are shown in Figure 3. Thermal environmental analysis using satellite data and the study of satellite thermal image accuracy are described in SiNG-C and E, respectively. The comparative study of brightness temperature difference between NOAA/AVHRR and Landsat/TM (Thematic Mapper), SiNG-E, was done as a basic study for estimating volcanic eruption clouds height by using thermal image, SiNG-G. In order to study the characteristics of low temperature region, the analysis area was set to Hokkaido, Japan (Figure 3a). As shown in SiNG- D and L, thermal images are also useful for the sea surface and river water dispersion studies. In these pages, the black current (e.g. Figure 3b) and various eddies, e.g. Karman vortex, observed around the Western Japan, and the dispersion of cold river water in the Kagoshima bay are shown in NOAA/AVHRR thermal images.

The post analysis results of disaster are displayed in SiNG-J and N. SiNG-J shows analysis results of serious flood disaster that occurred in Kagoshima, Japan in August 1993. The disaster areas shown in satellite images are compared before and after the flood. Related to the flood, the process of housing development in the suburbs was studied by using Landsat data from 1972 to 1993. The urbanization during 20 years in Kagoshima City is demonstrated by the change in the land cover and land use shown in satellite data based on the classification and differential methods. In SiNG-N, post analysis results of a forest fire occurred in 1991 in Hitachi City, Ibaraki Prefecture is displayed. The burnt area and the damage levels were estimated by means of the Normalized Difference Vegetation Index images and land cover classification, using Landsat/TM data.

The topographies of the Western Japan and Yakushima are displayed at SiNG-F and I, respectively. Former is related to the 1997 earthquake in the northwestern part of Kagoshima Prefecture. Yakushima, nominated as the world heritage in 1994, is located at about 60 km south from the cape Sata, the southernmost of Kyushu.

3. SATELLITE IMAGES OF VOLCANOES AND ASH CLOUDS

3.1 Volcanoes and Their Clouds in Kyushu

The publications of previous study about volcanoes in Kyushu are edited as a booklet (Kinoshita, 2001). MOS(Marine Observation Satellite)/MESSR(Multispectral Electronic Self Scanning Radiometer) images of Aso and Unzen volcanoes and Sakurajima volcanic clouds of various dispersion types are displayed in GIF format and in JPEG format with simple text. In the SiNG A- C, E and G, satellite images are shown in these formats.

The MOS-1 and 1b observed the earth during 1987-1995 and 1990-1996, respectively. Thus it observed valuable volcanic activities at Aso, Unzen and Sakurajima. The MESSR has four bands: visible bands of 1 (0.51-0.59 µm) and 2 (0.61-0.69 µm); near infrared bands of 3 (0.72-0.80 µm) and 4 (0.80-1.1 µm). A natural color image assigning (Red, Green Blue) to (bands 2, 4

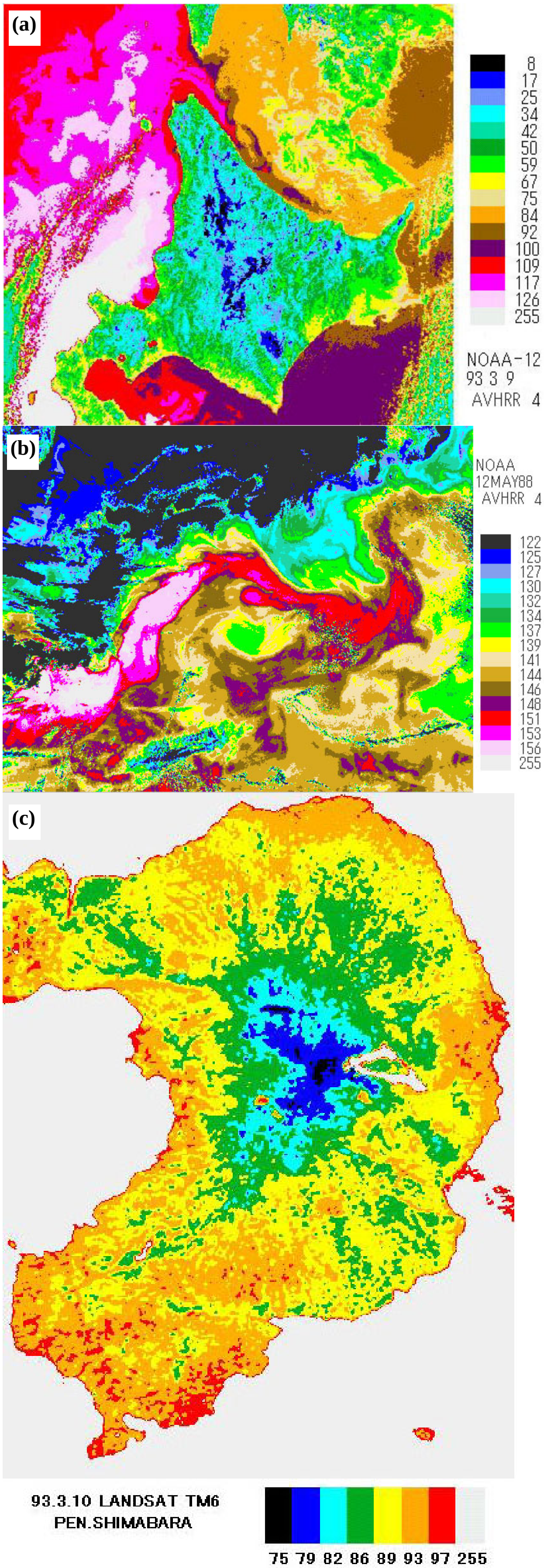

Figure 3. Typical thermal images

and 1) is shown in SiNG-A. In the natural color image, vegetation area is shown as green due to their strong reflectance of near-infrared band, while volcanic clouds are shown in white, and the lava and bare surfaces, less vegetation areas, are shown in pink.

Aso volcano was very active during June 1989 - February 1991. In the Aso volcano section, SiNG-A1, very active volcanic cloud is seen in the image on October 1989 (Figure 2a), and the caldera shows very clearly in the image of November 1991.

Mt. Unzen is the central peak of Shimabara Peninsula in western Kyushu. The volcano had pyroclastic activities during May 1991- February 1995. In the Unzen volcano section, SiNG-A2, volcanic clouds and the pyroclastic tracks are seen in color images. In addition, near-infrared image shows topography well. In SiNG-C, thermal image is displayed. As shown in Fig3c, the thermal distributions corresponding to the contour lines, and the pyroclastic tracks shown as high temperature regions from the summit to east, are clearly seen.

Sakurajima volcano in Kyushu, Japan has been acting continuously with the ejection of ash clouds since 1955. The volcanic plume clouds usually flow in the free atmospheric layer 1,000-3,000 m above sea level, while the explosive eruption clouds reach up to 4,000-5,000 m occasionally. These ones visualize and exhibit the dynamical behavior of the free atmosphere at wide altitudes in the lower troposphere. Therefore volcanic cloud from Mt. Sakurajima is a good tracer and plays an important role in understanding the long-range transport of air pollution materials.

Now, we describe a brief summary of volcanic clouds at Sakurajima volcano based on the ground observation and the remote sensing imagery from the space in conjunction with the upper wind data (Kinoshita, 1996, Kinoshita and Togoshi, 2000). The horizontal dispersions for plumes, which drift downstream after reaching equilibrium height are essentially determined by the wind shear within the vertical thickness of the plume. Typical ones are the followings: (i) Linear advection with small spread under strong and/or collimated winds. (ii) Fan-type spread under weak winds with large vertical shear. (iii) Belt-type spread under mild winds with indefinite shear, or due to shear wind near an edge height of the plume. On the other hand, the eruption cloud at Sakurajima volcano usually reach around 2,000-4,000 m, while for a few big eruptions, they reach about 5,000 m.

Typical dispersion clouds images of MOS/MESSR and JERS (Japanese Earth Resources Satellite)-1/OPS (Optical Sensor) are displayed in SiNG-A and B (e.g. Figure 2b). Topography of Sakurajima shown in SAR (Synthetic Aperture Radar) image is also shown in SiNG-B. In SiNG-G, the estimation of the Sakurajima eruption clouds heights using the brightness temperature obtained from NOAA/AVHRR and Landsat/TM are illustrated. Figure 2c shows the thermal distribution of Sakurajima eruption clouds taken by Landsat/TM.

As related studies, ground observations of volcanoes in the Kagoshima Prefecture have been continuing by the Kagoshima University Group (Volcanic Cloud Research Group, 2004). The observing volcanoes are Sakurajima, Satsuma-iwojima and Suwanosejima. The website is called ‘Volc’ and it is linked from the SiNG top page. The Sakurajima observation by using web-camera from Kagoshima University is reported in another contribution to this symposium (Tsuchida et al., 2006).

3.2 Satellite Images of Volcanic Clouds and High Sulfur Dioxide Concentrations at Miyakejima

The eruptive activity of Miyakejima volcano started on 8 July 2000, and the ejection of enormous amounts of sulfur dioxide (SO_2) has been continued since August 2000. The Tokyo Metropolitan Government started monitoring volcanic gas concentrations at the foot of the volcano from the end of 2000. The eruption clouds and plumes have been detected by the Kagoshima group by using meteorological satellite data since August 2000. The resultant satellite images and the time variation of SO_2 concentrations and upper wind during 2000-2004 are displayed at SiNG-M and O-R.

We have been analyzing the SO_2 concentrations to investigate the mechanism of high concentration occurring at the volcano. The following results were obtained (Iino et al., 2003, 2004a, b). (i) High SO_2 concentrations at the ground surface on Miyakejima are mainly caused by downdraft owing to strong wind. (ii) The seasonal and regional characteristics of high SO_2 concentrations correspond well to the 925 hPa wind observed at Hachijyojima, the nearest upper air observatory from Miyakejima. (iii) There is notable difference of environment of SO_2 concentrations owing to a slight directional difference from the crater. This should be considered in making a volcanic gas hazard map at the volcano. (iv) The frequency distribution of high SO_2 concentration events corresponds well to the distribution of vegetation shown in an image of Terra/ASTER. In addition, we proposed a method to estimate the volcanic gas hazards for the whole Miyakejima using satellite imagery, which shows the distribution of vegetation before and after the 2000 Miyakejima eruption. The resultant hazard map is examined by comparing with the occurrence frequency of high SO_2 concentrations at each gas-monitoring station and with the ground observations by visible (VIS) and near-infrared (NIR) cameras (Iino et al., 2006). The NIR photographs are obtained based on our previous studies (e. g., Kinoshita et al, 2004).

3.3 MODIS Database of Volcanic Eruptions in the Western Pacific

Large eruptions pose a danger for aircraft because of the hazardous effects of volcanic ash. In the western Pacific, four Volcanic Ash Advisory Centers (VAACs) are responsible for forecasting the dispersion of volcanic clouds. As shown in Figure 4, MODIS database of volcanic eruption in the Western Pacific is provided at SiNG-S. Nine, seven and one volcanoes located in the Tokyo VAAC, Darwin VAAC and Washington VAAC areas are covered. These color images are results of a collaborative study with the Darwin VAAC, the Australian Meteorological Agency (e.g., Tupper et al., 2003).

As the related study, ground observation by using web-camera has been continuing at Mayon volcano, Philippines since June 2003 as a collaborative study between Kagoshima University and the Philippine Institute of Volcanology & Seismology. The photographs are shown at: http://ese.mech.kagoshima-u.ac.jp/Mayon/mayontop.htm.

4. SATELLITE ANALYSIS OF ASIAN DUST EVENTS

Heavy Asian dust causes decrease in visibility and increase in suspended particulate matter (SPM) concentrations, and thus it affects traffics, human health, and industrial products such as semiconductor and liquid crystal. On the other hand, Asian dust

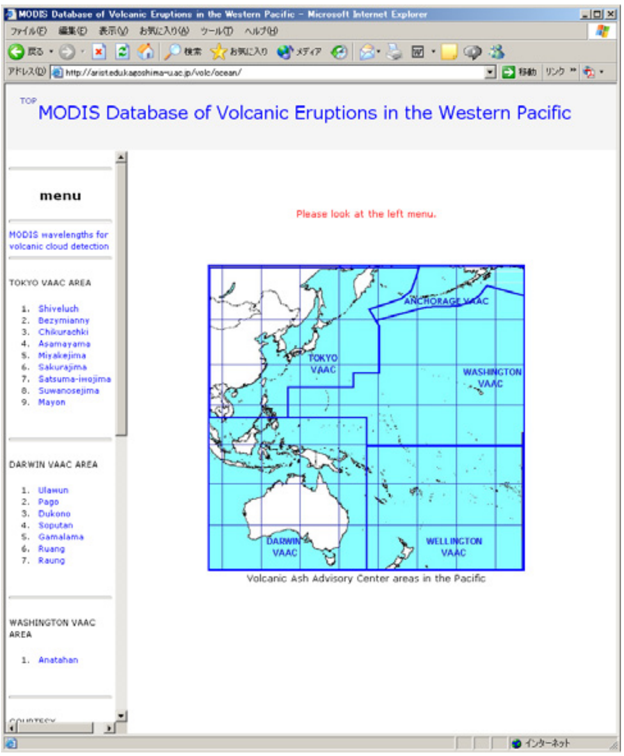

Figure 4. SiNG-S top page

may be regarded as a kind of tracer in examining atmospheric flow.

We have analysed the transport of Asian dust from China to the Pacific Ocean around Japan using Aerosol Vapor Index (AVI) imagery, taking the brightness temperature difference between11 and 12 μm bands of AVHRR data from NOAA satellites, and VISSR data from GMS-5 since 1997. To visualize Asian dust, we calculate the brightness temperature difference in 11 and 12 μm bands as the Aerosol Vapor Index (AVI) by the following equations.

AVI (AVHRR) = n(5) - n(4) + 200, for NOAA/AVHRR, (1)

AVI (VISSR) = IR(2) - IR(1) + 100, for GMS-5/VISSR, (2)

where, n(i) and IR(i) of thermal-infrared band i correspond to the brightness temperature t(i) and T(i) in centigrade as t(i) = 0.1 n(i) - 50, for i = 4, 5 and as T(i) = 0.5 IR(i) - 85, for i = 1, 2, respectively. The imagery is very effective for monitoring dust in East Asia, because of the capability of infrared techniques to monitor the dust during the night (Iino et al, 2004c and d). All of the resultant satellite images are displayed at SiNG-K. The index page of SiNG-K is shown in Figure 5.

As the related studies, ground observation has been performed at Changchun, China since 2003 as a collaborative study between Kagoshima University, Japan and Northeast Normal Univesity (Kinoshita et al, 2005a-c). In addition, the ground observations in Ulaanbaatar and Dalanzadgad, Mongolia has started since 2004, as a collaborative study between Kagoshima University and the Institute of Meteorology and Hydrology,

Figure 5. A part of SiNG-K top page

Mongolia (Kinoshita et al, 2005b and c). As shown in Figure 5, the photographs taken each observation site are linked from SiNG-K.

5. CONCLUDING REMARKS

In this report, we described the SiNG Kagoshima contents in detail in conjunction with the research results, references and related studies and websites.

Finally, we introduce the contributions of these contents for education and disaster prevention. Sakamoto (2006) used the SiNG contents of Sakurajima volcano for the disaster prevention education in high school, and reported the usefulness. In understanding the Sakurajima hazard map, these contents helped as the background knowledge. As the social contribution, Miyakejima high volcanic gas concentrations hazard map was provided to Miyake Village, and it gave valuable information in making the public safety map of Miyakejima. Our results are displayed at http://ese.mech.kagoshima-u.ac.jp/miyake/ (in Japanese).

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HIGH GROWTH JOB TRAINING INITIATIVE FOR REMOTE SENSING COMMUNITY

Gino GUZZARDO [a], Timothy W. FORESMAN [b]

[a] Kidz Online, 600 W. 7th Street, Suite 120, Los Angeles, California, USA 90017 - gino@kidzonline.org
[b] International Center for Remote Sensing Education, P.O. Box 18285, Baltimore, Maryland USA 21227 – foresman@direcway.com

Commission VI

KEY WORDS: Job Training, Web-based, e-Learning, K-16 Education, Geospatial, Apprenticeship

ABSTRACT:

An innovative geospatial training and awareness program has been initiated by a consortium led by Geospatial21 and the International Center for Remote Sensing Education, to include an apprenticeship component for high school and college students utilizing a combination of e-learning and classroom training augmented with apprenticeships and internships to solidify their textbook learning with hands-on industry experience in the primary geospatial domains of GPS, GIS, and remote sensing. Recognizing the advances in web-based education and the potential for expansion of e-learning for remote sensing, the consortium has developed a strategy to integrate the international resources of ISPRS Commission VI and other appropriate leading remote sensing associations into the framework for creating a geospatial workforce pipeline to be tested in the three cities with the highest concentration of employers that utilize geospatial technologies: Denver, Colorado; Los Angeles, California; and Washington, D.C.. A core-concept for the expansion of the remote sensing/geospatial training series and awareness initiative is to provide fully web-based learning modules online to K-16 students. Based on the success of the initial Kidz Online's (KOL) innovative e-learning program created by Geospatial21, which includes a collection of career interviews with geospatial professionals, documentaries demonstrating how geospatial information affects everyday life, and interactive training tools, the coalition will augment the materials to raise the science literacy and professional levels to those appropriate at the international standards for the remote sensing community. The goal of incorporating continued education levels is to provide the framework, technical, and financial support to ensure upgrades in the materials available to any educational or professional organization attempting to retool the workforce with effective geospatial training as well as build the foundation throughout the educational ladder. A description of the coalition initiative innovations and progress will be presented for both national and international context.

1. INTRODUCTION

1.1 Addressing Job Training Gaps

The U.S. Department of Labor (DOL) promulgated a grant program initiative to address training needs in areas of high growth. In response to the DOL High Growth Job Training Initiative grant, Kidz Online proposed to extend the scope of its foundational technology training content to include geospatial training and awareness components. Upon being awarded $1 million through the DOL grant, Kidz Online created Geospatial21 to produce educationally appropriate videos to highlight exciting areas of the geospatial industry, document the career stories of various industry leaders and professionals, and design an interactive e-learning video series for grades K-14. Building upon the success and momentum of this initial effort, Kidz Online is expanding Geospatial21 to include an apprenticeship component that will channel high school and college students through e-learning and classroom training into apprenticeships and internships to solidify their textbook learning with hands-on industry experience. This new effort, entitled the Geospatial21 Apprenticeship Program (GAP21), will focus on executing the an apprenticeship project in partnership with leading geospatial organizations, such as, George Mason University, Geospatial Information Technology Association (GITA), and the International Center for Remote Sensing Education (ICRSE). This coalition, (GAP21) was formed to fulfill the growing need for a geospatial workforce pipeline and will center GAP21 in the three cities with the highest concentration of employers that utilize geospatial technologies: Denver, Colorado; Los Angeles, California; and Washington, D.C.

A three-year pilot program has been designed with expectations that the training program will become self-sustaining thereafter.

2. CURRICULUM AND MANAGED LEARNING

2.1 GAP21 Design

GAP21 is designed to create a catalogue of various preexisting courses and programs offered by the high school, community college, and university coalition partners and focus on areas of the geospatial industry, especially remote sensing, that have previously been unaddressed in these curricula. To comprehensively prepare the incoming geospatial workforce and remote sensing professionals for the future, related technologies such as aerospace and information technology will be included in this catalogue. For their part, the educational partners will fill these educational gaps by designing and offering new courses or augmenting their current curricula. Concurrently, Kidz Online will work with its industry partners such as USGIF, GITA, and ICRSE, in addition to the Department of Labor's Employment Training Agency, to map each of the catalogue's courses to a Geospatial Competency Model. All curricular materials will reference the Geospatial Competency model as a base of education and understanding.

These efforts will be integrated into the Geospatial21 Competency Tracking program, a Learning Management System (LMS) that will allow GAP21 to manage the recruitment, enrollment, and placement process of the apprentice candidates. Understanding that each company is unique, the Geospatial21 Competency Tracking Program will allow a geospatial company to design a specific "skillset fingerprint" for various positions within their organization. The Geospatial21 Competency Tracking Program, based on the success of CompTIA's NITAS model for the information technology industry, will track the progress of apprentice candidates and provide statistical data on the number of apprentices placed into full-time, entry-level positions at the conclusion of their training. This process lets a student tailor his/her learning towards a particular career's "skillset fingerprint" within a specific company and also ensures a hiring manager that the recruited apprentice's resume accurately reflects their skills and experience for a specialized job function.

The program will be endorsed and vetted by industry corporations, thus insuring that all training will be applicable and acceptable industry wide. Kidz Online will also offer corporations the option of designing an individual training program, specific to the needs and demands of their corporation. By building upwards from employer and industry needs Kidz Online will assure students that their skill set will secure them future employment, and guarantee employers a workforce with the necessary core competencies to succeed.

The creation of a standard curriculum and training program will benefit employers, who will be able to incorporate best-practice models into their employee training programs and streamline training to improve productivity for both apprentices and their supervisors. In addition to helping the geospatial industry build employees from the ground up at a lower cost, it will also defray costs in training management, building stronger executives as well as entry-level employees.

GAP21 will benefit from the framework set within the current Geospatial21 program, which has quickly moved to incorporate the ETA's recent Industry Competency Initiative. Using the *Building Blocks for Competency Models* as the standard, Geospatial21 examined GIS, GPS, and Remote Sensing careers in the geospatial technology sector to identify common knowledge, skill and ability requirements throughout the industry. By identifying the areas common to geospatial careers, Geospatial21 has more clearly targeted the objectives of the training program. Information on CareerInfo.net was used to find the cross sections of job skills common to all geospatial fields, as well as the skills that are specific to particular industry sectors such as GIS, GPS and remote sensing and specific jobs within each of those three areas. The resulting data was used to create a draft of a Geospatial Competency Model. As evidenced by such events as the recent GITA/AAG 2nd Leadership Roundtable, geospatial competency is still being examined industry wide, so Geospatial21's initial contribution will likely grow and change with industry input and support. It is expected that with further communications with the international remote sensing community, via the ISPRS, that a more complete perspective of gaps and needs for professional training will become apparent. The attached graphic, Figure 1, displays the current Geospatial21 Competency Model.

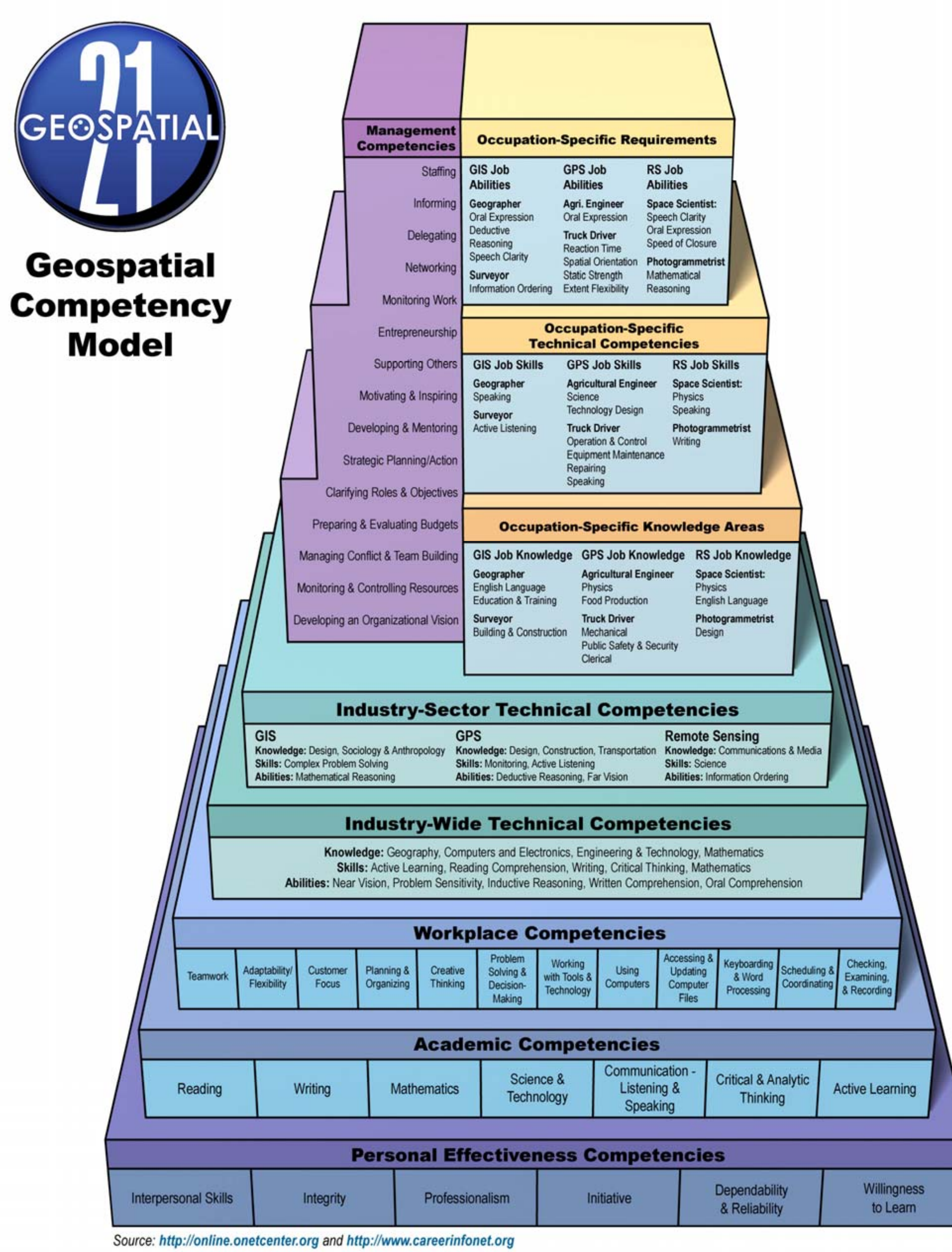

Figure 1. Geospatial Competency Model

2.2 Job and Internship Portal

Beyond providing apprenticeship opportunities, GAP21 will design and implement a job placement web portal that will allow students to seek permanent, full-time employment. Graduates will be able to search for job opportunities focused on only the industries in which they have been trained, without having to filter through employment opportunities that they are uninterested in and for which they are unqualified. With a standard program of training, certification and apprenticeship tied to preset competencies, employers will be assured that applicants to this web portal possess the necessary qualifications and education to be successful in the workplace. Students at the early stages of training, or apprenticeship candidates looking for a low-commitment hands-on experience, can use the portal database to search for internships and work-study positions.

Kidz Online is currently developing a software program, incorporating the Google Earth software, to map where geospatial corporations and community colleges exist in close proximity. This program allows interested students to seek enrollment near their future workplace, and aids industry employers in planning recruitment campaigns. Mapping out all of the available opportunities will be key in creating a strong program that leverages all industry and community support available in the targeted cities. Schools and employers will also be labeled according to their level of participation in GAP21, and students will be able to seek out and enroll in programs commiserate with their interest in the program, their educational needs and overall career goals.

2.3 Centers of Excellence for Educators and Students

The apprenticeship program will be based in the three metropolitan areas with the highest concentration of geospatial technology corporations: Denver, CO; Los Angeles, CA; and Washington, D.C. Fortifying these geospatial hubs, GAP21 plans include construction of a *Center of Excellence* in each of these three cities to provide on-site tutoring and career counseling for K- 14 students. These centers will work closely with state and national workforce investment boards to outline objectives and satisfy goals.

Part of the problem in creating a workforce pipeline that connects the education system to the geospatial industry is a geospatial-knowledge deficit in educators nationwide. Curriculum development workshops and GIS training classes run through these facilities will enable classroom teachers from all grades to integrate geospatial technologies into their classrooms and design appropriate lesson plans to utilize those technologies for various subject areas, such as science, history, math, geography, and business technology.

While each *Center of Excellence* will work to fulfill the above hands-on training needs, each is uniquely different due to its site partners and the varying sectors each location represents. Given that this program is a pilot program to evaluate the range of job training needed at different segments of society, three major centers have been selected as follows.

2.3.1 **The Los Angeles Center of Excellence.** This center will be based at Kidz Online's downtown studio. Since Kidz Online is the program lead and has an 8-gigabit digital infrastructure, this facility will serve as GAP21's organizational headquarters and manage the recruitment, enrollment, and placement of apprentices through the online LMS. Given the site's placement in the heart of the Los Angeles Basin, the facility's activities will include the aerospace applications of the geospatial sector. Kidz Online's experience in diversity, at risk, and Job Corps programs will serve the industry well by promoting a more diverse workforce.

2.3.2 **The Washington D.C. Center of Excellence.** This center will exist at George Mason University, which is currently constructing a facility for hands-on geospatial workshops. The campus' location is ideal to focus on government agencies, homeland security and defense.

2.3.3 **The Denver Center of Excellence.** This center does not currently have a selected location or site partner, but Kidz Online will propose to partner with the Denver Metro region to incorporate GAP21 into its $15M, three year DOL grant with emphasis on workforce boards, and civilian uses.

Cooperating with companies in such varied cities ensures a training curriculum applicable nationwide, and will allow students transportability of credentials between geographic areas, as well as helping assure a broad student pool. Particularly in Los Angeles and Washington, the varied ethnic population will help ensure workforce diversity, as well as giving traditionally underrepresented groups an opportunity to succeed in high-level industry careers.

These three facilities will use varying approaches in this pilot program, which will provide insight into how best to support the geospatial workforce pipeline. Once the pilot program is complete, evaluations will reveal advantages and disadvantages to each site's approaches and will serve as a case study in workforce development.

3. CONCLUSIONS

3.1 Outcomes

The Geospatial21 Apprenticeship Program will give students the opportunity to build on their classroom learning with real world experience by working as an apprentice in one of the many geospatial, aerospace or information technology corporations in Denver, Los Angeles or Washington D.C. Students will gain industry-specific skills and workplace competencies through applied training and will discover first-hand the benefits of working in these high-growth industries.

The Geospatial21 Apprenticeship Program will improve the overall productivity of geospatial, information technology and aerospace workers, lower employers' hiring and recruitment costs, as well as provide potential employees with a structured approach to career development. The process will also aid industry corporations in developing and streamlining their new-hire training programs to assure that incoming employees receive the most comprehensive instruction possible in the shortest amount of time.

Upon completion of the program, students will have recognized certifications as well as hands on experience in their chosen field, connections with leading employers and a comprehensive support network to allow them to plug into one of the most dynamic and widely applicable industries in the country today.

4. AKNOWLEDGMENTS

4.1 Project Partners

Geospatial21 is the team leader and facilitator responsible for all operations including infrastructure development, program administration, development and coordination of apprenticeship tracks, development and hosting, online curriculum creation, competency mapping, and marketing activities.

Geospatial21's Advisory Board members include senior executives from BAE Systems, Boeing, Booz Allen Hamilton, General Dynamics, ESRI, Lockheed Martin, Northrop Grumman, Raytheon, and Space Imaging. George Mason University is the primary university in partnership. The International Center for Remote Sensing Education is the lead NGO partner.

INTEGRATING DISASTER INFORMATION ON A WEB BASED GIS

Jong Hyeok JEONG, Yamamoto YUTA and Masataka TAKAGI

Department of Infrastructure Systems Engineering, Kochi University of Technology,
Miyanokuchi, Tosayamada-cho, Kami city, Kochi 782-8502, Japan

Commission VI

Keyword: web GIS, Spatial data integration, Spatial infrastructure, Database

Abstract: Local governments, research institutes, universities and disaster consultant companies have established disaster information in various formats and coordinate systems. In this study, we established a web based GIS system using the MAPSERVER. The disaster information was converted to a standard format and coordinate system to be integrated on the system, then the information is opened to the public through the internet. Additionally, a function was added to the system which enables users to report disaster information using a GPS camera. The system extracts the coordinate of damaged site from a picture, and displays the position on the web with the picture. This system assists decision makers and users to understand the damage situation in a short time, and reduce the time for disaster site investigation. Therefore this system will take important role for disseminating disaster information.

1. INTRODUCTION

Severe damage occurred in every year due to weather such like deadly strong typhoons, floods, snowy weather or wind in Japan. Totally the damage by bad weather reached 4692.5 billion yen.

Earthquake is one of main disasters in Japan. In 2004, Magnitude 6.8 Earthquake occurred in Niigata prefecture, the Earthquake continued until September 2005. Many buildings and roads were collapsed and cracked. The first Earthquake was occurred at early evening, so the surveying of damage was delayed. Therefore the damage by the Earthquake became worse.

Huge tsunami by Indian Ocean Earthquake occurred on December 2004. The magnitude of the earthquake reached from 9.0 to 9.3. Due to late rescue and subsidy distribution, the tsunami killed more than 28,3100 people.

From the experience of the disasters, we learned that data integration of disaster information for the analysis of damage situation and a practical disaster site investigation method for fast monitoring damage site are required. A powerful Earthquake called Nankai earthquake will occur around Shikoku Island Japan within 30 years. To prepare the disaster situation, a disaster information system is required. We set the Shikoku Island as the test area for this study.

The objective of this study are integrating disaster information on a web based GIS, opening the information through the internet and developing a practical disaster site investigation method for disaster monitoring using a handheld GPS camera.

2. INTEGERATION OF DISASTER INFORMATION USING A MAPSERVER

Figure 1 shows the concept of disaster information integration. The data integrated in this study is divided into data preparation before disaster and data acquisition after disaster.

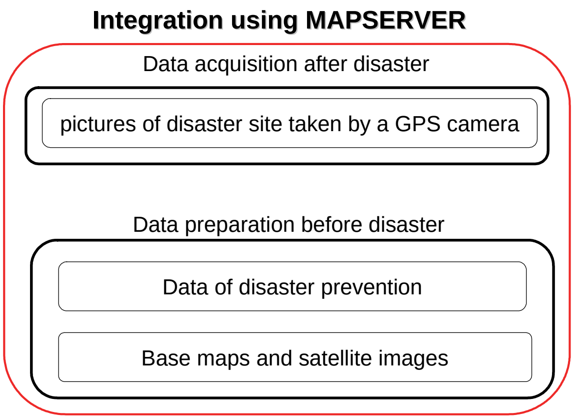

Figure 1 The concept of disaster information integration

2.1 Data preparation before disaster

2.1.1 Base maps and satellite images

Maps and satellite image are used as background data. Those data take very important role to help faster interpretation of location of disaster site.

1) Digitized maps and satellite images

1:25000 scale digital maps which contain various spatial information was prepared (Figure3). Mosaiced Landsat images which cover Shikoku island Japan, SPOT and ASTER images were prepared as satellite images.

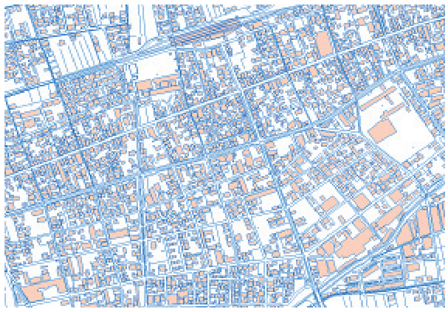

Figure 3 1:2500 scale digital map

2) Map digitizing by image processing

In this study, we prepared spatial data for landcover change evaluation: time series data are required for landcover change, however there are few data for the landcover change evaluation. Map elements such like road, rice field were extracted from a 1:25000 scale paper map. Figure2 shows the extracted map elements from the map produced in 1984 and 2003, and how the landcover changed.

Figure 2 data for landcover change evaluation

3) Map digitizing by topographic analysis of DEM

50m resolution DEM which enhanced by its elevation was prepared (Figure 4). Map of landform pattern analysis was carried out using the DEM.

2.1.2 Data of disaster prevention

Disaster prevention data which developed by local government of Kochi prefecture and Kochi university of technology was integrated.

As disaster prevention data, tsunami simulation data, a map of landslide area and map of blockade area were integrated in the web GIS.

1) Data preparation by conversion

The local government of Kochi prefecture prepared the data to predict the wave elevation by the earthquake. However the data is in special data format and coordinate system. Therefore the data could not be overlaid on other data in standard data format and coordinate system. The data was converted to grid format and standard Japanese coordinate system (JGD 2000). Figure 5 shows the converted tsunami simulation data.

2) Data preparation by digitizing

There are many landslide areas in Shikoku Island. The landslide area was digitized. Figure 6 shows the map of landslide area and the polygons in the figure are landslide areas.

3) Data preparation by spatial analysis using GIS

A Map of blockade area was established by using a DSM and road data. To detect blockade area, shadow simulation and landcover classification were carried out: 8 shadow data according to the sun's location on the south, west, east, north, southeast, southwest, northeast and northwest were established. Then the 8 shadow data overlaid. In this study, we set the blockade area when shadow data overlaid more than 7 times. Figure 7 shows the map of blockade area and dangerous path to pass when the earthquake occurred.

Figure 4 50m resolution DEM

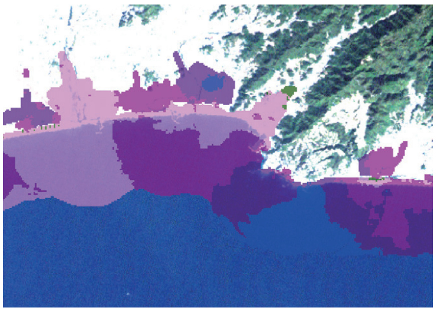

Figure 5 Tsunami simulation data

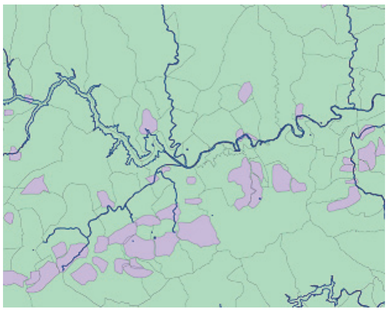

Figure 6 A map of landslide area

The data described in this section unified in the data format and coordinate system, then open to the public using MAPSERVER.

Figure 7 A map of blockade area

The data can be seen at the web site http://www.infra.kochi.ech.ac.jp/takalab/.

2.2 Data acquisition after disaster

Remote sensing is widely used for monitoring damages by disasters. However there are advantages and disadvantages of each disaster in using remote sensing for disaster monitoring: Very high resolution satellite images provide very detail spatial information, however they are expensive and acquired contents depend on recurrent time and weather condition. Aerial surveying is less influenced by cloudy weather, aerial photos present more detail spatial information than very high resolution satellite image. To use aerial photos, data processing time of them is required. Radar sensing can be carried without disturbance by cloudy weather. However, most radar data have low resolution and no color information. One of advanced remote sensing platforms is radio control helicopter, it can acquired detail information from a low height, is not affected by cloudy weather. Remote sensing using radio control helicopter is still experimental and expensive. The damage information acquisition using remote sensing has limitations for the various reasons.

1) A practical data acquisition method for field surveying

To cover the limitation of data acquisition by remote sensing, field surveying is required. Field surveying is not much influenced by weather condition, however much time and labor work is required to monitor wide area.

In this study, a practical disaster site investigation method that reduces acquisition time and labor work was developed using a handheld GPS camera and a web GIS.

Figure 8 shows the flow of the proposed data acquisition method for field surveying. Firstly, a surveyor brings a GPS camera to a damaged site by nature disaster, then he takes some pictures. Figure 9 shows a digital camera with a GPS.

The pictures taken by a GPS camera are stored in JPG format, and the coordinates of the positions are stored as EXIF (EXchangeable Image file Format). EXIF is widely accepted format to store various information such like time, date, focal length and coordinate derived from a GPS.

After surveying, the file and comments are uploaded to a computer server through the Internet using a file upload interface shown in the figure 10.

Figure 11 shows the result of upload. The coordinate of disaster site was extracted by a program in PHP.

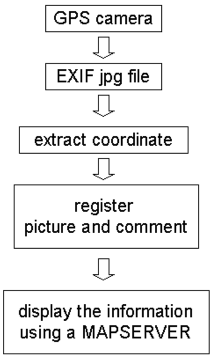

Figure 8 The proposed data acquisition method for field surveying

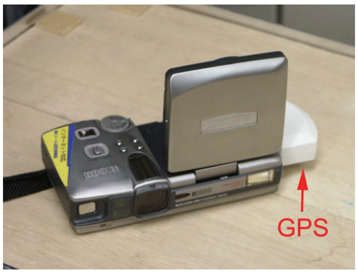

Figure 9 GPS camera

Figure 10 File upload interface to register pictures taken by a GPS camera.

Figure 11 After uploading a file, the interface shows the picture uploaded, file name and coordinate system.

The coordinate information is stored in shape file format which is developed by ESRI, then the web GIS displays the position and the uploaded picture using the shape file.

In this study, MAPSERVER is used as a web GIS. MAPSERVER is an open source GIS server which is developed by University of Minnesota. In Figure 12, A MAPSERVER shows the position of the site in the picture with the link of the comments.

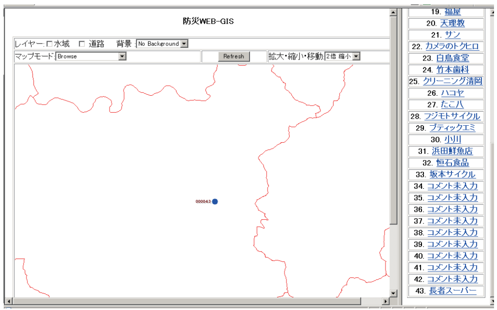

Figure 12 MAPSERVER display the registered picture's position and comments

2) Evaluation of the data acquisition method

In this study, empirical evaluation of the proposed method was carried out. Data acquisition time using a GPS digital camera (proposed method) compared with data acquisition time using a paper map (manual method). We measured the time taken from data acquisition to presentation in a GIS. In data acquisition, the information of buildings along downtown, national road route 195 and Akebono street was acquired using handheld GPS camera and a paper map.

Table 1 shows consumed time for data acquisition and processing using the proposed method. Table 2 shows consumed time of data acquisition and processing using a paper map. As increasing the number of buildings the gap of consumed time between the two methods become bigger and bigger. In comparison of the two methods, the proposed method is 1.5 times faster than the manual method.

3. CONCLUSIONS

In this study, various disaster data in various format and coordinate systems was integrated by image processing and spatial analysis on a web based GIS and the data was opened to the public through the Internet. Additionally, a practical disaster site investigation method was developed, then the evaluation of the proposed method was carried out.

The proposed method shortens data acquisition time comparing with the data acquisition using a paper map.

Although this system was developed for wireless and online environment, the system can be used in offline environment.

This system has much potential, because the third generation cellular phone which equipped a digital camera and GPS will become standard in 2007. Therefore this system can take important role to make fast data acquisition for disaster monitoring in near feature.

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Table 1 Consumed time for data acquisition and processing using the proposed method

	Downtown	R 195	Akebono str.
Number of buildings	154	125	20
Consumed time for taking pictures (minutes)	200	160	30
Consumed time for establishing GIS data (minutes)	95	85	14
Total (minutes)	295	245	44

Table 2 Consumed time for data acquisition and processing time using the manual method

	Downtown	R 195	Akebono str.
Number of buildings	154	125	20
Consumed time for recording the information of buildings (minutes)	300	250	30
Consumed time for establishing GIS data (minutes)	130	105	30
Total (minutes)	430	355	60

THE IMAGE INTEGRATED DATABASE FOR WEATHER STUDY USING MT. SAKURAJIMA

Satoshi TSUCHIDA [a], Kisei KINOSHITA [b], Daisuke KAJIKAWA [a]

[a] Faculty of Education, Kagoshima University, 1-20-6, Korimoto, Kaoghima, 890-0065, JAPAN
tsuchida@edu.kagoshima-u.ac.jp
[b] R&D Center, Kagoshima University, 1-20-6, Korimoto, Kaoghima, 890-0065, JAPAN
kisei@rdc.kagoshima-u.ac.jp

KEY WORDS: Observations, Volcanoes, Meteorology, Education, Teaching, Visualization

ABSTRACT:

Mt. Sakurajima is a volcano located about 10km east from Kagoshima University. We are continuing observation of this Sakurajima volcano with a web camera since December 2000. The picture is taken from 5:00 to 20:00 JST at 5 minutes interval, and archived in web server. The flow of volcanic plumes and meteorological clouds covering the summit are influenced by the surrounding weather condition. Therefore, the observation of Mt. Sakurajima is important for weather study to expect a motion of the distribution of atmospheric pressure and the front by reading a wind direction and velocity. The database for weather study we built has the following features. - It is possible to show the cloud picture of the Sakurajima volcano of the day we wish. - It can compare the weather map and the satellite cloud picture simultaneously with the image of the Sakurajima volcano. - The feature of the weather phenomenon read in an image is shown also as a text. - Easy operation. - Public presentation by a web is possible. We expect that students can perform weather study effectively by using the picture of Mt. Sakurajima, clouds data from satellite, and weather maps.

1. INTRODUCTION

In Japan, The contents of learning from elementary school to upper secondary school are decided in the course of study notified by MEXT - Ministry of Education, Culture, Sports, Science and Technology -.

"The weather and its change" are included in the second field of lower secondary school science, and are taught at the second grade. Objectives of science teacher are to make students realize the regularity of weather changes through meteorological observations and measurements, and on the basis of this knowledge, to strengthen students' recognition of their mechanism and regularity.

Moreover, in both lower and upper secondary school science, the positive application of computer communication network is called for in information retrieval, data processing, and experimental measurement.

1.1 Previous Research in Japan

Japan Society of Earth Science Education is one of the central societies of Japan which is performing activity from 1948 about earth science education. Many researches of weather education have been done since inauguration, and the proposal to the weather teaching materials using satellite images is reported from 1975 (e.g. Yamada, 1975a, 1975b, Kitamura et al., 1982, and Urano et al., 1983). They use the images from NOAA launched in the U.S. since 1970, and HIMAWARI launched in Japan since 1977. On the other hand, computer use in weather teaching materials also started with the spread of the personal computers from the 1980s (e.g. Urano et al., 1984, 1989).

With extension of the Internet, researches using the cloud picture taken from the Internet resources and live cameras are reported (Sakakibara, 1995, Misaki, 1996).

Matsumoto and Tsubota (1997) developed the teaching materials which connected the web camera images at several places in Japanese, and the satellite cloud picture. The satellite is taking the cloud picture from the space. Therefore, some motions of clouds become the reverse of ground observation, and the students who get confused may exist. By combining the cloud picture of satellite and ground observation with a camera, students would be able to understand a motion of clouds in tree-dimension. Ikemoto and Sakakibara (2000) developed the teaching materials which learn a distribution and form of clouds using the satellite picture which can be obtained by the Internet. Nakazawa and Sakakibara (2003) report the digital pictorial book of clouds, and make public on the Web. Moreover, Nakagawa et al (2004) tries to integrate the live camera network which observes clouds, satellite cloud pictures, and weather bulletin pictures, such as a weather map, and is achieving success.

All aim at attaining the target of weather study by combining the weather bulletin from a satellite with a familiar weather phenomenon. In every research, an important element is the necessity for accumulation of the continued observation data.

1.2 Sakurajima Volcano

Sakurajima is an isolated volcanic mountain in the Kagoshima bay, and it is in the south of the Aira caldera formed after blowing off the Ito pyroclastic flows about 25,000 years ago. In recent years, the crater of the south-side summit, 1040m above sea level, erupted in October 1955, and it is continuing eruption activities till today. This volcano is located in about 10km east from the down town of Kagoshima-shi.

Since Sakurajima is an isolated volcano, the clouds produced near the summit, ash or vaporous plumes flow are greatly influenced by surrounding weather conditions (Kinoshita et al., 2003a, 2003b, Tsuchida et al., 2003).

Therefore clouds production, motions, and plumes flow will show surrounding weather conditions, e.g., frontal passage, change of atmospheric pressure, change of the upper winds, and so on. Sakurajima can be called a vary big anemometer in nature.

2. CONSTRUCTION OF ING IMAGE INTEGRATED DATABASE FOR WEATHER STUDY

As in the preceding section, Sakurajima gives us the interesting knowledge about relevance not only with a volcanic eruption phenomenon but a weather factor. Then, we projected to develop weather teaching materials using the information that we would get from Sakurajima. For the student who lives in Kagoshima, Sakurajima is familiar existence. And student would often see clouds and plumes of Sakurajima with TV news and a weather forecast, nevertheless it is hard for a student to notice the effect of weather phenomenon on this.

It is outside the course of study for lower secondary school that students learn about relationship between clouds of Sakurajima and weather phenomena. However, by introducing such phenomena of Sakurajima, the Kagoshima residents' symbol, we expect students to keep the interest about weather phenomena after science classes.

2.1 Continuous Observation of Mt. Sakurajima

Sakurajima is one of the volcanoes that the Kagoshima University Volcanic Cloud Research Group is holding continuous monitoring from the ground and satellite. Since December 2000, we are continuing observation of Sakurajima with a video camera (SONY 1/3” 380,000 pixels CCD video camera SSC-DC430, CANON video lens: f=6.5mm-65mm) (Figure 1). This camera system is shown in Figure 2. Video inputs are captured for making a still image (640 x 480 pixels) from 5:00 to 20:00 JST in every 5 minutes by the web-camera software (ListCam, http://www.clavis.ne.jp/), and stored in HDD of a web-server.

This web-server’s URL is http://voleye.edu.kagoshima-u.ac.jp/. In April 2006, amount of still images accumulated at the server is about 20GB. It is about 30KB-120KB/picture, and about 20MB/day.

Figure 1. Sakurajima observation camera installed in faculty of education, Kagoshima univ.

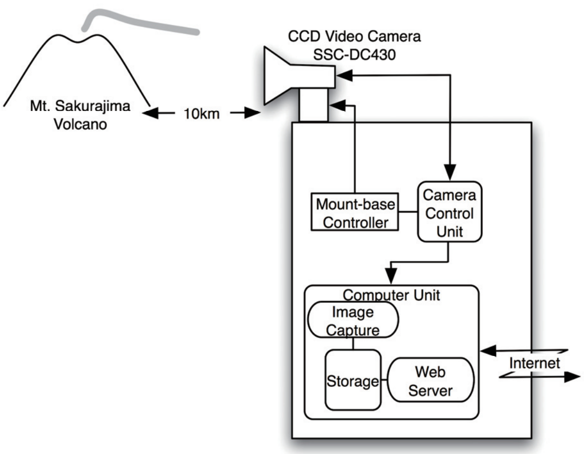

Figure 2. System diagram of Sakurajima web camera

2.2 Transformation Still Images to Quick Time Movie

The Sakurajima picture accumulated at the server is a still picture. We can access these still pictures through the Internet.

By saving as still picture data in every 5 minutes, HDD capacity required for preservation can be made small. Moreover, we can carry out advanced analyses using these still images, e.g., height measurement and structure observation of plumes and clouds.

However, as introductory teaching materials to a weather phenomenon, it is hard to evoke interests of lower secondary school student using still pictures only. A motion is required for the image to be used. Then, we planned to change the archived still picture data into a video data.

Still picture data is named as a sequential file-name which consists of a photography date and time. And it is saved in the holder newly created day by day.

In this research, we transformed these still pictures to a movie file for each holder using the QuickTime©, Apple inc. The Quantity of one movie per day is about 2.5MB, 6 frame/s.

Now, we have finished converting Sakurajima pictures, taken in 2000 and 2001, into movie files. We can observe comparing those movies with satellite cloud pictures and weather maps.

There are also days that we couldn’t get images because of the down of networks, a server, or power supply, and so on (APPENDIX).

2.3 Selecting Database Management System and Frame Structure

In this research, it is necessary that we should construct the database to integrate a lot of Sakurajima movies, satellite cloud pictures, and weather maps. Furthermore, we consider that school science teacher participate in our research for construction and improvement of this database in the future.

Therefore, the database management system is demanded the following features.

- Movie data can be treated.
- A novice of a database can also build easily.
- Database field can be created and added easily.
- Database has the relational function for reduction of single file size, and an easy improvement of it.
- The correction and distribution are possible though the Internet.

We chose FileMakerPro6©, FileMaker Inc., that satisfied these matters.

As users will be able to gain easy and quickly accesses to data that they wish, this database has frame structure as shown in Figure 3.

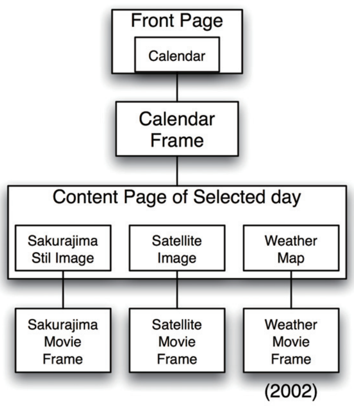

Figure 3. Frame structure of data base

2.4 Operational Images

The step of choosing data from a database is as follows.

1. Select a year you wish to see on a front page.
2. Click a day to see in calendar form.
3. If a contents page comes out and you click the Sakurajima picture, the Sakurajima movie frame of the day will be shown.
4. Moreover, you click a satellite cloud picture on a content page, the movie frame of a NIR cloud image is presented.

In the content page of 2002, we can also see the motion picture of weather maps.
A satellite cloud picture is allowed to use this database from the Sendai science museum. We have transformed these pictures to the motion image (2 frame/s).
This URL of The Sendai science museum is
http://www.kagakukan.sendai-c.ed.jp/himawari/index.html/.
Moreover, the weather map in 2001 has been obtained permission to use from the windsurfing weather bulletin (wivon - http://www.wivon.com/tenkizu.htm/.)
The weather map of 2002 has been permitted by the Kanagawa labour union of mountains (http://k-rouzan.net/main.html/). These weather maps are saved in every 3 hours at their server. We have made motion images from those still pictures with 1 frame per second.

Figure 4. Front Page
If you wish to select events in 2001, click a calendar of 2001.

Figure 5. Calendar frame for selecting a day
This case shows that January 5th is chosen.
You will be able to select another day or month.

Figure 6. Content page include Sakurajima image, a satellite image and a weather map
If you wish to see a Sakurajima movie, click Sakurajima picture.

Figure 7. Open new frame for showing a Sakurajima movie.
Click Sakurajima image to show a movie
(Left side of this image is north, and right side is south.)

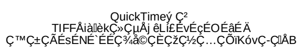

Figure 8. Click satellite image to show a NIR clouds movie

3. FUTURE TASKS

In order to develop this database furthermore, we need to do the following work.

- To develop the system for gathering weather maps automatically from JWA web site.
- To construct the system for generating motion images automatically from the archive of Sakurajima still pictures.
- To try local web publication by using the web companion tool plugged in FileMakerPro6.
- To inquire some teaching methods for using effectively in lower secondary school science.

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APPENDIX

Date	Time (JST)
2001/1/19	8:55-9:10
2001/3/14	12:10-12:25
2001/3/15	9:10-9:50
2001/3/19	12:20-12:30
2001/3/19	15:30, 16:10, 16:15
2001/4/22	8:35-19:00
2001/7/18	4:30-9:00
2001/8/24	4:30-9:30
2001/9/22	9:05-19:50
2001/11/3	all the day
2001/11/4	all the day
2001/11/5	6:00-8:25
2001/12/16	8:35-18:55
2002/1/29	10:40-11:55
2002/1/29	12:05-12:15
2002/1/29	17:25-18:55
2002/7/10	18:15
2002/8/1	7:35-7:40
2002/9/16	5:00-17:50
2002/9/21	9:05-19:50
2002/11/17	15:40
2002/11/18	10:25
2002/12/15	8:35-18:20

Table 1. Date and time without images (2001, 2002)

SEA ICE IMAGE DATASET FOR EDUCATION (SIDE)

[a]Kohei CHO, [a]Yoshimi Yano, [a]Reiko Iwasa

[a]Department of Network and Computer Engineering, Tokai University,
2-28-4, Tomigaya, Shibuya-ku, Tokyo 151-0063, JAPAN
cho@yoyogi.ycc.u-tokai.ac.jp

Commission VI

KEY WORDS: Sea Ice Types, WMO, Remote Sensing, Okhotsk Sea

ABSTRACT:

The use of remote sensing is necessary for monitor wide sea ice areas. However, since different scale sea ices often show similar geometrical shapes and patterns like fractal, it is not easy for unskilled people to interpret the conditions of sea ice from aerial photos or satellite images. Moreover, the feature and name of sea ice changes as it grows. The sea ice types are defined in details. It is not easy for the beginners to identify each sea ice types at their field survey. In order to allow beginners to understand about the sea ice types and how the sea ice looks in different scales of remote sensing images, the authors have developed a sea ice image dataset called SIDE(Sea ice Image Data set for Education). SIDE allows users to understand various kinds of sea ice type with categorized descriptions and many color images.

1. INTRODUCTION

Satellite images are daily used for sea ice monitoring on a global basis. ESA is operating the ICEMON service system(2006) for monitoring sea ice in the polar regions. The National Ice center(NIC, 2006) of USA is a multi-agency operational ice center operated by NOAA, US Navy and other organizations to provide various ice services. In Japan, the Japan Coast Guard is operating the Ice Information Center(IIC, 2006) every winter to disseminate sea ice distribution information of the Okhotsk Sea. In these organizations, various information on sea ice are provided to users to make them understand more about sea ice.

However, there are various kinds of sea ice types (see Figure 1), and their conditions/sizes/locations change from time to time. Different scale sea ices often show similar geometrical shapes and patterns like fractal. Various type and size of sea ice are often mixed and distributed in same sea ice area. Thus sea ice information interpretation from aerial photos or satellite images is not easy. Without certain knowledge on sea ice and resolution difference of remotely sensed data, users are likely to misread the sea ice information from sea ice images taken by airplanes or satellites.

In order to allow beginners to understand about the sea ice types and how the sea ice looks in different scales of remote sensing images, the authors have developed a sea ice image data set called SIDE(Sea ice Image Data set for Education). The outline and the initial result of SIDE is described in this paper.

2. DEVELOPMENT CONCEPTS OF SIDE

The development concepts of SIDE are as follows.

2.1 Target users

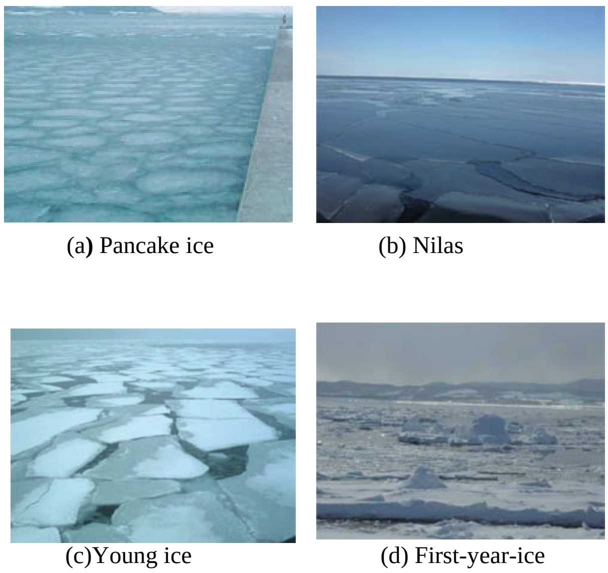
The target users of SIDE are beginners on sea ice and remote sensing who are interested in using remote sensing data for studying/ monitoring sea ice.

2.2 Sea ice type definition

The definition of sea ice types were conformed to World Meteorological Organization (WMO) definition (1970).

2.3 Structure

SIDE mainly consists of sea ice classified table, sea ice development chart, and sea ice images. All of the information are in HTML format, mutually hyper linked, and accessible via internet.



(a) Pancake ice (b) Nilas

(c)Young ice (d) First-year-ice

Figure 1. Examples of various types of sea ice

DATA USED IN THIS STUDY

In this study, various sea ice images consist of on site photos, aerial images, and satellite images of the Okhotsk Sea were used for making the SIDE dataset. Most of the satellite images were from optical sensors. Table 1 shows the main data sources used for the initial dataset development.

Table 1. Main data sources used for SIDE

Date source	Observation date	Reolution
On site photo	Feb. 23, 2000	
	Mar. 2-4, 2004	
	Mar. 1-4, 2005	
Aerial photo	Mar. 6, 2003	10～12cm
IKONOS	Mar. 10, 2000	1m
Landsat / ETM	Mar. 6, 2003 etc.	15m
MOS-1 / MESSR	Feb. 22, 1995	50m
Terra / MODIS	Feb. 21, 2003 etc	250m
Radarsat/SAR	Feb. 21, 1998	30m
DMSP SSM/I	Feb. 23, 2004	25km

4. DEVELOPMENT PROCEDURE

The following procedure was performed to develop the sea ice image dataset SIDE.

4.1 Sea ice type classification

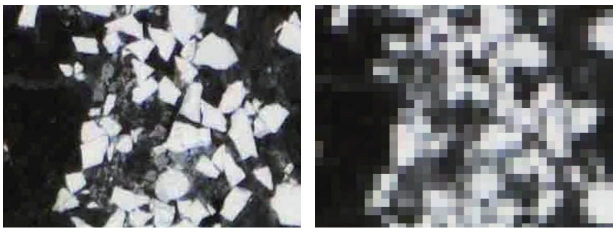
Firstly, the sea ice types were classified with (a)development, (b)formation and (c)surface features of sea ice as defined by WMO and put on a table.

4.2 Classification of sea ice images

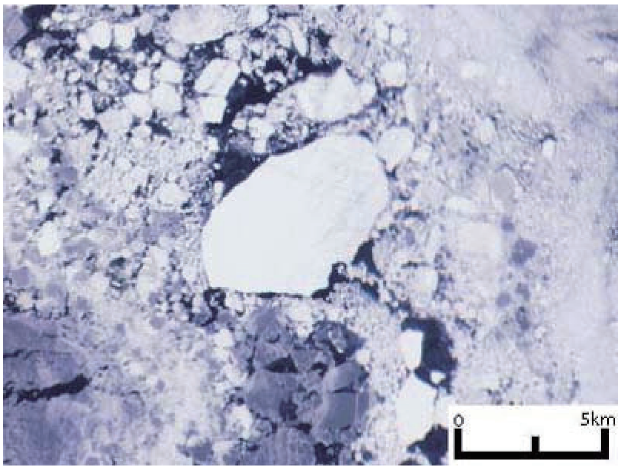
As shown on Table 1, various types of sea ice images were collected and classified by sea ice types and data source.

4.3 Image processing

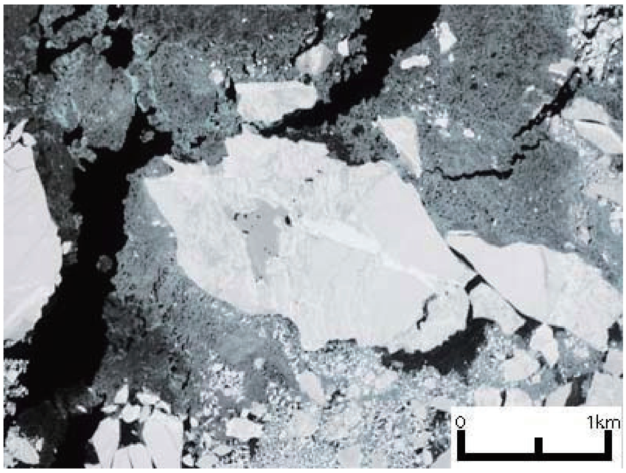
The appearance of sea ice in aerial images and satellite images dramatically changes according to the spatial resolution of sensors and display scale of the images. A set of low resolution images were produced by averaging the higher resolution images to show how the outlook of sea ice changes with the resolution reduction of images. Figure 2 shows such an example. To show the sensor difference, different sensor images were collected for same type of sea ice as shown on Figure 3.



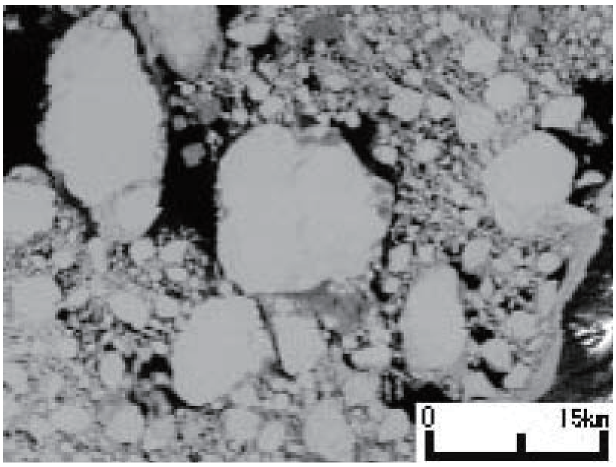
(a) Original image(IFOV:1m) (b) Averaged image(IFOV:10m)
Figure 2. Comparison of sea ice image in different resolution.
(Data source: IKONOS, (C) JSI)



(a) IKONOS image (© JSI)



(b) MESSR image (JAXA)



(c)MODIS image (NASA)

Figure 3.vast floe in different sensor images

4.4 Structuring of the dataset

Figure 4 shows the structure of SIDE .The dataset is consisted of the following five sections.

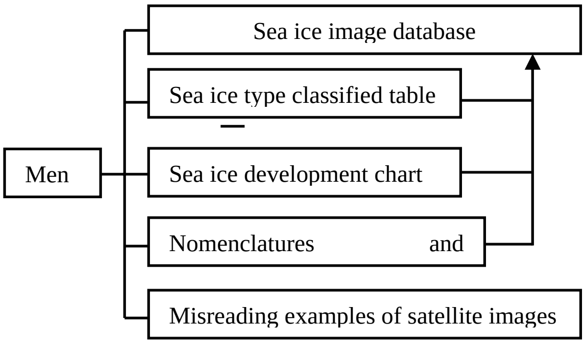


Figure 4. Structure of SIDE

4.4.1 Sea ice type classified table

The sea ice types are classified by three subjects which are "development", "forms", and "surface features". Table 2 shows a part of the classified table according to the forms of sea ice.

Table 2. Example of sea ice type classified by forms.

Classification by forms		
Type	Subtype	explanation
Floe		Any relatively flat piece of sea ice 20 m or more across. Floes are subdivided according to horizontal extent as follows.
	Small floe	20-100 m across.
	Medium floe	100-500 m across.
	Big floe	500-2000 m across.
	Vast floe	2-10km across.
	Giant floe	Over 10 km across.

4.4.2 Sea ice image database

Various sea ice images were collected including on site photo, aerial image, and satellite images. Figure 5 shows on site photos examples of grease ice.

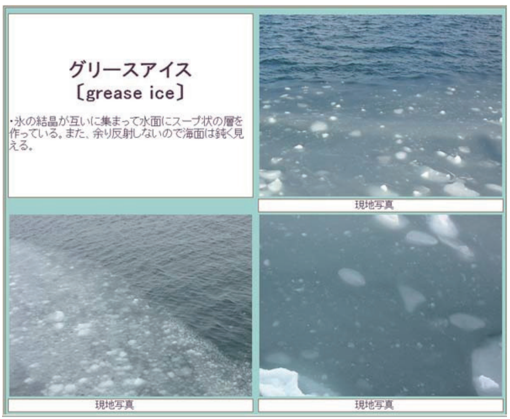


Figure 5. Image galley of grease ice

4.4.3 Sea ice development chart

To help users to understand the sea ice development process, sea ice development chart was produced as shown on Figure 6. Each sea ice category names are hyper linked to actual sea ice images. For an example, if the user clicks "grease ice", Figure 5 will pop up on the screen.

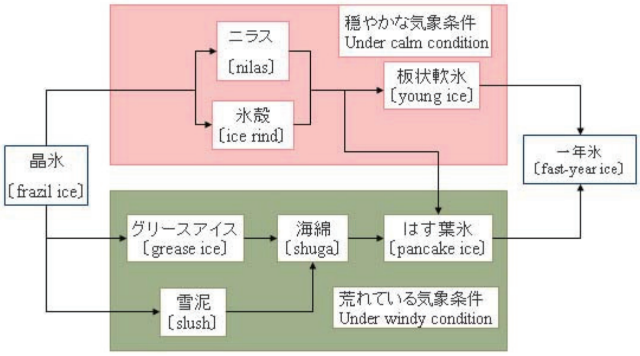


Figure 6. Sea ice development chart

4.4.4 Misreading examples of satellite images

As described in the introduction, the scale difference of satellite images is quite difficult to recognize. In this section, examples of satellite images that may cause misreading of sea ice information are presented.

Figure 7 shows sea ice images of IKONOS(IFOV=1m) and MOS-1/MESSR(IFOV=50m). The ice plate in the center of both images look similar, but their sizes are very different from each other. Without checking the scale of remote sensing images, users are likely to misread the information from those images.

Figure 8 shows IKONOS images in different resolution (IFOV). (a) is the original IKONOS image with IFOV=1m, and (b) is 20pixel x 20pixel averaged IKONOS image which corresponds to IFOV=20m. In the original image (a), thin ice is clearly recognized in the center of the image. However, in the averaged image (b), the area looks as open water. Also, ice crack in a medium floe which can clearly be seen in the image (a) can not be recognized in the image (b). These images clearly show how sea ice information are reduced as the resolution goes down.

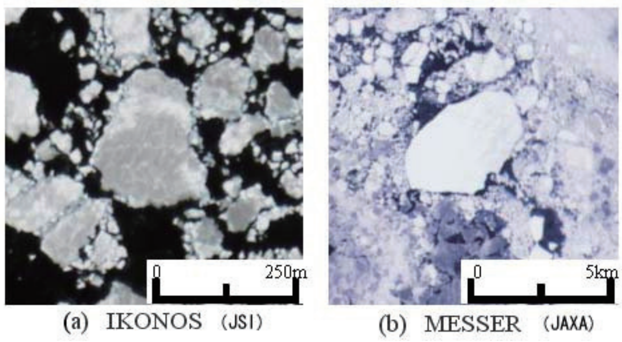
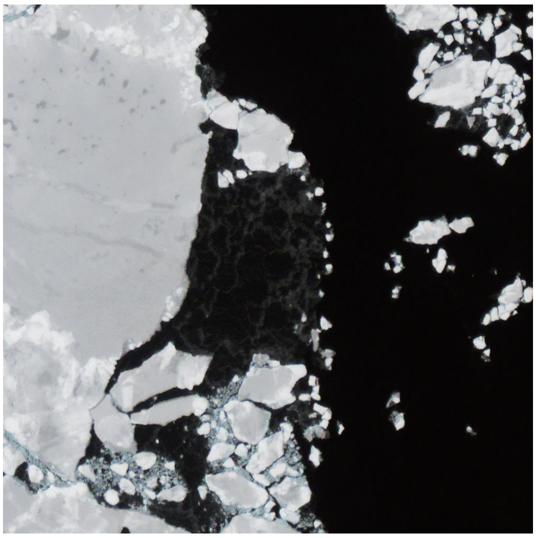
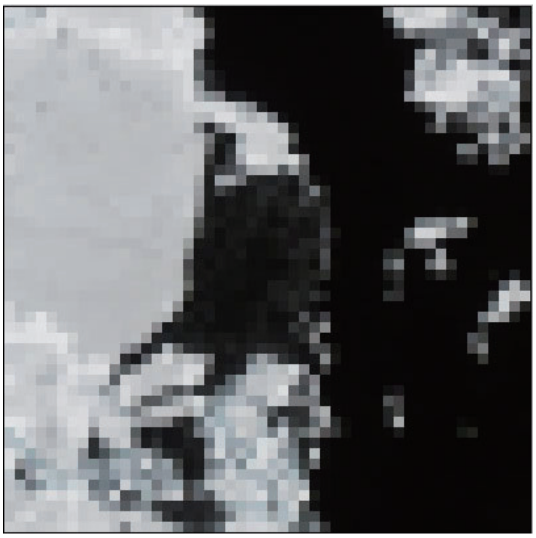


Figure 7. Scale difference of satellite images.



(a) IFOV=1m



(b) IFOV=20m

Figure 8. IFOV difference in an IKONOS image (© JSI)

Table 3. Examples of nomenclatures and definitions of sea ice

[Development]

New ice: A general term for recently formed ice which includes frazil ice, grease ice, slush and shuga. These types of ice are composed of ice crystals which are only weakly frozen together (if at all) and have a definite form only while they are afloat.
Frazil ice: Fine spicules or plates of ice, suspended in water.
Grease ice: A later stage of freezing than *frazil ice* when the crystals have coagulated to form a soupy layer on the surface. Grease ice reflects little light, giving the sea a matt appearance.
Slush: Snow which is saturated and mixed with water on land or ice surfaces, or as a viscous floating mass in water after a heavy snowfall.

4.4.5 Nomenclatures and definitions

The nomenclatures and definitions of sea ice types are described in this section following the definition of WMO. Table 3 shows an example of the description. Most of the sea ice type names in this section are also hyper linked to the sea ice image database. So it is easy for the users to recognize definitions and outlook of each sea ice type.

5. CONCLUSIONS

The authors have developed a sea ice image dataset SIDE. The SIDE helps beginners to understand about the names/definitions of various sea ice types and how each sea ice type looks in various kinds of images such as on site photos, aerial images and satellite images. Especially, various kinds of satellite images of sea ice are collected and displayed in systematic manner which allow users to recognize the scale difference and resolution difference of satellite images for interpreting sea ice information from them.
The initial version of SIDE is now accessible at the following site. http://www.yc.ycc.u-tokai.ac.jp/ns/cholab/seaice/top.htm
SIDE needs more to be improved. The authors are planning to expand and revise it from time to time. One of the plans is to add kinds of interactive exercises to allow users to check their understanding on the sea ice types. The authors are pleased to have comments, suggestions, and contributions from the scientific community.

ACKNOWLEDGEMENT

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INDONESIA EXPERIENCE IN GEOSPATIAL TRAINING

Fahmi AMHAR
National Coordinating Agency for Surveys & Mapping
Jl. Jakarta-Bogor Km. 46 Cibinong 16911 – Indonesia
telp. /fax. : ++62 21 8790 1254
email: famhar@telkom.net, famhar@yahoo.com

Commission VI

KEYWORDS: Geospatial Education.

ABSTRACT:

Training as non-formal education form is a very important step in long-live learning paradigm, also for geospatial. This paper described five highlighted Indonesia experiences in organizing of geospatial training, which in the past four years are carried out by National Coordinating Agency for Surveys and Mapping together with other partners. These trainings are training for Government Officer (TGO), Training for Teacher & Lecturer (TTL), Training for Children and Teens (TCT), Training for Student & Activist (TSA) and Training for Business Actors (TBA). Each training has different characteristics about their goals, prerequisites, curriculum, duration and financing.

1. INTRODUCTION

One of the duties and responsibilities of the National Coordinating Agency for Surveys and Mapping of Republic Indonesia (BAKOSURTANAL) is to promote geospatial technology in the country. This duty is implemented in form of several trainings, which is given to the people. In the past four years, some form of trainings is done, but five of them are found as the most favorable. There are: training for Government Officer (TGO), Training for Teacher & Lecturer (TTL), Training for Children and Teens (TCT), Training for Student & Activist (TSA) and Training for Business Actors (TBA). Each training has different characteristics about their goals, prerequisites, curriculum, duration and financing.

2. TRAINING FOR GOVERNMENT OFFICER

It is the most frequent training form – and also the oldest. Government Officer from several Provinces and Counties – sometime also from villages' administration - come to the training. The venue is sometimes in BAKOSURTANAL Training Center near Jakarta, otherwise in hotel or other government buildings, sometimes also in the remote provinces. The organization and financing is sometimes BAKOSURTANAL responsibility but more often on the hand of other office or self-supporting. The ministry for internal affair and the province governments are few of big sponsors today.

The goal is mostly to give government officers the broader knowledge and know-how about geospatial benefit and technology. These could be: boundary demarcation (this training is really the most favor one since the regional autonomy policy!), green resources accounting, GIS for planning, GIS for e-Government, until toponimy and language-mapping. The duration of training is variously, from just two days until two months – depend on the demand and job-complexity-level of participating institutes.

Their own institutes mostly do the selection of participants – and this is sometimes not yet ideal. Not many of 33 Provinces and 440 counties (Kabupaten / Kota) in Indonesia have already special staff for geospatial data with enough geospatial education background (i.e. geodesy, geography, geology, civil engineering, planology, forestry, soil science, etc). In some cases, the trainee has background just in Law, Economics or Informatics.

In the past two years, BAKOSURTANAL has promoted a functional officer (aside of structural officer) in surveys and mapping. Ideally each county has at least five such functional officers. A training for surveys & mapping should be organized nationwide. Each training has maximum 20 participants. The duration of the basic training is two weeks, consisted of 82 training-hours. There are two level of basic training: Level A – Basic Training for non-academician, level C – Basic Training for academician. Training Level B (between A and C) is projected for transition of some experienced non-academician.

An example of the curriculum is in the fig. 1.

Session	*Level A - Course*	*Hour*
01	Basic Mathematics	8
02	Survey Instruments	8
03	Introduction to Mapping	10
04	Introduction to Thematic Mapping	8
05	Computer Drawing	12
06	Introduction to GIS	8
07	Introduction to Remote Sensing	8
U1	Professional Administration	4
U2	Professional Ethic & Motivation	4
U3	Health, Safety & Environment	4
U4	Ergonomy	4
U5	Business & Consumer Protection	4
	TOTAL	*82*

Session	*Level C - Course*	*Hour*
01	Topographic Mapping	8
02	Thematic Map Application	4
03	Digital Mapping	10
04	GIS Application	10
05	Remote Sensing Application	10
06	Planning of Survey Project	8
07	Quality Management	8
08	Publication Technique	4
U1	Professional Administration	4
U2	Professional Ethic & Motivation	4
U3	Health, Safety & Environment	4
U4	Ergonomy	4
U5	Business & Consumer Protection	4
	TOTAL	*82*

Fig.1. Materials in Training for Government Officer (Mapping Surveyor)

There are five "universal session" both in Level-A or C. These session should help every mapping-surveyors to help himself in "jungle of bureaucratic administration", give them something for their character building, know well about how to work safety and comfortable and how to "sell" his skill.

The training (and also other training) is designed to be fun like motivation training (such as 7-habbit-training, ESQ-training). For instance, in the beginning the trainee will speak loudly the training yells "Go-go-go, Get-get-get, Draw-draw-draw".

After the basic training, a functional mapping surveyor can follow further specific training, i.e. Remote Sensing, GIS, Softcopy Photogrammetry, Boundary Demarcation or Digital Cartography with each duration of about two months.

3. TRAINING FOR TEACHER & LECTURER

The rapid technology development in geospatial world (terrestrial instruments, GPS, INS, photogrammetry, remote sensing, GIS, and now: Location Based Service System – LBS) made high demand for teachers and lecturers to continuously update their knowledge. There are a lot of request to BAKOSURTANAL to give such training. The request comes mostly from geography teacher of senior high school – but also from university lecture in civil engineering or forestry.

There is some time not easy to give adequate training materials for them, since the education background are very variously. In some school, geography teacher is often in the hand of teacher with background in linguistics or psychology. If we talk about GIS, then it means we must give them the elementary of informatics, mathematics and graphics. The second problem is that the number of interested teacher is so big, but the budget from the ministry for education is very limited – so the number of trainings and training-hours must be limited. The result, the training is normally only two days (16 hours), with participant more than 50 in a class (fig.2). An example of the curriculum of this training is in the fig. 3.

Fig.2. Situation in the teachers training

Session	*Materials for Teacher & Lecturer*	*Hour*
01	An overview of new geospatial technology and its benefit	2
02	Reading and understanding of paper map (with practice)	2
03	Reading and understanding of digital map (with practice)	2
04	Photogrammetry & Remote Sensing for non specialist (demonstration)	2
05	Data entry - from GPS to GIS (with practice)	2
06	A taste of GIS Application (with demonstration & practice)	4
07	Design of simple but impressive map with GIS (with practice)	2
	TOTAL	16

Fig.3. Materials in Training for Teacher & Lecturer

Some teachers or lecturers will not participate in the big class, and with their own cost, they follow a special class, sometime 7 persons, sometime just 2 persons, and it was happened: just 1 persons.

3. TRAINING FOR CHILDREN & TEENS

When someone has open their eye about the benefit of "geospatial literacy", then sometimes they like to make their children or teens has geospatial vision earlier. But this training should be fun, with many games and role-play.

Currently, training for children & teens is not yet often organized, but its popularity is increased. One of popular TV-cartoon in Indonesia is "Dora Explorer", told about a girl make adventure with some tools, including map. So reading, using and drawing map is a favor skill for children. The duration of this training is normally short, less than 4 hours. Each two year, BAKOSURTANAL organized national contest for map drawing and map using. The best map drawn by children will be sent to international contest held by ICA.

An example of the curriculum of this training is in the fig. 4.

Session	***Materials for Children & Teens***	***Hour***
01	Found your way with map - *Find your gold with an old map*	2
02	Let your friend find your home - *draw where is your castle*	2

Fig.4. Materials in Training for Children & Teens

4. TRAINING FOR STUDENT & ACTIVIST

Student and Activist (usually Environment Activist) is the most vocal member of the society. It will be good when their idealism is supported by good information – especially geospatial information. BAKOSURTANAL organized also some training for them. The training is designed so that in the short time they know how to start by themselves if they need to use or learn more geospatial data and technology. It is clear that some students are already from geospatial faculty and they like to hear more advanced topics, different to their class. But most of the participants of such training don't have any geospatial background, since more activists have their root in medicine, law, sociology or political science.

Several non governmental groups (NGO) trained by BAKOSURTANAL have used their knowledge for activities in Aceh, which in 2004 is hit by great tsunami. The other groups engaged for tropical forest protection, biodiversity, indigenous knowledge archiving, social work etc. So the training should be rather in how to use geospatial data to optimize their non profit oriented work.

The training is normally two days (max 16 hours) and arranged usually in Saturday & Sunday (often in an outdoor camp). The number of participant is variously between 10 and 40. An example of the curriculum of this training is in the fig. 5.

Session	*Materials in Training for Students & Activist*	***Hour***
01	Map as a communication tool	2
02	Reading and understanding of paper map (with practice in the field with traditional & conventional instrument and GPS)	4
03	Participative Mapping (with practice in making a simple base map and thematic map)	4
04	An overview of GIS & Remote Sensing, its benefit and limit	2
05	A taste of GIS Application (with demonstration & practice)	2
	TOTAL	16

Fig.5. Materials in Training for Students & Activist

In some cases, the participants use the evening time to complete their participative map with interview the village inhabitant. They can collect the names, boundary or discuss some actual phenomena of surrounding area which should be mapped. They learn also that a functional map could be inexpensive and feasible in short time.

5. TRAINING FOR BUSINESS ACTORS

Business Actors is normally high reactive for the technology change, because it is strong related to their competitiveness in the market. But unfortunately, not all business actors have enough capital to follow various workshop or seminars internationally. BAKOSURTANAL make bridges between business actors and technology providers. Yearly, BAKOSURTANAL organize at least one big event such as Forum of Geoinformation & Mapping ("ForGeoMap") or Geomatics Research Forum ("GeoReForm"), in which various workshops and training is served at low cost – and some times free.

In this workshop, major vendors like ESRI, INTEGRAPH, INTERMAP or AUTODESK can give an overview of their new products. Member of national TC211-Working-Group gives a talk-show about new ISO 191xx to the audience. And senior geospatial researcher discuss interactively with the public about actual topic. The most interesting topics are how to gain high benefit in a business using geospatial information or technology. And we can say that this kind of training is very dynamic. The duration of the training itself is maximum one day, and often just 2-3 hours.

After the training, the organizer distributes a short quiz for the content of training just to measure the success-rate of training and the expected follow-up. Some participants show their interest to more intensive training on their cost.

CONCLUSION

Various geospatial training should be designed for several target audience with different needs, background and organizational limitation.

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Promoting ISPRS Aspirations in Geospatial technology application in Developing Countries and EReT Cameroon Approach to the International MSc Geoinformatics programs.

Njohjam Peter Naburo, Njohjam Lucas Munju
Environmental Resource Trust (EReT) Cameroon, P.O.Box 475 Buea, South-West Province, Republic of Cameroon
njohjam@yahoo.fr, eretcam@yahoo.fr

Working group VI/1

KEY WORDS: MSc, International assistance, Geoinformatics, Resource Management, Education.

ABSTRACT

Environmental Resource Trust (EReT) Cameroon is a Non Governmental Organization working on the development and promotion of geospatial technology application with headquarters in Buea, South-West Province in the Republic of Cameroon, West Africa.
As an NGO working in a new scientific field with less local experts in this domain, we are building capacity for future experts who will serve in various organizations handling spatial data in Cameroon. It is for this reason that Environmental Resource Trust (EReT) Cameroon is introducing Geoinformatics to undergraduates and graduates students as preparation for the MSc in Geoinformatics offered by foreign universities to be mentioned in this paper. These institutions have fellowship opportunities that they offer to support candidates from developing countries and they have diplomatic representation in Cameroon to facilitate visa acquisition. To achieve this goal in promoting geospatial technology application in Cameroon, many actors have to come into play such as international institutions, national government departments and our local university authorities. Such a program requires a memorandum of understanding in International cooperation and technology transfer to be reached by the host institutes abroad, local universities and the NGO for the establishment of terms of reference for collaboration. Geospatial data management for strategic decision making, introduced by the NGO to national organizations such as Ministerial departments, local councils, health services will be presented.
It is not an easy undertaking to develop a program to be implemented in a university curricular except there is concrete proof of qualified and well trained staff that will ensure the handling of the various courses and the sustainability of the program. This means a new program has to show proof of its success in a previous university before it is introduced to another. This will require the need of visiting lecturers in Geoinformatics, signing of collaboration memoranda with institutions in the developed countries in view of exchange academic visits. Some collaboration agreements already initiated by the NGO will be presented in this paper.
Finally, collaborative work executed using geospatial technology for sustainable development will be presented and the paper will be finalized with a request of partnership in the promotion of geoinformatics education in Cameroon and Africa.

1.INTERNATIONAL ASSISTANCE

This initiative in Cameroon is being encouraged by donors such as Pr.Klaas Jan Beek former XIXth ISPRS congress director (Amsterdam 2000) with the donation of twenty two used computer hardware and peripherals from the International Institute for Geoinformation Sciences and Earth Observation (ITC) Enschede the Netherlands. Mr. Jack Dangermond, President of Environmental System Research Institute (ESRI), Redlands California donated ESRI software, higher education data package (ArcGIS 8, ArcPad, ArcSDE etc) which are used for GIS training in preparation for the MSc in geoinformatics courses abroad. We also use this opportunity to thank Mr.Frank Holmuller ESRI

regional Manager Europe, Middle East and Africa (EMEA) who was assigned to handle our problem by ESRI president and he did it successfully, Since the year 2002 we are a Registered Research Laboratory (RRL) with the Intergraph Mapping and GIS Solutions. The NGO received a donation of ArcGIS 8, Digital chart of the World ArcWorld and necessary documentation on GIS from Environmental System Research Institute (ESRI) California USA. Gift from ESRI President Jack Dangermond who was met after his opening speech at the Amsterdam RAI during the XIXth ISPRS congress. The development of GIS components attached to local services and higher educational institute will be a point of focus in Cameroon.

2.GEOINFORMATICS STUDIES IN CAMEROON

Land measurements have always been carried through Surveyors' work in the field. The theodolite , compass and the chain were the essential instruments used to acquire land measurements. Today in the third millennium information technology has brought in new methods of data acquisition based on remote sensing, global positioning system (GPS) and geographical information systems (GIS).

In Cameroon about only 1% of the country Surveyors have undergone university education. Most of our Survey engineers have only gained this grade through in-service promotion and further training in international institutions abroad after completing a diploma course. In the same time thousands of graduates are leaving the universities with BSc degrees in mathematics, geography, physics, chemistry, agriculture and other disciplines. Very few of them have knowledge about geoinformatics and its application in geodata management.

It is for this reason that Environmental Resource Trust (EReT) Cameroon developed the awareness program in Geoinformatics as a prelude to create new jobs opportunities and for the entrance into the International MSc Geoinformatics program in foreign universities abroad.

In this program they are shown the various fields in which geoinformatics is applied. It was realized that since this is a new field in developing countries, only few organizations are using this technology apart from international organizations working on bilateral agreement in the country. These include organizations such as the GTZ, WWF and DFID in their natural resource management program, the United Nation Development program (UNDP) in the mapping of aid assistance sites.

It has been very challenging to present a new subject to an audience which is almost ignorant about it.

Posters were pasted calling for university graduates to register for the geoinformatics initiation program. Twenty five graduates were registered for the program amongst who three female graduates.

Since all the students were versed with Cameroon, it was easy to take local geographic locations to explain the use of GIS because all the data available in our office is from foreign countries.. Although we are still facing a hardware problem for the installation of this program, the students are shown demo CDs dealing with photogrammetry, remote sensing and GIS.

Through these demonstrations, students are encouraged to undergo remote sensing with specialization in their field of study at under graduate level.

Before any development or project is carried out, there is a need for data acquisition to be transformed into usable information.

How ever, Environmental Resource Trust (EReT) Cameroon with its library of books and CD-ROMs on geoinformatics is always at the assistance of the students to guide them through the GIS documentation as well as the software.

Upon graduation from the university, many Cameroonians have not yet found the possibility of changing their lives with a postgraduate course in Geoinformatics. The role of EReT Cameroon is to encourage university graduates to follow a Master degree in Geoinformatics at any of the universities listed in the directory. Most of the students in the NGO are attracted by the programs since they found that with any scientific degree, one is eligible to follow the MSc program.

To introduce it to the students, each of them was requested to summarize his/her thesis so that we can jointly see how geoinformatics can be applied in it for timely decision taking.

The following BSc topics were studied:

- The effect of water pollution to the environment in the Kumba municipality.
- Study of the Geology of Manyemen village.
- The effect of Spontanous hawkers markets within the Bamenda urban area.
- Geomorphology of the Sabga hills in the North West Province of Cameroon.

Each topic was analyzed and the location town considered as the study area. The various thematic layers were identified and classified according to usage. From the first topic, water is an indication for linear or polygon feature, the municipality constitute a polygon feature, point features for buidings types, roads and utility lines are linear features.

Many types of pollution originate from sources such as organic, industrial, chemical, mining etc, which are located at certain points along the river flowing in the municipality. This implies that the toxicity of the river water is not the same at all the points. Using GIS, the prediction of an epidemic can be shown where the amount of pollution is seen to be very high. This begins exactly where the river has covered a long distance through all the various types of waste. The development of a spatial query based on the buffer operation in ArcView GIS will determine the areas of high epidemic spread. The results of the research can now be used to plan for the intervention strategy. This will enable the public health department to dispatch an emergency intervention team at the shown highly polluted localities.

The introduction of Geoinformatics to university graduates by EReT Cameroon has developed a new direction of orientation in the sense that these graduates now visit web sites dealing with GIS, photogrammetry, remote sensing, mapping etc. They are more concerned with a variety of workshops, seminars, symposium and conferences worldwide dealing with Geoinformatics. The bio-diversity conservation project of the botanical garden in Limbe Cameroon requested the position of a BSc degree holder in Geography with some knowledge in GIS. Many graduates attended the interview but non was selected because they hadn't any GIS experience.

This creates concern for them to follow postgraduate courses in Geoinformatics such as those offered by the Stuttgart University and the International Institute for Geoinformation Sciences and Earth Observation (ITC) The Netherlands. These institutions have tailored their courses to the need of developing countries.

3. GEOINFORMATICS APPLICATION TO THE CHAD – CAMEROON PIPELINE PROJECT.

This is a 1070 km long pipeline project for the evacuation of crude oil from the Republic of Chad to the Atlantic coastal town of Kribi in the Republic of Cameroon. This project was used as a case study for the students in the NGO. The application of remote sensing was used at the initial stage for mapping the proposed pipeline track. Aerial photography was carried out by Maps Geosystems of the United Arabs Emirates under a contract from the Exxon oil mining company.

All geographic entities such as settlements, rivers, plantations, forests, road network and savannah was mapped as thematic layers by interpretation of the aerial photographs based on their spectral signatures and ground truthing with the GPS. The altimetric data was used to generate a DTM to enable the visualization of excavation cost of the pipeline trenches and minimizing the destruction of natural habitat. A multidisciplinary team was dispatched to the project areas for socio-economic surveys, wildlife, botany, agriculture, ecologists, geographers, and cartographers.

From existing data some fragile ecological sites were avoided in order to maintain their natural biodiversity and the buffer operation was used to estimate the total area of land occupied by the project.

4.GEOINFORMATICS INITIALISATION PROGRAM AT EReT CAMEROON

4.1Computer Basics

-Introduction to basic computer programs (Windows, MS Words, MS Excel, MS Publisher, MS Access).

-Drive A demonstrations.

-Drive C demonstrations.

-How to use CDs.

-System connections.

-Assessment

4.2Introducing Geoinformatics,

-What is Geoinformatics

- Related terminology**:** Remote Sensing – Global Positioning System (GPS), Land Information System (LIS) –Landuse

Planning (LUP) Environmental Impact Assessment (EIA) and photogrammetry.
-Case Study
-Assessment

4.3Remote sensing
-What is Remote Sensing
-Sample Remote Sensing Processes
-Electromagnetic Spectrum (wave length ,frequency etc)
-Satellite imagery (Types of images, SPOT , Landsat , SAR , RADAR , IKONOS)
-Remote Sensing applications to environmental conservation
- Case study within Cameroon locality
-Assessment

4.4 Geographic Information System (GIS)
Introductory Lessons to GIS.
What is GIS .
Questions GIS can answer.
Components of GIS.
Data linkage.
Data Automation (Digitizing, Scanning,).
Different GIS Softwares.
Field trips to GIS organizations (CAMGIS, Limbe botanic garden, The Tropenbos Project Kribi)
Sample application of GIS in Cameroon
Case study (In relation to student's BSc research work)

4.5 Using a GIS
Careers with GIS applications.
Geoinformatics M.Sc. degree programs in European Universities.
Job positioning in Cameroon and abroad with GIS (Ministry, Municipalities, NGOs etc)

The governments of Germany and the Netherlands are supporting these MSc programs by granting scholarship such as the DAAD for studies in Germany, university of Stuttgart and the Netherlands Fellowship Program (NFP) granted by the Dutch government.
For the promotion of Geoinformation sciences in developing countries, we will request these institutions to be flexible in the selection procedures by allowing some direct universities graduates from developing countries to be admitted in the MSc program without the required professional experience. Reason being that no institution in many developing countries offers Geoinformatics courses to enable them gain the experience. Another setback is the English language test which is sometimes required from students who have followed their studies in English from the primary to university level. A country like Cameroon is considered French speaking whereas one part is English speaking and the other one French speaking. That is why the country is in the Common Wealth and Francophonie. The cost of the English proficiency test is high and hinders the participation of many Cameroonian students from international courses.

5 GEOINFORMATICS IN THE NATIONAL ADVANCED SCHOOL OF PUBLIC WORKS

The Survey department of the National Advanced School of Public Works is using mechanical theodolites for land measurements. No electronic instruments exist in the school and there is a need to introduce electronic instruments such as the distance meter, the GPS receiver. Cartography and photogrammetry are still taught in theory.

As a first step in Geoinformation development in the National Advanced school of Public Works Annex Buea in the Republic of Cameroon, we contacted the Director of the School and proposed the introduction of GIS in the school program. He has never heard of a geographic information system so the NGO has to explain what the GIS does and the advantages it offers in spatial data management for sustainable development. With its four departments namely: town planning, land surveying and cadastre, civil engineering, and rural engineering, there was a need to know which school department should benefit from the program . It was concluded that the town planning, cadastre and rural engineering departments should have a GIS course in their curriculum. These departments operate directly with data located on the earth surface and which positions can be defined in x,y,z coordinates. Presently some instructors are teaching GIS while expecting a better training in future. The Provincial Service of Surveys is applying a computerized system for the production of cadastral plans using the AutoCAD software. This is a personal initiative of the Provincial Chief of Service surveys Mr. Mbella Simon Mwambo who is actually developing a digital cadastral database for South-West Province. This initiative is highly recommended, as there are plans to tie all the cadastral plans to the UTM coordinates systems. This enable cadastral plans to be sent through the internet for a global use.and to avoid an overlap of land parcels in the cadastral database

6.ECOMMENDATION TO ISPRS COMMISSION VI PRESIDENT

The International Society of Photogrammetry and Remote Sensing (ISPRS) commission VI should seek further means of securing fellowship opportunities for participants from developing countries to follow MSc courses in Geoinformatics in order to enable the teaching of this discipline by nationals of the countries concerned in higher institutions of learning
As a continuous effort to promote geospatial education, regular fellowship programs should be reached with institutions in developed countries and funding organizations to support selected candidates from developing countries as defined in international co-operation.
We are proposing that the ISPRS commission VI President Dr. Maria Sausen Tania elaborates with the ISPRS Council a strategy to secure sponsorship from donor organizations so that scholarships could be directly offered to NGOs in developing countries dealing with Geoinformatics who will now nominate candidates for the required program. This process will facilitate the promotion of Geoinformatics since a potential candidate can be chosen among the Resource Counterparts in the NGO, staff of the collaborating academic institutions directly involved in the program. The NGO will now work in collaboration with the beneficiary institution to maintain the sustainability of the program.
Some prominent geoinformation equipments manufacturers such as Leica Geosystems are changing away their mechanical / electronics survey equipment to Global Positioning Systems (GPS), we would request that the ISPRS Commission VI President negotiates with Mr. Hans Hess Leica Geosystem President and CEO to help NGO
in developing countries with some of these used electronic spatial data acquisition equipments for educational purposes. Some total stations are partially computerized and some are robotic such as the bifocal total station displayed by Leica Geosystem during the exhibition at the XIXth ISPRS congress in Amsterdam are some of the innovations in spatial data acquisition. We have been

introducing such instruments to students using the illustrations in the GIM international magazine. It will be our high esteem to receive such hardware for surveying and earth observation from these big companies as a tool for training and research in developing countries.

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INTERNATIONAL PARTNERSHIP FOR A JOINT EDUCATIONAL PROGRAMME IN A DEVELOPING COUNTRY IN SOUTH AMERICA, CASE OF BOLIVIA

J.S. Dalence Martinic and J. Horn

a Centro de Levantamientos Aeroespaciales y Aplicaciones SIG para el Manejo de los Recursos Naturales – Universidad Mayor de San Simón, Cochabamba, Bolivia – dalence@clas.umss.edu.bo
b International Institute for Geoinformation Science and Earth Observation (ITC), Enschede, The Netherlands – horn@itc.nl

Business Plan

KEY WORDS: ITC, CLAS, UMSS, partnership, Implementing Masters, Bolivia, The Netherlands

ABSTRACT:

Since 1996, the International Institute for Geo Information Science and Earth Observation (ITC) from The Netherlands and the Centro de Levantamientos Aeroespaciales y Aplicaciones de Sistemas de Información Geográfica para el Manejo Sostenible de los Recursos Naturales (CLAS) from Bolivia have been running joint masters courses in water resources, soils and natural resources.
With the assistance of the Dutch Government, in the first stage of the co-operation, three separate but parallel eleven-month Masters Programs have been established in Cochabamba, and these are largely modelled on those offered by ITC in Holland, The programs have been highly successful in training a large number of young Bolivians professionals for careers in various Earth Sciences disciplines. The “Soil Information For Land Use Planning” and “Watershed conservation and management” courses have now been running for nine years and the course “Irrigation & Drainage” for six years already. The first two of these Masters courses started in 1998 and the third one started in 2000 with the additional support of UNESCO-IHE, also from The Netherlands.
To date 165 PM students have graduated from the masters courses, the new professionals included people from Bolivia, Cuba, Perú, Argentina, Colombia and Mexico. Currently 21 students are enrolled in the “Soils” and “Water” courses.
The Masters diploma is awarded jointly by the Universidad Mayor de San Simón (UMSS) from Bolivia and by the ITC from The Netherlands. Eighty five percent of the professionals graduated from CLAS obtain jobs (consultancies and permanent positions) within a year of graduating, generally in the fields of land use planning and watershed management.
The masters courses are divided into a modular system (15 modules including fieldwork plus the personal study topic), 6 modules are common and the others are specific for each program. In the establishment of the programme, the lecturers included a wide range of experienced professionals from Bolivia, Perú, Colombia, México and The Netherlands. Currently since the UMSS incorporated the CLAS into its structure, the lecturers are Bolivians trained in Bolivia and in The Netherlands (ITC and IHE) with a Professional Master, Master of Science and PhD degree with multidisciplinary backgrounds.
CLAS is an international post graduate unit within the UMSS and it has been recognized as a Centre of Excellence by the Ministry of Sustainable development of the Republic of Bolivia due to the fundamental academic role that it plays within the country.
The Universidad Mayor de San Simón is one of the biggest universities in Bolivia and well recognized in South América. It has more than thirty international programs with developed countries such as France, Germany, Switzerland, Sweden, Denmark, The Netherlands, Belgium amongst others. It is in the process of achieving the accreditation of its education programs with the MERCOSUR (Mercado Común del Sur) that it is comparable with the European Union at its early stages.
The courses focus on the latest technologies such as Geographic Information Systems and Satellite Remote Sensing in the environmental sciences and the study topics include land use planning, land evaluation, land degradation, watersheds management, water quality, hydraulics design among others. These courses offered are unique in South America and hence the centre has been established acts as a regional one. Due to the importance of CLAS within the region, it is one of the first and only institutes in the world that has registered its three master courses (“Soil Information for the land use planning”, “Watershed conservation and management” and “Irrigation and Drainage”) from 2005 to 2007 with NUFFIC (The Dutch organisation responsible for providing fellowships to Dutch universities and International Training Institutes that run programmes for developing countries). CLAS obtained four fellowships from NUFFIC in 2005 and twelve fellowships in 2006. These fellowships are available to candidates from the NUFFIC list of 57 eligible countries, who have a background in environmental sciences, two-year professional working experience and who speak Spanish.
In a further stage of cooperation with ITC in The Netherlands plans are being formulated at CLAS and ITC to introduce a joint of Master of Science Program and a post graduate diploma courses in water resources, soils and natural resources as well as the existing masters courses. In the early stage, the Program will be executed partially at CLAS in Bolivia (as a part of the current professional master course) and it will be completed at ITC in The Netherlands. Eventually CLAS hopes to be able to independently run a full-master of science-course in Cochabamba. A pilot group of five people has been successfully completed an initial Joint CLAS-ITC MSc course in the Water resources survey and Natural resources management programs in 2003.
In order to reach these new goals, a number of new techniques involving e-learning tools are being explored. Steps are being taken to strengthen the research skills at CLAS and to further enhance its position as an important educational centre in Latin América. In this respect ITC and UMSS have signed an agreement on research co-operation, one of the central aims of which is joint PhD supervision.
A network of affiliated Institutes called GI-NET was created between ITC and all its educational partners that include India, Mexico, Nigeria, China, Bolivia and others. This network exists to promote the technologies of Geographic Information System (GIS) and Remote Sensing (RS) and to explore opportunities for collaboration in education and research.

1. INTRODUCTION

1.1 Background

In 1996 the International Institute for Geo-Information Science and Earth Observation (ITC, The Netherlands) started the CLAS Project (Centro de Levantamientos Aeroespaciales y Aplicaciones SIG para el Desarrollo Sostenible de los Recursos Naturales) with the Universidad Mayor de San Simón in Cochabamba, Bolivia. In this project two joint professional masters programmes Water Resources Environmental Management (WREM) and Natural Resources Management (NRM), were developed and subsequently entirely delivered in Bolivia in the Spanish language. A limited number of successful candidates of those masters programmes continued with an MSc degree at ITC with exemption for a specific number of modules according to the program they were following.

The ambition of CLAS to become a centre of excellence of internationally recognised quality within the UMSS and to contribute to the improvement of the educational system in Bolivia is both a logical development from CLAS as a centre into an institutional entity, and an important prerequisite for a sustainable CLAS. ITC's decentralised education programme has identified CLAS as a potential partner for implementing joint educational programmes. The development and maintenance of a strong partner relationship between CLAS and ITC is seen to be of mutual importance.

The capacity built at CLAS provides good opportunities to continue the collaboration and even expand it to an official Joint Educational Programme meeting some conditions and requirements.

At the moment CLAS offers a Masters degree in 'Geoinformation of the natural resources' with three specializations: a) Survey, evaluation and planning of the territory; b) Watersheds management and conservation and c) Irrigation and drainage.

A pilot joint MSc. course has already been established in 2003, where 5 students from CLAS completed successfully an abridged Master of Science degree at ITC.

In September 2003 a mission from ITC took place representing the **Water Resources and Environmental Management (**WREM) and **Natural Resources Management (**NRM) programmes to review the quality of the current courses taught at CLAS and to develop a draft curriculum plan for a decentralised ITC Master of Science programme at CLAS. The mission proposed two scenarios for upgrading the PM course to a MSc-course.

Scenario 1: (Masters at CLAS + finish MSc ITC), Students complete the regular Masters programme at CLAS then finalise an abridged MSc at ITC.

Scenario 2: MSc CLAS = MSc ITC

The CLAS MSc course would run exactly parallel to the ITC courses. Parts of the course will be taught at CLAS and ITC. In this approach, different operation modes would be possible.

1.2 Rationale

A foreign university degree (outside of Latin América) is highly valued in Bolivia because it gives a competitive advantage. This is one of the reasons why many Bolivians and Latin-Americans aspire to study abroad. However, the main problem related to this desire is that overseas scholarships are scarce and almost none students can afford the costs of a full course overseas, as well as the fact that the language for this fellowships is in English. The course at CLAS is the only Masters course of its kind in Bolivia that gives the participants an international diploma (Bolivia & The Netherlands).

The best solution for these problems is a joint courses, where students study partly in Bolivia and partly in the Netherlands. This offers to the students the possibility of gaining knowledge about the latest technologies used recently and import them to their "environment" such as Bolivia or other countries within Latin América.

It is very important also to remark that there are high capacities already established in CLAS because of the almost 10-year-relationship. The interest of ITC is the establishment of a joint course in which its core training elements are implemented together with a reliable partner.

The CLAS centre has offered and still offers professional masters courses, and this joint programme offers the opportunity to continue a master of science degree abroad. Also a possibility to add an innovative course in emerging fields (Land use planning and Watershed management) to the centres *curricula*.

The need for such courses are because the increasing interest in the topic of the GIS technology across the world and including Latin América and particularly in Bolivia. Every year it has been apparent that the job opportunities grow for professionals with a specialization in the environmental fields using GIS technologies. Furthermore, the policy of the local government is based on the land use programmes were multidisciplinary teams are required in fields such as land planning and watershed management. With these programmes social problems related to the land use have been decreased within the municipalities. It is also a fact that 80% of the professionals formed at CLAS get a job the next year they finished the master programme. CLAS has already a reputation in the country about training professionals in GIS and RS and also about performing consultancy work in this field.

A long cooperation already exists between ITC and CLAS, and hence the present initiative of implementing a Joint Educational Programme is a natural progression of that relationship. The present agreement aims to document and formalise the existing relationship and to guide its progression into the future.

This long-term goal exactly matches ITC's mandate of capacity building and institutional strengthening in higher education in developing countries. The time frame for reaching this ultimate goal is estimated at around six years. Yearly evaluations should determine the speed in which the curriculum is progressively taken over by CLAS. In an equal partnership between the two institutes, there should also be cooperation in research, (which should be improved), consulting and staff exchange. While ITC's input in teaching will diminish over time, it is anticipated that the activities in these other fields will increase. Since CLAS occupies a privileged position in the UMSS, the EUPG [1] will help CLAS to provide Bolivian PhD researchers members to upgrade their skills.

2. THE MARKET

2.1 Overview

There is clearly an increasing need for critical mass of human capacity as well as institutional and organizational capacities in Geoinformation, focusing on land use planning and water management in Bolivia and in the region (South America).

The course has two types of students as its target, i.e. young students who continue their education and mid-career professionals who want to upgrade their skills and knowledge. The first group consists of the BSc students wishing to obtain an MSc degree and develop a career in the field of geoinformation, either in the natural resources or water field. The career perspective for graduates is good. There are job opportunities both in the public sector (government and non-governmental) as well as in the private sector. The second group consists of the people who are already working in a professional organization. They are professionals with several years of working experience holding a BSc in subjects related to the environmental sciences. They are until now not a traditional target group of the Universities. Most schools and departments in the University do not have market for this target group, as they can easily fill the classrooms with regular BSc students, but these people need to upgrade their knowledge in the geo-information field because in the actual market everything has a position in space and in time, since our target is related to the environmental sciences it is compulsory to be updated in this subject.

The Netherlands Fellowship Programme (NFP) could be a potential sponsor for some mid-career professionals, perhaps the ALBAN foundation too, since the Universidad Mayor de San Simón is a recognized centre for a economical support, also some ITC fellowships will be explored.

The course has already started with a pilot joint master of science program the year 2003 with 5 students that have completed successfully the MSc programme in NRM and WREM at ITC. A second one has been already sent in the first semester of this year.

Nowadays CLAS is a centre with high potentiality in GIS and RS, since there are no other centres like it in the country or region; it also presents unique opportunities for the formation of professional masters and masters of science not only in Bolivia but also in South América.

As an institutional strategy it has been agreed to involve the departmental and municipal governments in the form of fellowships to upgrade their personnel either under the modality of modules or a master course (PM or MSc.)

Another academic strategy is to increase the national and regional market (so far the 75% of our graduated students get a job immediately after they finish the master course at CLAS, this can be seen in figure 1).

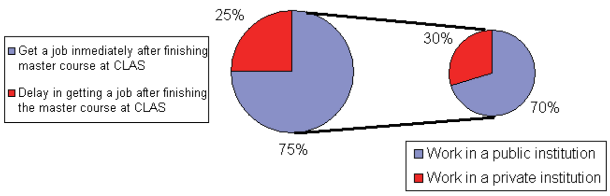

Figure 1. Placement in the job market of students formed at CLAS

For the promotion of the master courses, CLAS counts on the support of the EUPG and Vice-Rectorate of the UMSS.

Since the students on the proposed Joint MSc will do their thesis research on carefully selected topics of relevance to Bolivia, this will, over the years, result in a thriving research programme. The staff exchange is necessary to develop this research programme. Along the way, possibilities will be investigated for outside funding of the research as well.

To the year of 2007 CLAS will be giving Masters degree with the validation of ITC. Moreover, in the second semester of 2007 the Master of Science program is scheduled to start at CLAS and with completion at ITC. This approach will be followed until the centre obtains enough experience and upgraded lecturers that will be capable of lecturing a MSc course with the international recognition of the ITC. At the same time the Masters course will remain an option (collateral choice) for those professionals that still are interested in such degree. It is very important to remark that this kind of taught Masters will correspond to the regular formation of the MSc, in other words, the program will start the same but it will

[1] EUPG = Escuela Universitaria de Posgrado (Universitary Centre of Postgraduate Studies) from UMSS

culminate in an Individual Final Assignment (IFA) while the MSc students continue with their thesis. At this stage, the accreditation and degree of the Masters will be only given by the UMSS.

Regarding the prospective for the Joint MSc course, based on the data and assumptions that CLAS has about the origin of the students and also after making a future projection of the courses, figure 2 shows the estimated total percent of master of science alumni from 2008 to 2010 across Latin América.

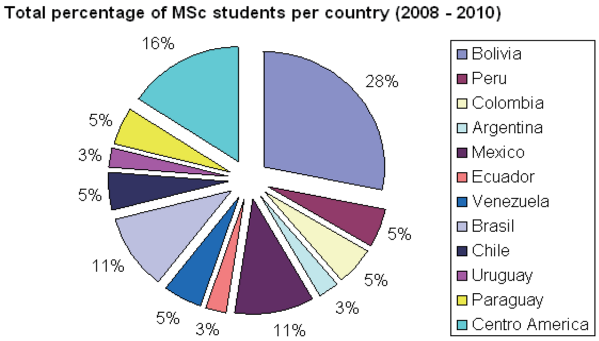

Figure 2. Projection in the future (2008 – 2010) of the CLAS MSc students in Latin América

3. IMPLEMENTATION OF THE MSC. COURSE

The implementation of the master of science course is foreseen in four phases as shown in the following table 1, 2 and 3.

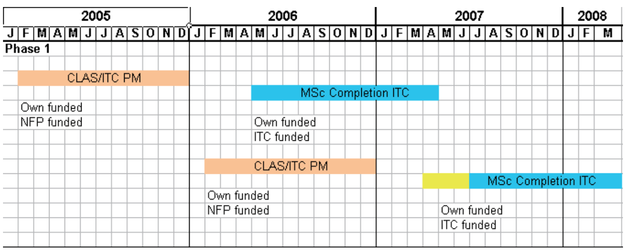

Table 1. Phase 1 of MSc implementation

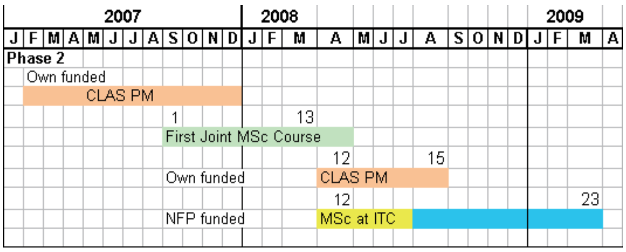

Table 2. Phase 2 of MSc implementation

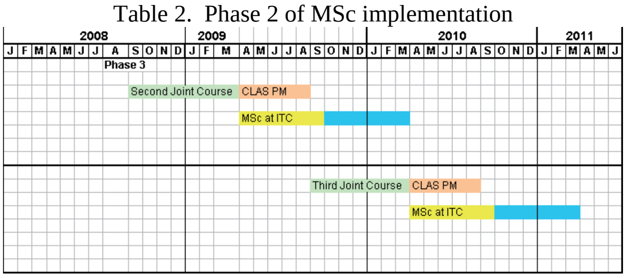

Table 3. Phase 3 of MSc implementation

All the masters courses given at CLAS are taught in Spanish but the material (such as handouts, bibliography, power point presentations, papers and others) are given in English. From 2006 to 2007 the degree will be awarded jointly by both ITC and UMSS. After 2007 the possibility that ITC can give certificates for the modules followed in CLAS is still under consideration.

The joint MSc courses that will be taught in CLAS (modules 1 – 13) will be taught in Spanish but the material (such as handouts, bibliography, power point presentations, papers and others) will be given in English including the research proposal and also the students have to present at the beginning of the new academic year some certificate or exam that proves their skills in English (from a known institution). Eventually the students will take the TOEFL test in order to continue the joint course in ITC (completion in English language).

From the second phase, the Masters course will be only a choice for those students that for many reasons (economical, time, personal, etc), cannot finish the MSc with the degree given by UMSS.

In the first years of the cooperation, it is envisaged that ITC will provide opportunities for a number of CLAS staff to be upgraded by attending ITC short courses, and to obtain the MSc degree for the remaining ones and also to explore the option that some members (probably one or two) could continue a PhD studies (sandwich) at ITC looking for some type of financial support.

The programme presented in the precedent tables, will be adjusted for the year 2007 in order to make the transition from the Masters courses lectured at CLAS to the Joint MSc programme.

3.1 Legal status and degree

Since ITC is in a transition itself to be accredited by the European Union, it is now its reviewing precisely which courses it will put forward for accreditation. As decisions on this matter are not yet final, it may prove difficult for ITC to accredit the present joint Masters course with UMSS after 2007.

It is considered that courses resulting in a diploma may not prove attractive to students from South America, as there are diploma courses for even 3 months and the curriculum value is the same.

CLAS still wishes to promote the existing Masters course and hopes to stimulate many applications,. It has decided to continue the programme by itself, with a degree being issued solely by UMSS. But since the potential students prefer to have an international recognition of the course it will be more attractive if ITC will provide module certificates.

For the phase II, those students that finish the master of science in ITC will obtain the ITC degree only. But for the phase III there will be 2 options described next:

- For those students that have any particular reason (economical, time, will, etc.) there will be a collateral choice that consists in completing the Masters course at CLAS with the UMSS degree and the module certificates from ITC.
- For those students that complete the Master of Science course in ITC will obtain an ITC MSc degree.

4. THE MANAGEMENT PROCESS

4.1 Admission

Both ITC and CLAS have to approve admission of the candidates to the joint MSc course. Thus, applications will be screened by both ITC and CLAS. A first screening will be done by CLAS. Initially selected applications will be sent to ITC for final selection.

Admission criteria that will be applied are:

- BSc in a relevant field with a mark of 60 or higher. Relevant working experience is an advantage.
- An English proficiency test result of TOEFL according to the regulation extended in ITC.
- Applicants will write a short one-page paper on their motivation and the research they would like to do. Optionally, an interview may be held with the applicant. This interview will be conducted at CLAS by the joint course coordinator, possibly (in the first years) together with the ITC joint course coordinator.
- The candidate should be eligible for a visa to the Netherlands, i.e. his/her legislation status should be satisfactory. This should be determined and confirmed before the fifth module in Bolivia (in order to avoid a situation that the candidate starts the course and is subsequently not permitted to travel to the Netherlands).
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The students, who obtained the joint Diploma in 2007 or later, would be allowed to enter the MSc joint course in module 11 if they fulfil the academic criteria and under the commitment that the module on research skills is attended if not yet. This entrance option is valid within a period as described in the ITC assessment regulations.

4.2 Assessment

At the end of every module, participants' progress will be monitored through an examination and/or an individual assignment. To avoid any inconsistency in the marks on course records, CLAS will apply ITC's marking system in the joint courses.

CLAS is responsible for performing the assessment and quality of the marking of the modules taught at CLAS and ITC is responsible for those ones given there. The assessment of the thesis is common responsibility with a veto right for ITC.

4.3 Transfer

Students who pass all modules at CLAS according to the ITC marking system will be candidate to come to ITC. Together with the CLAS Course Coordinator, the ITC Course Coordinator (or another ITC staff member) will be present towards the end of the CLAS lecture period, for transfer assessment. Those who are not selected or are selected but do not have the required resources for studying in the Netherlands, will receive a certificate.

Before moving to ITC, course participants will present a 1 to 3 page(s) research pre-proposal to the Course Coordinators. The purpose of this pre-proposal is to define the research interest and to obtain a broad idea of the topics.

4.4 Selection of research topic

The selection of research topics by the students is restricted by the expertise at the institute where the research is executed. A topic can only be chosen if supervision is available. The Course Coordinators will discuss proposed topics and list the appropriate ones.

4.5 Admission to the thesis period

Participants will be assigned a CLAS and an ITC supervisor that will help them to prepare a detailed research proposal during module 15. If the participant is at CLAS, the CLAS supervisor will discuss the topic and coordinate with the ITC supervisor and the opposite will happen if the participant is at ITC. The participant's research proposal will be formally assessed under the responsibility of the ITC programme Board, by a Thesis Admission Committee.

Students, who fail the thesis proposal defence at ITC, will not be admitted to the thesis period. Those will get a certificate.

4.6 Supervision during thesis period

Both supervisors, who will have equal responsibilities, will do the MSc supervision. However the supervisor of the Partner at whose premises the participant is will be the first contact person for the participant. All main feedback to the student should be done electronically, with a copy to the other supervisor.

During the MSc research period, participants will make a progress report every two weeks, which will be sent electronically to the ITC and CLAS supervisor(s) and course coordinators. Progress reports must include minutes of the meetings and communication of the MSc participant with his or her supervisors. The midterm presentations in phase 1 and 2 of the joint programme are under the same circumstances as those for the ITC group of students. In phase 3 of the joint programme, the CLAS supervisor and Course Coordinator and at least one ITC representative will attend the midterm presentations. The MSc participant will receive a written report with recommendations from the Course Coordinator. The possibility to use Blackboard at CLAS will be explored. In that case, students and supervisors at CLAS can communicate with ITC via Blackboard conferencing.

4.7 Thesis examination

Each thesis will be assessed by a Thesis Assessment Board, appointed by the ITC Programme Board. Regardless of the phase of the joint programme, each Thesis Assessment Board must consist of at least 4 members including one of the supervisors, an ITC professor or associate professor (chair), a CLAS lecturer and an external expert coming from the University (Universidad Mayor de San Simón). Since the degree is an ITC MSc degree, ITC members in the assessment board will have the veto right. The MSc exam and graduation ceremony will be held at CLAS or at ITC, depending on the phase. The MSc thesis defence and graduation ceremony, in phase 1 and phase 2 of the joint programme, will be at ITC and will be identical to that of the ITC group of students. ITC and CLAS could decide that in phase 2 the graduation will be at CLAS. In that case the last month of the research period, including the defence and graduation ceremony, is executed at CLAS. The MSc thesis defence and graduation ceremony, in phase 3 of the joint programme will be held at CLAS.

4.8 Monitoring progress

It is the responsibility of the Joint Course Coordinators, Module Coordinators and Thesis Supervisors to closely monitor the progress of the students during the course. They have to report any doubt on the students' capability immediately to the ITC Programme Director and CLAS Executive Director. They will take a decision whether or not the student should continue.

5. QUALITY ASSURANCE OF TEACHING AND STAFF DEVELOPMENT

A longer-term staff development plan will be elaborated. Subject to available funding, more CLAS staff members will be invited to ITC for additional training. The ITC Course Coordinator will make at least one coordination visit per year. The ITC Programme Director will also make occasional monitoring visits. In addition, there will be web-based support.

5.1 Course evaluation

For the modules at CLAS. The CLAS Course Committee will issue the module- and end-of-course evaluation forms, and will manage the results. For the modules at ITC the ITC Programme Director will do this. Content, quality of teaching and teaching materials will be evaluated. In addition, yearly evaluation reports (based on results of module and end-of-course evaluations, progress of participants, retention and completion rates and preferably also graduate and employer evaluations) and also improvement plans per course will be made by the ITC and CLAS Course Coordinators jointly and submitted to the ITC Programme Director and the CLAS Course Committee.

5.2 Quality assurance

The quality of the course has been and will be assured in a number of ways:

- Course structure and curriculum at CLAS very much alike such as the ones at ITC.
- Quality assurance process, each partner is responsible for the external quality assurance (accreditation / certification) in the own country. Consequently, the quality assurance measures for the joint courses have to meet the criteria of the accreditation / certification bodies in both Bolivia and The Netherlands.
- Adequate facilities and library services in CLAS and in ITC.
- Assessment regulations applied to the whole MSc course and to the common MSc/NRM or WREM modules of the course.

The course fee will be paid to ITC and will be administered by ITC. A part of the course fee will be transferred to CLAS, in accordance with the breakdown of the calculation of the course fee. Finally, running a new Joint MSc programme could be very attractive to many students not only in Bolivia but within the region (Latin América), whilst Masters still has good basis to continue running and will continue.

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PROBLEM BASED LEARNING IN SPATIAL INFORMATION SCIENCES – A CASE STUDY

A. Martin, E. McGovern, K. Mooney

Department of Spatial Information Sciences, Faculty of the Built Environment, Dublin Institute of Technology, Dublin, IRELAND – (audrey.martin, eugene.mcgovern, kevin.mooney@dit.ie)

KEY WORDS: Problem Based Learning, constructivist methodology, Spatial Information Sciences, Geomatics, WebCT.

ABSTRACT:

This paper describes the introduction, implementation and evaluation of a Problem Based Learning component in the Geodetic Surveying syllabus of the fourth / final year of the honours degree programme in Geomatics at the Department of Spatial Information Sciences, Dublin Institute of Technology, Ireland. The reasons behind adopting this constructivist educational approach as opposed to traditional instructivist methods more commonly employed are addressed, together with an evaluation of the process from both the educator (academic) and student (learners) perspective. The results of this case study are considered in the context of a number of interconnected pedagogical issues including (a) enhancement of student learning, (b) effective teaching, learning and assessment methodologies and (c) effective evaluation strategies. It was found that the adoption of PBL as a learning mechanism in Spatial Information Sciences represented a cultural change for both facilitators and learners, resulting in significantly increased time commitments from both parties. However, it was also found that student technacy abilities and reporting skills were greatly enhanced with WebCT used as a communication tool. Furthermore, learners covered a significant breadth of topics in an integrated way while identifying the inter-relationship between classroom material and real-world issues thus helping to equip them with the professional skills required in the modern commercial environment.

1. INTRODUCTION

In recent years it has become apparent that the traditional 'bottom-up' teaching methodologies (Shortis et al., 2004) ill serve modern engineering and geomatics graduates and that industry favours graduates with more problem solving and team based skills (Fink, 2001). These changes are partially due to rapid technological developments in the Spatial Information Sciences and, also, an increased requirement for cognitive flexibility in graduates.

The instructivist methodology for teaching, as traditionally applied in the tertiary educational sector is generally based on the traditional, passive approach to education, whereby the learner is provided with all necessary course information. Thus, it is possible for a student to excel in an examination situation through strategic learning but without having gained any deep understanding of the subject area. This approach is, therefore, not considered ideal for advanced students expected to become productive members of the commercial sector. In addition, graduates from a degree course in the Spatial Information Sciences area will, most likely, work in a team environment where they will be expected to bring their particular expertise and knowledge to solving problems in conjunction with other experts. To succeed in their profession they will require, *inter alia*, advanced communication skills and an ability to apply the team approach to problem solving.

The constructivist approach to education, as used in Problem Based Learning (PBL), emphasises the importance of social interaction between the students (learner to learner) and establishes more mature learner to lecturer (learner to facilitator) interaction. Furthermore, by placing the emphasis on the individual (self directed learning) a vigorous interaction with the content material is established thus reducing the passive approach to learning that has become prevalent amongst students (Smerdon et al., 1999).

With this in mind a pedagogical change in the teaching methodology has been introduced in the Dublin Institute of Technology (DIT) and in the last two academic years students of the honours degree in Geomatics undertook PBL in one module of their fourth year syllabus during the first semester. Initially, in 2004-05, the syllabus module chosen to implement PBL was Geodetic Surveying. This subject was chosen for a number of reasons including the number of disparate module components being delivered by different academics resulting in granularity of the module content and leading to a lack of subject coherency for the student group.

2. METHODOLOGY

At the inception of this pedagogical approach (PBL) it was recognised that a cultural shift for both academics (facilitators) and students (learners) would ensue and, therefore, in advance of implementing the PBL process the facilitators needed to become familiar with the PBL process. This was achieved through attendance at many of the specifically designed in-house PBL workshops and School training seminars provided by the DITs' Teaching and Learning Centre. The following sections describe delivery of the PBL module from induction to final evaluation.

2.1 Introduction to PBL

Induction seminars were arranged for the learner group to ensure that they were familiar with the concept of PBL and could actively engage in the learning process. These seminars included:

(a) A seminar aimed specifically at the learner group to introduce the concepts of PBL and brainstorming, and to provide the cohort with a geodetic surveying-related problem to solve. Bearing in mind that PBL problems should be loosely defined and relate to current real-world issues, the problem assigned to the learner group was:

"It is post-war Iraq and peace has returned. The national survey control framework infrastructure is largely destroyed. As part of the international aid programme for the redevelopment of Iraq you have been commissioned to advise on the design of a replacement framework. Prepare your report."

(b) An inter-school seminar conducted by an academic from outside the Department but within the Faculty aimed at both Spatial Information Sciences students and Property Economics students. The rationale for joint attendance of the different student groups at this seminar was to increase their awareness of PBL as a cross-discipline means of learning and assessment and to learn from the experiences of others within the Faculty.

(c) A seminar led by a senior academic from the DIT Learning and Teaching Centre outlining the constructivist teaching methodology and providing mock PBL exercises.

At the induction stage of the PBL a personality testing study using the Belbin Test (Belbin, 2000) was undertaken by a member of the DIT Faculty Careers Department. The objective of this test was to establish effective PBL teams based on personality strengths and weaknesses. It had the added advantage of providing the learners with an insight to differing personality traits and how these might be most effectively utilized to further the team experience. This method of team selection was a major departure from previous selection criteria whereby groups were formed on a random basis or relative to previous academic performance. It also distinguished between group project work, with which the learners had become familiar during the first three years of their studies, and team roles within a self centred study environment. In reflective analyses of PBL, individuals were expected to critically examine their role within the team.

2.2 The PBL Process

The PBL module progressed with bi-weekly team meetings. PBL is primarily a learner-driven teaching process wherein the most effective teaching methodologies are through self study and peer teaching (learner to learner) and therefore, for the team to progress, each team member had to amass a certain knowledge base and disseminate this information to his/her peers. To facilitate the peer teaching process each team was allocated a private space on a web-based educational course management system known as WebCT for discussion and information dissemination. The adoption of WebCT promoted and increased demand in the level of technical literacy (technacy) by the learners and further permitted remote ("Big Brother") monitoring of the weekly process of individual teams by the facilitators. Furthermore, WebCT served as a project documentation service whereby all the minutes from team meetings were presented. Thus, monitoring of the range and quality of reference materials used by each team and the effectiveness of this teaching process could be discretely undertaken.

In addition to the self and peer teaching methods, group moderation of each PBL team by the facilitators took place on a weekly basis. This enabled the facilitators to directly monitor the level of self study and peer teaching that had occurred, and also to assess the group dynamics in terms of their internal communications.

2.3 Assessment of PBL

To ensure effective assessment of each aspect of the process, formative assessment methodologies were applied. The assessment techniques applied included:

1. Formative staff assessment of students:
   This was on a team basis and was assessed weekly under the criteria of critical thinking, quality of research, and effective group methods. Feedback allowed the learners to make beneficial changes in their solutions.
2. Peer assessment:
   The team members twice assessed performance of their peers, once during the interim presentation and once during the final group presentation where the assessment criteria were mainly focused on the group dynamics rather than academic quality.
3. Self assessment:
   During the peer review process each team member assessed his/her own contribution to the process under the same criteria as in 2 above.

Comparability of formative assessment results was ensured through double reading of all technical submissions by the facilitators and grades were subsequently analysed for anomalies in the results.

2.4 PBL Evaluation

Effective evaluation of the PBL process was through the strategies of a final meeting of staff involved, student individual feedback through the DIT quality assurance procedures, student group feedback through informal round-table meetings and both interim and final monitoring reports from the Teaching and Learning Centre. Reflection on the process took place in the months following the completion of the module and was summarized in a lunchtime presentation to Faculty staff.

3. RESULTS

The results of this case study focus on a number of interconnected pedagogical issues including: Enhancement of student learning; Effective teaching, learning and assessment methodologies, and; Effective evaluation strategies, each of which is outlined in the following sections.

3.1 Enhancement of student learning

Effective learning was achieved for the team through a problem-solving approach, whereby an understanding of the solution came through an appreciation of the relevance of individual topics culminating in a final written report. As the individual problem statements allow for multiple possible solutions, technical solutions proposed by individual teams could vary significantly in their emphasis.

The enhancement of student learning was evident from an examination of (i) the team final written reports, (ii) the team oral presentations and (iii) the individual reflective writing reports. By placing the emphasis on the individual (self directed or 'learner-centric' learning) a vigorous interaction with the content material was established thus reducing the passive approach to learning that has become so prevalent. The learning evident from these reports shows a wealth of knowledge in both breadth and depth gained by each team and is a real example internally driven learning. The reflective writing report, in particular, demonstrated the development within individual students of thoughtful review and self-appraisal skills, and an understanding of the group dynamic.

It was also evident that, in comparison to the traditional, instructivist approach to the teaching of fourth-year Geodetic Surveying, the students have covered a significant breadth of topics in an integrated way while identifying the inter-relationship between classroom material and real-world issues. Furthermore, while developing written and oral presentation skills and learning to work effectively in group situations they are, by addressing the particular PBL problem, gaining an appreciation of the international value of their third-level qualification.

3.2 Effective teaching, learning and assessment methodologies

Overall it was found that learners extended their knowledge base and incorporated cross-subject disciplines. The ability of learners to interact on different levels with both their peers and their mentors was improved, and promoted deep learning by forcing the learners out of their 'comfort zone'. In terms of assessment the learners, on average, increased their grades by approximately 10 – 15 % from previous examination results, this was considered appropriate relative to the increased self-learning time required for the module. Table 1 shows the grades awarded in each of the aforementioned assessment techniques. From this table it can be seen that, in general, the grades awarded at each stage were high. Furthermore, a fundamental change in approach by team members to the importance of peer and self-assessment techniques was evident on comparison of the interim presentation grades (column 3) and the final Group Presentation grades (column 6). In the first peer assessment no grade distinction was made by individual team members however, as the process progressed the importance of peer assessment became more apparent, there is a significant difference between the lowest (59) and highest (73) marks awarded.

3.3 Effective evaluation strategies

Quality assurance procedures adopted enabled objective learner group feedback through informal round-table meetings with both module facilitators and specialized PBL coaches from within the institution but external to the Department of Spatial Information Sciences. In addition, reflective analyses of the PBL process and outcomes from both the learners and facilitators perspective were achieved through interim and final monitoring reports.

4. CONCLUSIONS

The main findings of this case study indicate that the adoption of PBL as a learning mechanism in Spatial Information Sciences represents a cultural change for both facilitators and learners. Learners covered a significant breadth of topics in an integrated way while identifying the inter-relationship between classroom material and real-world issues thus, equipping them with the professional skills required in industry today. The adoption of PBL as a learning mechanism has improved the ability of learners to interact on different levels with both their peers and their mentors, and promoted deep learning by forcing the learners out of their 'comfort zone'. However, it is also recognised that the development of any new and innovative teaching and learning methodology is an iterative process. The initial PBL case study in Geodetic Surveying module from the academic year 2004/2005 resulted in significantly increased time commitments from both parties and, as a remedy, has been extended in 2006 to encompass additional, related course components. Generally, the introduction of PBL has been seen as a positive development by learners, academic staff and external moderators alike and, going forward, it is expected that PBL will be adopted in other course components.

08/10/2004 WM1	15/10/2004 WM2	22/10/2004 Int. Pres. + P.Rvw.	29/10/2004 WM3	05/11/2004 WM4	03/12/2004 Gr. Pres. + P.Rvw.	03/12/2004 Gr. Rpt.	10/12/2004 Refl. Rpt.	Final Mark
8	9.5	69	9.5	9	81	83	78	81
8	9.5	69	9.5	9	81	83	70	78
8	9.5	69	9.5	9	81	83	65	76
8	9.5	69	9.5	9	81	83	67	76
8	9.5	69	9.5	9	81	83	58	73
6	7	59	6	8	73	70	90	77
6	7	59	6	8	73	70	75	71
6	7	59	6	8	61	70	60	64
6	7	59	6	8	64	70	65	66
6	7	59	6	8	59	70	60	63
7	9	68	8	9.5	79	70	70	73
7	9	68	8	9.5	79	70	58	69
7	9	68	8	9.5	79	70	80	77
7	9	68	8	9.5	79	70	64	71
7	9	68	8	9.5	79	70	60	69
7	9.5	71	8.5	9.5	67	70	50	65
7	9.5	71	8.5	9.5	75	70	62	71
7	9.5	71	8.5	9.5	72	70	50	66
7	9.5	71	8.5	9.5	75	70	65	72
7	9.5	71	8.5	9.5	75	70	80	78
7	9.5	71	8.5	9.5	75	70	68	73
Contribution = **5%**	**5%**	**10%**	**5%**	**5%**	**10%**	**20%**	**40%**	

WM = Weekly Meeting; Int. Pres. = Interim Presentation; P. Rvw. = Peer Review; Gr. Pres. = Group Presentation; Gr. Rpt. = Group Report; Refl. Rpt. = Reflective Report.

Table 1: PBL Assessment Results

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TEACHING CARTOGRAPHY THROUGH VRML: INCLUDING BREAKLINES AND VERTICAL WALLS IN TINS TO RENDER ARCHAELOGICAL SITES

Gómez Lahoz, J[a]. González Aguilera, D[b].
Department of Cartographic and Land Engineering. Universidad de Salamanca.
c/Hornos Caleros 50. 05003 Ávila. Spain
[a]fotod@usal.es; [b]daguilera@usal.es

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KEY WORDS: Archaeology, Learning, Rendering, Simulation, Software, Web based

ABSTRACT: The Bologne process stresses the importance of developing professional skills. In Cartography nowadays, a very important competence is to understand and asses competitive software. The cartographic products are rendered by means of software and thus, the latter becomes essential in the cartographic flow and in the cartographer profile.
VRML as a cartographic standard, as well as a communication (internet) standard, is a crossroad in our world: a place we can hardly avoid if our product is to be disseminated. VRML is simple and accessible as is raw code; is powerful as is quoted and increasingly used by cartography professionals, and is pedagogical as it contains the main Computer Graphics concepts and provides prompt and rich feedback of our scripting task.
This contribution presents teaching / learning experiences developed at the Department of Cartographic and Land Engineering of the "Universidad de Salamanca". Several algorithms have been written under the main goal of improving a TIN representation of terrain to allow archaeological features rendering on VRML.
While participating in this task, students can access deeper comprehension and exercise skills concerning issues like: triangulation, interpolation, intersection and enclosure of features within polygons, dealing with points, lines and faces topology, computing photogrammetric resection and generating an orthophoto by means of the so called anchor points method.

1. INTRODUCTION: THE TURNING POINT

After a time of decay comes the turning point. The powerful light that has been banished returns. There is movement, but it is not brought about by force ... The movement is natural, arising spontaneously. For this reason the transformation of the old becomes easy. The old is discarded and the new is introduced. Both measures accord with the time; Therefore no harm results. (I Ching)

Following the point of view of Capra, author of the Turning Point, a widespread change is progressing slowly but firmly in our world perspective. According to Capra, this powerful tide is structured on a three threads web:

- The construction of a progressively open society in which women are assuming the responsibility they should have never lost; in which races become more and more interdependent and in which cultures (and religions) are called to a necessary understanding.
- The end of fossil - fuel resources that urges to look for an alternative in the energy production; but, mainly, that makes plane the need for a change in the concept of ever growing progress to be replaced by a sustainable and environmental awareness of development.
- The shift in the scientific paradigm (stemming from Newton, Leibnitz, Descartes), from analytical, rational, static, linear, objective, deterministic and machine - like, approach to knowledge to a synthetic, holistic, open, dynamic and ecological perception of mankind and science as just a process, interacting in a complex game of fluctuations. The stages of this transition could be portrayed by the apparition of the Theory of Relativity, The Quantum Physics and more recently, the System and Chaos Theories.

1.1. Education: changing to deal with change

In the Education context, we are witnessing the corresponding overcoming of the new paradigm. The entire educational system - and of course the University - is changing to include change itself as one of the main features to learn and teach.

The White Paper on Education and Training (European Commission, 1995) points out three factors of upheaval in our modern world:

- The impact of the information society with consequences such as a growing trend in flexibility in the labour market; the development of work in teams by means of net - based cooperation; the requirement of initiative and the ability to adapt; a higher autonomy for workers mixed with a less clear perception of the work context and, finally, a higher integration of the producing system and the learning system.
- The impact of internationalisation, with an unprecedented freedom of movement for capital, goods, services and workers.
- The impact of scientific and technological knowledge based on a know how approach sustained by a combination of specialisation and cross - disciplinary creativeness.

According to this report, *the ultimate goal of training, to build up the individual´s self reliance and occupational capacity, makes the linchpin of adaptation and change.*

We are summoned to work on the construction of the so called Learning Society, that is to say, a society in which institutional learning as well as diffuse long life learning constitutes the core of every professional profile. A learning based both on firm and deep scientific disciplinary roots and on cross and soft views. As Sursock (2002) states *"considering the long history of higher education, disciplinarity has been an organising feature of universities for only a relatively short time (mostly in the 19 th and 20 th centuries). We also know that intellectual creativity requires a certain degree of interdisciplinarity and that this trend is increasing.*

We need to foster individual autonomy to improve own knowledge and competences along professional life. We need to stress not only practical everyday skills but also a deep comprehension of our environment, a wide capacity of emitting sound assessments a creative and dynamic view of our professional background and a keen ability for decision taking. We must take into account that (European Commission, 1995):

> *Individuals will be called upon to understand complex situations which will change in unforeseeable ways (...). They will have to contend with a mass of fragmentary and incomplete information open to varying interpretation*
>
> *Observation, common sense, curiosity, interest in the physical and social world around us and the desire to experiment (...) are the qualities which will enable us to train inventors rather than mere technology managers.*
>
> *Powers of judgement and the ability to choose are two essential skills for understanding the world around us*

1.2. Quality assurance and student learning approach

The Bologne process, to which we must adjust our programming tasks, is the natural consequence of the framework portrayed above. As is well known, this process is based on certain features:

- a common structure of degrees and periods of study
- a common frame for syllabi
- a credit transferable system

In this common higher education space, according to the Tuning Project (2002), the main goals are:

- to achieve employability
- to build students capacity to learn in an autonomous way
- to acquire capacity for analysis and synthesis
- to acquire capacity for applying knowledge in practice

This leads to a shift from a teacher centered approach with students mastering academic contents to a student centered approach with students exercising professional competences.

The way in which this targets should be delivered is the Quality Assurance Concept. First of all, because it provides de main frame against which different efforts can be made comparable, and so, interchangeable. And secondly, and mainly, because it provides the tuning, the motivation and the means to build a demanding and permanently renewable system. Fortunately, this concepts are being grasped at the highest level of responsibility. According to the European Commission (2003):

The quality of higher education has proven to be at the heart of the setting up of a European Higher Education Area. Ministers commit themselves to supporting further development of quality assurance at institutional, national and European level. They stress the need to develop mutually shared criteria and methodologies on quality assurance

And going one step further:

Ministers encourage the member states to elaborate a framework of comparable and compatible qualifications for their higher educations systems, which should seek to describe qualifications in terms of workload, level, learning outcomes, competences and profiles.

But Quality Assurance, as stated above, is not only a standard to achieve the goal of constructing the common european space. The key feature to understand this proposal rend is the growing need for a self-reliant graduate whose skills are the same of the self-reliant learner. The main skill is to develop personal autonomy in acquiring skills and so, the education goal becomes to create incurable learners, to build learner autonomy through skills. Against this background it is not surprising that general (and not subject dependent) skills are the most valuable to get a job. According to the FIG, (1999):

Best practice promotes observation and assessment of teaching staff in the classroom together with targeted feedback from students on their perceptions of its effectiveness.

In this frame, there is a key concept that gathers the meaning of them all and provides motivation and inspiration to help redesigning syllabus adequately: feedback. Professional and learning competence may be synthesized on the capability of generating, monitoring and learning from feedback:

- Developing awareness, positive attitude and gaining experience on open, related, transversal, multidisciplinar, complex and fuzzy actions / decisions where linkages are as important as deepness or specialized, vertical foundations.

- Developing awareness, attitude and capacity on monitoring own performance within a system of related elements. To improve is not to perfectly control every expected action and its consequences but rather to be able to deal with uncertainty and unexpected circumstances and accepting positively that own performance is improvable while confronted to real system evolution. So, we must pursue to be open minded and humble (intelligent) enough to foster (not only accept) means and channels to obtain feedback.

- Developing awareness, attitude and capability on modifying own performance according to results. This places the stress on evaluation and, of course, on the educational program evaluation. On one hand, it is important to suggest and encourage students to improve their self - assessment ability as a main professional skill. And on the other hand, programmers must address, while redesigning syllabi, to create an environment in which students have chances to provide themselves feedback. In this approach, the classical issue - teachers evaluating students performance - is not a final step but rather a means of achieving the former.

Last, but not least, we must consider the real implementation of these ideas. Unfortunately, teachers are not very fond of making changes and all this goal will come to a wreck if the micro-system, the classroom, is not a real witness of the new air. A way to deal with this is to involucrate students in the play. Not only because they are the true main characters but also because they are supposed to push more than the teacher staff itself, they are better stakeholders in the reform. As the European Commission (2003) states:

Students representatives express the highest hopes concerning the principles of the Bologna reforms and the harshest criticism concerning their implementation and frequently reductive interpretations.

2. THE RISING OF GEOMATICS

From the Cartography Production point of view, changes may be seen as the emergence of a new paradigm: the Geomatic Engineering.

The classic disciplines: surveying, geodesy, photogrammetry and cartography have evolved, through Remote Sensing, GPS, the WWW and CAD, to settle out the Geomatic Engineering. The core of this new paradigm is GIS. Through this, geographical data is integrated in a consistent framework and made available to Land Management.

So we can depict the new Cartography profile by the following features:

- A growing care for an adequate quality control
- In which new parameters, such as dynamism or interaction, are increasingly relevant.
- These features have to be managed by multidisciplinary teams, aware enough of the project circumstances. To this purpose, a basic tool is a Geographical Information System.

In this new paradigm, land management by means of a consistent set of tools applied on georeferenced data is the central core. Through GIS, geographic information is made available to multidisciplinary teams (from archaeologists to risk preventers) in order to provide support for sustainable wealth to the whole society.

Quality control is becoming not only an urgent need but also a basic tool. Quality Assessment is critical as a mean of preserving maps in high standards while Quality Management provides the framework in which cartography can fluently and efficiently provide interactive tools in a connected world. As the capacity of cartography surpasses the classic representation objectives, entering in an immersive context, new quality parameters have to be considered and implemented.

Against this background, a broad space for creative and personal enrichment is available. Cartography through GIS is a field where professionals can exert their capacity of problem solving through the powerful means that Information Technologies offer.

The solution of today geographical problems requires the application of concepts and skills derived from diverse disciplines. More and more, the Geomatic world is characterized by a holistic approach to dealing with spatial abstractions. Professionals must not be just graduates trained in the use of software but rather individuals with a wide reference frame, technically efficient as well as able to work in teams, to communicate both orally and verbally, and to solve problems.
More and more, Geomatics applications focus upon obtaining analytical automated solutions to spatial problems and upon the use of advanced visualization means to help the understanding of the results. Consequently, Geomatics syllabus must rely heavily on students ability to identify problems with spatial components, to develop potential solutions to these problems and to effectively apply existing concepts and tools to their solution.

In Cartography nowadays, a very important competence is to understand and asses competitive software. The cartographic products are rendered by means of software and thus, the latter becomes essential in the cartographic flow and in the cartographer profile.

Nevertheless, professional software usually is a black box, opaque to the user. But we can write and use and have our students writing and using open software. If our care is to teach and to promote our students widest understanding of our fundamentals, techniques and methods, we are almost obliged to provide them professionally demanding software that meets as well pedagogical conditions. This means transparent, dosified, comprehensible software, and this emphasizes the role played by simulation software.

3. VRML

VRML, as a cartographic standard as well as a communication (internet) standard, is a crossroad in our world: a place we can hardly avoid if our product is to be disseminated. VRML is simple and accessible as is raw code, is powerful as is quoted and increasingly used by cartography professionals, and is pedagogical as it contains the main Computer Graphics concepts and provides prompt and rich feedback of our scripting task.

Some powerful features are:

- Object based code addressing 3D reality objects and object properties. Objects - named *nodes* - may be grouped (and accordingly, may accept *children*) and so, may lead to the creation of large scenes or complicated devices. It also includes a prototyping system for encapsulating and reusing whatever recursive set of *nodes*.

- The objects (3D) support a *geometry* (shape and pose). This *geometry* is expressed by means of simple primitives or by sophisticated ones such as *ElevationGrids* (equivalent to cartographic raster Digital Elevation Models) or *IndexedFaceSet* (equivalent to cartographic 3D Triangular Irregular Networks). Objects also support a "skin" representation by means of a *material* implementation that may specify the surface response to light sources and by means of a *texture* or pattern representation of the surface.

- Objects may be endowed with *sensors*, and so, become "sensitive creatures". *Sensors* detect user movements through the scene or when he/she interacts with some input device. *Sensors* are the starting point of *routes* that build up an information web.

- Objects (*nodes*) may communicate with each other through an *event* or message - passing mechanism. Each *node* type has got an *event* generating or receiving specification.

- Objects may move, may receive events from so called *interpolators* of different types. These interpolators compute intermediate values, rated by a clock, within a set of determined set of values specified by the designer.

- Objects may be integrated in a decision taking (intelligent) frame. Flow control may be held by so called *scripts* in which java or javascript code may be written to analyze diverse circumstances and, consequently, adopt the better response.

4. OUR EXPERIENCE

We would like to present some teaching / learning experiences developed at the Department of Cartographic and Land Engineering of the Universidad de Salamanca concerning algorithms under the main goal of improving a TIN representation of terrain to allow archaeological features rendering.

Students participating in this task may access deeper comprehension and exercise skills concerning issues like: triangulation, interpolation, intersection and enclosure of features within polygons, dealing with points, lines and faces topology, computing photogrammetric resection and generating an orthophoto by means of the so called anchor points method.

Two aerial (vertical) and stereoscopic images (obtained by means of a captive blimp) are the input to generate a 3D model of House 1 at the ruins of the roman city of Clunia (Spain). As is well known aerial photogrammetry cannot plot vertical walls (both excavated or constructed on the ground). So, we used a conventional photogrammetric approach to capture, on one side, a dense point cloud rendering terrain and, on the other side, a specific straight and curved line representation of the upper side of the walls (if possible).

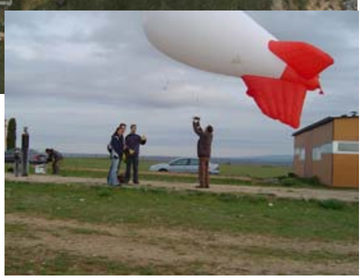


Figure 1 and figure 2. Aerial image of House 1 at Clunia, obtained by means of our blimp "Valentín"

Then, we designed scripts in the environment of VRML to include additional information concerning regular constructive elements. This task was planned in such a way that it highlighted the cartographic fundamentals involved and stimulated students participation.

The following were addressed:

- A Triangular Irregular Network generation from a point cloud input. This was supported by de *IndexedLineSet* node and, specifically, by its *coord* and *coordIndex* fields.

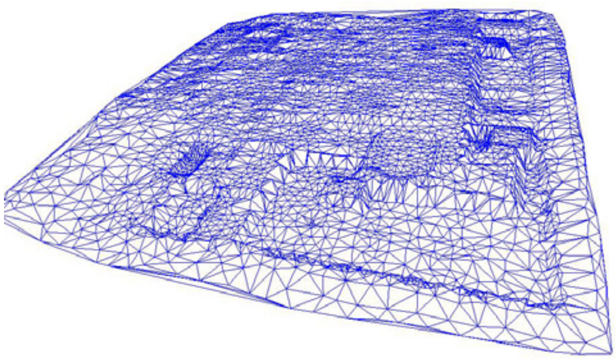


Figure 3. Raw TIN of House 1

- A Triangular Irregular Network generation structured over breaklines: consecutive points on the breakline provide sides of triangles and thus provide a first set of triangles. Breakline crossing becomes forbidden. Students can, thus, build out and experience the importance of this geometric feature.

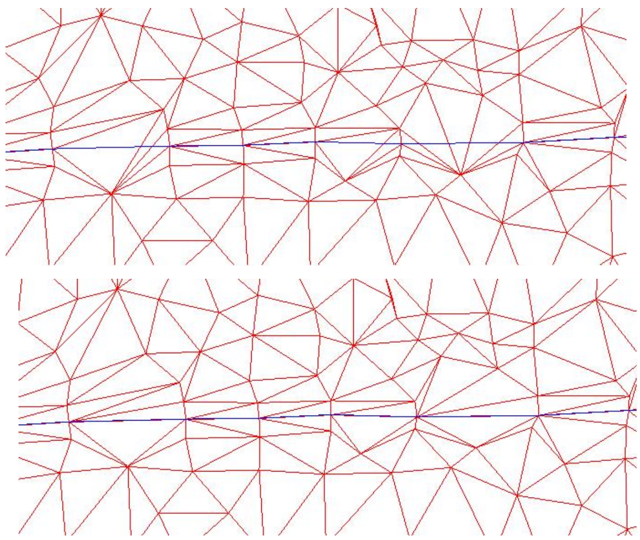


Figure 4. Raw TIN vs. Breakline TIN

- An orthophoto generation by means of the so called anchor point method and a TIN texture mapping from the image texture: after solving image resection, we computed a back projection of the terrain points on the more favourable image. Then we established the same terrain triangulation on the image and finally, projected forward each triangle texture on the image on its matching terrain triangle. We took advantage of the *IndexedFaceSet* node and, specifically, its *texCoord* and *textCoordIndex* fields. Immediate didactic consequences arised from working at this task.

Figure 5. Orthophoto projected on TIN of House 1

- A vertical wall generation: the lines of the upper side of the walls were vertically projected on the terrain. This demanded dealing with the TIN topology, interpolating and adding texture to the new polygons.

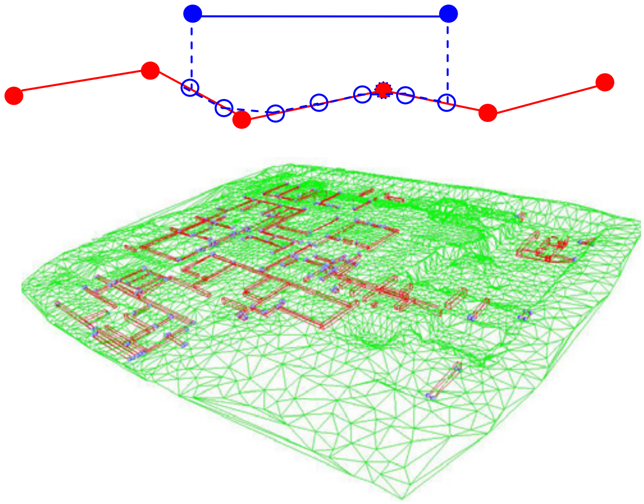
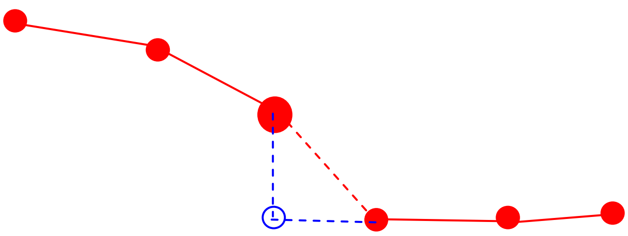


Figure 6. Upper side of walls projected on TIN

- A vertical wall excavation: as TIN is not able to render vertical walls excavated on the terrain we needed to change original triangles leaning against the upper side of the wall and on the ground (wherever the photogrammetric procedure make it possible) for an horizontal (ground) and a vertical (wall) triangle. Again, this demanded dealing with the TIN topology, interpolating and adding texture to the new polygons.



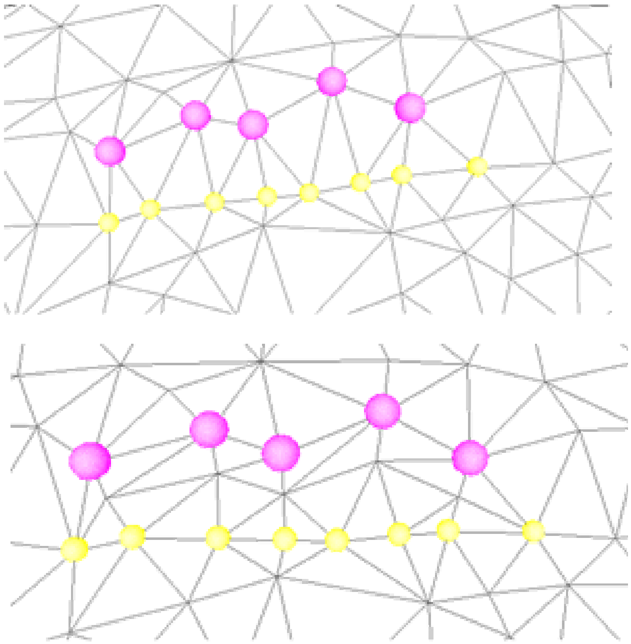


Figure 7. Excavated vertical walls on the TIN

- A vertical wall generation / excavation to meet a composition of the two precedent situations. The wall is constructed on one of its sides but excavated on the other. In this case the upper parts of the wall were included in the TIN and afterwards, identified as walls. As in the precedent case, every original triangle was substituted by a vertical and horizontal one.

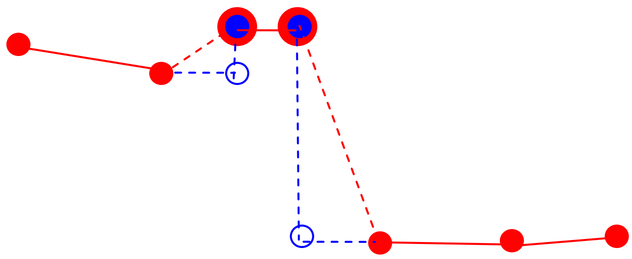


Figure 8. Mixed situation with walls constructed / excavated on TIN

5. CONCLUSIONS

Although students were not obliged to, they participated actively through all the steps listed above and their attitude was, in every sense, extraordinary. They offered help and support and, furthermore, they actively involucrated in every task they felt at ease. A very good atmosphere between teachers and students has been created and this has highly benefited the students (also teachers) performance. We can point out:

- Students learned VRML code. Though this is an important goal, is, by far, the least important of them all.

- Students exercised the systematic approach demanded by every programming task This leads to the organizing capacity.

- Students learned to coordinate and to work in teams, distributing effort and exchanging results and experience.

- Students acquired a big dose of interest and motivation in the Geomatic Engineering as they worked with real material and real demands and achieved real and competitive results.

- Students grasped the Geomatic fundamentals and procedures involved in the executed task in a wider and deeper way than they would have achieved in a less inmersive way.

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How to broaden the bases for digital remote sensing data analysis for everybody -From the experiences of promoting "MultiSpec 'hands on workshops-

Joji Iisaka

Department of Geography, University of Victoria, PO Box 3050, Victoria, BC,Y8Y 3P5,Canada
jiisaka@mail.geog.uvic.ca

Commission VI

Key Words: Digital Image Analysis Education, Remote Sensing, MultiSpec, Probability Image

Abstract:

Digital Image Analysis techniques are essential for extracting useful and practical information from remotely sensed images. The recent advancement of information technology has made it possible for every body to use computers and to access various remote sensing data. However, it is difficult to use computers for digital analysis of remotely sensed images without appropriate application software. A lot of software is available as commercial packages, but only professional organization or people in remote sensing communities can afford to use them. However, most of end-users of remote sensing such as schoolteachers, students and local governments as well as small business interested in applying remote sensing are not able to afford to use commercial packages.
This paper will describe the author's experiences in Japan to educate and train the peoples interested in remote sensing and digital image analysis techniques through a series of hands-on workshops on 'MultiSpec". During past five years, more than 650 peoples attended the workshops from wide variety of user communities

1. Introduction

1.1 Global Environments and Remote Sensing

Global environment and resource problems are one of major concerns of these days in the world. More than 3 decades have passed since the first satellite for earth resource and environment observation was launched. Since then, many countries have launched many similar satellites for remote sensing, and planned to launch more satellites. Currently every satellite is dumping a lot of scenes to the earth every second.

However, it would be difficult to say that every scene observed has been analyzed and utilized t o contribute to solve the practical problems of resources and environment.
Potential application areas are not limited to the existing scientific areas but there must be more practical applications or potential applications not yet identified. This means they need to involve more people of other disciplines as well as increasing the population in existing remote sensing communities.

1.2. Brief History of Digital Image Analysis for remote Sensing in Japan

Availability of digital tapes for ERTS program (Landsat 1) stimulated interest in digital image analysis for remote sensing in Japan. However, there were few demands on digital image analysis in Japan in the earlier period of 1970s, because of lack of competence with the digital image processing in remote sensing community in Japan. At that time, some organizations and institutes like large universities or computer companies like IBM Japan, Fujitsu, Toshiba and Hitachi Co. Ltd. had general computers for computing services, but software environment for image analysis for remote sensing was so poor, and mostly every body had to write programs by themselves. RESTEEC imported later a special purpose computer for image analysis, such as IMAGE -100, but only limited persons could access it.

As Japanese government, the Ministry of Education did not fund any software purchasing at that time, and every users, professors and students, at universities needed to write application programs with less advanced programming language.
On the other hand, there was already a lot of good software in US. Among them, LARSYS developed by LARS, Purdue University, was well documented and looked easy to use and to transplant to Japan.

LARSYS is one of the first remote sensing multispectral data processing systems, originally created during the 1960's. Originally, LARSYS was developed for the time-sharing system of IBM System 360-67. As that time, no time-sharing system was available in Japan, but there were nation- wide commercial based network computing services by IBM Japan and Fujitsu Co. Ltd.

Fortunately, a private foundation founded a project to promote remote sensing in Japan. A part of this fund was used to transplant the LARSYS to support all scientists participating this project having permission from LARS, Purdue University. The original version of LARSYS was modified for IBM and Fujitsu to fit their remote computing environment, i.e. Remote Job Entry systems.
Many workshops were held in the major big cities in Japan to educate how to use LARSYS for remote sensing data analysis. This is the first large scale promotional activity for digital image analysis for remote sensing.

Figure 1. The manual of LARSYS

2. Current Situation with promotion of Digital Remote Sensing in Japan

During the past three decades, Japan launched many earth observation satellites and developed many sensors for earth observation. However, fewer operational use of remote sensing has been implemented in Japan compared with the other countries in the world.

2.1 Resource environment for Remote Sensing Education and Promotion

Fortunately, during past three decades, there emerged a lot of technologies to support remote sensing, and the environment for operational remote sensing has been very much improved.

Data accessibility and cost: the environment for data availability of remote sensing has been dramatically improved, and now it is possible to download image data sets through internet and the cost of data sets became an affordable range. Recent data storage technologies such as CD /DVD facilitated to distribute, exchange and copy the remote sensing data of large volume. Now, many people have their own PC with CD/DVD drives.

Image Analysis Hard ware System: Now almost everybody can afford to have their own PC, which is capable to process large images at home. They have faster processing speed and more capacities than what they used to have in 1970s.

Availability of Digital Image Analysis Software: Many professional institutes of remote sensing are using many commercial products, but most of potential users of remote sensing cannot afford to purchase such expensive products.

2.2 Remote Sensing Education:

Above situation is an aspect of positive side. Unfortunately, there is another side with little progress. The number of universities or colleges, which provide courses related to remote sensing, is definitely increasing, but there are few departments, which dedicate to remote sensing in Japan. Even with department of geography, very few courses are offered. Education on geography itself at high schools is getting less appreciated now, because of the guide lines of government and most of education at high schools is addressed to pass the entrance examination of universities or colleges. Therefore few teachers has interest in depicting the earth and remote sensing. So the numbers of university graduates who have been educated remote sensing is very small compared with that of North America and Europe.
This situation might be influenced by the feeling of the people of Japan: they are wondering about job opportunity after graduation with remote sensing, much less interest in remote sensing at governmental organization, less industries appreciate importance of remote sensing. Past major concerns of government was to develop manufacturing industries, they have not paid enough concern about spatial design, landscape management, sustainability of the nature and balance between land development and ecological impacts.
They need to have more educators who understand remote sensing technology and its importance. It is also required to make them understand that remote sensing is not only scientific tools for the earth science, but also useful technology related to everyday lives.

Major tasks remained for promoting remote sensing to every sectors of Japan is to provide image analysis software of reasonable cost and increase the number of educators or professionals who are able to transfer their expertise to the potential people who wish to know about remote sensing and to apply it to solve their own tasks for environment and resource related problems.

3. What is “MultiSpec”?

3.1 MultiSpec:

The ‘MultiSpec’ (©Purdue Research Foundation) is a processing system for interactively analyzing multispectral image data including hyper spectral image data from current and future airborne and space borne systems. The primary objective of MultiSpec is as an aid to export the research results on multispectral image analysis of Purdue University.

MultiSpec has the following design objectives, and it is available in public through Internet. The implementation should be on a readily available computer platform, which has adequate processing power, but is financially within the reach of any Earth science researcher (i.e., computer platforms < $2000).

(1) The system should be easy to learn and easy to use, even for the infrequent user, using the most modern of software environments.
(2) The system should provide for easy import of data in a variety of formats, and easy export of results, both in thematic map and in tabular form.

The work of building the current capability began by implementing an upgraded version of the LARSYS multispectral image data analysis system. The current system, called MultiSpec, has been implemented for the Apple Macintosh and PC-Windows personal workstations. A reasonably current generation, middle range machine and color display, would have a street price of less than $2000 at the present time.

(1) Import data
(2) Display multispectral images
(3) Histogram data
(4) Reformat
(5) Create new channels
(6) Cluster
(7) Define classes (via designating rectangular or polygonal training fields or mask image files, compute field and class statistics, and define test fields for use in evaluating classification results quantitatively.
(8) Determine the best spectral features
(9) Classify: Six different classification algorithms are available: use of minimum distance to means, correlation classifier (SAM), matched filter (CEM), Fisher linear discriminant, the Gaussian maximum likelihood pixel scheme, or the ECHO spectral/spatial classifier.
(10) List classification results
(11) Utility functions including listing out a subset of the data e.g., for use externally, conducting principal component analysis, etc.
(12) Transfer intermediate or final results.

Not only conventional functions for image analysis for remote sensing, but also they are continuing to add new functions including many functions required for hyperspectral image analysis.

4. Approach:

The most important task is to increase the numbers of educators who have experiences with digital image analysis of remote sensing.
Thus, the author established the following strategies.
Advertise the availability of digital image analysis software in public domain.

(1) Provide the user; s guide in Japanese, translating from the English version, and open it on a web site. This is motivated by the fact many Japanese such as school teacher, public servants in local governments, young university students and so on, are still reluctant to read and use the thick manuals in English
(2) Conduct hands-on workshops to educate the people in every level at every geographical place as much as possible.
(3) Provide learning materials on remote sensing and digital image analysis.
(4) Establish a group of advisors who are able to make consultation on remote sensing.

5. Workshop on "MultiSpec"

5.1 Hosts of the workshops:

The workshops were hosted by the following organizations, and they advertised the workshops, and conducted every logistic activities necessary. A series of the workshop was conducted first by the computing center for Agriculture, Forestry and Fisher Research, Ministry of Agriculture, Forestry and Fishery, and JSPRS (the Japanese Society of Photogrammetry and Remote Sensing) took over the major parts of this later.

Central Government	Ministry of Agriculture, Forestry and Fishery
Local Government	Environment Research Center, Hokkaido
Academic Society	Japanese Society of Photogrammetry and Remote Sensing
University	Faculty of Fishery Science, Hokkaido University Kanazawa Institute of Technology Kobe University Tokyo University of Information Science
Teachers Association	Science Teacher's Association of Hakodate

Table 1: Workshop Hosting Organizations

5.2 Target participants:

Almost every people is welcome to the workshop.

5.3 Prerequisite:

Potential participants are assumed to have PC experiences and be familiar with popular PC operating systems such as MS-windows. Although MultiSpec is originally developed for MAC PCs and it have more functions that the Windows version, main participants are windows users since the window users in Japan is more popular and the author does not have Mac OS experiences. The Mac users were also welcome as well. However, no previous knowledge about remote sensing was assumed, but interest in remote sensing and global environment is essential.

5.4 Course Contents:

Two courses were offered based on the experiences of participants, their interest and previous knowledge with digital image processing.
1) Beginners' level and intermediate level.
2) Some workshops were combined these two.
In Japan, it is difficult to have workshops of longer duration more than two days; most of them should be one day or two days at most. So every workshop were designed as one day workshop and two day workshop combining the two courses Duration of each workshop is 6 hours, 3hour in the morning and 3 hours in the afternoon.
The major subjects for each course are summarized in Table 2. These contents are always modified and improved

Introduction of Remote Sensing	Definition, Principles of remote sensing. Outlines of remote sensing programs How obtain a data set.	1 hour.
Brief history of Digital Image Analysis for remote sensing	Digital Image Analysis Basic Outlines of digital image format for remote sensing data .	1 Hour
MultiSpec basic	What is 'MultiSpec" How to download and install it Basic operation and workspace and windows	1 Hour
Fundamentals of ground cover analysis with hands-on	Fundamental of ground cover classification Basic Procedure for ground cover classification Ground cover definition Retrieving of Ground information through internet	1 Hour
Example of Image processing	Image Arithmetic: NDVI and Others	30 min.
Ground Cover Classification	Principles and methods of Classification Exercise	1 1/2 Hour

Table 2-1 Workshop contents for the Beginners

Advanced Techniques for	Training Class Improvement	3 Hours

Ground Cover Analysis	Methods, Classification Feature Extraction Feature Selection Accuracy Assessment (confusion Matrix and Kappa coefficient)	
Introduction of Hyperspectral image analysis	Sensor Principle Hyperspectral Remote Sensing vs. Low Spectral Resolution Sensor data Application of Hyperspectral Remote Sensing	1 Hour
	Problems of Hyperspectral Data Analysis	1 Hour.
Hands-on of Hyperspectral Data Analysis	Ground Cover classification Using Hyperion data	1 Hour.

Table 2-2 Workshop contents for the intermediate level

5.3 Course materials

Program: If the Internet connection is available at the classroom, each participant was requested to download, uncompress and install "MultiSpec" at the beginning to the workshop.
Data set: Data sets for hands-on exercise were provided by the following organizations: TM images are EROC (Earth Observation Center) of JAXA (Japan Aerospace Exploration Agency) and RESTEC (Remote Sensing Technology Center), ASTER images were provided by ERSDAC (Earth Resources Data Analysis Center). Aircraft Hyperspectral Images were offered by PASCO.
The scenes were selected as much as possible to cover the geographical location of each workshop.
A CD is created for each course to store all materials including program, image data and hands-out, and distributed to each participant. And these materials were
As the last two materials are opened on Web Site, every potential people interested in "MultiSpec" can be downloaded.

Figure 2. Hands－On Training Course of MultiSpec : Every attendee is requested to bring their own PC or note-book PC.

Presentation Materials: All of the materials presented during each course is included in a CD-ROM, and uploaded to a Web site.

5.4 Physical Planning：

Power Supply: Every workshop participants are requested to bring their own PCs, the workshop room should be able to supply enough electric power to accommodate required power even with PC are being used. . Required capacity is proportioned to the number of attendees. It is also desirable to provide much power cable extension code. These requirements should be well examined before workshops in advance. Some workshops were held in rooms for computer lab, where sufficient computer environments are provided.

Air Conditioning: The workshop rooms are ordinary well air- conditioned,
But they might not have enough cooling capacity to cover many PCs. Especially, in summer time in Japan; the cooling capacity will not be enough

Projector: Two Projectors: One projector would be fine, but it is more desirable to use two projectors: the one will be used for general explanation, and the second one will be used to present the current tasks, procedures or operation.

Internet connection: It is also desirable that each PC of participants is able to have Internet connection. Through which every participants is able to access and download the software, data and other reference data. In Japan, various digital maps are available through Web, and many high-resolution images area accessible.

5.5 Size of Works Shops

As the workshop has hands-on training using PCs, the number of participants is limited to it manageable size to supervise the progresses of each participants. In some cases with large number of participants, say, over 30, we provided some assistants to help computer operation or computer oriented questions as each participants have different levels of PC operations and competences.

5.6 Image Analysis Hands On -Ground Cover Classification-:

Land-cover classification using a TM image or ASTER image is selected as a hands-on subject.

Class Definition:

First of all, they have to define all of ground cover classes of user's interest. It is very common to use existing categories such as land use map categories, but they might have their own categories of interests based of their objectives of analysis. However, most of participants had difficulty to define their own class categories, and in many cases, they expect some classes, which might not be observable by existing remote sensors. For simplicity, existing categories were used.
Simple image arithmetic was exercised first to generate NDVI maps, and this helps them understand to significance of digital image processing and band combinations.

As for a set of ground reference, it was suggested to use the following information:

(1) Conventional map information: 1:50,000 scale maps can be retrieved through Internet.
(2) Digital landuse map: digital urban landuse data (10mx10m resolution) is available on CD
(3) Air-photographs/high spatial resolution satellite images: most of these data is also available through internet (i.e. Google Earth)

These ground information helps to define classes to be classified and to identify the location of objects and to define classes.

Training Field Selection:

In order to locate the objects on ground, it is helpful if a conventional digital map can be overlaid to the displayed image of the study area. If the image is projected to same mapping projection systems with GIS systems and formatted as a shape-file, "MultiSpec" has this function to overlay the GIS date on an image displayed on screen. The Figure 3 is a sub-image of ASTER data overlaid with the road net work in a shape file.
Some software is available in public or as commercial basis that can convert existing digital numeric maps into a shape file.

Major tasks of this hands-on were to select s set of training fields and test fields for accuracy assessment. Ordinary, they are selected by means of spatially defined and spectrally homogeneous areas spectral band.

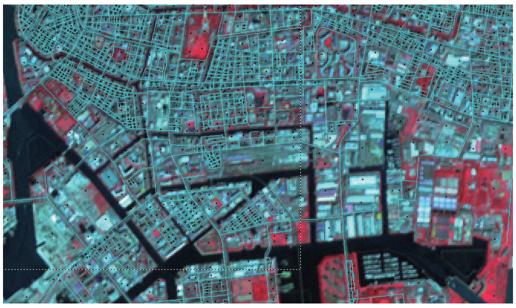

Figure 3. ASTER sub-image of Tokyo, overlaid with GIS data(road network) :

Interactive training/test field selection method is widely used, and "MultiSpec" has this function, too. However, in Japan, the sizes of ground cover parcel or objects are very small compared with the resolution sizes of satellite based remote sensors. Therefore, ground features observed in remote sensing images are complicated. Thus, even with image magnification functions, it is so difficult to find spatially and spectrally homogeneous areas, and interactive selection of training/test fields are less useful.

Therefore, alternative approach was emphasized at the workshops.
Step 1: Identify spectrally similar pixels using conventional unsupervised methods (See Figure 4.) The cluster map can be separated into masks of each class.

The result stored as an integer-file coded with class codes (cluster No.) is used to estimate the class statistics, instead of drawing rectangles or polygons interactively. Associating this mask with the image of study area, operators can define other fields interactively from the inside of masked areas.

Labeling of each cluster class is conducted by common procedure. A NDVI image also assists to label the cluster. Spatial patterns and shapes of objects assist to label the clustered class. At least, use of his procedure can guarantee the spectral similarity of the pixels selected for training field much more consistently compared with interactive visual selection method.

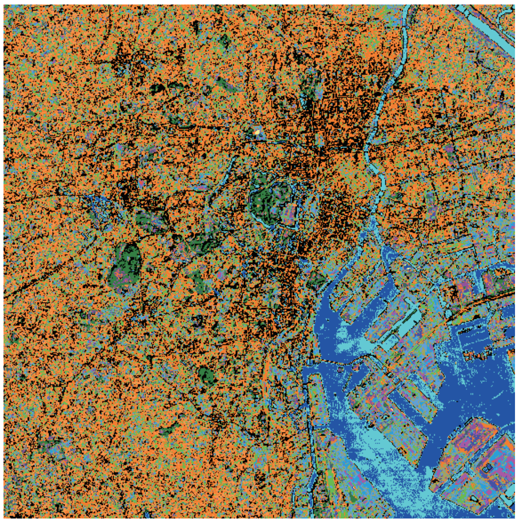

Figure 4. Clustered Result as a Mask

Step 2: Some features are still difficult to select them interactively. For an example, road/ or railroad features are a line-like object, and difficult to extract them with a polygon. This kind of masks can be generated using external image processing programs and integrated into "MultiSpec'.

Figure 5 illustrates an image of a mask to select fields of line-like patterns generated from TM visible bands applying local fractal information of dimension 1 between 1 and less than 2.0. (Joji Iisaka. 1998;Joji Iisaka 1994)

Figure 5 Line-like Object Mask

Step 3: Use of Classification Probability Map: With the conventional classification methods such as maximum likely hood classifier, the images are classified based on the defined classes or assigned to an extra class, unclassified class if a threshold is set to the classifier. and the classifier assign the label of that pixel to a class which shows the maximum probability among the probabilities of all classes.
If this maximum probability is not being large enough to convince for that pixel belong to

than, the number of classes defined for that classification For this purpose, "MultiSpec" had an option to generate a probability map during a classification process, which pixel values correspond to the probability with which the class label is assigned. . If this pixel does not belong to the one of these classes, they need to add some new classes and have a complete list of classes in a scene.

Associating these masks with the images of study areas, training fields can be selected consistently.

6. Discussions and Finding

6.1 General Observation:

As explained before, only one-day workshops were affordable for most of participant to attend .It is difficult to cover every required topic in depth in six hours. It might need at least one week to explain every topic sufficiently, or one-term courses at universities or college to educate students at expert levels.

6.2 Computer Skill:

some participants were not so good at the common computer operation such as mouse dragging and window switching, cut –past operation, file navigation and selection, and so on. So there was some complaining that the author was demonstrating the operation too fast. With these circumstances, the assistants standing in the classroom did great help.

6.3 Remote sensing General:

some terminologies were not so familiar especially with the beginners of remote sensing. On-line help with remote sensing, or at least on-line glossary of remote sensing might help them. To understand remote sensing basics, some background of scientific knowledge such as physics and chemistry is required. Especially, it is essential to explain the significance of Hyperspectral images, principles for classification principle for multispectral images, knowledge of probability concept and statistics are required. Fortunately, they had most of required knowledge, as they graduated colleges or universities. However, advanced knowledge such as multivariate date analysis, hyper-space geometry and communication signal processing are required to understand the functions of "MultiSpec" for Hyperspectral data classification; it was difficult to explain the details of them.

6.4 Mathematical knowledge:

In order to explain basic algorithms for classification and feature selection and extraction, university level knowledge about statistics and algebra will be essential.

6.5 Image Analysis Methods:

Many graphic or picture processing software for digital cameras is getting more popular, so they could understand visual effects of processing, but not for multispectral images and quantitative analysis.

6.5 Defining Classes:

This was most important part as hands-on. Most of existing categories are not well define quantitatively. It was also essential to make them understand the concept of spectral classed and conventional ground cover types. They might need to establish a standard ground cover types based on sensor resolutions and objectives of classification

7. Conclusions and Future Plan:

Through these activities, "MultiSpec" has been proved to be a useful image analysis program not only for remote sensing experts but also for the people of non-professionals of remote sensing ._ At the end of 2005, more than 650 peoples attended this series of workshop.

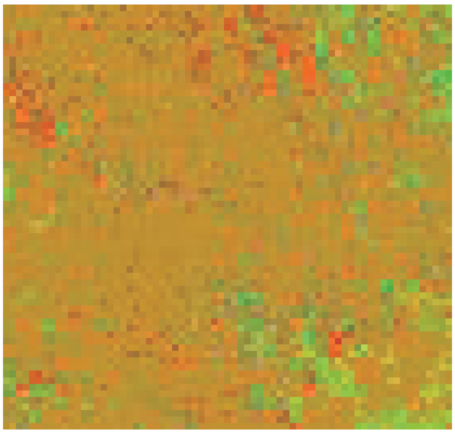

Figure 6. Color-coded Probability Map:
Red and orange area indicate higher probability
Green and Blur areas are of lower probabilities Additional classes can be defined from these areas.

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Already some participants from academic educational institutes started courses of remote sensing with MultiSpec for domestic and international students. The author's aspiration is to extend this activities to cover other countries.

8. References:

MultiSpec related References: With the following URL, Every material related to "MultiSpec" including program, documents, sample data sets and links to other references.

http://dynamo.ecn.purdue.edu/~biehl/MultiSpec/

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TRAINING SCHEME FOR LAND-COVER MAPSVALIDATION BY GROUND-TRUTH

Koki IWAO [a,] , Kenlo NISHIDA[b] and Yoshiki YAMAGATA[a]

[a] National Institute for Environmental Studies, 16-2, Onogawa, Tsukuba, Ibaraki 305-8506, JAPAN –
iwao.koki@nies.go.jp
[b] Institute of Agricultural and Forest Engineering, The University of Tsukuba.
Tennnoudai 1-1-1, Tsukuba 305-8572, JAPAN -

KEY WORDS: Land Cover, Classification, Global-Environmental-Databases, Accuracy, Sampling

ABSTRACT:

Land cover maps validation data acquisition from ground-truth is proposed. Land cover maps are used in the numerical models which estimate ecosystem behaviour, water cycle, and climate in global scale. Therefore, accuracy validation of these land cover maps is important. Each of the existing land cover map has been validated with its own validation method. However the distribution is restricted by the differences in the fields made into the researchers' interests and the researchers' experiences may affect those accuracies. As a result, there is no validation method which evaluates these land cover maps with single validation dataset in global scale. This might makes less agreement if the existing land cover maps are compared. To overcome these problems, authors summarized the matter which is needed by training for land cover validation data development which makes possible for many people to participate. This gives fairly uniform ground-truth information with accurate location information worldwide.

1. INTRODUCTION

1.1 Importance of global land cover data and its accuracies

The land cover map is positioned as one of the important data with which improvement in accuracy is desired scientifically and politically most, when arguing about global environment problems. [Patennaude et al., 2005; DeFris et al., 2000] From sensitivity analysis of some terrestrial biosphere models, area total of Net Primary Production (NPP) or its spatial distribution which a model presumes may change by changing a land cover maps. So, improvements in global land cover maps are desired [Ahl et al., 2005; Kok et al., 2001].

Until now, many validation techniques about global land cover maps are advocated. For example, validation by the interpretation using an aerial photograph or a high spatial resolution satellite picture is proposed. However, subjects, such as spatial size of a sample, the number of validation points, and accuracy of the ground validation data itself, remain. [Strand, et al., 2002; Kelly et al., 1999; Rosenfield and Fitzpatrick-Lins, 1986; Hord and Brooner, 1976] The distribution is restricted by the differences in the fields made into the researchers' interests and the researchers' experiences may affect those accuracies. As a result, there is no validation method which evaluates these land cover maps with single validation dataset in global scale.

Inventory information (agricultural statistics, forestry statistics, etc.) are also used for accuracy appraisal method and it is widely adopted as accuracy validation of a land cover data. [Foody et al., 2002]. However, according to the research which carried out the relative comparison of two or more global land cover maps where accuracy validation was performed based on them, the gross area of each classification class is alike, but the spatial distribution differs greatly. [McCallum et al., 2006; Giri et al., 2005]. This shows that validation of global land cover data is not fully progressing.

1.2 Proposed validation method

To overcome these problems, authors proposed a validation method that can address this shortcoming [Iwao et al., 2006]. Our method employs information gathered by "the Degree Confluence Project (DCP)," a voluntary-based project that collects on site data from each of the degree confluence points (DCPoints) in the world [DCP, 1996]. DCPoints are located at the intersections of integer level latitude and longitude grid lines. Volunteers with the project visit the DCPoints and collect data in the form of GPS readings, pictures and descriptions of the landscape. Focusing on the IPCC LULUCF (Land Use, Land Use Change and Forestry) guidelines, we classified each DCPoints into six classes (Forest, Grassland, Crop, Wetland, Residential, and Other) manually [IPCC, 2003]. In this paper, we focus on the improvement of this DCPoints information.

2. METHODOLOGY

2.1 DCP

As DCPoints information, the present condition information and photograph of the point are exhibited. In order to evaluate whether special knowledge (knowledge, such as a types of vegetation and a technical term about cultivation) is needed on the interpretation, three persons' interpretation person was prepared. Three persons are general office worker, an ecologist and a remote sensing researcher. Among three persons, when two persons' result was the same, the method of making it into majority was taken. The visual situation of land cover may differ depending on the season (exploration time). Then, interpretation gave priority to present condition information (descriptions of the landscape). Photograph information was used in order to mainly check the accuracy of present condition information. However, when present condition information was inadequate, interpretation was tried from the photograph. On the other hand, the check of a spatial distribution was evaluated using photograph information mainly.

2.2 Visual classification with Landsat images

These DCP derived classifications were then compared to classifications derived from Landsat Thematic Mapper images by visual interpretation. High resolution ortho-rectified Landsat TM (Thematic Mapper) images which Earth Science Data Interface [University of Maryland, 2004] opens through the web site were used. The colour composite (Red: 4, Blue:3 and Green: 2) was used for visual interpretation. Interpretation was performed who has the experience which handled the remote sensing images for more than ten years. However, information related to that spot such as crop calendar was not used.

2.3 Ground Truth

We have conducted ground truth of three DCPoints already successfully completed. The reliability of the information (position information is included) indicated was checked. Then we consider the training scheme for the improvement of DCP information for validation of land cover maps.

3. RESULTS AND DISCUSSION

3.1 DCPoints derived information

We found that there are no discriminable differences in the validation results of three persons. Compared with the results from Landsat image interpretations and this accuracy were comparable as the visual interpretation by a Landsat Images.

3.2 Ground Truth

To assess the reliability of DCP information, ground truth (13N, 100E; 14N 100E; 13N 101E) was also actually performed and the reliability of the information (position information is included) indicated was also checked. Among these, in 13N, 101E points, three explorations have already been performed (May 2001, October 2004, and April 2006).Although the photograph of this point is looks same, written information differs among three dates. With the ground truth, we could confirm the land cover types (Crop). But the contents information was not correct (A coconut is indicated to be a rubber tree).14N, 100E are the points read as the typical paddy area (Crop), and have confirmed the point. 13N, 100E points are the areas (other) which were not able to be interpreted from DCP. There was a location gap (approximately 50m) between the indicated DCP information and our exploration. This can consider the setting mistake of GPS etc. However the classification class (Crop) presumed from DCP could be checked. From the above results, I found the following conclusions.

1. In some point, the names of the trees or types of crops were not correct. This was not because of the time difference. When specifying the names of trees or types of crops in DCP as text, it is good to also take a picture which can be used to confirm it.
I hope that a database (illustrated guide to flora and crops) can be built through this procedure.

2. There was a place which deviates about fifty meters from the last exploration person's position information and my exploration. Since the accuracy of the DCP must be to within 100 meters, it is still acceptable, but I am afraid that some people are not been careful enough with WGS84 settings.

3. In order to mitigate this error, I advocate using a feature of the land such as a coastal area or an intersection to carryout confirmation with satellite pictures (e.g. Google Earth, which has geographic information in the image) to confirm whether it is truly in agreement with the GPS values.
Such information may also be useful to include in a database someday to be used for validation or geometric correction of satellite data.

4. CONCLUSION

We proposed a new validation method which employs DCP information. Then we proposed a scheme to improve the information of DCP for land cover map validation. When specifying the names of trees or types of crops in DCP as text, it is recommended to take pictures which can be used to confirm it. Also, to confirm the GPS settings, using a feature of the land such as a coastal area or an intersection to carryout confirmation with satellite pictures (e.g. Google Earth, which has geographic information in the image) to confirm whether it is truly in agreement with the GPS values is also recommended.

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CONSTRUCTION AND APPLICATION OF SATELLITE IMAGE 3D PRESENTATION SYSTEM FOR EDUCATION

Kisei KINOSHITA [a], Nobuya TOMIOKA [b] and Hirotsugu TOGOSHI [c]

[a] Research and Development Center, Kagoshima University, Kagoshima 890-0065, JAPAN
kisei@rdc.kagoshima-u.ac.jp
[b] Learning Information Center, Kagoshima City Board of Education, Kagoshima 890-0816, JAPAN
n_tomi912@ybb.ne.jp
[c] Oumaru Junior School, Kawanabe-cho, Kagoshima 897-0131, JAPAN
t-hiro@po4.synapse.ne.jp

KEY WORDS: DEM/DTM, Infrared, Internet, Land Cover, Landsat, Landscape, Vegetation, Volcanoes

ABSTRACT:

A system to provide data sets for 3D presentation of the Landsat image for any part of Japan and their viewer are constructed, and uploaded as the SiPSE homepage in the Internet with the address http://sipse.edu.kagoshima-u.ac.jp/sipse/. The digital elevation model data with 50 m resolution are embedded in the data sets. A satellite image for 3D presentation may be selected from true or natural color, and single band modes. Especially, monochromatic view of TM band-4 is very useful to recognize water and land areas, to see the vegetation coverage and mountainous topography, and to compare with aerial and ground photographs with near-infrared mode. The SiPSE data viewer is able to drive a satellite 3D image in real time motion as a flight simulator in a personal computer. The system is very useful for the education to understand the geographic situation of the environments such as mountains, rivers and planes, various volcanic topographies, and many scenes related to history and literature. In addition to the on-line system described in Japanese for the domestic use, off-line systems are developed with larger file size and other functions for research and international uses.

1. INTRODUCTION

In order to promote the public and educational uses of satellite images, a group of interested researchers and students in Kagoshima, southern Japan, started in July 1996 the homepage SiNG-Kagoshima, which is an abbreviation of Satellite Image Network Group in Kagoshima (Tomioka et al., 1997). The homepage was composed of two sectors, Public and Education. In the Public sector, various output images of satellite remote sensing studies have been displayed with compact explanations, as reported in another contribution to this symposium (Iino et al., 2006).

The SiNG Education sector was constructed to provide the Landsat TM data in a reduced format, called the SiNG data (Tomioka and Kinoshita, 1997). A user may cut out a scene with the pixel size 512*512 with different scales, and handle it by the SiNG data viewer downloaded from the same homepage. The coverage of the SiNG data extended from Kagoshima prefecture at the beginning, to Kyushu and other areas of Japan.

Understanding of a satellite image improves greatly by applying the 3D presentation. We have developed a system to perform the 3D presentation of satellite images in real time motion in ordinary personal computer as a flight simulator (Togoshi et al., 1999, 2000) and opened in September 2000 the SiPSE home page, where the combination of SiNG data with topographic information is provided as the SiPSE data, together with the SiPSE data viewer to handle it. Here, SiPSE is an abbreviation of Satellite image Presentation System for Education, and its home page is the developed form of the SiNG Education sector. The address of the SiPSE homepage is http://sipse.edu.kagoshima-u.ac.jp/sipse/, with the data sets covering Japan since 2001.

We have also developed SiPSE off-line systems for research purposes so as to include new functions: Some of them are covering submarine topography, embedding the volcanic eruption cloud, simulation of the sea level rise and so on (Kinoshita et al., 2006). For the international use, the CD packages of the viewer in English and some data have been used in China, The Philippines, Australia, U.S.A., and Italy on the personal exchange basis.

In the followings, we discuss the properties and utilities of the SiPSE system, and show a few typical outputs. A scene with the pixel size 1024*1024 is available, as well as the size 512*512, with differently reduced scale.

2. THE SIPSE SYSTEM

2.1 Source Data

SiPSE data sets are obtained from the Landsat TM image data for the land cover, and digital elevation model (DEM) data provided by Geographical Survey Institute (GSI), as shown in Figure 1.
As the satellite image data covering Japan with reasonably high spatial resolution, Landsat-5 TM data is adopted, because of the following reasons. First, we may select out almost cloud-free, less snow-covered and relatively new scenes from the archived data during 1984-2001 received at Earth Observation Center (EOC), JAXA (previously NASDA). Second, true-color image is available from the TM band 1-3 data corresponding to blue, green and red colors, respectively.

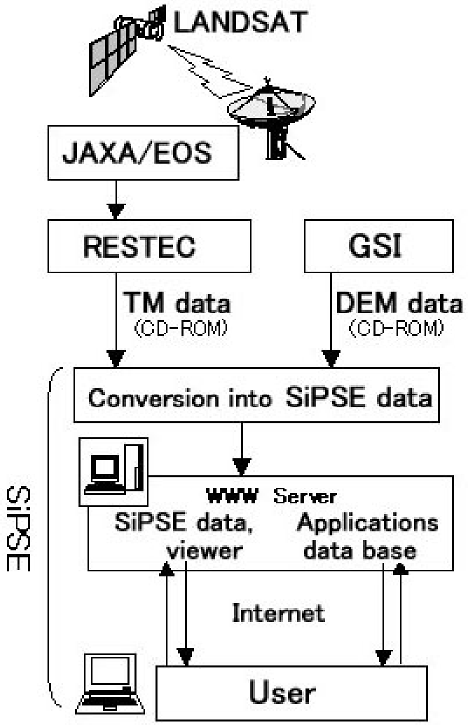

Figure 1. The data flow for the SiPSE system.

2.2 SiPSE Data

As a polar orbital satellite, Landsat-5 observed the earth along its path toward the south slightly inclined to the west with the swath width 185 km, with the 16 days period for the same place. The data along a path is divided into rows, and a full scene data with 6920 pixels and 5965 lines is provided after geometrical correction by EOC through Remote Sensing Technology Center (RESTEC). As a pre-process to prepare the SiPSE data, a rotation to put the north direction exactly upward is applied to some of full scene data if necessary. Another pre-process is to trim off wide sea area in some of full scene data. Thus, almost all of the lands in Japan are covered by 48 source-scenes for the SiPSE data. Furthermore, three additional scenes are prepared in different days for southern Japan so as to get cloud-free data.

The SiPSE land cover data is obtained from TM 1-4 data by reducing the brightness from 8 bits into 4 bits, while keeping the spatial resolution 28.5 m/pixel. This reduction and the discard of the bands 5-7 are done so as to reduce the file size for the Internet use, retaining basic features in visible and near-infrared bands. The land cover is expressed by the true-color mode with TM 1, 2 and 3, or by the natural-color mode, with TM 1, 2+4 and 3 corresponding to B, G and R, respectively. TM 4 is also utilized for the gray scale presentation of the near-infrared image. (This form of the land-cover data in pre-processed form for the web use had been adopted as the SiNG data, where TM 6 was maintained converting into the temperature scale.)

The DEM data provided by GSI have the spatial resolution 50 m, and cover Japan with three CD-ROMs. For the use in the SiPSE system, the DEM information is converted to fit with the land cover data, which have higher spatial resolution, by linear interpolation. Thus, a DEM data file is prepared corresponding to each source-scene.

A client user may select out a scene with the pixel size 512*512 or 1024*1024 with a reduction factor 1-6 from the source scenes in the SiPSE server, and download on one's computer a SiPSE data set for the 3D presentation composed of a pair of the land-cover and DEM files, having the extension such as *.nov and *.hir respectively. Thus, a SiPSE scene may be a squire with the side length about 15 or 30 km corresponding to 512 or 1024 pixels without reduction, while it may be wider with the maximum length 90 or 180 km for the reduction factor 6 by lowering the spatial resolution. The pixel size of the data format is decided so as to be appropriate for the smooth 3D motion in ordinary personal computers.

2.3 SiPSE Data Viewer

The SiPSE data can be handled by means of the SiPSE data viewer downloaded from the server. The 3D presentation in a Windows computer with a selected land cover image of a scene can be done in still or motion modes, specifying ways and the speed of the motion. The vertical/horizontal ratio of scales in a 3D image can be adjusted, as well as the overall scale. The viewer has other functions such as free drawing on the land-cover image, measuring a distance between specified points and the size of a specified area.

As an illustration, we show Mt. Fuji and the surroundings in Figure 2 in the true-color image. By changing the dip angle and the direction of the viewpoint, one may easily understand the topography of the scene very well.

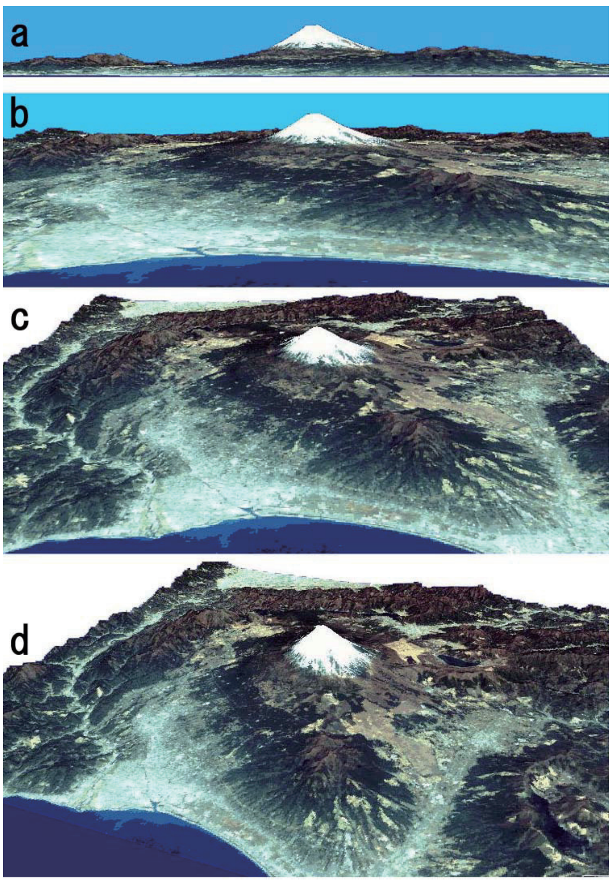

Figure 2. Mt. Fuji and the surroundings in the true-color image, observed from the south with different dip angles (a, b, c), and from SSE (d).

The viewer may run on a Windows computer with the OS 98SE, ME, 2000 and XP. It may also run on a machine with Windows 95 and 98 with direct-X installed. As for the Mac, appropriate Windows emulator is necessary.

3. NEAR-INFRARED PHOTOGRAPHY

Close to the half amount of the solar energy belongs to the reflective infrared wavelength, about 0.78 - 4 µm, and it is an important factor to determine the climate condition on the earth's surface. Multi-spectral satellite image data are good teaching materials to explain the properties of the infrared radiation in reflective and thermal bands. The reflective band is composed of near and intermediate infrared bands. The near-infrared (NIR) photography by a digital camera may contribute further to understand the satellite imagery and the NIR radiation.

3.1 Filters for NIR Photography

Ordinary CCD sensors in digital cameras have primitive sensitivity to the radiation up to about 1.1 µm. A cut-off filter is put in front of a CCD to shield the NIR light, while passing visible light, so as to accommodate with the color sensitivity of human eyes. In the night-shot mode, the cut-off filter against NIR band is removed, so as to increase the sensitivity under dark situation, with the sacrifice of the color balance. Recently, IR filters to cut-off the visible band with the boundary around 840 nm are available. In the night shot mode equipped with such filter as shown in Figure 3, one can get NIR images of 0.84-1.1 µm.

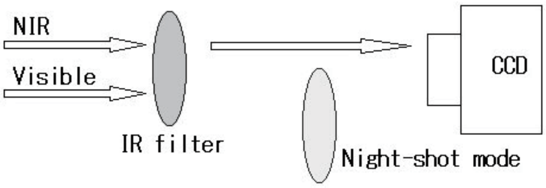

Figure 3. Visible and NIR lights versus filters on a CCD camera head for NIR photography.

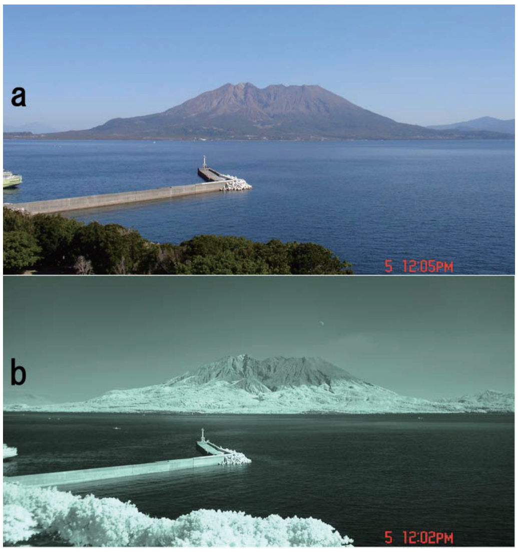

Figure 4. Mt. Sakurajima taken by a digital still camera SONY DSC-V3 at 9.8 km WSW from the summit on 5 Feb. 2006 at 12 JST. (a) Daylight mode. (b) Night-shot mode with Fujifilm IR84 filter.

Let us compare visible and NIR photos of Mt. Sakurajima and the surroundings shown in Figure 4, taken by a digital still camera SONY DSC-V3 in (a) ordinary mode and (b) night-shot mode with IR84 filter, respectively. In the NIR photo, vegetated areas are bright, while the sea surface is very dark and the summit part lacking vegetation is rather dark. The contrasts between sunny and shadow parts are enhanced in the NIR photograph with respect to visible one.

The NIR photography with a SONY video camera has been developed for the quantitative survey of very hot anomaly at Aso volcano, Japan by Saito et al. (2005). For the daytime use of a video camera for various purposes, a neutral density (ND) filter is necessary to reduce lights, since the iris is maximally open in the night-shot mode (Kinoshita et al., 2004, and papers cited therein). The ND filter is unnecessary for the NIR photography with DSC-V3, in which the auto iris works in the night-shot mode. A proto-type of this camera, DSC-V1, has been utilized for the remote sensing from a balloon (Fukuma et al., 2005).

3.2 NIR Photography from the Air

It turned out very easy to take NIR photographs from an airliner by using a digital camera with IR filter. We may obtain remarkably clear view through the NIR light, in contrast to misty or hazy view in the visible light.

Let us compare an aerial photograph of Hakone volcano from the south, Figure 5, and a SiPSE-3D image from the east, Figure 6, This volcano stands about 30 km south-east from Mt. Fuji, and is partially seen in Figure 2d at the down-right corner. The large caldera structure with Lake Ashi is realistic in both images. As for Figure 5, the topographic structure is much enhanced owing to the shading by the sunshine with rather low elevation. In general, NIR images are sensitive to the direction and elevation of the sun, and disturbed by small drifting clouds.

Figure 5. Hakone volcano from southern air on 27 Dec. 2005 at 15:19 JST taken by a camera as in Figure 4b.

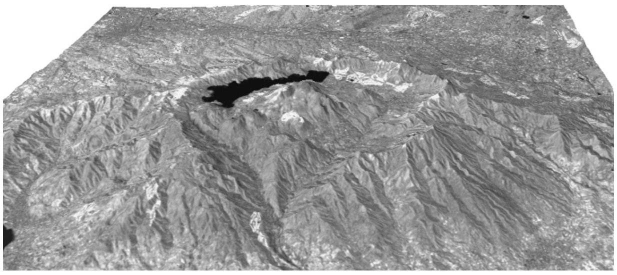

Figure 6. SiPSE-3D NIR image of Hakone volcano from eastern sky.

4. SATELLITE 3D SCENERIES

4.1 Volcanic Topography and Land Cover

There are a lot of beautiful volcanic sceneries in Japan, such as Mt. Fuji and Mt. Hakone near Tokyo, and Mt. Sakurajima and others in southern Japan. They are nice subjects of the SiPSE imagery, as illustrated in a book (Kinoshita et. al., 2005).

In Figure 7, we show the 3D images of Hokkaido-Komagadake in northern Japan, observed from southern sky. We see the lack of vegetation around the summit as dark places in the NIR image, Figure 7c, similar to the ground NIR photograph of Sakurajima volcano, Figure 4b. We may see the topographic structure of the stratovolcano with the U shaped crater toward the east, by changing the viewing direction in the SiPSE data viewer. Figure 8 is the caldera lake Shikotsu in Hokkaido with three volcanic mountains along a NW-SE line, where the lack of vegetation on Tarumae volcano is evident in this NIR image.

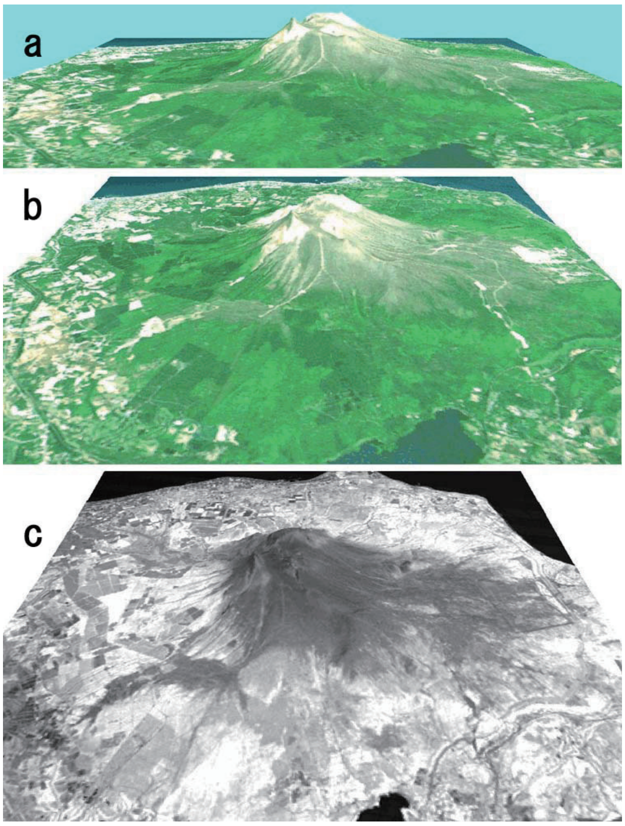

Figure 7. Hokkaido-Komagadake volcano observed from southern sky in true-color (a and b) and NIR (c) images.

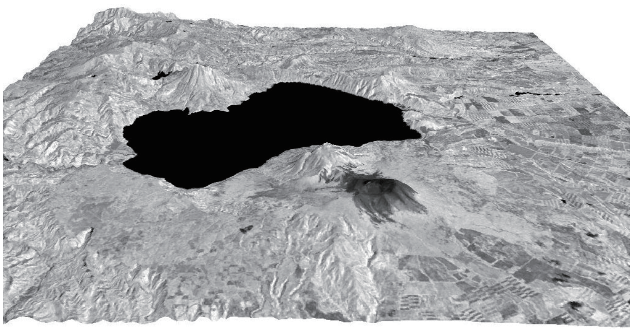

Figure 8. NIR image of Lake Shikotsu observed from southern sky. Eniwa-dake, Fubbushi-dake and Tarumae volcanoes are seen.

Thus, the SiPSE system may be utilized to improve the understanding of the topographic situation around volcanoes as a basis for the prevention of the volcanic disasters.

4.2 Mountains in Central Japan

There are series of steep mountains from north to south in central Japan, called the Japan Alps. They are composed of Hida mountains called Northern Alps shown in Figure 9, Kiso mountains called Central Alps and Akashi mountains called Southern Alps shown in Figure 10. These 3D images are in true color observed from southern sky. Thus, the SiPSE system is able to represent the topography and the land cover of wide mountainous areas.

Figure 11 is an aerial NIR photograph of Southern Alps from southeast. Central Alps is seen at the back-left and southern part of Northern Alps is seen quite far, mixed with clouds. The NIR view near the horizon thus reaches quite far.

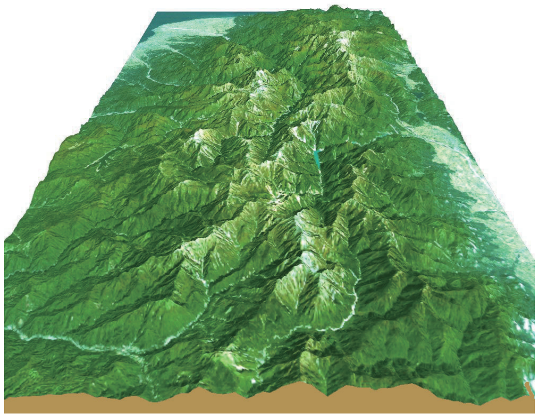

Figure 9. Northern Alps in true-color SiPSE-3D image with 45 km x 90 km observed from southern sky.

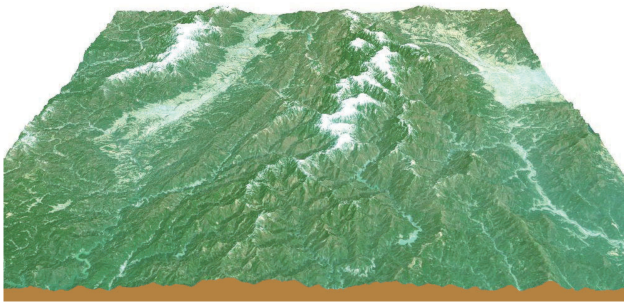

Figure 10. Central Alps (up-left corner) and Southern Alps (center) in the true-color image with 90 km square observed from southern sky.

Figure 11. NIR photograph of Southern Alps from an airliner at south-east direction on 14 Dec. 2003, with a video camera DCR-TRV30 equipped with IR84 and ND filters.

4.3 Rivers in NIR Images

Water areas are clearly seen in NIR images as very dark objects in contrast to land areas. Therefore, river lines may be found depending on spatial resolution. Figure 12 exhibits the meandering flow of the Kumano River in the mountainous district of Kii, formed as an antecedent river before the uplift of Kii Peninsula.

Figure 13 shows the Chikuma River flowing toward northeast in Nagano basin, where Sai-kawa is joining from the west. The Chikuma River is the midstream of the Shinano River, the longest river in Japan, and the central part of this figure is the old battlefield Kawanakajima between UESUGI Kenshin and TAKEDA Shingen in the medieval age of civil wars. SiPSE-3D images may be useful to understand such historical scenes.

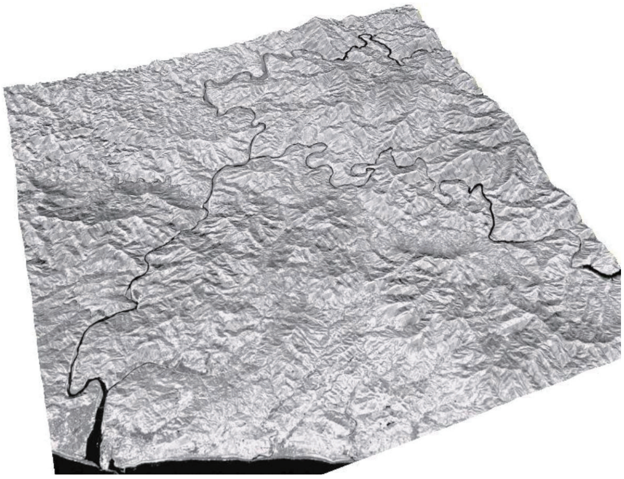

Figure 12. NIR image of the Kumano River observed from the ESE sky.

Figure 13. NIR image of the Chikuma River and Sai-kawa observed from southern sky.

4.4 Lake Biwa

The largest lake in Japan is Lake Biwa near the east of Kyoto shown in Figure 14. The lake color reveals duckweeds on the southern part of the lake, while the NIR image shows topographical structure of the surroundings. Especially, Hanaore fault line, known as Kuchiki valley, along western side of the lake is remarkable. An aerial NIR photograph of the valley and the west coast of the lake is shown in Figure 15. Lake Biwa can be seen by the NIR view from the air at quite long distance, as shown in Figure 16.

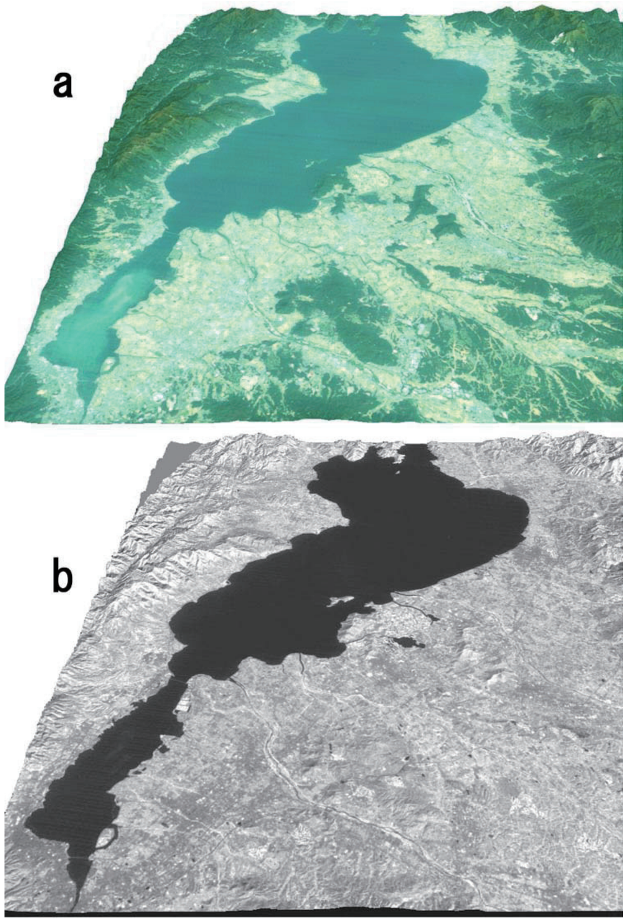

Figure 14. Lake Biwa observed from southern sky in true-color (a) and NIR (b) images.

Figure 15. An aerial NIR photograph of western side of Lake Biwa and Kuchiki valley from the south on 4 Mar. 2006..

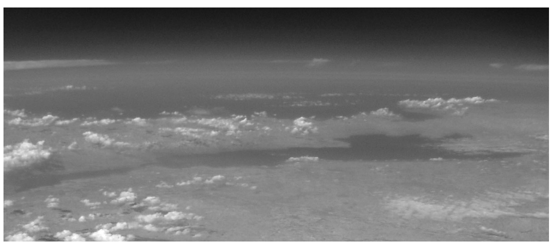

Figure 16. An aerial NIR photograph of Lake Biwa from 120 km southeast on 4 Nov. 2005.

4.5 Anglo-Satsuma War

On 16 August 1863, the British naval action in Kagoshima Bay resulted in the battle between Satsuma clan and the British fleet. This event turned out to be an important turning point in the Japanese history toward modernization to accept Western civilization. The course of the fleet is described in Figure 17. Although basic features of the topography did not change much for many years, there are remarkable changes of coastlines owing to civil construction works reclaiming land from the sea and the lava flows from Sakurajima volcano. In Figure 17, coastlines are restored to the old time by an off-line version of the SiPSE system.

Figure 17. The course of the British fleet at the Satsuma-British war, observed from southern sky.

5. CONCLUDING REMARKS

Let us summarize the properties of the SiPSE on-line system and the data, which can be used freely for non-commercial purposes.

a. The SiPSE data viewer is able to drive a satellite 3D image in real time motion in a Windows computer with ordinary specification.

b. The source data of Landsat TM 1-4 and DEM covering Japan are prepared to provide a set of SiPSE data to be downloaded.

c. The band structure of the Landsat TM data is maintained in the SiPSE data, which can be handled by the viewer.

d. The NIR 3D image is useful to understand the topography, and to compare with the digital NIR photography.

e. The output SiPSE images as well as the real time 3D demonstrations are useful for the e-Learning with various purposes.

In addition to the on-line system, off-line systems are being developed for research and international uses. Finally, let us mention some other activities in Japan and the world, complimentary to our approach. A landscape computer graphics software Kashmir has been developed based on DEM by Sugimoto since 1995. It has now a function to use natural-color images of one hundred famous mountains by ASTER sensor provided by National Institute of Advanced Industrial Science and Technology (Sugimoto, 2003). Landsat images of large cities in Japan are also provided to the members of Sky-viewscape (Sugimoto, 2005).

In June 2005, Google Co. Ltd. released the free software Google Earth that combines satellite imagery, maps and the power of Google Search on the worldwide basis, as far as the satellite images and DEM data are prepared, on http://earth.google.com/. It runs on Windows 2000 and XP computers, and the data should be used by the streaming through the Internet. The document is in English and a broad Internet traffic is necessary.

Thus, the approach to obtain bird's eye views by using 3D images on personal computers may serve as a powerful method to improve our understanding of the satellite images, and provide useful materials for the e-Learning.

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COMPUTER-ASSISTED SURVEYING EDUCATION USING 3D SIMULATOR

Yoichi KUNII [a], Hirofumi CHIKATSU [b], Tatsuya OHDAKE [b], Kunihiko ONO [a]

[a] Japan Association of Surveyors, 1-3-4, Koishikawa, Bunkyo-ku, Tokyo, 112-0002, JAPAN
kunii@geo.or.jp, ono@jsurvey.jp
[b] Department of Civil and Environmental Engineering, Tokyo Denki University,
Ishizaka, Hatoyama, Hiki-gun, Saitama, 350-0394, JAPAN
{chikatsu, ohdake}@g.dendai.ac.jp

Commission VI

KEY WORDS: Simulation, Education, Learning, Computer, Surveying, Design, Error, Three-dimensional

ABSTRACT:

In order to support self-paces learning of field survey practice and error concepts, 3D surveying simulator was developed by the authors. Contents of the 3D surveying simulator are traverse and leveling survey, and each kind of survey can be simulated. In addition, several procedures for each survey can be experienced; e.g. points setting, measurement of angle and distance and so on. Notwithstanding whether or web-based environment, the use of 3D surveying simulator allow students to learn design, practice and error concepts of survey at their own space. This paper will describe the 3D surveying simulator. Furthermore, the simulator was used for lecture of university, and evaluates the simulator under questionnaire for students.

1. INTRODUCTION

Recently, surveying educations in many universities and colleges are expanded for involving new technologies which are GPS, GIS, remote sensing and digital photogrammetry. However, in order to prevent declination of academic ability for engineering students in Japan, the trend for curriculum constitutions in some universities are prioritized fundamental or social educations. Therefore, the curriculums of surveying education are decreased in such universities.

In these background, the lecture of field survey practice couldn't be mastered enough surveying techniques. In addition, there are some issues for the field survey practice that influence of weather, requirement of expensive equipments and so on. Furthermore, error concepts for measuring are into black box due to simplification of the operation for recent technical innovation.

On the other hands, some study support systems which utilize recent communication technology have been receiving more attention; e.g. debate learning support system (Obayashi, et al., 2002), web-based field survey practice simulator (Shortis, 2001), environmental learning based on mixture of real and virtual experiences (Okada, et al., 2004) and so on.

In these circumstances, in order to support self-paces learning of field survey practice and error concepts, 3D surveying simulator was developed in this paper. Notwithstanding whether or web-based environment, the use of the 3D surveying simulator allow students to learn design, practice and error concepts of survey at their own space.

This paper will describe the 3D surveying simulator and evaluate the simulator under questionnaire.

2. 3D SURVEYING SIMULATOR

The 3D surveying simulator is constituted 2 kinds of survey which are traverse and leveling survey. This paper describes the simulator mainly along the traverse. The operation flows for the traverse by the simulator are as follows.

2.1 Selection of Area and Equipment

The simulator prepares 3 kinds of measuring fields and 3 classes of total stations, and the students can select from them in the main menu, and survey simulation can be performed on own situation. Figure 1 shows a main menu window for the simulator.

Figure 1. Main menu

2.2 Point Setting

Some measuring points for the traverse are set on the selected field, and traversal network is constituted automatically. Figure 2 shows the measuring points and the traversal network. However, each neighbouring point should be viewed for traverse. Therefore, the point setting operation should be considered topographical undulation and occlusion. Therefore, the students can study importance of the point setting operation. Figure 3 shows confirmation of viewing.

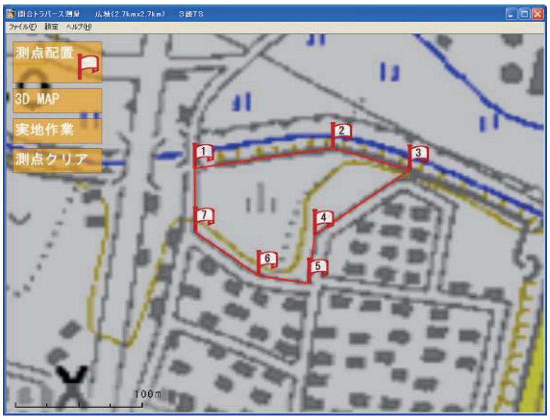


Figure 2. Measuring points and traversal network

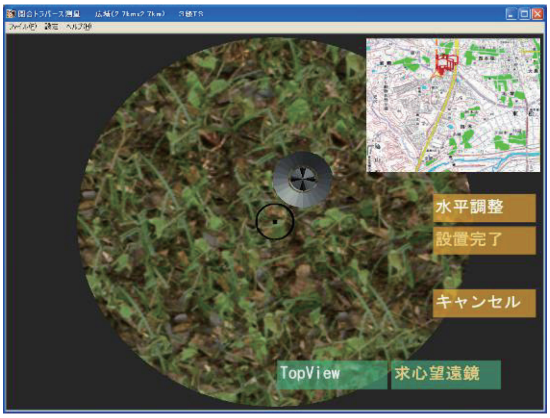


Figure 5. Centripetal

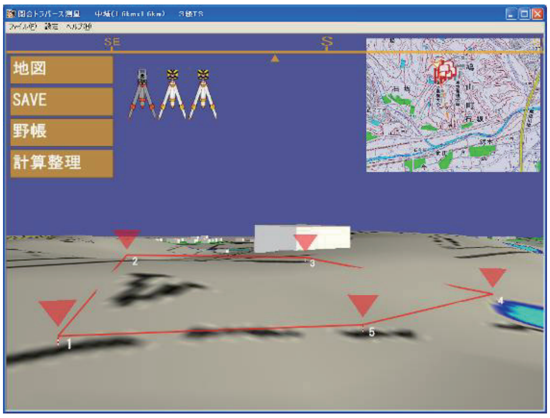


Figure 3. Confirmation of viewing

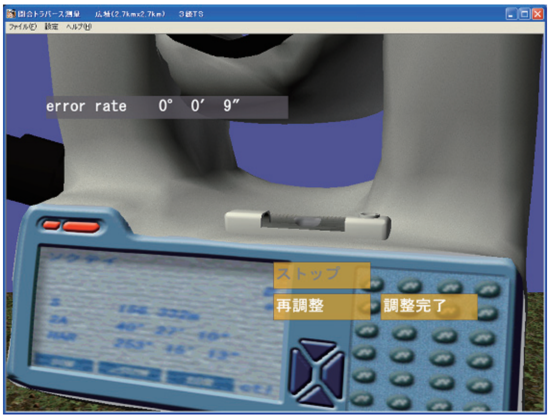


Figure 6. Leveling

2.3 Equipments Setting

The total station and reflectors are set at each measuring points, and distances and angles can be measured. Figure 4 shows operation for setting of equipments. However, centripetal and leveling operation should be performed before these measurements in the simulator. Therefore, the students can study similar to real operation by using the simulator. Figure 5, 6 shows centripetal and leveling operation.

2.4 Measurement of Distances and Angles

The measurement of distances and angles for traverse can be experienced by the simulator. The students can experience not only operation of the equipments but also generation of some kind of errors which are collimation, pointing and centripetal. In addition, accuracy for the distances and the angles are varied for the selected class of the total station. Therefore, error concept also can be studied by the simulator. Figure 7, 8 shows collimation of the reflector by peep sight and telescope.

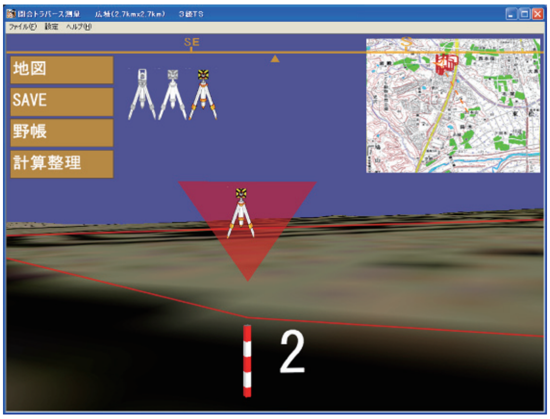


Figure 4. Setting of equipments

Figure 7. Collimation by peep sight

Figure 8. Collimation by telescope

2.5 Movement of Equipments

The total station and reflectors are moved to next point, and repeating these procedure to the last point. After the surveying for all points, ratio of closure, error of closure and area are calculated, and the students can evaluate own results.

2.6 Leveling Survey

The simulator also can be experienced leveling survey. Figure 9 shows collimation of a staff by leveling telescope. The staff is moved to up and down, and the scale is read by the student. Nevertheless, the operation of points and equipment setting and so on are almost same method to the traverse.

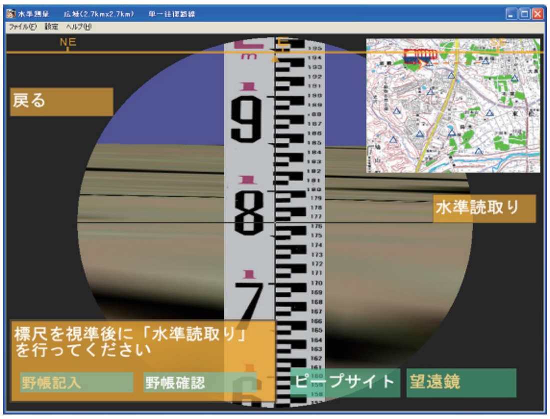


Figure 9. Collimation by leveling

3. SURVEY PRACTICE BY "3D SURVEYING SIMULATOR"

The survey practice was lectured by using the simulator in Dept. of Civil and Environmental, Tokyo Denki Univ., Japan. The lecture of the survey practice was performed 15 units in a semester, and the simulator was used in 3 units out of those units. The simulator for leveling and traverse survey were used in the lecture respectively, and all of class (120 students) were operated by using own PC. Figure 10 shows lecture scene by using the simulator.

The practice for leveling was performed as an establishment of new benchmark. Figure 11 shows the simulator of leveling. These red square points are existing benchmarks, and "P" is a new point. The students selected any 3 benchmarks, and altitude for the point P was measured by leveling survey for 3 routes from selected benchmarks to point P. Furthermore, in order to evaluate own results and study error concept, most probable value and root mean square error for the altitude of point P were calculated for own results by each student. Figure 12 shows the root mean square error and number of students.

On the other hand, the practice for traverse survey was performed specific area shown in figure 13. The student learned not only equipment operation, but also points and equipment setting or error concept. Furthermore, the grade of the subject for each student was evaluated under the ratio of closure. Therefore, in order to acquire acceptable results, the students tried so many times in the lecture. Figure 14 shows the ratio of closure for the traverse and number of students.

Figure 10. Lecture by using "3D surveying simulator"

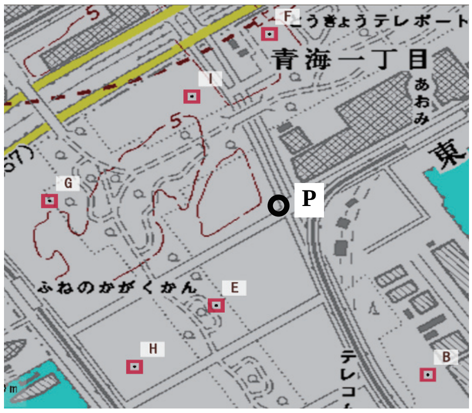


Figure 11. Benchmarks and new point

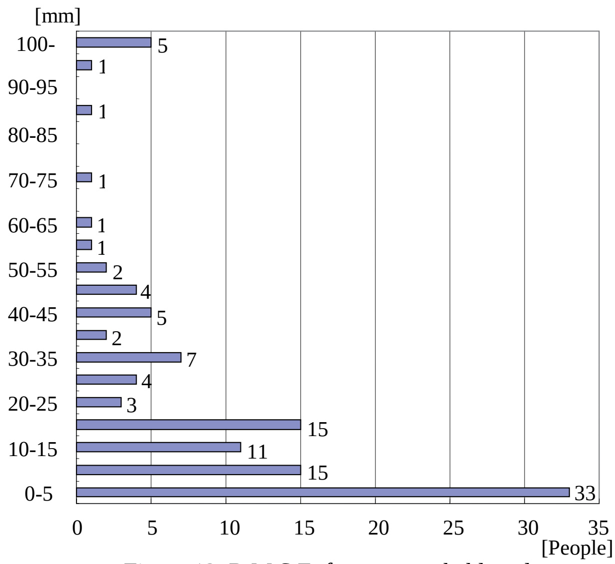


Figure 12. R.M.S.E. for most probable value

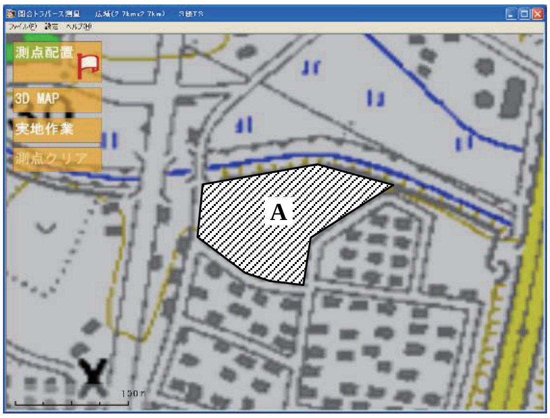


Figure 13. Area for traverse

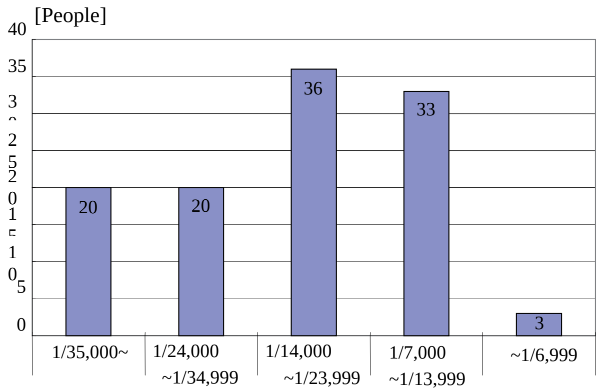


Figure 14. Ratio of closure

4. QUESTIONNAIRE FOR “3D SURVEYING SIMULATOR”

After the lecture, a questionnaire for the simulator was performed for the students. Figure 15 shows questions and results of the questionnaire. Some results for the questionnaire are as follows;

(Q1) Was the “3D surveying simulator” useful for understanding of methods and subjects of surveying practice?
Useful: 94%, Useless: 6%

(Q2) Was the “3D surveying simulator” useful for study of error concept and processing of surveying results?
Useful: 78%, Useless: 22%

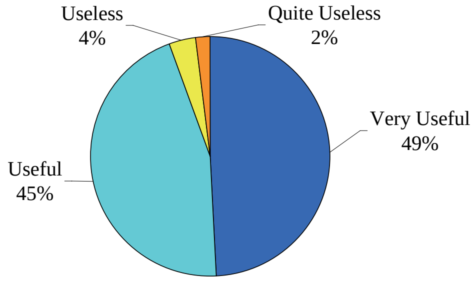
(Q3) How was an impression for the “3D surveying simulator”?
Interesting: 78%, Uninteresting: 22%

(Q4) Did you use the “3D surveying simulator” not only lecture of the university?
Yes: 65%, No: 35%

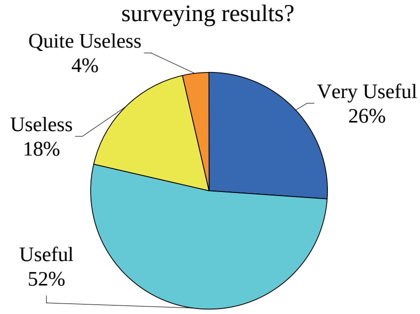
For these results, the simulator was useful for understanding of method and subjects for almost students, and error concept and processing of surveying results were also understood for many students. Furthermore, the impression for the simulator was answered “interesting”, and the simulator was used not only lecture by many students. Therefore, the students can study survey technology and error concept independently, and purpose for development of the simulator was realized.

On the other hand, 6% students who answered “Useless” for Question 1 answered also negatively for other questions. It is expected that such students couldn’t operate the simulator smoothly due to spec of own PC. However, the simulator was impressed “Useful” for 94% students, and it can be said the simulator is efficiently for surveying education.

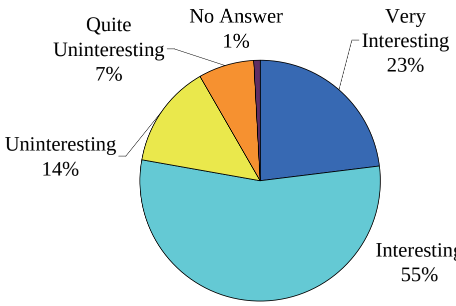
(Q1) Was the “3D surveying simulator” useful for understanding of methods and subjects of surveying practice?



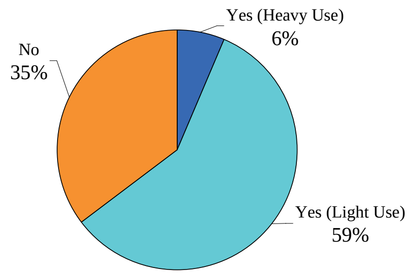
(Q2) Was the “3D surveying simulator” useful for study of error concept and processing of surveying results?



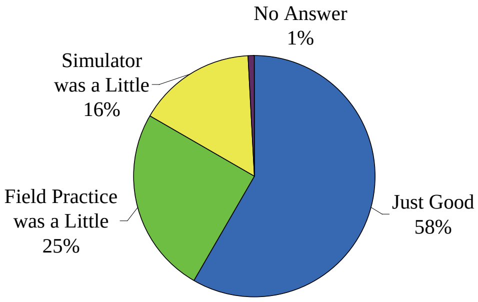
(Q3) How was an impression for the “3D surveying simulator”?



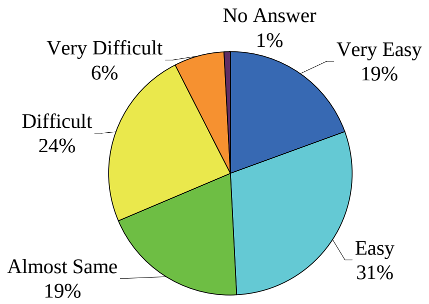
(Q4) Did you use the “3D surveying simulator” not only lecture of university?



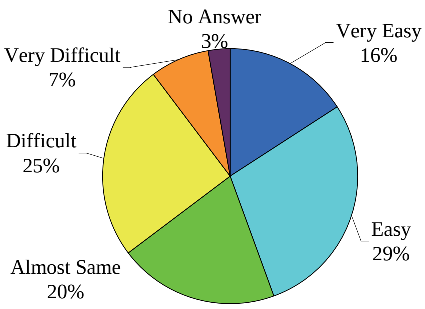
(Q5) How was a balance of number of units between field survey practice and the simulator?



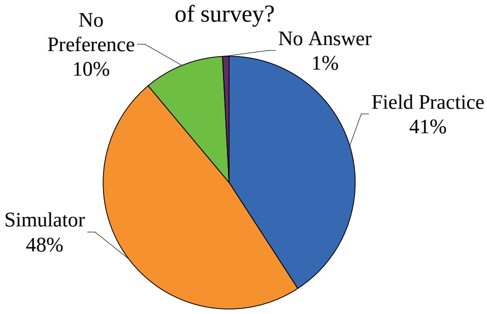
(Q6-1) How difficult was the simulator used than field survey practice? (Leveling)



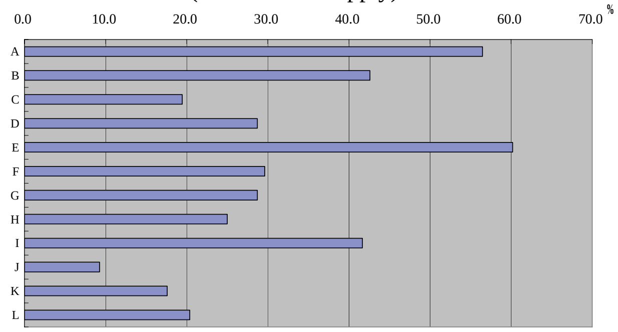
(Q6-2) How difficult was the simulator used than field survey practice? (Traverse)



(Q7) Which field survey practice or simulator should be learning earlier for easy understanding of survey?



(Q8) Please select the merit of the simulator (Select all that apply)



A: Easy understanding for contents of field survey practice
B: Virtual experience for field survey practice
C: Learning for error concept or processing of surveying results
D: Possible to review and preparation
E: Not influence for environment (whether, hot/cold, sunset)
F: Possible to learning anywhere
G: Possible to learning without survey equipment
H: Possible to retry easily for failure
I: Automatic calculation for results
J: Available for learning of PC operation
K: Like a game operation
L: Possible to learning alone

Figure 15. Results of the questionnaire

5. CONCLUSIONS

This paper investigates development of the "3D surveying simulator" for support self-paces learning of field survey practice and error concepts. In addition, the lecture of field survey practice by using the simulator was performed for the students, and the questionnaire for availability of the simulator was performed. As a result, the simulator was useful for understanding of method and subjects, and error concept and processing of surveying results were also understood for many students. Consequently, the students can study survey technology and error concept independently, and purpose for development of the simulator was realized.

As further works, addition of some contents for the simulator is still issue (e.g. surveying item and area); in particular, function for cost-effectiveness learning should be added on next version.

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SV3DVISION: DIDACTICAL PHOTOGRAMMETRIC SOFTWARE FOR SINGLE IMAGE-BASED MODELING

Diego González Aguilera [a], Javier Gómez Lahoz [a]

[a] Dept. of Land and Cartography Engineering, High Polytechnic School of Avila University Salamanca,
50, Hornos Caleros Street, 05003 Avila, (Spain) - daguilera@usal.es, fotod@usal.es

Commission VI, WG 1&2

KEY WORDS: Bologna Declaration, Photogrammetry, Didactical Software Development, image-based modeling.

ABSTRACT:

The modern World is constantly changing and education is one of the last things that do not get obsolete. However, its techniques must be adapted to newer resources and environments. Particularly, Photogrammetry is a science that has suffered from so many abrupt changes in the last fifteen years. We have passed from an enclosed and convergent dynamic characterized by Stereoscopic Aerial Photogrammetry, as well as the specialization in instruments and methods, to a divergent dynamic marked by flexibility in instruments, methodologies and relation with affine disciplines. Nevertheless, Photogrammetry continues relying on a strong hardware and software dependence. In fact, some companies have invested heavily on digital implementations for photogrammetric principles, and lead the market in order to obtain massive cartographic data production. Consequently, prices remained high and the access to photogrammetric equipment continues being limited only to those who can afford it.

The ISPRS Symposium organized by the Commission VI on “Education and Outreach” has a very interesting motto: “E-LEARNING AND THE NEXT STEPS FOR EDUCATION”. Our Photogrammetry Research Group at Salamanca University aims to contribute in this line through the development of an educational software known as sv3DVision. The basic idea is to develop photogrammetric tools that can be used as didactical elements as Computer-assisted teaching and training on Internet, Classes, Summer Courses and Seminars, in order to ease the students’ assimilation of main photogrammetric concepts. Furthermore, a new way of learning Photogrammetry supported by the Bologna Process, which stresses the importance of developing professional photogrammetric skills is put in practise.

The paper presents the following structure: the first section gives an overview about the European Higher Education Space (EES); the second section puts across our photogrammetric learning approach based on Bologna Process; the third section analyses the sv3DVision educational software: from its main features to its own didactical structure; a final section is devoted to remark the main conclusions and future perspectives.

1. INTRODUCTION: TOWARDS THE EUROPEAN HIGHER EDUCATION SPACE (EES)

The University passes through an important change patronized by the European Cultural Frame, whose principal aim is to preserving social and ethical values, as well as to adapt socioeconomic and technological changes progressively. In this sense, the University, through its own research and educational duality, have to ‘fight’ in order to represent a principal role in the new European Higher Education Space (EES). This EES will allow more comparability and compatibility among Educational Systems, so a confluence of quality in the academic awards together with an optimal integration in the labor market will be a reality.

In this process towards the EES, the Bologna Declaration in 1999 supposes an important reference, not only because constitutes a coordination and integration tool, but also because performs as principal starting point, as well as precursor of guidelines at the University by 2010.

The formal and informal aspects associated to Bologna Declaration could be portrayed through Figure 1.

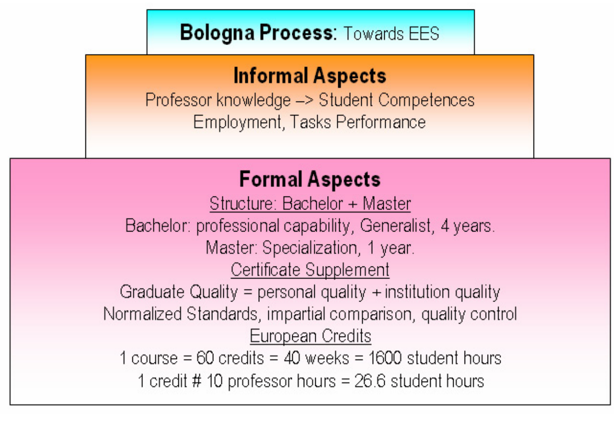

Figure 1. Formal and informal aspects of Bologna Declaration.

Next sections give an overview about a new way of learning Photogrammetry. Particularly, a partial e-learning approach based on the development of an educational software, *sv3DVision*, and the design of a pilot course, *Close-Range Photogrammetry and Computer Vision*, is proposed.

2. BOLOGNA PROCESS ADAPTED TO PHOTOGRAMMETRY TEACHING

The central concept around this new model is that the student instead of acquiring knowledge, develops skills that allow him/her to perform his/her future profession efficiently, considering his/her learning capability and thus his/her capability to self-evaluation. The most important innovation of this new paradigm is that we have passed from a teacher centered approach with students mastering academic contents to a student centered approach with students exercising professional skills. In this sense, the pilot course is structured, developed and evaluated according to students work and not in relation with the traditional contents mastered by the professor. The general aim is not that the student dominates a closed whole of photogrammetric and computer machine concepts and performs specific practices, if not that the student develops his/her capability for solving theoretic and practical tasks or projects related with Photogrammetry and Computer Vision. A tutorial function in its different modalities (individual, collective or electronic) supports this stage.

As a result, the following goals related with this pilot course could be remarked:

- The student should change his/her learning capability: from knowing Photogrammetry and Computer Vision to doing Photogrammetry and Computer Vision.
- The student should be immersed in the International Photogrammetry and Computer Vision Community.
- The student should build his/her own learning methodology, moving forward the self-learning.
- A self-evaluation should be applied in the whole process in order to obtain a permanent feedback

On the other hand, this pilot course is under the global scheme of Quality Assurance, which can be divided in three different principles:

- Transparency: those elements which constitute the course are public documents, thus everybody can access them.
- Coherence: each content of the course should have its own hierarchical structure, at the same time that establishes relation with others courses.
- Feedback: course should provide critical evaluations about its own elements. Furthermore, a feedback is given to students at the end of each theme through open tasks performance.

Next paragraphs describe the methodology applied to this pilot course. *Close-Range Photogrammetry and Computer Vision* course presents a workload of 160 hours (student work) divided in the following manner (Figure 2):

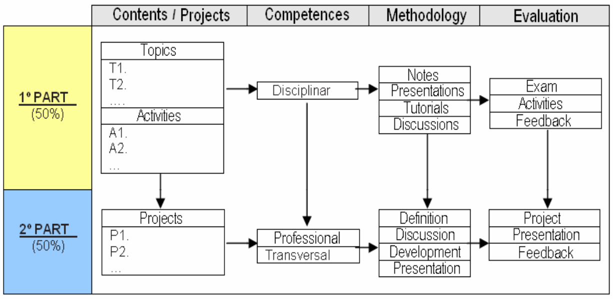

Figure 2. Pilot course planning.

1st part: BASICS PART. (80 hours)

Goal: Guarantee an active and meaning learning about Photogrammetry and Computer Vision. This part of the course is focused towards developing basics competences, which perform as support in the second part of the course.

- The contents are distributed through CD-ROM.
- Each theme is explained, commented and interpreted by the professor.
- Open questions and tasks are proposed by the professor in order to stimulate active and meaning learning.
- Contents are studied and analysed by students, taking into account their own criterion and study style, as well as the professor assistance.
- Contents are discussed by professor and students through individual or collective tutorials.
- Tasks related to open questions are put in common and evaluated by the professor.
- Evaluation of theoretical contents is carried out through partial exams. Only, those students who have solved open question correctly could access to these exams.
- Exams and open questions are corrected, commented and reviewed in order to provide feedback.

2nd part: PROJECT PART. (80 hours)

Goal: Develop tasks and specific projects related to Photogrammetry and Computer Vision, in order to develop professional (skills) and transversal competences. In this sense, the student can chose between the following proposals:

- Resolution of specific tasks.
- Algorithms development.
- Lecture, review or presentation about a specific or general topic.

- Documentation on Internet about the activities of International Community in Photogrammetry and Computer Vision.
- Design, develop and perform a photogrammetric and computer machine pilot project.

For these proposals, the methodology would be the following:

- Inform and study the proposals.
- Select one or several proposals to develop.
- Discussion with the professor about the proposal chosen.
- Design, develop and perform the proposal by the student.
- Public presentation about the proposal developed.

In the pilot course the discussion board and e-mail are used extensively, particularly for course announcements and the dissemination of additional reference material by way of attachments to messages. Such tools function well and are easy to use.

3. SV3DVISION: AN EDUCATIONAL PHOTOGRAMMETRIC SOFTWARE

3.1 Overview

In principle, the educational software sv3DVision consists of two parts: Knowledge and Tasks. In the 'Knowledge' part, sv3DVision describes the synergies between disciplines such as Close-Range Photogrammetry, Computer Vision and Computer Graphics, as well as the methodology developed for single image-based modeling. These contents are interlaced with hyperlinks to a glossary of technical terms and definitions, as well as supported with graphic illustrations. In the 'Tasks' part, sv3DVision allows to work under three different interfaces (Figure 3) in order to carry out exercises and simulations. This triple structure allow to work in different levels, from students who use the program only with learning purposes to PhD students who develop new tools and even professionals who are interested in applying the software to an specific context.

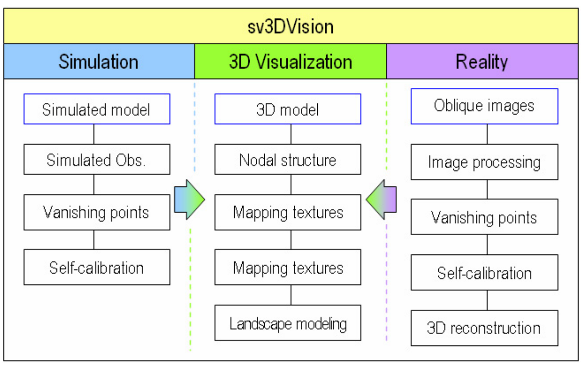

Figure 3. Triple structure in *sv3DVision*.

The general idea above the educational software sv3DVision can be portrayed by the following features:

- It constitutes a considerable change with respect to the classical photogrammetric software based on stereoscopic vision.
- It supposes a contribution in a multidisciplinary context, destined to the synergic integration of methodologies and tools of others disciplines such as: Photogrammetry, Computer Vision and Computer Graphics, providing an ideal learning and research frame and contributing with different approaches: from camera self-calibration and 3D reconstruction, to the interactive and dynamic 3D visualization on Internet.
- It establishes an own methodology for the 3D reconstruction from a single view combining several scientific approaches.
- It represents a multidisciplinary tool for the popularization and dissemination of the Architectural Cultural Heritage, as well as its utilization in research and education.

3.2 Simulation interface

Through the Simulation interface (Figure 4), the user can control whatever type of geometric or statistical parameter in the generation of a simulated model. The graphic and dynamic simulation of the perspective model is achieved based on the modification of camera parameters (internal and external) and the colinearity condition. In this way, the Simulator developed performs as a checkup platform, where the different input parameters such as: vanishing lines, accidental errors, gross errors and even the own radial lens distortion, can be setup in order to analyze the accuracy and reliability of the algorithms before being extrapolated to real situations (images).

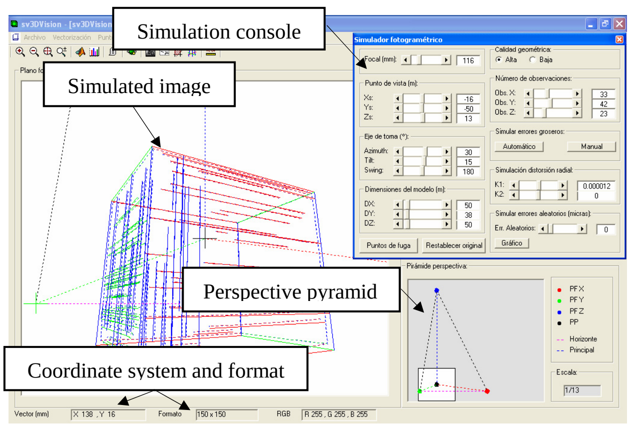

Figure 4. Simulation interface in sv3DVision

The simulation console (Figure 5) enables to control the following parameters:

- Camera geometrical parameters, corresponding to the internal and external parameters.

- Object simulated parameters, corresponding to the three orthogonal dimension (length, depth and height), as well as the datum definition.

- Quality geometrical parameters, corresponding to the maximum and minimum size of observations, segments inclination, as well as gross and an accidental errors ratio.

- Radial lens distortion parameters, corresponding to the value of the coefficients K_1 and K_2.

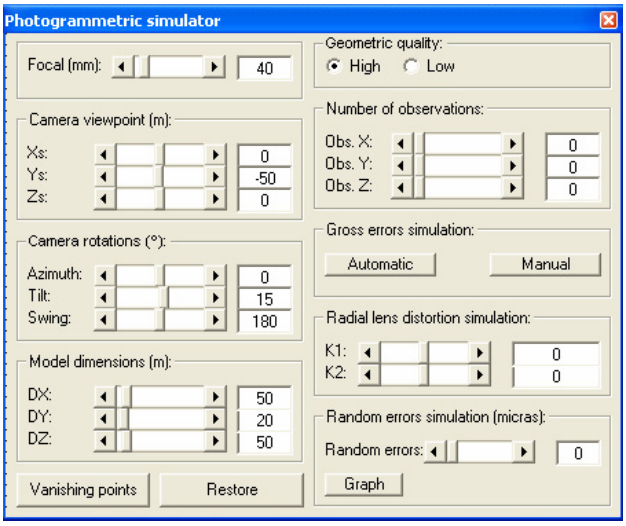

Figure 5. Simulation console in sv3DVision

A complete description of this simulation interface and its performance is given in (Aguilera et. al., 2004).

3.3 Reality interface

Through the Reality interface the user can work with real oblique images belong to architectural buildings, in order to obtain a 3D reconstruction from a single view.

Next, it will be described the most relevant features of sv3DVision corresponding to the Reality interface.

Digital processor. One of the most critical steps in 3D reconstruction from a single view resides in detecting with high accuracy and reliability the structural elements belonging to an oblique image. This is not an easy task, taking into account that usually images contains noise due to the own acquisition process as well as the radial lens distortion. So, although a huge proliferation of image processing algorithms exist currently, hierarchical and hybrid approaches are required in order to guarantee quality. Unfortunately, it does not exist an universal method for automatic vectorization, so the own requirements of each case define and adapt the algorithm. In this way, (Heuvel, 1998) applies a line-growing algorithm so-called Burns detector (Burns et al., 1986) for vanishing lines extraction; (Tuytelaars et. al., 1998) create a parameter space based on Hough transform (Hough 1962) to detect vanishing lines automatically; more recently (Liebowitz et. al, 1999), (Almansa et. al 2003) and (Remondino, 2003) apply Canny filter (Canny 1984) for the same purpose.

With relation to the methods remarked above, sv3DVision incorporates an original approach for processing oblique images. An automatic vectorization algorithm has been developed which presents a hierarchical structure that starts with the basic task of filtering and ends with the detection of basic primitives through segmentation and clustering approaches. Particularly, in a first level, a preliminary extraction of edges supported by Canny filter is performed. In a second level, basic primitives are obtained through a labelling process supported by colinearity condition. This step provides also an estimation of the radial lens distortion parameters. Finally, in a third level, the lines are clustered with respect to the three main vanishing points direction supported by a RANSAC (Fischler&Bolles, 1981) algorithm.

Figure 6 illustrates the result of clustering process for three vanishing points.

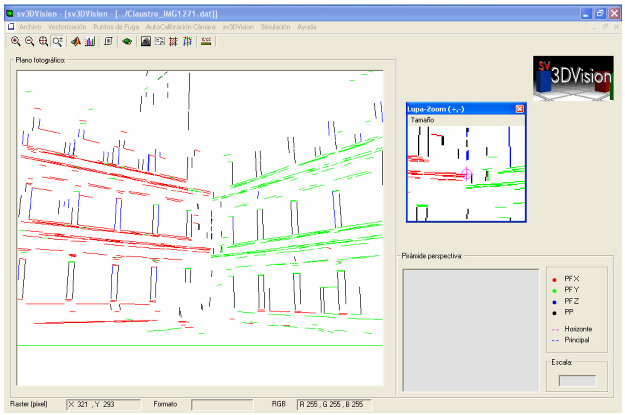

Figure 6. Clustering lines in sv3DVision

Vanishing points calculator. sv3DVision allows to combine several proven methods for vanishing points detection together with robust and statistical techniques (Figure 7).

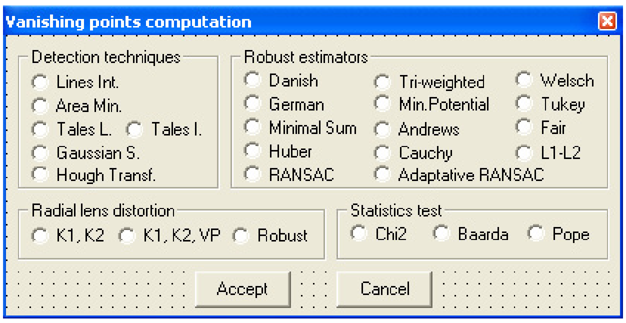

Figure 7. Methods and estimators for vanishing points detection in sv3DVision

A large selection of methods have been developed: from the easiest approaches such as: intersection of lines and triangle area minimization methods, to the most successful methods supported by Hough transform and Gaussian sphere. In regard to statistical tests, every one is based on a hypothesis contrast supported by several statistical parameters. Particularly, Chi-Squared Test allows to obtain a global balance about the model adequacy, while Baarda (Baarda, 1968) and Pope (Pope, 1976) Test allow to detect automatically possible outliers corresponding with wrong vanishing lines through an iterative technique that analyzes the standardized residual with respect to a established threshold. This threshold well-known as 'statistical cutoff or critical value' is determined based on a specific statistical distribution: Gaussian and T-Student distributions are applied for Baarda and Pope Tests respectively. Finally, with relation to robust estimators, a double classification can be considered: M-estimators which apply a specific weight function in an iterative re-weighted least square process (Domingo, 2000), and RANSAC robust estimators which combine the traditional (Fischler&Bolles, 1981) and adaptative (Harley&Zisserman, 2000) approaches, incorporating a specific adaptation to each vanishing point technique.

Camera self-calibrator. Single image calibration is a fundamental task starting in the Photogrammetry Community and more recently in Computer Vision. In fact, both share several approaches with different purposes: while Photogrammetry tries to guarantee accuracy and reliability, Computer Vision is more concerned about the automatization and rapidity in camera calibration. In this way, approaches exploiting the presence of vanishing points have been reported in Photogrammetry (Bräuer&Voss, 2001), (Heuvel, 2001) and (Grammatikopoulos et. al. 2003), as well as in Computer Vision (Caprile&Torre, 1990), (Liebowitz et. al., 1999), (Cipolla et. al., 1999) and (Sturm, 1999). In the context of Photogrammetry the general approach established is based on the use of three orthogonal vanishing points and some constraints among lines. Alternatively, in the context of Computer Vision, several approaches are supported by the computation and decomposition of the absolute conic from three vanishing points or the rotation matrix.

The self-calibration method performs by sv3DVision presents a hybrid character that combines approaches related to Photogrammetry and Computer Vision. On the one hand, applying tools belonging to the image processing and geometric constraints of the object in order to estimate the radial lens distortion parameters, and on the other hand exploiting the geometry of structural elements, mainly vanishing points based on the orthocentre method (Williamson, 2004), in order to compute the geometric camera parameters.

Therefore, sv3DVision allows to calibrate unknown or semi-unknown cameras taking into account the following assumptions: (*i*) the single image contains three vanishing points; (*ii*) the length (in 3D space) of one line segment in the image is known; (*iii*) the own geometry of the object provides the necessary constraints not being necessary to use calibration targets. In this sense, sv3DVision performs the camera self-calibration following a triple process: Firstly, internal camera parameters (principal point, focal length and radial lens distortion) are estimated automatically. Secondly, camera orientation is computed directly based on the correspondence between the vanishing points and the three main object directions. Then, camera pose is estimated based on some priori object information together with a geometric constraint.

More details about this calibration method are given in (Aguilera, 2005).

Oblique image rectifier. sv3DVision allows to rectify oblique images without using control points, once the vanishing points and internal camera parameters have been computed. In this sense, given an oblique image corresponding to a 3D object, the goal is to obtain a metric rectification of each plane that composes the object. This is equivalent to obtaining an image of a specific plane of the object where the camera's image plane and the object plane are parallel. Nevertheless, the own complexity of the scene which presents several planes with different depths carries that a partial rectification corresponding with each fundamental plane has to be performed. In this way, the user will have to define manually each one of the structural planes of the object and assign the corresponding geometrical constraint (Figure 8).

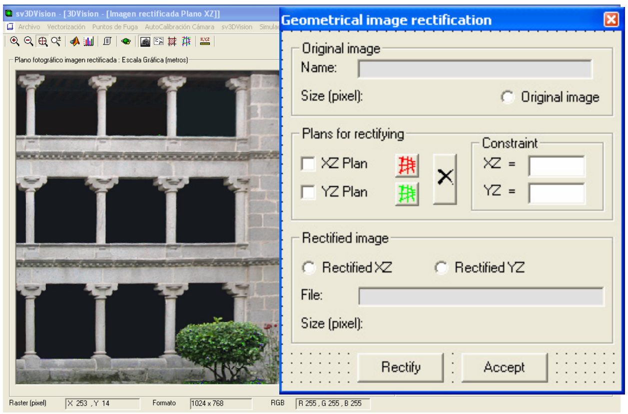

Figure 8. Rectification in sv3DVision

Particularly, the approach developed in sv3DVision is based on the projective transformation and in its decomposition using the Singular Value Decomposition (SVD) method (Golub&Reisch, 1971). As is well known, the map between an object plane and its corresponding image plane is a projective transformation. Habitually, this map can be determined from the correspondence of four (or more) points with known position. However, it is not necessary to determine the entire projective transformation in order to obtain a metric rectification (Liebowitz et. al. 1999); the plane rotation, translation and uniform scaling which are part of the projective transformation map, and account for four degrees of freedom, are irrelevant to the rectification. Thus, the idea is to determine only four of the eight parameters of the projective transform, exploiting geometric relation on the object plane such as parallelism and orthogonality. These geometric relations maintain correspondences in the image plane with the vanishing points and infinite vanishing line. Concretely, the infinite vanishing line determined by the union of two or more vanishing points, represents the image of the line at infinity of the object plane and allow passing from projective to affine geometry and the opposite. Thus, this line has two degrees of freedom which encode all the pure distortion of the plane. This interchange between transformations based on a decomposition of the projective transformation is carried out applying a SVD approach supported by several Gives rotations (Golub&Reisch, 1971), which allow to introduce zeros in the projection matrix selectively.

Dimensional analyzer. sv3DVision allows to analyze the different dimensions of the object based on coordinates, distances and areas, as well as contrasting the corresponding associated deviations in order to estimate the accuracy of the reconstructed 3D model (Figure 9). Particularly, sv3DVision incorporates procedures supported by colinearity condition and geometric constraints (coplanarity and parallelism) (Heuvel, 1998) that allow to obtain dimensions of whatever part of the object measuring directly onto the oblique image. Obviously, the camera calibration parameters must be known.

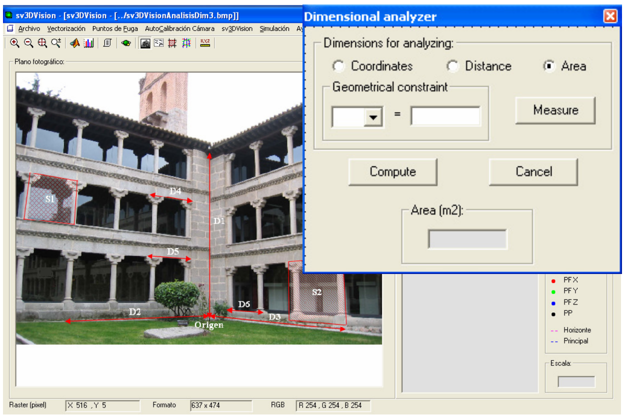

Figure 9. Dimensional analyzer in sv3DVision

An interesting approach to obtain whatever dimension related with the object from single images is developed in the ImageModeler software (ImageModeler, 1999).

3.4 3D Visualization interface

sv3DVision and its 3D Visualization interface (Figure 10) fulfils the following requirements and features:

Requirements

Flexibility*:* the 3D Visualization interface allows its utilization in an independent and flexible way, so we can work directly with VRML files in order to create, edit and visualize 3D models and scenes.

Extensibility: the 3D Visualization interface provides the possibility to develop new tools in order to improve the program.

Scalability: the 3D Visualization interface allows the combination of different 3D models together with real or artificial landscapes, in order to generate and extend complex scenes.

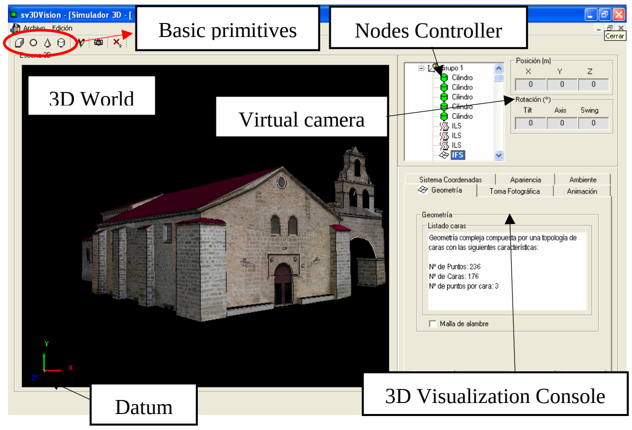

Figure 10. 3D Visualization interface in *sv3DVision*

Features

Obtain a 3D interactive visualization of the reconstructed model. The 3D Visualization interface provides an automatic transformation of the reconstructed 3D model into a topological structure (points, lines and surfaces) sorted hierarchically in a nodes network similar to VRML (Aguilera et. al., 2004).

Nodes Controller and 3D Visualization Console. The Nodes Controller and the 3D Visualization Console allow an integral control over the 3D model and the scene. In this way, whatever operation of creation, editing or deletion over the model or scene, will be performed selecting the element over the Nodes Controller and introducing the corresponding value in the Visualization Console (Figure 11).

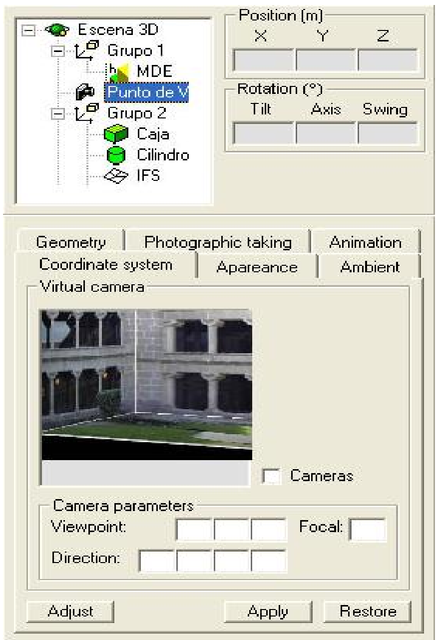

Figure 11. Nodes Controller and 3D Visualization Console

Define global and local coordinate systems. The 3D Visualization interface enables the definition of multiples coordinate systems that allow whatever spatial action: rotation, scale factor and translation over the model (local system) or scene 3D (global system).

Create and edit different types of geometries. The 3D Visualization interface allows to create, edit and visualize different types of geometries: from simple geometries (basic primitives) to complex geometries supported by the topology of points, lines and faces. Furthermore, the 3D Visualization interface allows three different levels of representation: (*i*) Wire-frame representation, which represents the geometry exclusively; (*ii*) Shaded representation, which represents the faces that integrate the object; (*iii*) Textured representation, which represents the faces that integrate the object together with its texture.

Scene modeling. The 3D Visualization interface allows to create and edit different environments: from artificial landscapes based on cylindrical or spherical illuminated panoramas which represent the remainder of the landscapes and far objects, to the automatic generation of real environments through Digital Elevation Models (DEM) with orthorectified textures (Aguilera et. al. 2005). The final integration of the 3D Model with the artificial or real scene will provide an increase in the level of realism (Figure 12).

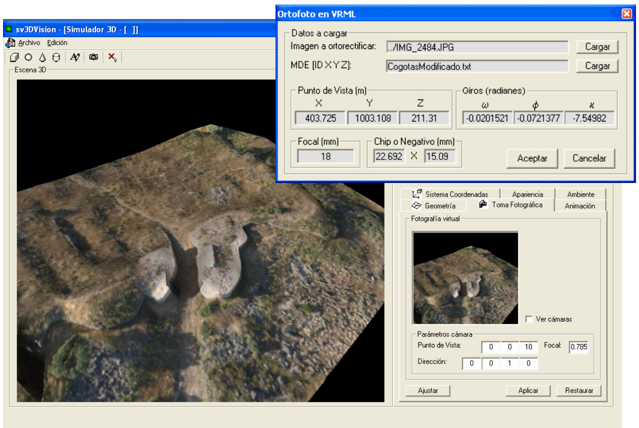

Figure 12. DEM and orthophoto generation in sv3DVision

Furthermore, a Triangular Irregular Network (TIN) generation structured over breaklines together with the incorporation of TIN topology is added in order to deal with vertical walls, event pretty common in archaeological excavations.

Materials and orthorectified texture mapping. Materials defined by their colours and radiometric properties (opaqueness, transparency, diffusion, reflection and emission), are mapped through a uniform and continuous renderization supported internally by VRML. Unfortunately, the photo-texture mapping cannot follow the same approach and a previous correction (rectification) will be required in order to obtain a realistic result. In this sense, an adaptation of 'Anchor Points Method' (Kraus, 1993) to VRML has been developed, allowing a orthorectified texture mapping between the 3D geometry and the image.

Virtual camera. The 3D Visualization interface allows the introduction of view points into the scene and the manipulation of the different camera parameters in order to visualize the object from whatever imaginable perspective. In this sense, the virtual photograph can be saved and used for different analysis and operations. Furthermore, a simple algorithm supported by a Proximitysensor node enables to obtain the camera pose in real time and thus the possibility to create animated flights.

4. CONCLUSIONS AND FUTURE PERSPECTIVES

Wit relation to the pilot course designed '*Photogrammetry and Computer Vision*', participants fell that the new system adapted to Bologna philosophy represent a very effective means of updating their knowledge and continuing their professional development. They fell the learning experience is a good one provided that feedback is forthcoming from course professor in a timely manner. Nevertheless, the generation of content suitable for the efficient learning of complex concepts is time consuming. Material must, therefore, be re-usable in other courses or educational resources. Tutorials covering complex concepts are possible through the use of communication tools provided they are well prepared and structured.

With relation to educational software development, sv3DVision represents a clear contribution in a multidisciplinary context, destined to the synergic integration of different methodologies and tools, in the 3D reconstruction from a single view. Therefore, teaching and research work can be presented as an interactive learning program. The 'knowledge' is presented by dynamic figures and hypertexts, while 'tasks or experiments' can be carried out with different free educational tools such as sv3DVision. Good learning is achieved by doing and by self-assessment.

Regarding future perspectives, our aim is to go on developing pilot courses together with free educational tools and software in order to incorporate them in a new master study program of Photogrammetry.

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AIRBORNE ALTIMETRIC LIDAR SIMULATOR: AN EDUCATION TOOL

Bharat Lohani, Parameshwar Reddy, Rakesh Kumar Mishra

Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur 208016, INDIA – blohani@iitk.ac.in

Commission VI

KEY WORDS: LiDAR, Simulator, Modelling of sensor, Education, Software, Tutorial

ABSTRACT:

This paper describes development of a simulator for airborne altimetric LiDAR. Main aim of simulator is to replicate the functioning of LiDAR sensor and generate data for a given terrain with specified parameters of the sensor and trajectory. The simulator has three components: 1) Terrain component, 2) Sensor component, and 3) Platform component. The terrain component is formed using multiple mathematical surfaces for bald terrain and for objects on top of the surface. The sensor component is designed to account for various parameters that can be set and varied in a LiDAR sensor. The third component attempts to replicate the platform parameters, viz., velocity, roll, pitch, yaw and accelerations. Simulated data should be similar to the data which might have been collected by actual sensor when operating with specified sensor and trajectory parameters over the given terrain. This is realized by first finding the time and space varying equation of laser vector and then determining the point of intersection of this vector with the mathematical surface representing terrain. Numerical methods are used to solve complex problems of determining the intersection of laser vector and ground surfaces. This GUI based simulator, developed in JAVA, will help in classroom and in producing data as required for conducting laboratory exercises.

1. INTRODUCTION

1.1 Background

The last decade has seen manifold growth in the use of airborne altimetric LiDAR (Light Detection and Ranging) technology. LiDAR data are complimenting several other remotely sensed data for various applications. At the same time LiDAR is competing with existing topographic data collection techniques. The main advantage of LiDAR is that highly dense and accurate topographic data are captured at high speed. In view of its typical characteristics and ease in data capture LiDAR is also finding applications in several new areas which were not considered feasible hitherto with conventional techniques.

1.2 Principle of LiDAR

LiDAR works by measuring time of travel of laser pulses fired from an airborne platform. The location and attitude of laser head are determined using onboard GPS (Global Positioning System) and IMU (Inertial Measuring Unit). The range computed using time of travel measurement is combined with the laser scan angle and attitude values to yield the laser vector. Transformation of laser vector from the laser head coordinate system to WGS-84 coordinate system is carried out to determine the WGS-84 coordinate of the point on ground hit by laser. The forward motion of platform combined with scanning in transverse direction measures a large number of points across a wide swathe on the ground.

1.3 Concept of simulator

A LiDAR simulator is aimed at faithfully replicating the LiDAR data capture process as discussed above with the use of mathematical models under a computational environment. Basically, data generated by simulator should exhibit all characteristics of the data acquired by an actual LiDAR sensor. Further, the simulator should possess flexibility of operation as in case of actual sensor.

Literature reveals that only a few attempts have been made by researchers to develop simulator for LiDAR instrument. These efforts are limited in their scope as either these consider effect of only single parameter on one kind of object (Holmgren et al., 2003) or inaccurate scanning pattern (Beinat and Crosilla, 2002). More focused and comprehensive efforts have been made to simulate the return waveform from a footprint (Sun and Ranson, 2000; Tulldahl and Steinvall, 1999).

1.4 Need of simulator

Considering the significance of technology there is a need to introduce LiDAR technology to students at undergraduate and postgraduate level. LiDAR instrument and data are costly. Collecting LiDAR data with varied specifications, as are desired for classroom teaching and laboratory exercises, may not be viable considering the cost and availability of instrument. A simulator can generate various kinds of data, as and when desired, at minimal or no cost. This data could be very useful for conducting laboratory exercises. User control over the entire data generation process in simulator can also help students in understanding the functioning and limitation of LiDAR instrument. Further, error sources and their effect on LiDAR data can be understood. In any laboratory exercise availability of ground truth is fundamental. While it may be difficult and expensive to collect ground truth in case of actual LiDAR data, for simulated data the ground truth is readily and accurately available.

In addition to education, there are several other applications where data generated by simulator can be employed. In particular, for testing the information extraction algorithms for their performance over a wide variety of data is conveniently possible with simulated data.

2. DESIGN CONSIDERATION FOR A SIMULATOR

Considering the aforesaid applications the following benchmarks are set for a simulator:

1. Simulator should employ a user-friendly GUI (Graphical User Interface.)
2. Simulator should be designed for wider distribution over various computational platforms.
3. The simulator should come along with a help/tutorial system which can explain concepts of LiDAR using user-friendly multimedia techniques.
4. It should simulate a generic LiDAR sensor and some widely available sensors in market.
5. The simulator should facilitate selection of trajectory and sensor parameters as in actual case along with the facility of introducing errors in various component systems of LiDAR.
6. Simulator should facilitate data generation for actual earth-like surfaces.
7. The output data should be available in commonly used LiDAR formats.

3. DEVELOPMENT OF SIMULATOR

In view of the aforesaid requirements programming language JAVA has been chosen for developing the simulator. This language offers good numerical and graphical programming besides, and most importantly, being platform independent. The simulator is composed of three basic components in addition to input and output modules as shown in Figure 1.

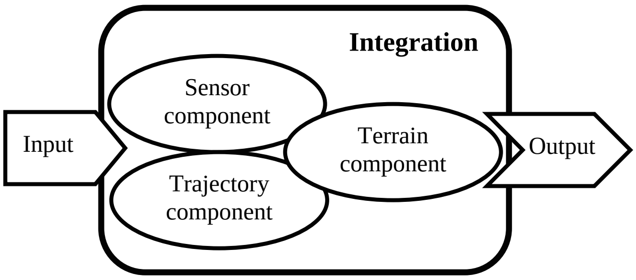


Figure 1. Basic components and their integration in simulator

These components take the form as per the user input, while their integration generates LiDAR data as desired by user. Each of these components is realised using a mathematical model. The following paragraphs describe development of these components as implemented in present version of simulator.

3.1 User input

Through a GUI the user is prompted to input various parameters as required to define the three individual components and output format. To help the user in understanding various terms and processes in LiDAR technology a help module is activated at any instance during the parameter input.

3.2 Trajectory component

As shown in Figure 2 two coordinate systems are considered. The first coordinate system is (X, Y, Z), which is absolute. All trajectory and terrain coordinates are determined in this system A system which translates with platform and remains parallel to absolute coordinate system is considered at the laser head and is referred to as gyro coordinate system henceforth. The second coordinate system is the body coordinate system, which has its origin at laser head and is affected by roll, pitch and yaw rotations. The laser vector at any instance is defined using direction cosines and coordinate of laser head in gyro coordinate system. The location and attitude parameters, as required at the instance of each laser pulse firing, are simulated as following.

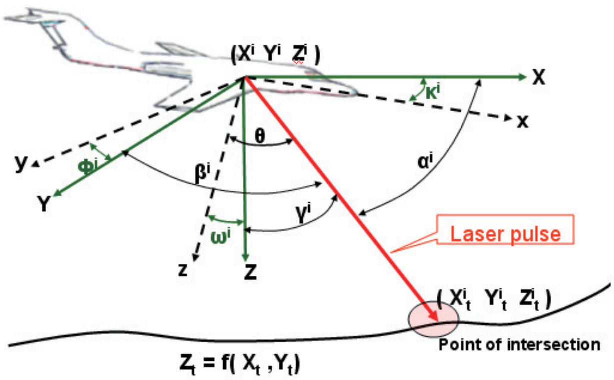


Figure 2. Schematic of laser vector intersection with a surface

3.2.1 Location

A trajectory is defined by the location of laser mirror centre (point of origin of laser vector) in the absolute coordinate system at each instance of firing of laser pulse. To simulate the trajectory and to incorporate a possibility of introducing errors in trajectory parameters the following procedure is employed.

Let:
Firing frequency = F.
Time interval between firing of successive pulses= $d_t = 1/F$
Total number of points on trajectory wherefrom pulses are fired = n
Velocity of platform in flight direction (which is considered here as X axis) at i^{th} point on trajectory = u_x^i
Laser head coordinate at i^{th} point on trajectory = (X^i, Y^i, Z^i)

At each successive d_t interval one needs to compute the location of laser head. The aerial platform is subject to internal and external force fields. While the external forces result in accelerations in X, Y and Z directions the internal force attempts to maintain a uniform speed and the designate trajectory. The net effect is that the platform is subject to random accelerations in three axes directions. The following system is employed to simulate accelerations. This system ensures a pseudo-random generation of acceleration values.

$$a_x^i = \sum_{j=1}^{J} A_j \sin(B_j(\frac{2\pi}{T}(id_t))) + \sum_{k=1}^{K} C_k \cos(D_k(\frac{2\pi}{T}(id_t))) \quad (1)$$

Where a_x^i is the acceleration at i^{th} point in X direction. T is the total duration of a trajectory. The parameters of this equation J, K, A, B, C and D control the nature of curve. Developed software permits selection of these parameter values within ranges that generate accelerations as may be observed in a normal flight. Similarly, a_y^i and a_z^i are also generated with different values of parameters in above equation. Using the acceleration values at i^{th} point the new location of laser head (i.e., X^{i+1}, Y^{i+1}, Z^{i+1}) after d_t interval is computed using equations similar to:

$$X^{i+1} = X^i + u_x^i d_t + \frac{1}{2} a_x^i d_t^{\,2} \qquad (2)$$

3.2.2 Attitude

As in case of acceleration, due to internal and external force fields, the attitude will change within certain limits and may exhibit a random behaviour. To realise this the attitude values (i.e. ω^i, φ^i, κ^i) at any i^{th} point are determined using the equation 1. Similar to the case of acceleration, the developed simulator permits selection of these parameter values in the ranges which generate attitude values as in case of a normal flight.

The outcome of aforesaid is that at each point wherefrom a laser pulse is fired the attitude values and coordinate of point are known in the absolute coordinate system.

3.3 Sensor component

The sensor component aims to replicate the scanning mechanism of sensor as per the user input parameters. The following differential equation is employed to simulate sinusoidal scanning pattern.

$$\frac{d^2\theta}{dt^2} + \frac{k}{R}\theta = 0 \qquad (3)$$

Where θ is the instantaneous scan angle measured from the z axis of body coordinate system. k and R are the driving acceleration and radius of the scanning mirror, respectively. Solution of equation (3) gives value of θ at any time t as:

$$\theta = \frac{\frac{S}{2}\sin(t\sqrt{\frac{k}{R}})}{\sin(\frac{1}{4f}\sqrt{\frac{k}{R}})} \qquad (4)$$

Where S is full scan angle and f is the scanning frequency as input by the user. At $t=0 \Rightarrow \theta=0$, i.e. beginning of scan, i.e. laser vector along z axis in body coordinate system. At $t=0.25*\text{time period} \Rightarrow \theta=S/2$.

3.4 Terrain component

Two approaches have been investigated for simulating the bald earth surfaces and above ground objects.

3.4.1 Vector approach

In this, a terrain is represented using mathematical equations, which yield earth like surfaces. A few of these are:

$$\begin{aligned} Z &= AX + BY + C \\ Z &= A[\sin(X/B) - \sin(XY/C)] + D \\ Z &= A[\sin(X/Y) - \sin(XY/B)] + C \end{aligned} \qquad (5)$$

The GUI permits selection of these surfaces and their parameters.

3.4.2 Raster approach

In this the surfaces resulting from above equations are rasterized. Most importantly, this approach permits populating the raster with above ground objects so as to create the terrain like a 3D city model. Those cells where an over ground object is desired to be placed take new values as per the height and shape of object.

3.5 Integration of components

In the heart of simulator lies generation of the laser vector and its intersection with simulated terrain. The point of intersection yields the coordinate of terrain point. As shown in Figure 2, for any i^{th} point on trajectory there exists a laser vector. The equation of laser vector is given as:

$$\frac{X - X^i}{a^i} = \frac{Y - Y^i}{b^i} = \frac{Z - Z^i}{c^i} \qquad (6)$$

Where a^i, b^i, and c^i are direction cosines ($\cos\alpha^i$, $\cos\beta^i$, and $\cos\gamma^i$, respectively) of laser vector with respect to gyro coordinate system at i^{th} point. The values of α^i, β^i, and γ^i are determined from known values of attitude (ω^i, φ^i, κ^i) and instantaneous scan angle (θ).

The point where laser hits the terrain, following the above laser vector, is computed by solving for intersection of equation (6) and equation (5) or the rasterized terrain. Solution is realised using specially formulated numerical methods. These methods differ for vector and raster terrain and also depend upon the basic equations employed to create terrain. Full description of these methods is beyond the scope of this paper. At this stage coordinates of all points of intersection (X_t^i, Y_t^i, Z_t^i) are known.

3.6 Error introduction in data

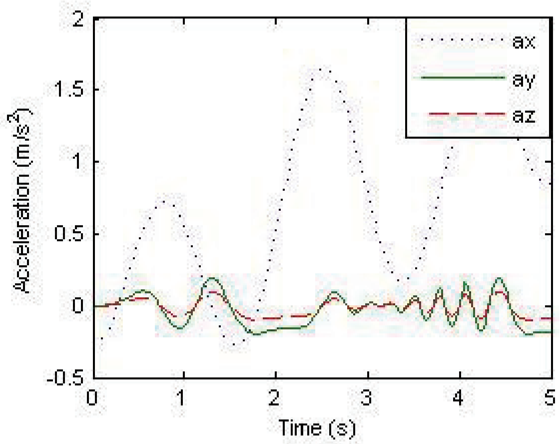
In present version of simulator a normal error is introduced in the terrain coordinates computed in the above step in X, Y and Z directions separately. The system for introducing error in X direction is shown below:

$$X_T^i = X_t^i + N(\mu_X, \sigma_X^{\,2}) \qquad (7)$$

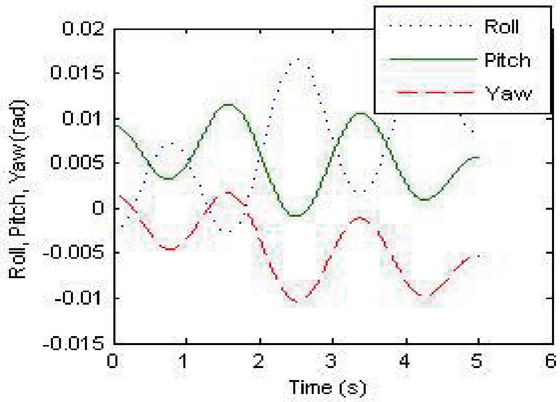
Where X_T^i is the X coordinate value with error. Similar systems with different values of parameters are used for Y and Z coordinates. It is assumed that errors in X, Y and Z directions follow normal distribution. Further, when introducing these errors it is ensured in algorithm that there is no spatial auto-correlation of error. The parameters of this distribution are known from field experience and are reported by the vendors of sensors. The simulator facilitates variation of these parameters.

4. RESULT AND DISCUSSION

Simulated trajectory and attitude parameters are shown for a duration of 5 seconds (Figure 3, a and b). Though, it is statistically difficult to compare simulated data with any set of actual flight data, as these two represent two different populations, the former amply exhibit the random nature of parameters as in any normal flight.



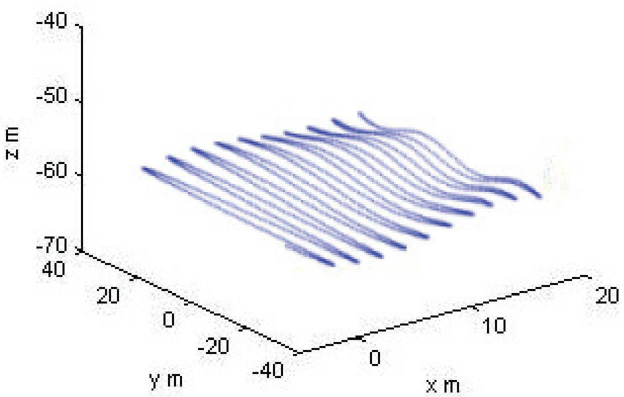
(a)



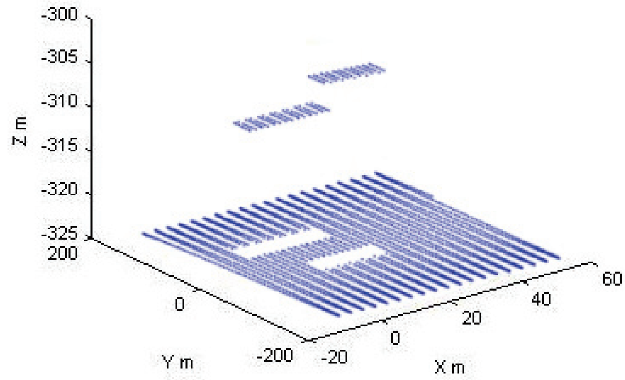
(b)

Figure 3: Acceleration (a) and (b) attitude values for simulated flight.

LiDAR data generated for two terrain types are shown in Figure 4 (a and b) along with the corresponding terrain parameters. For both of these cases the flight parameters are: $u_x^0 = 100$ *m/s, F= 10kHz, f=48Hz and S=50°.*



(a)



(b)

Figure 4: (a) Vector terrain *Z=sin(X/10)-sin(XY/90)-60* for *0<X<20* and *-40<Y<40* with flying height 60m; (b) Raster terrain at *Z=-325* for *0<X<50* and *0<Y<400* with flying height 0 m. First roof plane (20 m by 30 m) with left-bottom corner at (0 m, 30 m, 15 m) and second roof plane (15m by 30 m with slant height 5m) with left-bottom corner at (10 m, -40 m, 18 m)

The simulator is GUI based. Figure 5 shows example screenshots of user interface. The actual performance of software can be demonstrated when a user works on it.

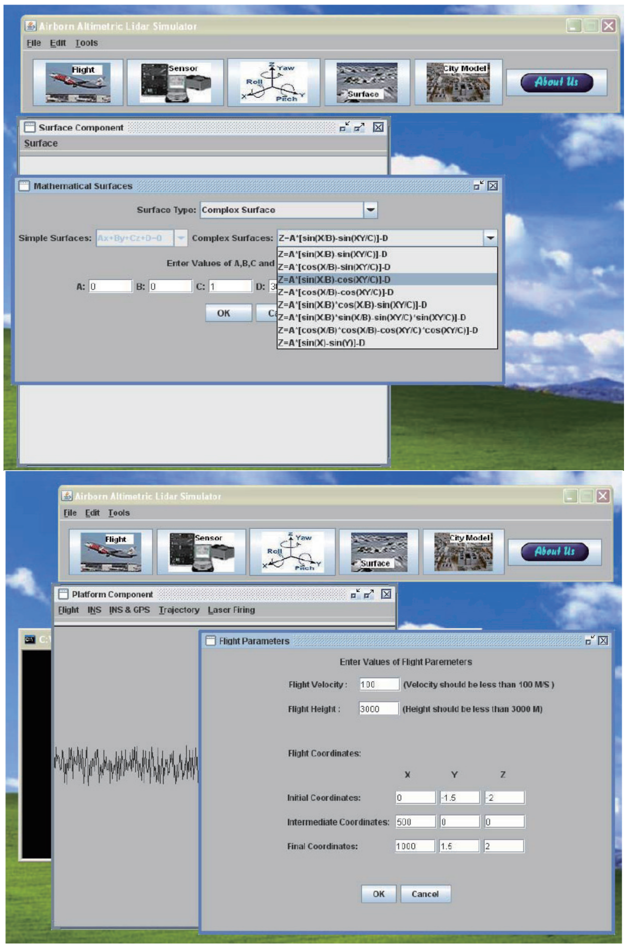


Figure 5: Two example screenshots showing user interface and input of parameters.

5. CONCLUSION

The developed simulator facilitates generation of LiDAR data for the user created terrain as per the specified sensor and trajectory parameters. The simulator can be highly useful in a classroom for demonstrating LiDAR data capture process and the effect of changes in flight-sensor parameters and error. Different kinds of data that can be generated along with accurate and full ground truth will help in conducting laboratory exercises.

The present version of simulator is being modified to incorporate more faithfulness by introducing separate GPS and IMU data collection and their integration; by introducing concepts of separation of GPS antenna, laser head and INS; by incorporating atmospheric effects and by facilitating for multiple returns, etc. Further efforts are on to generate a full waveform digitization. The main stumbling block in this development is simulation of bald earth and above-ground objects. Voxel representation of terrain will be attempted to handle this problem.

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THE ROLE OF ISPRS IN EDUCATION AND TRAINING WITHIN THE FRAMEWORK OF INTERNATIONAL ORGANIZATIONS

John C. Trinder
School of Surveying and SIS, University of NSW, UNSW SYDNEY, NSW 2052, Australia - j.trinder@unsw.edu.au

Commission VI, WG VI/3

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ABSTRACT:

The history of education and training efforts in ISPRS dates back to the early days of its formation in 1910, when it was realised that education and training were key components of the development of photogrammetry in member countries. Some of the recent achievements of the Commission include the compilation of worldwide data on educational institutions which are teaching the photogrammetry, remote sensing and spatial information sciences, and data of available web sites providing education data and training materials. Other international organisations have realised the importance of education and training in the fields of interest of ISPRS and also are developing programs in education and training. Some of these developments will be described in the paper. They offer ISPRS opportunities to participate and contribute to the worldwide efforts to improve education and training in the spatial information sciences, especially in the less developed and reform countries. Consideration will be given to how ISPRS can cooperate with these programs in the future.

1. INTRODUCTION

Since the early days of its formation in 1910, ISPRS has made considerable efforts to contribute to education and training in its technical commission activities. The relevant technical commission was originally responsible for other professional activities, such as dictionaries, bibliographies, and history. However, over recent years these latter activities have been deleted from the work of the commission so that it can concentrate on education and training, and communications or outreach. It has been difficult to attract a large audience into the Working Groups and technical sessions of Commission VI, but the work of the Commission is essential for the future of the Society and the community at large. This is especially so, given the large membership in ISPRS from developing and reform countries. Some of the recent achievements of Technical Commission VI include the compilation of worldwide data on the ISPRS Home Page on educational institutions which are teaching the photogrammetry, remote sensing and spatial information sciences, data of available web sites providing education data and training materials, and guidelines for the preparation of web pages in ISPRS. Constant funds are required to maintain this information. In addition, CATCON, the computer aided teaching competition held at each ISPRS Congress since 1996, has provided a boost to ISPRS resources of teaching software, since these packages are made available to ISPRS membership.

The developments in education and training by other international bodies have also been significant. These include: the Working Group on Education (WGEdu) of Committee for Earth Observation Satellites, (CEOS); Module 1 (on education and training) of the CEOS initiatives following the World Summit on Sustainable Development (WSSD) in 2002; the Capacity Building Committee of the Group on Earth Observation (GEO); the activities of the Joint Board of Geospatial Information Societies; and the International Council for Science (ICSU). They offer ISPRS opportunities to cooperate in the worldwide efforts to improve education and training in the spatial information sciences, especially in the less developed and reform countries. The intention of this paper is to describe developments in education and training in other organisations with interests in the spatial information sciences and consider how ISPRS can cooperate with these organisations.

2. INTERNATIONAL ORGANISATIONS

2.1 CEOS WGEdu

In 1999, the CEOS (Committee for Earth Observation Satellites) Plenary established a Working Group on education and training, named WGEdu. The Mission of the WG is:

> WGEdu will focus CEOS efforts in education, training and capacity building with the aim of maximising the societal benefits to be derived from the use of Earth observation data, particularly for developing countries.

The Objectives of WGEdu are:

> The WGEdu will establish an effective coordination and partnership mechanism among CEOS agencies and institutions offering education and training around the world. The key objective is to facilitate activities that substantially enhance international education, training and capacity building in Earth System Science and the observation techniques, data analysis and interpretation skills required for the use and application of Earth observation data to meet societal needs.

WGEdu has developed a Strategic Plan, a draft implementation plan on principles of satellite data provision in support of Earth observation (EO) training and education, guidelines on availability of and access to data for education and training purposes, and a "discovery portal" [http://wgedu.ceos.org], for the provision of the data. The Strategic Plan stated in part:

> "Education holds the key to future Earth observation technology development and its applications. Earth observation education and training is an essential element in today's competitive world. Several countries have recognized the lack of specialists, scientists, technologists and engineers as a major impediment in the successful implementation of applications programs. Education and

human resource development is imperative to building capacities with far reaching impacts on the utilisation of space assets and data. Moreover, Earth observation data and applications are an important tool for promoting general sciences and for attracting students to scientific fields of study.

The CEOS strategy for Earth observation education and training is to establish an effective coordination and partnership mechanism among CEOS agencies and institutions offering education and training around the world. The key objective of the strategy is to facilitate activities that substantially enhance international education and training in Earth System Science and the observation techniques, data analysis and interpretation required for its use and application to societal needs."

2.1.1 CEOS – WGEdu - Data Access and Availability

WGEdu identified four categories of data that should be available for user groups for capacity building purposes. These data should be accessible through the "discovery portal". The four categories of data categories are as follows:

1. **Generically Available Free Data:** This category of data will be a central focus of the "discovery portal", which will have links to web pages for free data, without duplications. Where necessary, some hints or suggestions will be provided to portal users before they access certain sites where downloading may be difficult.
2. **Case Studies from Space Agency Archives:** Working with the CEOS advisory groups and other experts, the WGEdu hopes to develop five or six "continental super sites" where data from multiple sources would be brought together to create a large case study set of data on select areas of interest to educators (i.e. the Sahel), and be updated on a regular basis.
3. **Archival (Near Real Time) Data Following a Significant Event:** This type of data would be available free or at least costs to applicants who request the information following a significant event (i.e. a hurricane) that occurs in a pre-identified regional hotspot or globally interesting test site. This category of data was identified as a future initiative of WGEdu, but is intended to be implemented in the future.
4. **Archival or Near Real Time Data to Support Professional Development:** This data would be available free or at least cost to applicants who clearly establish their interest in building their operational capabilities. It is important for an institution to be able to develop operational capabilities. There needs to be ground work done in support of the satellite data collection. As well, a GIS infrastructure of other data types needs to be established to support the program. Other considerations to develop a real-time education program also need to be considered such as data ordering, mission planning and fieldwork.

The 7th Annual Meeting of WGEdu was held from 19 to 21 April 2006 in Vienna. The main objective of the meeting was to plan the way forward in light of the preparation of the CEOS Implementation Plan for Space-based Observations and its contribution to the capacity building components of the GEOSS 10-year Implementation Plan (described below).

Although the mandate of the Working Group was initially intended for several years, it has taken on increased importance since the World Summit on Sustainable Development WSSD, held in Johannesburg, South Africa in 2002. CEOS determined five Modules, as its response to the outcomes of WSSD:

Module 1: Education Training and Capacity Building
Module 2 - Water resources management
Module 3 - Disaster Management and Conflicts
Module 4 - Climate Change
Module 5 - Global mapping, GIS and Land Cover.

2.1.2 CEOS WSSD Module 1 - Education Training & Capacity Building

The CEOS Module 1 plans to assist in the provision of a capacity building framework to facilitate its other WSSD Modules in meaningful and relevant training for sustainable development, assist in the establishment of infrastructure for training and partnership, and increase awareness of application and utilization of Earth observation data. WGEdu and the CEOS WSSD Follow-up Program are cooperating and plan to concentrate on several targets for delivery in 2006 and beyond.

A key result of Module 1 has been the establishment of the African Advisory Group (AAG) which provides feedback on concerns, advice, and recommendations on the beneficial use of EO data in Africa. The WGEdu discovery portal, the Africa User forum (EUMETSAT), and TIGER (ESA) are also useful contributions to AAG. The TIGER initiative is to integrate space-based Earth observation satellites and services for water management in Africa.

Close coordination and action is also envisaged within the scope of the ten year implementation plan of GEOSS, where the importance of education, training and capacity building is highlighted as a key target area. AAG and the TIGER program may offer ISPRS opportunities for cooperation particularly for its initiatives in Africa.

2.2 Group on Earth Observation (GEO) and Group on Earth Observation System of Systems (GEOSS) - Committee on Capacity Building

Following the Summit on Earth Observation in Washington in 2003, the Group on Earth Observation (GEO) was formed by agreement at government level for "..timely, quality, long-term, global information as a basis for sound decision making". Members of GEO will cooperate in the development of Earth observation programs, the GEOSS, as well as operational procedures. A number of committees that will target important implementation issues have been established. One of these committees is on capacity building, to which ISPRS will contribute participants from the Council. The programs of the Committee are currently being developed and they comprise descriptions of work to be performed, outputs and deliverables, milestones, and responsibilities, under the headings of Agriculture, Capacity Building, Disasters, Ecosystems, Health, Outreach, and Water.

Objectives of the Committee are:

1. To facilitate Earth observation capacity building activities among GEO Members, in concert with GEO Participating Organizations.
2. To build the capacity of all GEO Members to access, retrieve, analyze, include into appropriate models, and interpret relevant data from global data systems.
3. To build the capacity of all GEO Members to integrate Earth observation data and information with data and information from other sources, improving understanding of problems in order to identify sustainable solutions.

4. Support the GEO in developing a coordinated GEOSS capacity building strategy based on the principles articulated in the GEOSS 10-Year Implementation Plan Reference Document.
5. Recommend strategies for resource mobilization.

Approach and Functions:
1. In collaboration with existing capacity building mechanisms of GEO Members and participating organizations, identify priority areas in which Earth observation capacity building would have significant impact and benefit.
2. Examine existing and proposed Earth observation capacity building activities by national governments, participating organizations, and other relevant institutions, and identify mechanisms for leveraging, developing and coordinating Earth observation capacity building initiatives.
3. The Capacity Building Committee will monitor and report to Plenary on the achievement of milestones and deliverables in the implementation of relevant elements of the GEO annual work plans.

The Minutes of the 19th CEOS Plenary state that WSSD Team Leader and Chair of WGEdu have jointly identified to the CEOS Chairs where contributions can be made to the two-year targets of the longer term GEOSS implementation plan. Ongoing WSSD follow-on module activities will then be mapped in more detail to the multi-year targets, largely in coordination with WGEdu. ISPRS has commenced its involvement in the GEOSS Capacity Building Committee, which convened for the first time in March 2006. At the meeting a total of 19 Task Sheets were prepared detailing actions in a number of areas involving Capacity Building under the headings of Agriculture, Capacity, Building, Disasters, Ecosystems, Health, Outreach, Water and Weather. ISPRS is taking the lead role, with The Netherlands in the Task CB-06-01 with the title:

CB-06-01 - *Perform a review of capacity-building initiatives in GEO Members and Participating Organizations, taking into account results of existing surveys, to identify existing and planned capacity-building activities and gaps*

ISPRS is also participating in the following Tasks:

CB-06-03 - *Perform a review of existing education and training initiatives for Earth observation utilization in developing countries, and promulgate the use of best practices in cooperation with specialized UN agencies and other organisations*

DI-06-12 - *Initiate a knowledge-transfer programme to developing countries, to ensure basic capacity to utilize Earth observations for disaster management*

HE-06-05 - *Building on the existing work of WHO, perform an assessment, with emphasis on developing countries, of existing capacities for the integration of Earth observation and health data (in terms of data collection, processing and integration). Identify gaps, and explore funding as well as existing projects to close gaps and build capacity*.

These tasks demonstrate the commitment of GEOSS to developing capabilities in the applications of Earth observation data, especially in developing countries. It is appropriate that ISPRS should also play a role in these activities. At the time of writing the determination of duties associated with these tasks were underway.

2.3 UN International Training Centres

The United Nations General Assembly, in December 1990, endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space that:

"... the United Nations should lead, with the active support of its specialized agencies and other international organizations, an international effort to establish regional Centres for Space Science and Technology Education in existing national/regional educational institutions in the developing countries."

In 1995, the United Nations General Assembly further endorsed the regional centres initiative and recommended that:

> "... these centres be established on the basis of affiliation to the United Nations as early as possible and that such affiliation would provide the centres with the necessary recognition and would strengthen the possibilities of attracting donors and of establishing academic relationships with national and international space-related institutions;."

In order to translate the recommendations of the Committee and the General Assembly into an operational program, the Programme on Space Applications initiated a project aimed at the establishment of regional centres for space science and technology education at existing research and higher education institutions in each region covered by the United Nations Economic Commissions: Africa, Asia and the Pacific, Europe, Latin America and the Caribbean, and Western Asia.

Each centre is conceived as an institution that should offer the best possible education, research and applications programs, opportunities and experience to the participants in all its programs. Thus the principal goal of each centre is the development of the skills and knowledge of university educators and research and applications scientists, through rigorous theory, research, applications, field exercises, and pilot projects in those aspects of space science and technology that can contribute to sustainable development in each country.

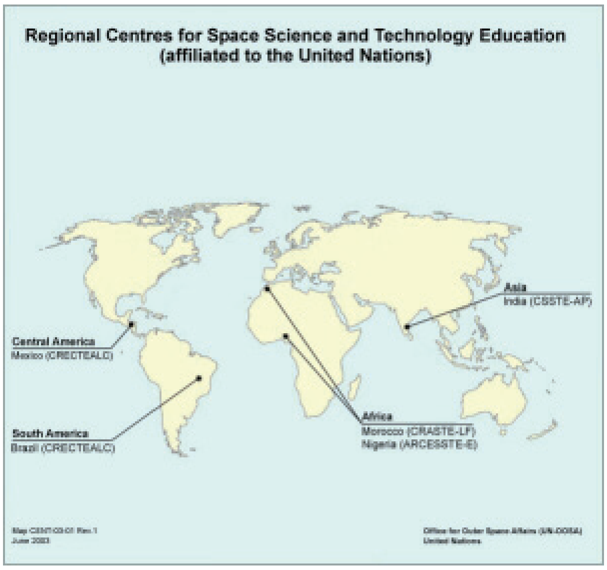

Figure 1. Locations of Current UN Regional Centres

The initial programs of each centre focuses on:

(a) remote sensing and geographic information systems;
(b) meteorological satellite applications;
(c) satellite communications and geopositioning systems;
(d) space and atmospheric sciences.

The activities at each centre are undertaken in two major phases. Phase 1 emphasizes the development and enhancement of the knowledge and skills of university educators and research and application scientists in both the physical and natural sciences as well as in analytical disciplines. It is accomplished over a nine-month period as laid out in the curricula of the education program of each centre. Phase 2 focuses on ensuring that the participants make use of the skills and knowledge gained in phase 1 in their pilot projects, which are to be conducted, over a one-year period, in their own countries.

In order for the centres to become model institutions that are respected both within their regions and around the world, they need to meet internationally recognized standards. To promote the achievement of those aims, the United Nations Programme on Space Applications developed a model curricula on the basis of input made by prominent educators participating at the UN/Spain Meeting of Experts on the Development Of Education Curricula for the Centres for Space Science and Technology Education in 1995. This model curricula were published in 1996 and subsequently updated in Frascati, Italy in 2001. Experts who are associated with ISPRS have regularly been involved in the development of these curricula.

ISPRS has developed good contacts with the UN Regional Centres in Latin America and the Caribe (Brazil), Africa (Nigeria) and Asia (India), but links have not been made with the French speaking centre in Morocco. It seems advisable that this should be rectified for future activities of the Commission. As well, the Commission could play a leadership role in the cyclic revision of the curriculum on remote sensing, in cooperation with the UN Office of Outer Space Affairs and other experts.

2.4 Joint Board of Geospatial Information Societies www.fig.net/jbgis

The Joint Board of Geospatial Information Societies (JBGIS), which was established in 2003, is a coalition of leading international geospatial societies, which can speak on behalf of the geospatial profession at the international level, especially to the United Nations and other global stakeholders. A further goal is to coordinate activities within the geospatial society and organizations. The current members of the JB GIS are IAG (International Association of Geodesy), ICA (International Cartographic association), FIG (International Federation of Surveyors), IHO (International Hydrographic Organisation), IMTA (International Map Traders Association), ISCGM (International Steering Committee for Global Mapping) and ISPRS. The JBGIS can appoint ad hoc committees for certain projects and important topics. Normally these committees shall have clear goals and are normally appointed for a limited time period.

The JBGIS ad hoc committee on Capacity Building in Africa was formed in 2005 with the following terms of reference:

- Collect and maintain information of meetings on capacity building in the geospatial area in Africa held by any organisation.
- Review the information and advise members of the Joint Board of opportunities for collaboration and for organisation of events and of potential duplication of effort.
- Establish and maintain an email network of interested individuals and organisations who can contribute to information on activities and any problems.
- Advise the Joint Board on any problems or potential problems which could be reduced by members of the Board.

The Joint Board's ability to play an active role in capacity building in Africa is dependent on their limited funds. However, the cooperative efforts of all bodies will lead to greater efficiencies in addressing the needs of the region. In the area of Earth observation, there would be advantages in cooperating with other bodies that are planning to contribute to capacity building in Africa, such as CEOS WGEdu, AAG and GEO.

2.5 International Council for Science (ICSU)

In 2002, ICSU decided to establish Regional Offices in Africa, the Arab Region, Asia and the Pacific and Latin America and the Caribbean. Their goals are to enhance participation of scientists and scientific organizations from the region in ICSU's research and policy activities; and to enable ICSU to play a more effective role in strengthening science within the context of regional priorities and building capacity through South-South and North-South collaboration. A decision has been taken to open the first Regional Office in Africa in Pretoria, South Africa, where the host will be the National Research Foundation. The Vision of the Regional Office is:

- Excellence in science is to be linked to policy making and to the sustainable socio-economic development in Africa.
- Equitable access to scientific data and information; and establishment of scientific capacity that may be used to contribute to the production of new scientific knowledge for the sustainable benefit of society.

The Mission is:

In order to strengthen international science for the benefit of society, ICSU mobilizes the knowledge and resources of the international science community to:

- Identify and address major issues of importance to science and society;
- Identify and address major issues of importance to science and society;
- Facilitate interaction amongst scientists across all disciplines and from all countries;
- Promote the participation of all scientists-regardless of race, citizenship, language, political stance, or gender-in international scientific endeavour;
- Provide independent, authoritative advice to stimulate constructive dialogue between the scientific community and governments, civil society, and the private sector.

While ISPRS is a member of ICSU, the aims of the Regional Offices are more directed to broad outcomes in science and therefore it is unlikely have benefits for ISPRS's education and training objectives in the short term.

3. Discussion and Conclusions

Each of the organisations described in this paper is developing programs in education, training, and capacity building for specific purposes. However, there is considerable overlap in the overall goals of many of the organisations, particularly between the CEOS WGEdu, the CEOS Capacity Building Module 1, and the capacity building aims of GEOSS. ISPRS is participating in all three of these organisations, being an associate of CEOS and a participating organisation in GEO. The most advanced of these organisations is CEOS WGEdu, but ISPRS has made limited contributions recently to this WG, primarily due to the difficulties of participating in the teleconferences. Some solution to this problem should be found to enable ISPRS to play a more significant role the activities of CEOS WGEdu. In the future, the provision of the discovery portal, the cooperation of space agencies to provide sets of data, and its education programs, will be of significant advantage to the activities of ISPRS Commission VI in education and training. As well, members of the Commission should be able to assist the operations of the WGEdu, by providing course materials and web based teaching materials. Developments in most of these organisations are ongoing and updates will be provided at the Symposium.

4. References

CEOS WGEdu Documents

GEO Documents

GEO Capacity Building Documents

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37 YEARS OF INTERNET, 12 YEARS OF ISPRS ONLINE

Tuan-chih Chen*

*Events Calendar Editor, ISPRS; Dept. of Civil Engineering, China Institute of Technology, Taipei, Taiwan
E-mail: profchen@cc.chit.edu.tw

ISPRS Commission VI, WG VI/4

KEY WORDS: Internet/Web, Information, Education, Statistics, On-line

ABSTRACT:

Conceived by the U.S. government in 1969 with the aim to create a network that would allow researchers to 'talk each other' from different universities, the Internet today is a public, cooperative and self-sustaining facility accessible to hundreds of millions of people. The Internet is at once a broadcasting capability in the entire world, a mechanism for information dissemination and a medium for collaboration or interaction between individuals and their computers without regard for geographic location. Sometimes called simply "the Net," it is a world-wide system of computer networks, a network of networks in which a user with his computer can get information from any other computer. Nobody owns the Internet but there are some no-profit organisations that define how we use and interact with the Internet. The most widely used part of the Internet is the World Wide Web, created in 1990 as user-friendly face of the information available on the Internet and, together with e-mails and search engines, provides efficient access to an increasing amount of information.
After 37 years of developments and improvements, nowadays there are more than 650 million people online. Everyday more people use an online computer to find information, learn, educate and communicate. But the presence and the access to the Internet are not well distributed in all the countries as there are still part of the world were the use of Internet has yet to grow because it was politically repressed or the infrastructures are still in development.
Inside this big electronic world, ISPRS is present since 1994 with the goal of providing information, coordination and activities of its structure. ISPRS homepage contains infect information regarding the structure of the society, its Events Calendar and its members but also a wide gamma of educational material and software for Photogrammetry, Remote Sensing and GIS available on the Internet as well as job opportunities and Academic Sites for Geomatic Engineering. After 12 years of 'online information', nowadays there are more than 800 HTML pages available on the ISPRS web site. ISPRS server has an average of 400000 requests per month, serving ca. 170 domains (~country) world-wide and has contacted ca. 50000 distinct hosts (~users). The ISPRS homepage will remain inside this big e-word improving its appearance and providing always more information to its users and we will continually strive to increase the available resources and expand ISPRS online services. 'ISPRS Highlight', the official bulletin of the ISPRS exclusively appears starting from June 2006 as 'e-Highlights' in digital form, in order to save the costs and on the other hand more members can reach it.

1. INTRODUCTION

The Internet and the World Wide Web (WWW) have revolutionised computers and communications around the world like nothing before and can be considered one of the greatest inventions of our time. The Internet is at once a world-wide broadcasting capability, a mechanism for information dissemination, and a medium for collaboration and interaction between individuals and their computers without regard for geographic location. Sometimes called simply "the Net," it is a worldwide system of computer networks or a network of networks in which users at any one computer can get information from any other computer or talk directly to users on other computers. It was conceived by the U.S. government in 1969 and was first known as the ARPANet with the aim to create a network that would allow researchers to "talk each other" from different universities. Today, the Internet is a public, cooperative, and self-sustaining facility accessible to hundreds of millions of people. For many users, electronic mail has practically replaced the postal service for short written transactions and this service is the most widely used application on the Net. Live written conversations with other computer users are also available using chats and more recently Internet hardware and software allows real-time voice conversations and broadcasting real-time images or video (web cam). The most widely used part of the Internet is the World Wide Web (often abbreviated as WWW or called "the Web"). Its outstanding feature is the hypertext, a method of instant cross-referencing and displaying information. Using the Web, we have access to millions of pages of information all over the world. Other services widely used are FTP, e-mail, RSS and telnet. Using this Net, we have changed the way to do business, communicate, entertain, retrieve information, and even educate ourselves and in the future, this phenomenon will be the major data sharing system for all the people in the world.
The goal of this paper is not to address all the aspects of Internet but to give a general overview of the global network, over its history, its services and its growth. Then we also described how ISPRS is inserted in this network and which

initiatives are taken to present the society to the worldwide public.

2. THE INTERNET AND THE WWW

In this section a brief history of the Internet, from its origin till the 90's is presented. Then some brief but useful descriptions of Internet word, available services and tools to find information are provided. The last part reports some statistics about the growth and the development of the Net.

2.1 History of Internet and WWW

The precursor of the Internet is called ARPANet (Advanced Research Projects Agency Network). It was developed in the late 60's by the US Department of Defence as an experiment in wide-area-networking that would have survived a nuclear war. In the autumn of 1969 the first ARPANET computer was connected to a node at the UCLA University and by the end of the year, the network already included four computers. All the computers used different operating systems and they were able to talk to each other across the network. During the 1970's, the ARPANET grew to connect research institutes and laboratories in various parts of the USA. During the 1980's, the Internet was still considered to be a temporary system designed for the research world while the TCP/IP data transmission protocol was adopted as the official network protocol by the U.S. Department of Defence. At the same, other networks and networking technologies were being tested in other parts of the world (USENET, BITNET, NSFNET, NSINET, EUNET). In the next years, Internet started to be an essential tool for communications (e-mail) and new words, such as "hacker" or "cracker" were created. In 1990 ARPANET ceased to exist while the other networks started to connect each other to create a larger Net. In the same year, Tim Berners-Lee, researcher at CERN of Geneva, noticed that many people were having difficulties in sharing information due to a range of different network protocols and a range of workstation types [Berners, 1990]. For this reason he proposed an Internet-based hypertext system which would have linked together behind a single and easy-to-use interface, the various information spread around the Internet. He produced a WWW browser-editor, which read HyperText Markup Language (HTML) documents from URL addresses: i.e., the Web was born.

In the next years the Internet Society (ISOC) was founded (1991); the World Bank went on-line (1992); Mosaic, the first commercial graphical Web browser was released (1993); the first search engine, "Yahoo" (Yet Another Hierarchical Officious Oracle) was invented (1994); The Federal Networking Council passed a resolution defining the term Internet (1995) [FNC, 1995].

As the Internet celebrates its 30th anniversary, the military strategies that influenced its birth become historical footnotes. Nowadays, approximately 650 million people (in almost 240 countries around the world) are already connected to the global Net and the traffic on it expands at a 340% annual growth rate [NUA, 2004]. The number of computer hosts is more than 150 million and the Internet has passed from a Cold War concept to an Information Superhighway.

2.2 Internet definitions

Nowadays it is very common to read and hear words like Server, Host, Protocol and so on. But maybe we are not very familiar with the right meaning. Before going into details regarding the Internet, a short list of important terms, which does not cover all the aspects of the Net, is presented:

Client: a software program used to contact and obtain data from a server software program on another computer; each client works with a specific server program and each server requires a specific kind of client. A *web browser* is a specific client software used to locate and display web pages. When a computer is used to connect to the Net it is also a client. Other well-known example is the e-mail client software user to retrieve, read and send e-mail messages.

DNS (Domain Name System): an Internet service that translates domain names (i.e. human-readable words) into IP addresses (i.e. machine-readable numbers). Domain names are alphabetic and almost easy to remember; but the Internet is based on numerical IP addresses. Therefore DNS service must translate the name into the corresponding IP address. For example, the domain name www.isprs.org might translate to 129.132.26.2.

Domain name: the unique name that identifies an Internet site.

Host: every computer or machine on a network that is accessed by a user working at a remote location.

IP address (Internet Protocol Number): an identifier for a computer on a TCP/IP network. It has four groups of numbers separated by dots, with values between 0 and 255. Every machine on the Internet has a unique IP number.

ISP (Internet Service Provider): an institution that provides access to the Internet (usually for money).

Protocol: an agreed-upon format for transmitting and moving data (files) between two devices. Common networking protocols are *FTP* (File Transfer Protocol), *HTTP* (HyperText Transfer Protocol), *TCP/IP*, *Telnet*, *POP3* and *SMTP* (used for e-mail), *Gopher*.

TCP/IP (Transmission Control Protocol/Internet Protocol): the suite of communications protocols used to connect hosts on the Internet. TCP/IP was originally designed for the UNIX operating system but today is available for every major kind of operating system.

Server: (1) a computer with high performances that runs critical software applications (i.e. Mail server, Web server, Firewall). (2) A software that provides the implementation of the server part of a communication protocol (i.e. HTTP, FTP, Telnet). A *Web Server* is a software running on a computer that delivers web pages via the HTTP protocol. In order to be accessible from clients running on a different computer, a web server is connected to a TCP/IP network and has an IP address and possibly a domain name.

URL (Universal Resource Locator): a way to identify pages on the Internet. It is made up of three parts: the first part defines the data transfer method or protocol (ftp, mailto, telnet, http), the second part generally gives the address of the computer where the desired service is located, the last part contains the internal reference on the server in question.

Web page: an HTML document on the World Wide Web. Every Web page is identified by a unique URL.

2.3 How does the Web work?

In general, all the machines on the Internet can be divided in two types: servers and clients. Servers are all those machines that provide services (like Web servers or FTP servers) to other machines. And the machines that are used to connect to those services are clients.

When an html page is requested to a server, the browser (Netscape, MSI Explorer) forms a connection to a Web server, requests the page and receives it. More in detail, the browser breaks the URL into 3 parts: the protocol ("http"), the server name ("www.isprs.org") and the file name ("isprs.html"). The browser communicated with a domain name server (DNS) to translate the server name "www.isprs.org" into an IP numerical address, which is used to connect to the server machine. The browser then forms a connection to the server at that IP address and following the "http" protocol; it sends a GET request to the server, asking for the file "isprs.html". The ISPRS server then sends the HTML text to the browser, which formats the page onto the screen.

This big network is designed in a way that each information can reach its destination using many different paths. When the information is sent through the network, it is split into tiny packets and each packet use a different path to reach its destination. When all the packets reach the destination, they are regrouped to form the original information. If one packet does not reach the destination, the receiving site asks for another copy of this packet.

2.4 Internet Domain

A domain name identifies a web site on the Internet and has always two or more parts, separated by dots, e.g. 'www.commission6.isprs.org'. The part on the left is the most specific ('commission6'), the part on the right the more general ('isprs'). The extension .org identifies the kind of domain and together with the previous generic part; they are often called *Top-Level Domains* (TLD). There are two types of top-level domains:

1. *Generic Top-Level Domains* (gTLDs). Available since 1984, they are: .com (Commercial), .edu (Educational), .gov (US Government), .int (International Organizations), .mil (US Dept. of Defence), .net (Networks), .org (Organizations). On November 2000, new 7 gTLD have been added. They are: .biz (Business Organizations), .museum (Museum Organizations), .name (Personal), .info (Open TLD), .pro (Professionals as Accountants, lawyers and physicians), .aero (Air-transport industry), .coop (Cooperatives). Some of them are already operative while the others will be follow later [IANA, 2004].
2. *Country Code Top-Level Domains* (ccTLDs). They are designed to be assigned to each individual country (it, .fr, .uk, .jp, .ch, .co, .er, ...). As of May 2002 there are 243 country code domains ([IANA, 2004] provides an updated list).

2.5 Services on the Internet

The World Wide Web is often identifies with the Internet, but it is only the best known part of it. Inside the Internet *live* many other services developed to facilitate the sharing of information through the Net. In the following, the mainly used services are shortly described.

- **BLOG**: "blog" was short for "weblog". A weblog is a personal or noncommercial web site that uses a dated log format (usually with the most recent addition at the top of the page) and contains links to other web sites along with commentary about those sites. A weblog is updated frequently and sometimes groups links by specific subjects, such as politics, news, pop culture, or computer issues.
- **E-MAIL**: short for electronic mail, it is a transmission of electronic messages over networks. Usually it is a message sent from one user to another. Combination of hardware and software that links together different types of networks ('gateways'), allow users on different e-mail systems to exchange messages. Online services and Internet Service Providers (ISPs) usually offer free e-mail service (Hotmail, Yahoo) and this has made the e-mail the most widely used communication tool on the Internet. When an e-mail is simultaneously sent to a large number of people, we speak about *mailing-list*. When the size of the mailing list is bigger, we should call it *newsgroup*. An international network of newsgroups is USENET, a discussion forum that cover many interest groups with more than 14,000 forums. **FTP**: the File Transfer Protocol (FTP) is a common format for transmitting and moving data (files) on the Internet. There are many FTP sites (shareware archives) where it is possible to connect anonymously (so called 'anonymous FTP') and download a large number of files
- **IRC**: Internet Relay Chat, a chat system developed in the late 80's. It is a virtual meeting place where people from all over the world can meet and talk; it consists of different groups of discussions on different channels. Small client program like mIRC allows you to "converse" interactively with other people by typing messages that are instantly sent to other chat participants. A new revolutionary chat is called *ICQ* (I-see-you), a user-friendly Internet tool used to communicate with other people in real time; you can chat, send messages, files, URL or play games.
- **RSS**: RSS is a format for syndicating news and the content of news-like sites, including major news sites like Wired, news-oriented community sites like Slashdot, and personal blogs.
- **TELNET**: a terminal emulation program used to connect to remote Internet host. The Telnet program enables to connect to a server on the network, log in and access its resources. You can then enter commands through the Telnet program and they will be executed as if you were entering them directly on the server console.
- **WORLD WIDE WEB**: it is the best known and used part of the Internet (also called WWW or Web or W3). All the information is distributed in hypertext format and a browser allows us to read all these information. The pages on the WWW can contain text, images, sound, software and movies. The majority of the text documents are written in HTML or new extension and reformulation of this language (XHTML, XML, CSS, PHP). Moreover some programming languages (Java, Flash) can create special effects inside the Web pages. The capabilities of a web browser can be extended with particular programs (Plug-in applications) to play sound or video and to display particular documents. Common applications are Adobe Acrobat Reader (PDF files viewer), Apple QuickTime, Macromedia Shockwave, RealPlayer (animation and sound player), VRML viewers (3D visualization of Virtual Reality Modelling Language models).

2.6 The information on the Web

One of the main problems of the Internet is where to find the right information we are looking for in the less time. Since the 80's, special websites have been created to help the users finding all the information hidden in million of web pages. These sites can be divided in *search engines* and *online directories.* Another common resources used to stored information are the Internet *"Yellow Pages" Books*, which list Internet addresses by categories and can be found in computer and bookstores.

2.6.1 Internet Search Engines

Internet search engines are special web sites designed to help people find information stored on other sites. Before the Web became the most visible part of the Internet, programs like "Gopher" and "Archie" kept indexes of files stored on servers connected to the Internet. Early search engines held an index of a few hundred thousand pages and documents, and received maybe one or two thousand inquiries each day. Today, a top search engine will index hundreds of millions of pages, and responds to tens of millions of queries per day. All search engines perform three basic tasks:

1. They search the Internet based on keywords;
2. They keep an index of the words they find, and where they find them;
3. They allow users to look for words or combinations of words found in that index.

To find information on the hundreds of millions of Web pages that exist, a search engine employs special software robots, called spiders or crawl. Each spider takes different approaches but they are always crawling, because of the constantly changing nature of the Web. Some of the most popular search engines are Google, AltaVista, Yahoo, HotBot, Lycos, Excite, MSM. Some of these search engine entries present also a main menu organised with directories that can help a user in his research. Elsevier Science has developed a powerful Internet search tool called Scirus [http://www.scirus.com]. Scirus distinguishes itself from existing search engines by concentrating only on scientific content and by searching both Web and membership sources (articles, presentations, reports in all possible format). It provides for scientific information, university sites, reports and articles in a clutter-free, user-friendly and efficient manner. Other useful web-sites are called Metacrawlers: they use at the same time more search engines to search for a query, providing more complete research; common Metacrawler are Mamma, Metacrawler, Search Engine Guide.

2.6.2 Online Internet Directories

They are webpages where the information are stored and displayed to the users in thematic channels or categories. Lists of links are listed with short descriptions and related URL. It is also possible to search inside the web as a normal search engine. Good directories are Galaxy, Yahoo, the WWW Virtual Library, the Educational Virtual Library, the Earth Science Portal. The Earth Science Portal is a searchable links directory together with a web crawler search engine that spans all the web-based information of the NASA Earth Sciences database. AllConferencesNet instead provides interesting links for all kind of events in the world. It is a directory focusing on conferences, conventions, trade shows, exhibits, workshops, events and business meetings. This is a unique search directory that serves users looking for specific information on conference or event information.

2.6.3 Educational resources on the Web

Educational resources on the web are without limits. The possibility to find scientific articles, reports, journals or entire books on the Web is very high (and easy). These electronic documents contain nothing different in comparison with the same text and picture of the paper version, except some occasional hyperlink. They are quickly disseminated on the Net and everybody can read them. On the other hand, real e-zines or e-journal have no paper equivalent and are not always free. A big problem of electronic documents is that they are not permanent and they can be lost from the permanent record, as subject to changes in positions and unpredictable removal. Instead documents on paper or in electronic format (CD-ROM) are not transient and can be available and legible for many years. Therefore to preserve for a longer period also the Internet publication, a timely and active intervention at all stages is required.

A general database of educational material is provided by the "*Gateway to Educational Materials*" project, a consortium effort created to provide easy access to the substantial, but uncatalogued, collections of educational materials available in various states, universities, non-profit, and commercial Internet sites [http://www.thegateway.org]. Another database is *Education-line*, a freely accessible database with full text of conference papers, working reports and electronic literature (from 1997), which supports educational research, policy and practice [http://www.leeds.ac.uk/educol/]. Furthermore, an Internet portal full of relevant resources to faculties, students, and research staff at the university level is *Infomine* [http://infomine.ucr.edu/]. It is a huge database including electronic journals, books, bulletin boards, listservs, online library, articles, directories of researchers and many other types of information. More specific resources in Remote Sensing, just to mention few good links, are provided by NASA, ASPRS, CCRS and CEOS CD-ROM.

Also ISPRS pages list some links to tutorials, journals, glossaries and news in the field of Photogrammetry, Remote Sensing and Geographic Information Systems while a bigger database of educational-related links is provide by WGVI/1.

2.7 Internet growth and its statistics

It is very difficult to determine how many users and how many domains or hosts are on the net, besides making guesses and estimates. There are many companies that do surveys to estimate the number of users, but we can consider the numbers presented in these surveys to be fairly good estimates of the minimum size of the Internet. Moreover the geographical location of Internet host is somewhat problematic since a host need not to be located in the country, which correspond to its ccTLD; and gTLD has never an explicit geographic designation (e.g. ISPRS, with the server in Zurich, the Headquarter in London and the President in Sidney!). For these reasons is not possible to determine the exact size of the Internet, where host are located or how many users there are online.

The growth of the available information can be estimated from the number of registered host. According to the Internet Software Consortium [ISC, 2004], the number of registered **hosts** was 80,000 in January 1988 while in January 2004 states 233.1 million (see Figure 1). The number of hosts is considered one of the most accurate measures of the size of the Internet and include all network elements such as routers, Web servers, mail servers, workstations in universities and businesses. In [Zook, 2000] is shown that in the last three years the number of hosts per domain is becoming smaller while the number of new domain is grown: this suggests that more businesses and organisations are establishing a personal internet presence with new domain name registration. Nevertheless, new analysis from Netcraft [Netcraft, 2004] shows that there has been a dramatic reduction in new domain name registrations, in particular gTLD. This shows how difficult is to manage Internet statistics. As May 2002, the largest domains are .com, .net, edu; the top three countries with the largest number of Internet hosts are USA, Japan, Canada; the countries with the largest number of host per capita are Iceland, Finland and Sweden; the fastest growing domain are .co, .pt, .su, .sg, .mx; the fastest internet growing country are India, Indonesia, Mexico [Telcordia, 2004]. OCLC [OCLC, 2004] gives instead some interesting numbers about the existing websites: at the end of 2001, there are ca 8.7 million websites world-wide, compared to 1.6 million in 1997.

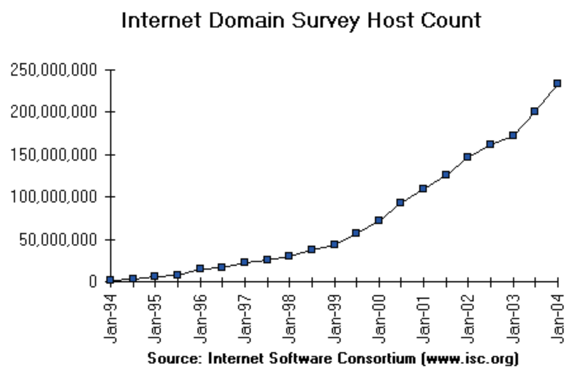

Figure 1: Internet growth represented with the number of hosts in the period 1994-2004. [Source: ISC]

Considering the million of **users** online (see Figure 2), the number of people is constantly increasing. In 1995 the Internet population was less than 30 million people (app. 0.35% of the world population) while in May 2002 there were more than 500 million people online (8.9% of world population) [NUA, 2004]. The number is expected to increase again in the next years and a CIA reports [CIA, 2004] gives a prediction for the next years: 'Over 765 million by the end of year 2005'! Comparing the number of users and host, in 2001 there was an average of 4.6 users per host. With the high quality of service in the United States there are approximately 2.4 Internet users per host, whereas in some developing countries such as China and India, there are more than 100 Internet users per host.

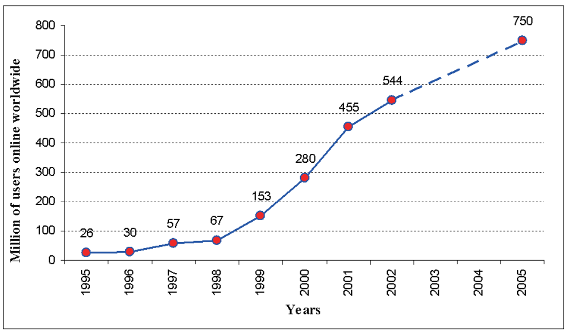

Figure2: Number of users online worldwide. [Sources: NUA, CommerceNet]

Despite these number which are just great estimates of the real values, it is widely expected that the Internet population and the number of domains will continue to growth, at least for another few years ([TelcordiA, 2004] provides a very interesting real-time estimate of these growths). But presence and accesses to the Internet are not well distributed in all countries. As reported by Nua [NUA, 2004], the top 10 countries account more than 80% of the world-wide population; moreover there are country with less that 0.01% of the country population who has an Internet access while European countries have ca. 60%.

2.8 Firewall

A firewall is a system or group of systems that enforces an access control policy between two networks. The actual means by which this is accomplished varies widely, but in principle, the firewall can be thought of as a pair of mechanisms: one which exists to block traffic, and the other which exists to permit traffic. Some firewalls place a greater emphasis on blocking traffic, while others emphasize permitting traffic. Probably the most important thing to recognize about a firewall is that it implements an access control policy. If you don't have a good idea of what kind of access you want to allow or to deny, a firewall really won't help you. It's also important to recognize that the firewall's configuration, because it is a mechanism for enforcing policy, imposes its policy on everything behind it. Administrators for firewalls managing the connectivity for a large number of hosts therefore have a heavy responsibility.

2.9 Wireless

Wireless means the use of radio-frequency spectrum to transmit and receive voice, data, and video signals for communications. The Wireless Internet Service Provider (WISP) is an organization providing wireless access to the Internet.

2.10 E-learning

E-learning is the education via the Internet, network, or standalone computer. Network-enabled transfer of skills and knowledge. e-learning refers to using electronic applications and processes to learn. e-learning applications and processes include Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. Content is delivered via the Internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM.

3. ISPRS ON THE INTERNET

In this section is described how ISPRS is inserted in the global network, the different representation and initiatives of to present it to the world-wide public and which technologies are used to improve and keep up-to-date the society web site.

3.1 ISPRS Homepage

The ISPRS homepage has turned out to be one of the most important components for ISPRS communications. It provides information about the society and links its various activities. Since 1994, when the first ISPRS html pages was inserted on ETH server by André Streilein, the homepage is a very important reference point of the society, providing up-to-date information and links related to the various activities of the society. Thanks to the international reservation of the domain name 'isprs.org' concluded in September 1999, all these information can be found at a meaningful URL and, moreover, all different ISPRS activities can have an Internet address ending on the suffix 'isprs.org'.
The ISPRS website (http://www.isprs.org), now online since 10 years, has turned out to be one of the most important components of ISPRS communications, providing up-to-date information about the society and linking its various activities. In April 2004 there are about 800 HTML pages with approximately 25,000 lines of information available on the ISPRS website; moreover there are ca 1,000 PDF files, i.e. a total of ca 2 GB of data available. A search engine (provided by Google) is also working inside ISPRS, with the possibility to search for pages inside ISPRS server or inside the WWW.
In September 2000 the ISPRS server has been moved (back) to ETH-Zürich after a short period in T.U. Delft. As May 2002, there were about 500 HTML pages with approximately 160’000 lines of information available on the ISPRS web site, i.e. ca 130 Megabytes of data.
Considering ISPRS Commissions and WG, all TC have a personal homepage while only about 50% of the Working

Groups provide information on their own webpages. Besides this fact, ISPRS WG VI/4 (1996-2000) created guidelines for preparation and maintenance of related webpages [Chen and Felkner, 1998] and basic downloadable template are available at http://www.isprs.org/sample.html with related logos and icons.

3.2 ISPRS improvements

In April 2001, a search engine (provided by Google) has been introduced inside ISPRS 'Table of Contents'; a user can search for pages inside ISPRS server or inside the WWW. Moreover the first page of the web site has been updated already three times, the last time using a dynamic menu and providing direct links to the main publications of the society. Since March 2002, a program (provided by Seven-twentyfour Inc.) analyses ISPRS pages checking for broken links and internal errors. It is very useful, in particular for ISPRS educational pages, to keep all the links updated. Furthermore, it found out that ISPRS has 878 internal links, 721 external links to related web sites and 174 web sites have a link to ISPRS web pages.

3.3 ISPRS Publications: Archives, Journals, Books and Reports

The publications of ISPRS are in seven categories: The *International Archives of Photogrammetry and Remote Sensing*, *The ISPRS Journal of Photogrammetry and Remote Sensing*, The *ISPRS Highlights*, The *ISPRS Annual Report*, The ISPRS Organisation and Programs (*Silver Book*), The ISPRS Member List (*Blue Book*), The *ISPRS Brochure*.

All existing stocks of the *Archives* prior to June 2000 is being offered for sale by RICS Books; Archives published from June 2000, volume XXX onwards (Hardcopies and CDs), are distributed by GITC bv.

The *ISPRS Journal*, the official publication of the Society, since two years can be read at Elsevier Science web pages (http://www.elsevier.nl/locate/isprsjprs) and full texts are available to those readers whose library has subscribed to ISPRS Journal via ScienceDirect Digital Collections, or has a current print subscription to ISPRS Journal and has registered for ScienceDirect Web Editions.

Moreover special circulars, announcements and Working Group newsletters are produced and distributed by the ISPRS Technical Commissions to provide information on Congresses, Symposia and other activities of ISPRS.

In the last period, some ISPRS workshop organisers use to provide online the proceedings or the presentations of the events. Electronic documents are available e.g. from the International Workshop "Recreating the Past - Visualization and Animation of Cultural Heritage" or from OEEPE/ISPRS Workshop "From 2D to 3D - Establishment and Maintenance of National Core Geospatial Databases"; the related links can be found inside ISPRS educational links.

3.4 Educational Resources and Job Opportunities through ISPRS web site

ISPRS educational page tries to collect the wide gamma of educational material and software for Photogrammetry, Remote Sensing and GIS available on the Internet (http://www.isprs.org/links/tutorial.html). It is not a complete list, but some pointers, continuously checked and updated, are listed about:

- *Free software*, in particular from CATCON, the Computer Assisted Teaching contest organised by WG VI/2. Free packages for computer vision, GIS and RS data are also listed
- *Education, training, research and fellowship opportunities in Remote Sensing, GIS and its applications* (http://www.ltid.inpe.br/dsr/tania/Rsdir/). It is an educational Directory that has been developed in the period 1996-2000 as a task of ISPRS TCVI/WG1 on education and as part of the ISPRS Educational Opportunities Program. It is a first attempt to providing a comprehensive directory of education and training services in the remote sensing and spatial information sciences. The Directory was developed from an original document prepared some years ago by the UN Office of Outer Space Affairs in Vienna. In this directory it is possible to get information from all members states that are involved in Space Science. The information contained in this directory for each institution includes its areas of specialisation, the educational and research programmes offered, the facilities available, the prerequisite qualifications, financial information, fellowship opportunities and opportunities for international cooperation. This Directory is necessarily incomplete because of the difficulty in obtaining accurate and timely information about all education institutions around the world in a range of languages. Therefore education institutions are encouraged to provide their new or updated details of education and training programs in the remote sensing and spatial information sciences.
- *Tutorials* in Photogrammetry, Remote Sensing, GIS and computer vision.
- *News* about satellite missions and launches
- *Glossaries and Acronyms* used in Remote Sensing, GIS, Radar and Cartography.
- *Journals* of Photogrammetry, Geodesy and Remote Sensing.
- *Presentations and Proceedings* of ISPRS Workshops, Symposium or Congresses.

Anyone who wants to contribute to this list, please send links or information to fabio@geod.baug.ethz.ch

Working Group VI/1 provides a bigger database of education-related links, including training opportunities, online publications and journals, continuing education courses, educational institutions, free software, missions and instruments information.

ISPRS web site also includes links to Job opportunities and Academic Sites for Geomatic Engineering:

- The *ISPRS Employment Opportunities archives*, a jobs listing, maintained by Mark R. Shortis, intended to provide offers for people who are seeking employment. Employers and universities are encouraged to submit an advertisement sending an e-mail to isprsjobs@sunrise.sli.unimelb.edu.au
- The *Academic Sites for Geomatic Engineering*, maintained by Robert Kauper, is a collection of links to academic institution, which provide education in the field of Geodesy, Photogrammetry, Surveying, Cartography and GIS.

3.5 ISPRS Events Calendar

The ISPRS Events Calendar [www.isprs.org/calendar.html] is one of the most important parts of ISPRS web pages. The Calendar contains a list of all ISPRS and Sister Societies (FIG, ICA, IAG, IHO, IGU, etc.) sponsored and co-sponsored workshops, symposia, tutorials, conferences, congresses, and other meetings. It also contains details of all international and national events on topics related to the activities of spatial information, photogrammetry, remote sensing, geomatics, surveying, mapping, machine vision, image processing and similar areas. The Calendar is published in the quarterly ISPRS bulletin, ISPRS Highlights, and regularly updated on the ISPRS Home Page by the webmaster. One of the purposes for this Calendar is to allow people of WGs, Commissions, and Sister Societies to identify open dates or events, which they may link up with or avoid conflicting with. This avoidance of conflicting with other events externally and definitely internally is a major responsibility of ISPRS. The calendar is published to encourage other Sister Societies to do likewise. It is important to cover events, which are on the interdisciplinary boundaries of ISPRS so that all Commissions and WGs are aware of who and how they can interface with related Commissions, WGs, and Sister Societies.

This Events Calendar was compiled manually by previous editors and contained some incorrect information, or missed some important events. The current Editor (2000-2004) has established an automatic system [Chen, 2002] to search the events information of geo-spatial information, photogrammetry, remote sensing, surveying, geomatics, and GIS on the Internet. The system is using the state-of-the-art technique of searching engine and programming tools for web pages and Internet server. The following software, operating system, programming languages, and programming tools have been used: Microsoft Windows 2000 Server, Microsoft SQL Server 2000, Microsoft .NET Web N-tiers, IIS, Microsoft Office XP, Dynamic HTML, XML/SOAP, JAVA Script, VB Script, CGI, ASP, PHP, Delphi, etc.

3.6 ISPRS Server statistics

Since the beginning of 1995 ISPRS server statistics are available to analyse the interest of the community. The logfile of the Apache server is examined with Analog, a program that analyses servers files. In Figure 3 are shown a monthly report of the number of requests to ISPRS server, in the period January 1995-April 2004.

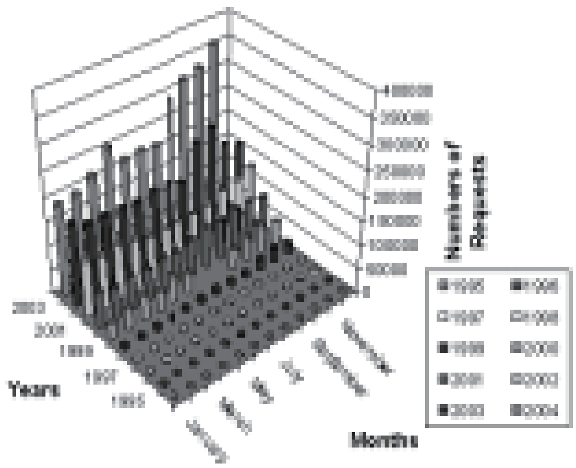

Figure 3: Monthly request on ISPRS server in the period January 1995 - April 2004.

An increasing interest of the community for the ISPRS homepage is evident: the steady increase of the requests over the years and especially after the registration of ISPRS domain is obvious. Figure 3 gives a reasonable estimate of the use of the server as only the request for single HTML documents are counted and requests for images, graphics, icons etc. are not taken into account. Moreover these statistics refer only to requests made outside ETH domain, which excludes all the accesses during the maintenance of the documents. The data missing from figure 3 in the period July-August 2000 is due to the movement of the server from Delft to Zurich. In 1995 the average of monthly requests were 424, in 1998 the average was 5780 while at present ISPRS server has an average of 400000 requests per month (see Figure 4). The different domain (~country) served at least one by the server were 170 (ca 65% of the registered country code domains), while the distinct hosts served (~users) were ca 50000 with an average of 25Mb of data transferred per day.

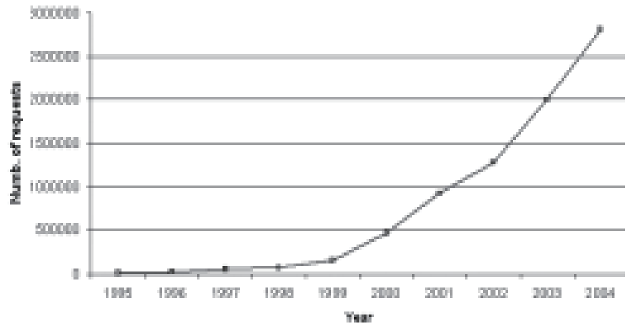

Figure 4: Average request per month on ISPRS server in the period 1995-2004

An interesting statistic concerns the words and queries used in the search engines to find ISPRS and its related pages: between 7000 words, the most used are remote (9%), sensing (8%), photogrammetry (7%), isprs (5%). Considering all the queries, the most used are 'photogrammetry', 'isprs', 'remote sensing', 'orange book', 'International Archive of Photogrammetry and Remote Sensing'. The browser most used to find information related to ISPRS is Microsoft Internet Explorer (59%), followed by Netscape (27%). The majority of the users (77%) has Windows as operating systems; then Unix (7%) and Macintosh (1.5%).

3.7 ISPRS e-Highlights

'ISPRS Highlight', the official bulletin of the ISPRS exclusively appears starting from June 2006 as 'e-Highlights' in digital form, in order to save the costs and on the other hand more members can reach it. ISPRS e-Highlights will be produced in electronic form, and the hardcopy version will be discontinued. The new version of ISPRS e-Highlights will be distributed electronically to all members free of charge, either to the organisation's offices, from where they can distribute it to their members, or directly to the members if the addresses are supplied to the ISPRS Headquarters.

4. CONCLUSIONS AND OUTLOOK

Will the Internet with its number of hosts and domain still grow? Which kind of operations or interactive application will we do with an Internet browser? All these queries are still open and interesting questions.

Within 37 years, the Internet has grown from a Cold War concept to survey a nuclear attack to a superhighway of information. Nowadays we are in the age of the Internet: people communicate, work, do shopping, move money and plan the holidays over the Internet; schools use the Internet as a vast electronic library, with untold possibilities. The Net has opened the access to information to everybody and has changed the way we see the world. As a new generation grows up accustomed to communicate through a keyboard, life on the Internet will become an increasingly important part of life on Earth. But the Internet can even create a second-class citizenship among those without access. Infect there are still part of the world where the use of Internet has yet to grow substantially: these include much of the Asian part of Russia, parts of the Middle East and those part of South East Asia and Africa where it has politically repressed or where the infrastructure are still in development. And this is also a lack for the education of the country. It is expected a growing demand for satellite capacity and links from those parts of the world that may never have full access to international fibre such as much of Africa. The use of satellite resources for Internet backbone and other new Internet related applications [Internet2, 2004] would improve the connections and the capacities of many domains. One of the most expected explosion is the use of satellite connection [IVS, 2004] also for residential users, while cable-modem is already common, in particular in USA. It is estimated that the Internet will double in size every year and the World Wide Web will double every 2 months. Many companies already use the Internet for sales, advertising and marketing and within the next 2-3 years 50% of all commerce will be conducted online [Ntoko, 1999].

Inside the Internet, the World Wide Web can be considered the greatest success. It is an example of a system that had humble beginnings and has grown to huge proportions. For many, it is the user-friendly face of the information available on the Internet and has been at least partly responsible for the recent explosive growth of the Net. The Web, together with the search engine, provides efficient access to an increasing amount of information. But create archives of publications and data is not enough: they must be maintained, updated and managed in a way that users can easily discover and access.

However, the rapid growth and interest for the WWW has introduced or amplified many problems like: security concerns for commercial applications, bandwidth and server saturation, demand for faster access in particular for multimedia data, controlling access to certain types of data, protecting the work of authors (copyright issues), not enough IP addresses to meet the demands. Therefore newer and more efficient protocols and ideas are needed to meet the demands and to solve the problems mentioned before.

Apart from any future technological development of the Net, the main source of the Internet remains the people, who use and contribute to make it always bigger. Everyday more people use an online computer to find information, learn, educate and communicate. We have to keep ourselves continuously up-to-date about all new developments and innovations of the Net to really exploit all its capabilities and possibilities.

ISPRS will remain inside this big e-world improving its appearance and always providing more information to its users. We will continually strive to improve and expand ISPRS online services, using the new available technologies and services. You could help us telling what is appreciated or which improvements you would like to see in the homepage.

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ORGANISATION AND FUTURE OF ISPRS STUDENT CONSORTIUM

Goksel AKKOCA[a], Petek TATLI[b], Rahmi NURHAN CELIK[a]

[a] Department of Geodesy and Photogrammetry Engineering, Istanbul Technical University, 80626 Maslak Istanbul, Turkey – gakkoca@gmail.com, celikn@itu.edu.tr

[b] Department of Geodesy and Photogrammetry Engineering, Yildiz Technical University, 34349 Besiktas Istanbul, Turkey – petektatli@gmail.com

Commission VI – WG 5

KEY WORDS: Student Consortium, International, Organization, Future, Education, Global

ABSTRACT:

During XX. Congress of International Society of Photogrammetry and Remote Sensing (ISPRS) in Istanbul, some student activities such as; Youth Forum, Summer Camp and Youth Technical Session were organised. These activities were regarded as the first, in ISPRS history and it was decided by the Council, that Youth Forum should be organised in the future ISPRS congresses. As a conclusion of these positive developments for students within ISPRS, Student Consortium (SC) was established under Commission VI "Education and Outreach" and the continuity of the Student Consortium was ensured by setting up an ISPRS Working Group "Promotion of the Profession to Students" that would provide a stable link between Student Consortium and ISPRS. ISPRS Summer School 2005 was the first main activity of Student Consortium and organised in Istanbul Technical University, with the topic of "Satellite Data Processing and Spatio-Temporal Analysis (for Resource and Disaster Mapping, Monitoring and Management)", between 19-26 June, 2005. Today Student Consortium has members from almost 30 countries all over the world and the members have started to build the future of Student Consortium. This study is a collective work of Student Consortium members and covers some topics such as; past, establishing & purpose, activities & today and future of Student Consortium.

1. PRIOR TO STUDENT CONSORTIUM

1.1 Students within ISPRS

It is trivial to mention that advanced graduate and especially postgraduate students generate a significant part of the scientific work developed within ISPRS and constitute the future backbone of ISPRS and its Members. However, for a long period there were no specific ISPRS activities targeted at this important group. It was only in 1996, during the Vienna Congress that the Best Papers by Young Author Awards were established and respective special sessions for presentations of these papers were organised. These awards were since then established and presented in all subsequent Congresses and many Technical Commission Symposia. However, neither other activities regarding students and young researchers were organised nor an organisational structure within ISPRS to host such activities was set up. In parallel to this, most National Societies, members of ISPRS, did not have a provision of student membership and student chapters. (Baltsavias, 2005)

1.2 Developing Idea: An Organisational Structure for Students within ISPRS

During the XX. Congress of ISPRS in Istanbul, some student activities were organised. These were Youth Technical Session, The Best Paper and Best Poster by Young Authors Awards, Youth Forum and Summer Camp. All the activities were really productive and encouraging for students.

These Youth Forum and Summer Camp were regarded as the first in ISPRS history.

During preparation of young people activities in ISPRS two targets were determined;

- first was to provide sustainability of Youth Forum
- second was to establish a Student Consortium under Commission VI "Education and Outreach".

Youth Forum

Organisation and preparation of Youth Forum is realized by a group of students under the supervision Local Organising Committee of the Congress. The topic of the Youth Forum was "Professional Contributions on Sustainable Development" and focused mainly on sustainable development including professional education and training methodology, future perspectives of the profession, the views of the youth community and their expectations from the professional society and pressures of technological developments.

A lot of students, young researchers from different countries and also the Council members were ready in the Youth Forum. Under the supervision student coordinators of Youth Forum everybody discussed and shared their ideas after speeches of keynote speakers.

Moreover, terms of references of an organisational structure for students within ISPRS are kindly suggested to the Council.

Sustainability of Youth Forum was agreed for all general assembly congresses in XX. Congress of ISPRS by the Council.

Figure 1. Youth Forum - ISPRS XX. Congress Istanbul

Summer Camp

Organisation and preparation of Summer Camp is realized by a group of students under the supervision Local Organising Committee of the Congress. ISPRS 2004 Summer Youth Camp was held in Guzelyali, Canakkale, Turkey; between 23-29 July 2004.

The camp was on the base of developing social relationships between students who are concerned with subjects in the content of photogrammetry, remote sensing and spatial information sciences. In the scope of the camp there were social and technical workshops, technical and social seminars, student presentations, leasure activities, and excursions. (Avci, 2004)

39 students from 10 different countries has participated the summer camp. The participation of students to both professional and social activities was enthusiastic.

Figure 2. Summer Camp Participants – Troya 2004

2. ESTABLISHING AND PURPOSE OF STUDENT CONSORTIUM

2.1 Establishing of Student Consortium

By the successful student activities during Istanbul Congress, the Council decided to set up ISPRS Student Consortium. It was established under Commission VI "Education and Outreach" and the continuity of the Student Consortium is ensured by setting up an ISPRS Working Group "Promotion of the Profession to Students" that will provide a stable link between Student Consortium and ISPRS.

Terms of References of WG VI/5 "Promotion of the Profession to Students"

- Promotion and support of international student activities including the ISPRS Student Consortium.
- Encouragement of active participation of students, especially undergraduate students, in ISPRS events and promotion of reduced fees and stipend for their participation.
- Collection and maintenance of a database on people who are involved in the promotion of the profession to students, including the members of ISPRS Student Consortium and educators.

Not only young researchers but also advanced diploma students can join Student Consortium. Student Consortium is led by student coordinators and **www.commission6.isprs.org/wg5** is the door through which you can find information on Student Consortium and its activities, announcements and also membership form of Student Consortium.

2.2 Purpose of Student Consortium

The main purpose of the Student Consortium is to link students in different countries who are interested in photogrammetry, remote sensing and spatial information sciences, provide a platform for exchange of information and culture and organise student-specific events either independently or within larger ISPRS events. By these events Student Consortium acts as a bridge between students and ISPRS.

3. STUDENT CONSORTIUM TODAY AND ITS ACTIVITIES

3.1 ISPRS Summer School 2005 Istanbul

Figure 3. Logo of ISPRS Summer School 2005

The designing and realization of the first ISPRS Summer School (SS) has also been one of the main goals for Student Consortium during the first year of its appearance. This event took place at Istanbul Technical University's Maslak campus during 19-26 of June 2005 and it was arranged in cooperation between Student Consortium Coordinators and the Local Organising Committee consisting of Turkish students. Altogether almost 50 students registered for the meeting, from which 39 from 11 different countries finally participated. The general topic of ISPRS Summer School was "Satellite Data Processing and Spatio-Temporal Analysis (for Resource and Disaster Mapping, Monitoring and Management)". In practice, this topic was presented to the participants in a wide range of theory and application lectures provided by many world-class lecturers, real professionals in their own subject matter. (Jarvinen, 2005)

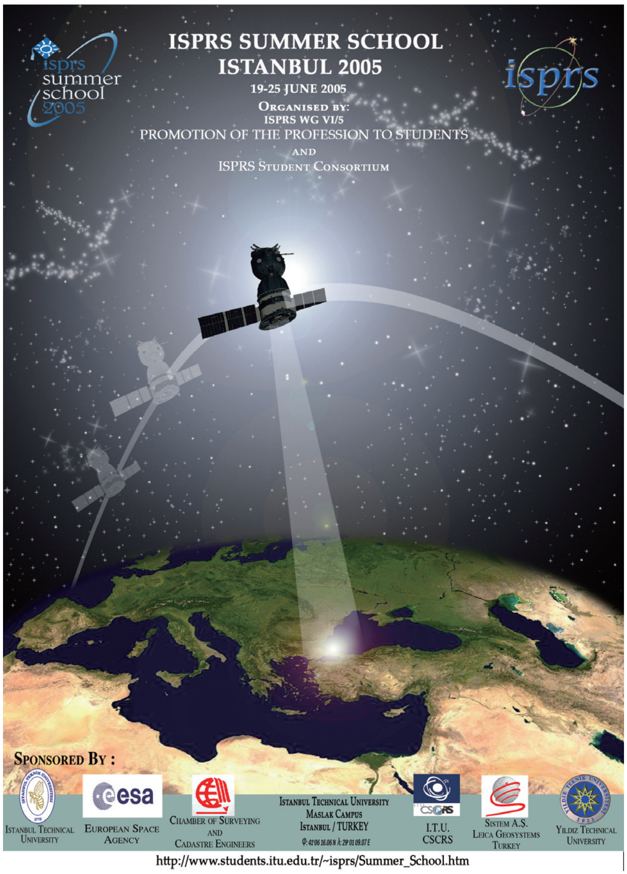

Figure 4. Poster of ISPRS Summer School 2005

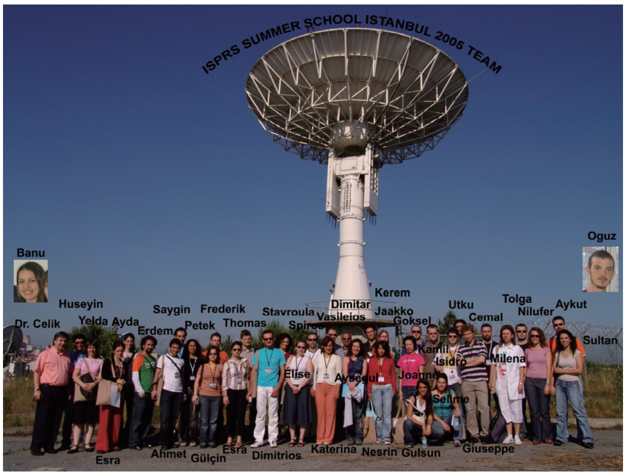

Figure 5. Participants of ISPRS Summer School 2005 (ISPRS SC web page, www.commission6.isprs.org/wg5)

3.2 Members of Student Consortium

Coordination of Student Consortium is ensured by Student Coordinators and current four Student Consortium Coordinators are from Turkey, Finland, Switzerland and Japan.

Distribution of Student Consortium members among the countries all over the world is graphically showed below.

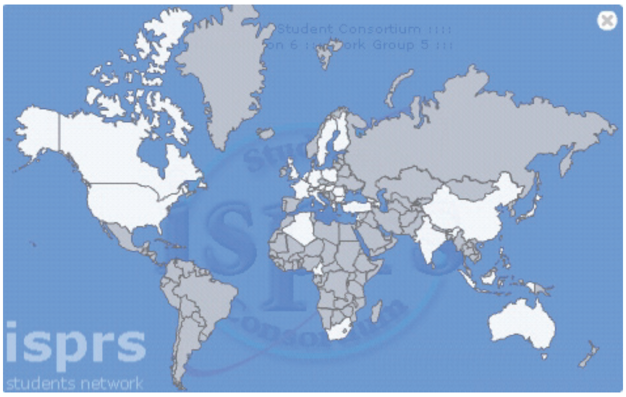

Figure 6. Distrubition of SC Members among the Countries

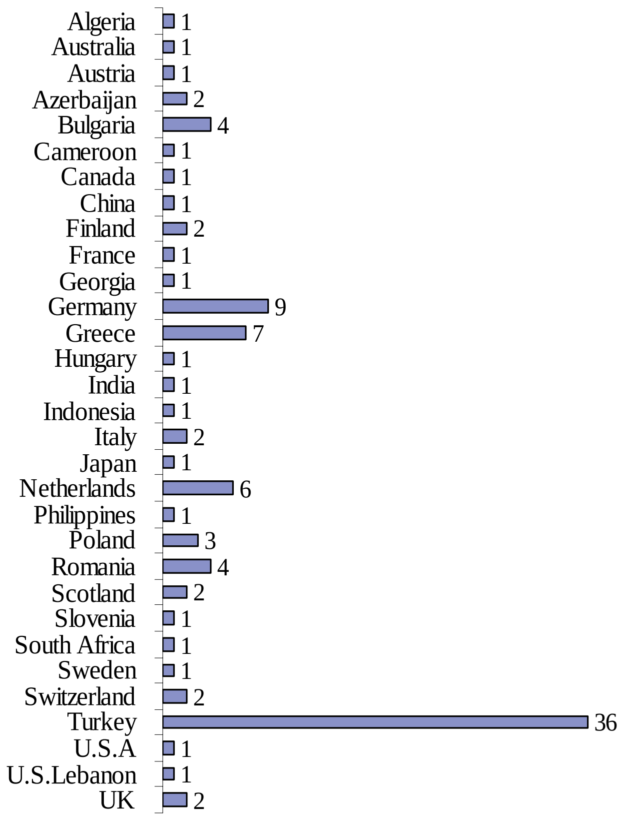

Chart 1. Distrubition of SC Members among the Countries

3.3 The Initial Team

In Turkey, an initial team, consisting of Student Consortium members, was established in November 2005 with a purpose of taking the role of shaping ISPRS Student Consortium's organisation plan and future. The team members include under-graduate, graduate students and young researchers. The team's main work topics are the new and permanent web site of Student Consortium, design of a member database and a sustainable student network plan all over the world. Infrastructure work of the team; the aim of which is to build Student Consortium on a strong base, is going on and developing.

4. FUTURE OF STUDENT CONSORTIUM

As a foresight of Student Consortium's future;

- the ideas and comments on developing of Student Consortium, which appear in the evaluation forum of ISPRS Summer School 2005,
- the tasks for Student Consortium which are drawn by the Student Consortium Coordinators,
- the topics on which the team in Turkey is working

are commented as:

National liaisons should be established and national coordinators should work for building, developing Student Consortium network in local region and for providing feedback to Student Consortium about universities, students and national liaison. Therefore, stable student network all over the world should be established.

Activities of Student Consortium should be varied; it should not be just a summer school; projects can be developed, as collective work of Student Consortium members.

Student Consortium should have an interactive and smart web page. It should work as a portal, which enables both coordinators and members to use different interfaces for performing some administration tasks and queries in member database.

Till XXI. Congress of ISPRS in Beijing, in 2008; organisational structure of Student Consortium, well organised advertising of Student Consortium, effective activities and establishing a global student network should be achieved. After the Congress, Student Consortium keeps on growing by impressive activities.

In conclusion, Student Consortium will be an effective bridge between students and ISPRS. By Student Consortium activities students will be familiar with ISPRS. People, who will take responsibilities within ISPRS in the future, will commence working within Student Consortium.

In other words, Student Consortium will shape the future of ISPRS.

LET'S COME TOGETHER TO MAKE THE WORLD SMALLER AND SMALLER, WHILE ENLARGING AND POWERING OUR STUDENT CONSORTIUM NETWORK!!

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THE STRUCTURE AND METHODS OF STUDENT ORGANIZATION FOR IGSM2004

Jaakko JÄRVINEN [a,*], Katri NUUJA [b], Mika ESKELINEN [b], Seija VINBLAD [a], Kirsi KARILA [b], Mikko HOVI [a], Kirsi KOIVULA [b], Katja KÄYHTY [b], Katri POHJANPALO [b]

[a] Dept. of Surveying, Helsinki University of Technology, 02015 Espoo, FINLAND – (jaakko.jarvinen, vinblad, mikko.hovi)@iki.fi
[b] Dept. of Surveying, Helsinki University of Technology, 02015 Espoo, FINLAND – (katri.nuuja, mika.eskelinen, kirsi.karila, kirsi.koivula, katja.kayhty, katri.pohjanpalo)@tkk.fi

Commission VI

KEY WORDS: cooperation, organization, international, planning, geodesy, IGSO, IGSM

ABSTRACT:

One week long IGSM (International Geodetic Student Meeting) was arranged in Espoo Finland in June 2004. In this paper we will present the structure of our student based organization behind all the various events of our meeting and essential facts relating to the successful arranging of this kind of international student meeting.

We will also present the four main phases of planning and realisation of our event: 1) preliminary announcing and free brainstorming, 2) specifying suitable categories and forming task-based teams, 3) action phase and combining results of teams' work and 4) collecting feedback and conclusion.

1. INTRODUCTION

In order the 17th IGSM (International Geodetic Students Meeting) took place in TKK (Helsinki University of Technology) in Espoo Finland 7-12 June 2004. IGSM is an annual and official event of the IGSO (International Geodetic Student Organization), non-governmental organization, whose purpose is to support international collaboration for the progress of geodesy in all fields and applications.

This paper will present you a comprehensive view into the processes behind the planning, organizing and realization of our IGSM, which finally gathered 120 participants from15 different Europian countries. This paper is intended to be a somekind of supportive guideline for all the forthcoming organizers of IGSM or other similar student activities.

In this way we want to thank all the previous IGSM organizers for their efforts in building and maintening of our great and time-honoured international geodetic student organisation. We also want to express our gratefulness to all our professors, sponsors and other people who have greatly supported us through this demanding but also rewarding and educating process.

2. THE MAIN PHASES OF ORGANIZING

The organizing assignment comes always with a process. No matter what is the size and duration or the character of that particular event, there are always some general similarities involved with the process of the event realization. This kind of general phases are for example: 1) *the defining of the major goals of the assignment*, 2) *realization phase* and 3) *combining all the separate elements into one working combination*.

Our IGSM organizing process consisted from four more or less separate main phases. In this chapter we will give you more detailed description about these main phases and all or them will also be represented in the form of timeline with some essential facts in the end of this chapter.

2.1 Phase I: Preliminary announcing and brainstorming

The first phase of organizing our IGSM started right after the ascertainment of the fact that IGSM will be held in Finland in 2004. This ascertainment happened in IGSM 2002 in Ljubljana Slovenia.

After returning back to Finland we gave a preliminary announcement to the all the students and the personnel of Department of Surveying in Helsinki University of Technology (TKK). We told them that IGSM will be the biggest and the longest international student meeting to be arranged in our department so far. And therefore we will need a lot of help to get succesfully through this challenging, but also very interesting assignment. We also started an e-mail list for all the people who had expressed their interest in arranging our event.

The first real meeting relating to our IGSM was arranged already in June 2002, almost two years before our IGSM. The idea of that meeting was to collect some useful ideas from the arrangements of the previous meetings in Ljubljana Slovenia in 2002 and Newcastle England in 2001. In addition to collecting experiences from the previous encounters we also used the method of free brainstorming for collecting all kinds of ideas popping ut of our minds.

In the first phase we were just gathering up ideas, even quite strange ones, without any particular aim to categorize these things or to make any decisions about the responsibilities. Those free brainstorming meetings were open to anyone who was interested in participation. In practice about 25-30 people participated more or less actively in this phase. It was also a good opportunities for surveying the personal interests and skills of the participants for the next phases of organizing.

2.2 Phase II: Specifying suitable categories and forming task-based teams

In the next phase after free brainstorming was summing-up. This summing up phase was carried out by much smaller group of people. Only 3-5 participants were mainly involved in this part of the organizing, where the most feasible and essential ideas were selected from all gathered ideas.

After this the next thing was to specify suitable categories, in which all the ideas could be fitted. Our aim was to find a good compination between descriptive and functional subject matters for all the ideas, however without getting too many separate categories. As said, this task was carried through by just a few people. That was because we thought that the more people we have involved, the more confusion we will have in preparatory decision outlining step.

The larger group of people is effective in creation of ideas, but the final categorization is better to do with less people involved. After doing this small group outlining, our suggestion was presented to the others and it was also accepted.

In our suggestion we ended up with four main categories: 1) *administrative tasks*, 2) *webpages/logo/video*, 3) *accommodation/food* and 4) *program*, which was soon separated further into two different, but still highly similar parts: 4A) *official* and 4B) *social program*. These main categories are presented in figure 1.

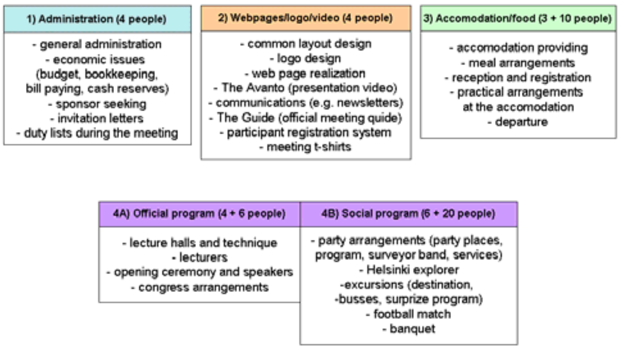

Figure 1. The main task categories

After specifying categories, it was time to situate all the ideas into them. When all the ideas were divided into the categories we wrote short descriptions and lists of tasks for each category. This way we had created good basis for forming of task-based teams and for the actual action phase.

Numbers after category names describe how many people were involved in each team during arrangements, in generally and during the actual IGSM week. There are also some individual tasks mentioned for each category.

Next step – *team forming* – followed. In this part it was important to find the right persons for the right tasks, which meant that the personal skills and interests of the each person were taken into account. In this way we could secure better motivation for each individual participant and therefore the whole organization naturally worked in more efficient way all the way through the planning and realization process.

One of the most important things before starting the actual arrangements was to actually write down the goals and the tasks of the each individual team. This operation did not only greatly improve the inner efficiency of each individual team, but it also created a good starting points for the awareness between different teams. With good planning and open flow of information the major responsibility unclarities could be avoided or at least their risk was greatly reduced.

Of course we naturally had some disagreement and problems inside of each team, between the teams and also in the personal level during our whole organizing process. But because of the good preliminary planning these problems did not ever affect to the arrangements in whole. Therefore other things were always moving forward, even though there were some momentary problems going on in some areas at the time.

The categorization was carried out in the end of year 2002 and primary task-based teams were formed in January 2003. In practice this means that they were done already one and half years before the opening ceremonies in our meeting.

2.3 Phase III: Action phase and combining results of teams' work

In our case effective action phase lasted approximately one and half years, from the January 2003 until the beginning of our meeting. I think that for many people this may sound like a long period of time to spend for one week student meeting. But it's good to remember that in the beginning, working rhythm was much slover when compared to the very hectic last weeks before our meeting.

There were also a quite big differences in the activity levels of the different teams throughout the organizing process. For example *2) Webpages/logo/video* team was very active before IGSM 2003, when our webpages were published and presentation video "The Avanto" was presented for the first time in Dresden.

Also the beginning of the year 2004 was also quite busy time for the Webpage/logo/video team, when the first round of the registration was opened in January 20th. This team was fairly active throughout the whole organizing process, for example by sending newsletters and keeping webpages updated. We think that the good information transfer and announcing in generally were the one of the strongest sectors in our arrangements. And we mean informing both in internal and external level.

The activity of the *3) Accomodation/food* team was pretty opposite, when compared with Webpage/logo/video team. Everything was fairly quiet until the last month came and it was time to make the all the practical things work at the accommodation place. This was also one of the most active and largest teams during the actual IGSM week.

As mentioned before, our program team was quite divided into two separate but still quite tightly connected divisions: official and social program. These two teams provided quite much work throughout the whole preparing process, because they both are very critical for successful event.

The tasks of the *4A) Official program* team consisted mainly of the two main things: opening ceremony and lectures, which both were located into the beginning part of our meeting. The good thing with the official program is that it do not need so many workers during the IGSM week. Just two people could easily manage with all the lecture arrangements. Another good thing with lectures is that they are pretty economical to arrange.

The *4B) Social program* was very opposite to the official one – arrangements always needed a lot of workers and expenses were quite high. One big challenge with the social program was: How to provide enough changing program throughout the whole week? Or actually: How to provide good social program with reasonable price? That was the biggest problem with the social program.

After a lot of calculations, optimizing and abandoned ideas we finally think that we still managed to provide quite satisfying and also informatic view to the Finnish style of life.

Then finally last but definitely not least there was also the *1) Administration* team, which was of course one of the major elements through the whole organizing process. After all, their responsibility was to bring all the different parts and elements finally together into one complete and smoothly working combination, economically and according all the other aspects as well.

2.4 Phase IV: Collecting feedback and conclusion

When the event itself is finally over, there still some duties to be taken care of before all the official arrangement of the meeting are finally over. For example all the bills had to be paid and also the budget and bookkeeping had to be completed. After the finance was concluded, the remaining money was forwarded to the next IGSM organizing committee.

After finishing all these economical aspects it was also important to draw some kind of conclusion of the event also in personal level, from the perspective of the participants and also from the viewpoint of the organizers as a whole. In practice it is good to collect feedback already during your meeting. This can be done for example in form of feedback form in the end of the event. Also direct discussions with the participants are good source of information.

It is also important to gather and share the thoughts of the organizers as well. This way you can more clearly analyze what was good during the event and what could be improved in the future.

Overall conclusion phase is one of the most important parts of the whole organizing process. In this part you can learn a lot of yourself, from the other team members and of the organizing process as whole, when you share and compare your own thoughts and experiences with others. In some cases summing up can be the hardest part of the whole process, but it also tells a lot of the true capabilities and incapabilities of the organization.

2.5 The phases and essential details presented on timeline

We have now described all four main phases of our IGSM organizing, their contents and goals. Now it's also good to visualize how these different phases are located on timeline which in representing the two years time period of our IGSM arrangements. This timeline can be seen in Figure 2.

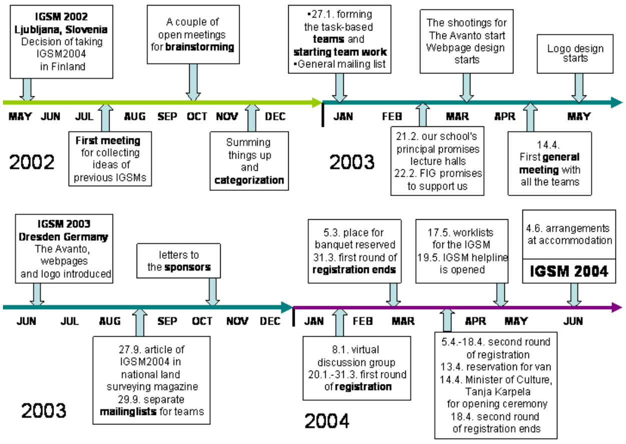

Figure 2. The main phases of arrangements and essential details presented on timeline

First two phases including: free brainstorming, specifying categories and forming task-based teams lasted only a very short period of time, only three months, as you can see from the timeline. But still we created a lot of important basis for the succesful realization of our IGSM organization, during that well spent time.

We have also mentioned some of the important and essential details of our IGSM planning in this same figure. From the figure you can easily get a somekind of quick overview to the things relating to the sponsor seeking, accommodation, two separate registration rounds, webpage design and other practical arrangements.

3. THE STRUCTURE OF OUR STUDENT BASED ORGANIZATION

In this chapter we will present some of the main aspect in our student based IGSM organization. We think that our organization represents Finnish and as a whole quite Scandinavian way to get things organized. Some of these aspects may be different from the ones you are normally using in your country.

Because of these national differences we think that it is important to present some of our main planning aspects in more details. Perhaps this way you can find some new and useful ideas for your own coming organizing needs. Or hopefully you can atleast understand better our systematic and beforehand planned Finnish style of organizing things in the future.

3.1 The four main aspects in establish our organization

3.1.1 Autonomous student based planning: In Finland we have very long traditions for student based decision-making and self guided activities. For example the Guild of Surveyor in Helsinki University of Technology (TKK) became already 105 years old this Spring 2006. All this history creates good basis for the individual and valuable student based decision making.

By this student autonomy we mean that our IGSM organization was planned, created and controlled fully by students all the way from the beginning. This autonomous student planning doesn't mean that the professors and other school personnel would have been totally ruled out of decision making. But their role reminds more like a consultant instead of organization leader.

So, what was the role of our professors in this kind of student based process then? Their role was to stay on the background, until the students really felt that they needed some guidance. Available and ready for discussions when students feel like it, but not giving students too direct and ready made suggestion for the actions from their own personal aspects.

Of course this kind of trustful attitude on both sides takes time and needs efforts to develop. And it also creates a lot of kick-backs and occasional frustration when student try to find their own and personal ways to solve problems. And this way may definitely not be the fastest one to get result.

But after the certain autonomous level has been reached, with a good combination of responsibilities and freedom of choice, it starts to finally benefit the both sides. Students have learned to work more individually and as a result professors don't have to pay so much time in direct guiding for all the things.

We think that our student based IGSM organization reached already a quite high level of autonomy, when in many cases the only task for our professors during the whole process was to accept our ready made plans by saying: "Looks good. Carry on!"

3.1.2 Effective and flexible working teams: The effectiveness and strong flexibility of our working teams we based on two main things: 1) good preliminary planning and 2) effective information exchange. When all the organizers were all the time more or less aware of each others actions and achievements, it was easy to direct resources where they were needed and when they were needed.

Sometimes during the organizing project we had a feeling that everyone was doing everything. Especially in the beginning, when there were not yet so many people involved in arrangements, it was more like a one team doing all the separately categorized tasks together.

But as the arrangements moved forward and when realization went more into details and more people joined to the arrangements, our organization moved very flexibly into more task-based way of actions.

3.1.3 Democratic decision making: In our Finnish culture democracy is very important aspect. In our IGSM arrangements this appeared so that everyone in our organizing team had a similar right to bring out their own ideas. And this right was equal to from the General Secretary and Treasurer to the temporary accommodation assistant.

Of course the people who were more involved with the arrangements, knew more about the matters and were therefore more capable to make the actual decisions based on their wider knowledge. But despite of these differences in backgroung knowledge, all the organizers were on equal level for giving out ideas and proposals for democratic decision making.

3.1.4 Aim survey – securing fundamentals – integrated realisation: When planning anykind of event, no matter how big or how long, it's always easy to come up with remarkably fabulous ideas of all that could be done. But the tricky question is: "How could we realize at least a part of all these great ideas?"

Basically a successful event arrangement depends only from three very simple things: 1) time, 2) money and 3) effort. And all of these three are closely connected together and everything else is more or less related to them.

It's very simple: if you have time and effort, you can save money in arrangements. If you have money, you can just buy things and services and thereby save time and efforts. If you won't save your efforts for example in good planning in beginning, you will have more time in the end. And if you put your efforts and time in sponsor seeking, you will most probably have more money to spent.

But how can you find a good or at least fairly functional combination between all these three things to be able to provide a succesful event? In our organization we approached this problem in three different steps, which are now presented in very simplified way in figure 3.

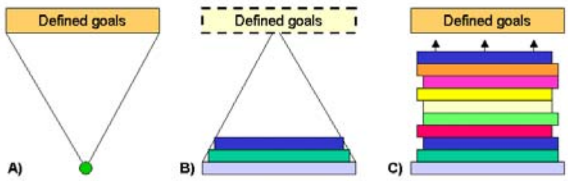

Figure 3. a) aim survey, b) securing fundamentals and c) integrated realization

First of all you have to have an *aim survey* step to get some kind of overview of the final goal you are aiming for, figure 3 a). You simply can not start planning your event efficiently before you have clearly defined wider overview of what the main goals are for the current event.

During the arrangement process it is also important to stop now and then and consider if you are still heading for your predefined goals. And if not, you have to decide how to change your actions and methods to achieve your goals better. Sometimes you may also have to change your original goals as well, at least partly.

Next step in the process is called *securing fundamentals*, figure 3 b). There are always some fundamentals, some basic things that just simply have to work or else your event might end up with disaster. Just imagine a situation of having several world class lecturers, but no suitable lecture halls at all for them to speak. Or hundred arrived participants, but sleeping place only for half of them.

The last and very crusial step is *integrated realization*, which takes place right before the beginning of the event, figure 3. c). No matter how well things have been planned beforehand and how well the individual fundamentals have been carried out during the preparatory phases, things can still go wrong without good final integration.

3.2 Our organization as a hierarchic organization chart

This headline is fairly misleading on purpose. As you can see from the figure 4, there wasn't so much hierarchy at all in our team based student organization.

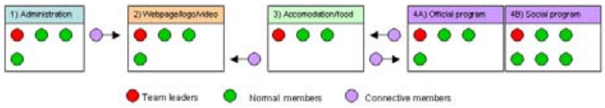

Figure 4. Hierarchic structure of IGSM2004 organization

Because we were the group of students, working together for the same shared project, we thought that there is not need for many specific hierarchic levels in our organization. As a matter of fact the only proper hierarchic instance was that there were team leaders in each working team.

Instead of having a vertically high organization we concentrated more in good communication and cooperation between different teams in horizontal level. In practice this happened so that some of the organizers were more like connective links between all the teams, instead of just being stable members of one specific team.

Of course and especially in the end of arrangements it was also important to have most the people working all the time only for one purpose, like contacting potential lecturers or planning social program excursions. But because we had some of the organizers constantly working as contact persons, we were able to keep different teams sufficiently aware of each other's actions all the time.

In addition to this constant communication between some of the organizers, there were also general organization meetings arranged once in 1-2 months. In these meetings all the teams regularly presented their accomplishments publicly to the others.

4. THE SCHEDULE OF OUR IGSM

The structure of our IGSM week's schedule is presented in figure 5. Schedule shows all the different events which we provided within our meeting.

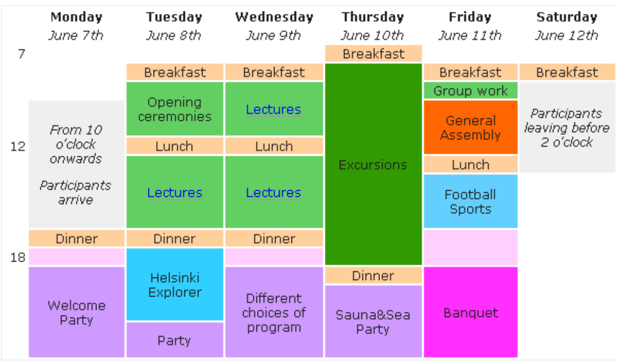

Figure 5. The schedule of IGSM2004

This kind of basic structure for schedule has already proven to be very functional in several previous IGSM events, e.g. Dresden 2003, Ljubljana 2002, Newcastle 2001. Therefore we decided to respect this working tradition and use the same basic principles in design of our IGSM schedule.

4.1 Official and profession-related program

In our opinion every professional meeting should have an official opening ceremony and so was the situation also with our IGSM. Opening ceremony started with the speech of the IGSO General Secretary Mr. Mika Eskelinen. And in the end of ceremony IGSM2004 was officially opened by Treasurer Ms. Seija Vinblad.

Opening ceremony included also welcome greetings from the Ms. Tanja Karpela, Minister of Culture, Mr. Olavi Nevanlinna, Vice Rector of TKK, Mr. Olavi Louko, City of Espoo, Prof. Kauko Viitanen, Head of the Department of Surveying at the TKK, Tiina Kauppinen, Guild of Surveyors and Mr. Markku Villikka, Director, FIG.

Because IGSM is the meeting of the international geodetic students, it should be self-evident that at least within the official program, there should be enough profession-related programme available. Only this way we can maintain the original idea and status of the IGSM as an annual event directed to all the geodesy and land surveying related students. This aspect is also important issue to remember in the future, if we want to remain the current professional status among our sponsors.

When designing IGSM as a whole, it is also good to remember that the official program is in many cases much economical to produce when compared to the more open social program. Therefore by providing lectures with good quality, you are also saving some money to provide better quality social program as well.

One developement for the future IGSMs would be to provide student participants a chance to give their own scientific presentations as a part of professional program. This would also bring even more student point of view into the official parts of the event.

We were considering having this kind activities as a part of our official program in our IGSM2004, but because of the lack of time with arrangements we finally decided to give up this idea. Therefore we were very delighted to see that this kind of activities were available in IGSM-GHG 2005 in Istanbul Turkey. And the same progression seem to continue in IGSM 2005 in Crakow Poland.

General Assembly is also one important part of the IGSO (International Geodetic Student Organization). There is a detailed description of General Assembly in IGSO's statute, so you can find more detailed information from there (IGSO Statute).

4.2 Social program and excursions

Social program is also a very important part of IGSM as a counterbalance for the official program of our meetings. The main idea behind IGSO is to bring together geodetic students from all around the world and to encourage them to make relationships in both professional and friendship level with each other. Social program provides good starting point for al this.

The social program is of course more open for different kinds of activities than the official side of our meeting. For example excursion trips with alternative resorts, football match and other sport activities have long traditions in our IGSO organization. Hopefully these traditions will be taken into accout also in the future, maybe in slightly up-to-date way.

Many of the participants of the IGSM have a chance to stay only one week of IGSM in arranging country. Therefore it is good to provide them a possibility to get to know also some other parts of your country in addition to the organizing center and lecture halls. Therefore it is good to keep in mind that the social program is the part of the meeting, where you can introduce your country, its' history and customs to the participants.

All the great meetings have also a somekind of high point. In IGSM we have had a tradition of having a banquet in the end of the meeting. This is most probably the last ceremony of the meeting and the thing that people will definitely remember from your IGSM, so it is always good to pay some extra attention in arrangements of the banquet. Even if the some of arrangements of IGSM haven not been so successful, people will forget easily at least some of those setbacks, if they will get a good last expression of your meeting because of the successful banquet.

It is also good to keep in mind that in many cases the most expensive is not the best. By using your imagination and creativity, good planning and elegant small details you will give much more sophisticated impression, instead of just using a lot of money. One should also remember to mention the dress codes in good time in IGSM info. This way participants can prepare themselves for this ceremonies and other events in the right way and therefore enjoy more of the ceremonious atmosphere.

5. CONCLUSIONS

We hope that we have accomplish to give you a general overview into our IGSM2004 arrangements and the structures behind the event in this paper. One of the main goals for writing this paper is help the forthcoming organizers of the IGSM in the future. We also hope that this paper could be somekind of guideline for orher similar events regardless of size, duration, meaning or subject matter of the event.

Another aim for this paper is to document what, how and why we have done within our event arrangements. As a conclusion we might say that the main aspects in our IGSM realization have been good preliminary planning and the flexible task-based team work. Also you can not ever overemphasize the meaning of the good communication between the organizers, when you are working together for the shared goal. We hope that you can find at least some new ideas and useful advices for your coming organizing need in the future from this paper.

References from websites:

IGSO Statute, defined in Graz, May 10th 1991 and complemented in Ljubljana, May 2nd 2002 http://www.igsm2006.agh.edu.pl/statute.html (accessed 31 Mar. 2006)

POSITIONING AND NAVIGATION SYSTEM USING GPS

J.Parthasarathy

Member Technical Staff, Sun Microsystems Pvt ltd, India, Divyasree chambers, off-Langford road, Bangalore-560027, India.
Parthasarathy.Jagannathan@sun.com

Commission VI

KEY WORDS: GPS, RS-232, NMEA, DGPS, Latitude, Longitude, Mapping

ABSTRACT:

In this paper, some of the ideas of positioning and navigation using GPS (Global Positioning System) where explored, GPS is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. This paper provides the use of a handheld GPS receiver in the areas of precise positioning, mapping locations, navigating across the mapped locations very easily. The purpose of this paper is to showcase the experiences that incurred in designing a positioning and navigation system (with the aid of a 12 parallel channel handheld GPS), which can be used as a moving compass, steering to any mapped destination, providing the information about near by places, tourist attractions, petrol bunks etc. The Magellan 310 handheld GPS which is being used for developing the proposed system allows users to connect to a personal computer through RS-232 Serial Interface and the protocol used by the device for communication is NMEA 0183, (National Marine Electronics Association). It is an American national regulatory body, which, among other things, sets standards pertaining to the interfacing of marine electronic devices. This NMEA 0183 Protocol transmits data to the connected PC every 1 second, this data has to be interpreted and filtered accordingly to get the needed information from the GPS device. This paper provides a case study in the process of designing such a system and its limitations in the era where through distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map. It also portrays the implementation details and their results obtained and along their pros and cons when compared with the other existing positioning and navigation system designed for basic handheld GPS (without having advance features like provision for electronic map etc. in the device), It also addresses some of the enhancements that can be accomplished in the designed system. This paper is organized by providing a brief introduction to GPS technology and then dealing with hardware description & NMEA Messages along with a case study implementation detail of the system, its features and possible enhancements in the system.

1. INTRODUCTION

In this section of the paper, a brief overview of GPS Technology is provided. The Global Positioning System (GPS) [1] is a constellation of satellites that orbit the earth twice a day, transmitting precise time and position (latitude, longitude and altitude) information. With a GPS Receiver, users can determine their location anywhere on the Earth. The complete system consists of 24 satellites orbiting about 12,000 miles above the Earth, and five ground stations to monitor and manage the satellite constellation. These satellites provide 24-hour-a-day coverage for both two-and three-dimensional positioning anywhere on Earth.

A GPS satellite navigation system was begun in the 1970s by the US Department of Defense, which continues to manage the system, to provide continuous, worldwide positioning and navigation data to US military forces around the globe. GPS basically offers two levels of service namely SPS (Standard Positioning Service) for civilian access and PPS (Precise Positioning Service) for exclusive military use with higher level of encryption.

As already stated above, the basis of GPS Technology revolves around precise time and position information, which is being accomplished through atomic clocks and location data. Basically the satellites broadcast the time and their position. A GPS receiver receives these signals, listening to three or more satellites at once (it’s also called tracking), to determine the users position on earth.

A GPS working principle is that, it measures the time interval between the transmission and the reception of a satellite signal, and then it calculates the distance between the user and each satellite. Through the distance measurements of at least three satellites in an algorithm computation, the GPS receiver arrives at an accurate position fix. To obtain a 2-D fix (latitude and longitude), information must be received from three satellites and for a 3-D fix (latitude, longitude and altitude), four satellites are required.

2.HARDWARE DESCRIPTION & NMEA MESSAGES

2.1 Hardware – Magellan GPS 310 Description

Figure 1. Magellan GPS 310

In this section of the paper, the hardware details used for building the proposed system is being dealt.

Magellan GPS 310 Model with a parallel multi-channel design to increase the accuracy of the receiver is used, these Magellan's 12 parallel channel receivers are relatively quick to lock into satellites when first turned on initially and they maintain strong locks, even in dense foliage or urban settings with tall buildings. They are accurate to within 15 meters on average and it offers the users with a low cost GPS Solution with NMEA data output and PC interface capabilities.

The advantages and features of using the Magellan 310 GPS hardware are stated as below.

Advantages

1. Powerful 12-parallel channel receiver and super sensitive quadrifilar antenna for fast satellite signal locking and accurate tracking.
2. Incredible easy to use with EZstart, dedicated operation keys, and three user-friendly navigation screens, and saves 100 waypoints and 1 route with up to 10 reversible legs.
3. Features a brilliant backlit display or nighttime use, and its small, portable, lightweight housing is not only rugged – it floats.

Important Features

1. NMEA data output for PC interface
2. DGPS ready
3. Powerful 12-parallel channel receiver
4. Displays distance, bearing, heading, direction, steering, speed, time to go, elevation, time and satellite directions.

2.2 NMEA Messages

The NMEA (National Marine Electronics Association) is dedicated to the education and advancement of the marine electronics industry and the market, which it serves. It's a non-profit association composed of manufacturers, distributors, dealers, educational institutions, and others interested in peripheral marine electronics occupations.

The proposed Positioning and Navigation System is developed in accordance with NMEA-0183 Standard. An NMEA standard defines and electrical interface and data protocol for communications between marine instrumentation. The electrical specifications actually recommend a newer standard called RS-422 Standard which slightly varies from RS-232 Standard, in the sense that, RS-422 standard adapts to two wires each for transmitting and receiving for a total of four signal wires.

The general sentence formats of NMEA message from GPS are discussed as follows. Under the NMEA-0183 standard, all characters used are printable ASCII test (plus carriage return and line feed). NMEA-0183, data is sent at 4800 baud. The data is transmitted in the form of "sentences". Each sentence starts with a "$", a two letter "talker ID", a three letter "sentence ID", followed by a number of data fields separated by commas, and terminated by an optional checksum, and a carriage return/line feed. A sentence may contain up to 82 characters including the '$" and CR/LF. If the data for a field is not available or field is variable width, the field is simply omitted, but the commas that would delimit it are still sent, with no space between them. The optional checksum field consists of a "*" and two hex digits representing the exclusive OR of all characters between, but not including the "$" and "*". A checksum is required in some sentences.

The standard allows individual manufacturers to define proprietary sentence formats. These sentences start with "$P", then a 3 letter manufacturer ID, followed by whatever data the manufacturer wishes, following the general format of the standard sentences.

Some common talker IDs are:

1. GP Global Positioning System Receiver
2. LC Loran-C Receiver
3. OM Omega Navigation Receiver
4. II Integrated Instrumentation (e.g.AutoHelm Seatalk system)

Magellan GPS 310 receiver supports the standard sentences like APB, GGA, GLL, RMB, RMC, and GSV. In the above standard sentences, let us see an example illustration for a most used sentence called GLL (Geographic Position Latitude and Longitude). The sentence format is as shown below.

GLL, 4916.45, N, 12311.12, W, 225444, A

4916.45, N	Latitude 49 degree 16.45 minute North
12311.12, W	Longitude 123 degree 11.12 minute West
225444	Fix taken at 22:54:44 UTC
A	Data valid

When the receiver is interfaced with a PC, these NMEA Messages have to be gathered through serial communication and the necessary information like user's Longitude, Latitude, Speed over ground etc. are to be filtered and they can be used in subsequent phases in developing the proposed system.

3. CASE STUDY IMPLEMENTATION OF A GPS SYSTEM

In this section of the paper, the phases involved in designing a GPS system are discussed and elaborated with the needed information.

The phases involved in developing a case study implementation are:

1. Initialization of the GPS Receiver
2. Serial Interfacing of GPS with PC and Mapping of various important locations
3. File Management & filtering of GPS data
4. Designing a Location Master to accommodate the mapped data
5. Moving Compass and precise positioning

The case study implementation of the GPS system is done for a city named Salem present in South India. The developed system acts as a basic positioning and navigation interface for traveling across the city providing the users the requisite information. The mapped data's that will be presented in the coming sections are all pertaining to the positional coordinates of the various locations present in the Salem city. The implementation to be portrayed below is easily extensible for any other corner of the globe since the positional coordinates needed for a particular location is going to vary and it only involves two primary changes namely

1. Re-Initializing of the GPS Receiver using EZ-Start
2. Mapping and storing the locations of the new destination

3.1 Initialization of the GPS Receiver

In this section the steps involved in initializing the GPS receiver are discussed, these steps are solely for the Magellan GPS receiver 310; however steps in initializing the other receivers will be more or less the same as described below. Initialization step in GPS is required while taking it more than 10,000 kms for fastest tracking and also it is always preferable to initialize the receiver for that region.

Before using GPS 310 for the first time, the receiver needs to know its approximate location. Using Magellan's EZStart procedure, the GPS 310 will prompt us for the information it requires when we turn it on for the first time. There is no need to initialize receiver each time we use it. For the first time when using GPS 310, the following steps needs to be done for initialization.

1. Press ***PWR*** to turn the GPS 310 on
2. SELECT REGION. Use the ARROW pad to change the flashing text to select the appropriate region for your present location, Press ***ENTER***
3. SELECT COUNTRY or STATE. Use the ARROW pad to change the flashing text to select the country or state for your present location. Press ***ENTER***
4. ENTER ELEVATION. Use the ARROW pad to enter the approximate elevation for your position. If unknown leave the elevation at 0. Press ***ENTER***
5. ENTER TIME. Use the ARROW pad to enter your present time. Press ***ENTER***
6. ENTER DATE. Use the ARROW pad to enter the date. Press ***ENTER***

When the above initialization steps are performed, the GPS 310 displays the ***POSITION screen*** and automatically searching for satellites that it knows are in this area for the date and time that the user entered. The reinitializing process mentioned above is similar to the initialization except for the reason that new datum has to entered in doing so. Example: In the proposed GPS system, the following values are selected when performing initialization, REGION: West Asia COUNTRY: India and other standard entries like DATE & TIME.

3.2 Serial interfacing of GPS with PC & Mapping of various important locations

In this section of the paper, we will discuss
1. The standard RS-232 interfacing of GPS with PC
2. Data acquisition of GPS data on to file through serial communication.

In general, the GPS 310 is designed to interface to a PC or other devices using a data cable. It continuously outputs NMEA messages through the data port at a rate of every one second. The GSV message is output all the time including when the receiver is not computing fixes. After the first fix is computed, GSA, GLL, GGA and RMC messages are also output.

These messages contain position, time, date, satellite position as well as other status information. The above said messages that are available for the personal computer are used in the case study implemented GPS system. Incase of the receiver computing fixes and has a route set the RMB and APB messages containing useful information like steering, distance to destination etc needed to navigate to the route destination are also output.

The standard settings needed to receive the NMEA messages outputted from GPS are furnished as follows.
BAUDRATE=4800
PARITY= NONE
STOPBIT=1
DATABITS=8
PORT ID=1

To acquire the NMEA Messages on to the PC connected with GPS, we have to open the serial port with the above settings by disabling all the system interrupts. The sample NMEA messages acquired when GPS compute fixes will be of the below format.

$GPGGA,054544.59,1140.7023,N,07807.4575,E,1,04,2.3,00316,M,,,,,*21
$GPGLL, 4916.45, N, 12311.12, W, 225444, A
$GPRMC, 054544.59, 1140.7023, N, 07807.4575
$GPGSV, 3, 3, 08,,,,,,,,,,,,,,,,,,,,*71

These continuously NMEA messages obtained through serial communication interface of GPS with PC have to handled, processed, filtered to formulate the necessary information so as to enable the users to track down their positions and give them inputs about other nearby important places, along with distance, directions for steering to destination of their interest, for providing the user with such information requires positional coordinates of various locations in hand before developing the GPS system. This task is accomplished through mapping of the important places manually. Let us discuss the process of mapping positional coordinates of a location.

The GPS 310 will begin to acquire information from the satellites and use this information to compute your current position (called a position fix). Before doing so, initialization of the GPS receiver has to be done, the screen of the GPS 310 displays the number of satellites are being tracked. After the GPS receiver has received positioning data from at least three satellites (it takes approximately 2-3 minutes), it will begin computing a position fix based upon the information it is receiving. As soon as a position fix is computed, the receiver switches to the navigation screen displaying the moving compass. The word "TRACKING" is displayed in the lower right corner indicating that the receiver is computing position fixes. The obtained position fixes can be saved in memory for use later when you want to return to that position, saved position fixes are referred to as landmarks or LMK (can be saved through pressing ***MARK*** in GPS Receiver). Using the above procedure for mapping and computing position fixes in GPS Receiver, the following precise positioning of some of the locations in and around Salem is taken and they are stored in the backend for further computing.

Example:

Certain samples of mapped locations using GPS in Salem stored in the backend are as follows:

Latitude	*Longitude*	*Location*
1139.2345, N	07809.3000, E	Collectorate, Salem
1139.1789, N	07809.2000, E	Gandhi Stadium, Salem
1139.0023, N	07808.0123, E	4 Roads, Salem
1141.0023, N	07806.3653, E	Burn & Co., Salem

Table 1. Sample Mapped Data

3.3 File Management & Filtering of GPS data

The file management and filtering of GPS data is done in real time while the GPS system acquires the NMEA data from the GPS through serial interface every one second. The GPS system is developed in such a way to handle large amount of NMEA data, by constantly flushing the buffer and then refreshing it to accommodate new sets of NMEA data.

As explained above in the previous section, mapping is equivalent to acquiring computing fixes of various positional coordinate locations and then storing them in the backend for further computing. The continuous NMEA messages outputted every one second from GPS is stored in the temporary file buffer for some period of time, where in the mean time exact filtering of different formats of messages like GLL, RMB, RMC, GGA, and APB are done and stored in different files for extracting different kinds of information like Latitude, Longitude, distance, direction, speed etc.

Example of continuous NMEA data outputted by GPS stored in the Main file.

$GPGGA,054544.59,1140.7023,N,07807.4575,E,1,04,2.3,00316,M,,,,,*21
$GPGLL, 4916.45, N, 12311.12, W, 225444, A
$GPRMC, 054544.59, 1140.7023, N, 07807.4575
$GPGSV, 3, 3, 08,,,,,,,,,,,,,,,,,,,,,*71
$GPGGA,054544.59,1140.7023,N,07807.4575,E,1,04,2.3,00316,M,,,,,*21

From the sets of NMEA data, the GPS system filters for GLL, RMC, RMB, GGA message formats and then store them in different files for further processing. Example of a GLL (Geographic Latitude Longitude) file (filtered from the Main file).

$GPGLL, 4916.45, N, 12311.12, W, 225444, A
$GPGLL, 4916.47, N, 12311.17, W, 225444, A
$GPGLL, 4916.49, N, 12312.01, W, 225444, A

3.4 Designing a Location Master to accommodate the mapped data

The GPS system uses a location master backend file for processing and comparing of the real time data outputted by GPS with that of the static mapped positional coordinates present in it. It is designed in such a way for easily adding, updating, marking, viewing of the mapped coordinates present in the location master.

For instance if say a user finds an important place in the city Salem which is not being present in the location master file, then the user has got an option to view the current location master file and then add a new entry on to it. Location master maintains the mapped positional coordinates in the following format with the location code acting as a primary key to use other additional files as shown below.

ID	Latitude	Longitude	Area	City	Country
1	1139. 2345, N	07809.30 00E	4roads	Salem	India
2	1139. 1789, N	07809.2000, E	Shop	Salem	India
3	1141. 0023, N	07806.36 53,E	GH	Salem	India
4	1123. 4533, N	07807.23 22,E	5roads	Salem	India

Table 2. Location Master Data

Id	Latitude	Longitude
1	1139.2345,N	07809.3000,E
1	1139.1789,N	07809.2000,E
2	1141.0023,N	07806.3653,E
2	1139.2315,N	07803.1200,E
3	1123.2322,N	07923.5454,E
3	1125.5454,N	07803.2332,E

Table 3. Example Mapped Coordinates

Location master file allows the GPS system users to perform ADD, DELETE, VIEW and UPDATE on it.

3.5 Moving Compass and precise positioning

This section of the paper portrays the task done in moving compass module of the GPS system as it holds the key for precise positioning and navigation across the city with relative ease. It basically is used for precise positioning by comparing the mapped positional coordinates present in the location master with that of the newly acquired positional fix of the current location of the user while traveling across the city.

With respect to the difference it finds with the existing mapped positional coordinates in the location master, their current locations is found when it is approximately zero and then for difference exceeding but relatively of certain small margin are its nearby places. This information computed after acquiring continuous NMEA messages every one second and then comparison done with that of the mapped positional coordinates present in the location master yields the user about all necessary information that is required. But the accuracy of the computed fix about the current location and nearby places, distance for steering to destination, direction and speed etc. are entirely dependent on the mapped positional coordinates present in the location master and other modules.

This module is dependent on other modules mentioned above like Initialization, Mapping, Location Master, File management and Filtering of GPS data for precise positioning across the city that is shown below in the figure.

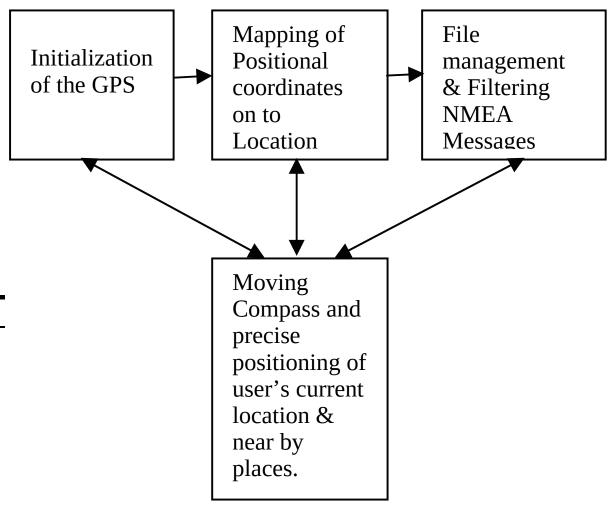

Figure 2. Implemented GPS System

4. APPLICATIONS OF THE GPS SYSTEM

The applications of the designed GPS System are illustrated as below as follows.

1. Identifying user position precisely
2. Navigating from point to point
3. Moving compass
4. Steering to destination
5. To act as a city guide software
6. To identify nearby important places, tourist attractions by computing user's current location

5. CONCLUSION

This system developed is a miniature of what can be done with the usage of GPS technology, since cost being a constraint for further advancement, it provides the users a wide variety of applications by using a basic GPS receiver which is costing less. Thus the implemented system can pave way for developing other systems using high end GPS receivers with lot of new features and advancements, so that applications such as vehicle tracking, tourist guide software etc. can be developed for the users.

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THE PHOTOGRAMMETRY EDUCATION FOR MULTIDISCIPLINARY GEOMATICS IN P.R.CHINA

Qing Zhu

LIESMARS, Wuhan University, PO Box C310, 129 LuoYu Road, Wuhan, P.R.China, zhuq66@263.net

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ABSTRACT:

After briefly reviews the history of photogrammetry education in P.R.China, the development of undergraduate and graduate program, and the corresponding curricula design are analysed by using of the data from Wuhan University in which the photogrammetry is awarded as the state-level key discipline. The academic educational program of photogrammetry in universities has trained students to perform tasks in all fields of the photogrammetric profession. In recent years, the nature of photogrammetry is changing and multidisciplinary geomatics are developing very rapidly, the educational program of photogrammetry has also been changed in new concepts and structures to adapt such new technologies and the extension of the field. Finally, the prospect of photogrammetry education for the requirements of multidisciplinary geomatics is proposed. The growing interest in fast and accurate 3D spatial data collection (such as city modeling and digital earth) results in the increasing need of photogrammetry as principal tool, photogrammetric courses are therefore requested to be up to date and to become one kind of the fundamental professional courses for university geomatics and remote sensing degree programs.

1 INTRODUCTION

The word photogrammetry comes from Greek words photos (meaning “light”), gramma (meaning that which is drawn or written) and metron (meaning “to measure”). It originally signified measuring graphically by means of light (Whitmore and Thompson, 1966).

The development of photogrammetry can be traced back to the middle of the 19th century. Since the invention of the camera in the mid-1800s, photography has played a large role in surveying. With the conventional use of the airplane, an area called photogrammetry became a huge specialty of surveying. Photogrammetry is the tongue-twisting term for the science and technology of obtaining reliable measurements, maps, digital elevation models, and other GIS data primarily from aerial and space photography (http://www.asprs.org/career/). In summary, photogrammetry has undergone three well-known stages of development, i.e., analogue, analytical, and digital photogrammetry. The characteristics of these three stages are listed in Table 1. The academic education of photogrammetry has to adapt such development for qualified photogrammetric professionals.

Components and Parameters	Stages of Development in Photogrammetry		
	Analogue	Analytical	Digital
Input Component	Analogue	Analogue	digit
Model Component	Analogue	analytical	analytical
Output Component	Analogue	digit	digit
Degree of Hardness	3	1	0
Degree of Flexibility	0	2	3

Table 1. The characteristics of the three stages of photogrammetry

In China, the aerial photographs and space images are the most significant data source of national basic geographic information, the photogrammetry are employed as the most effective official way to produce and update the national basic scale of topographic maps (1:10000 and 1:50000). In most cases, large scale of topographic maps (1:500, 1:1000, 1:2000) are also produced by photogrammetric methods for urban planning, highway and railway design, and so on. At the stages of analogue and analytical, photogrammetric instruments such as the stereoplotters were so expensive and complicated that the operator training was very difficult, and the operations then largely rely on the professional photogrammetrists with college education. Compared to the manual analytical stereoplotter, however, softcopy systems are easier in terms of operator training. Just need fairly good knowledge of the mapping business generally, as well as some basic computer skills, but don't have to be photogrmmetrists or have skills of stereoplotter operator, this opens up the number of people able to use it. Since 1996, the digital photogrammetric workstations (DPWs) on Windows NT became practical tools, two kinds of DPWs, i.e. the VirtuoZo by Wuhan University and the JX-4 by Chinese Academy of Surveying and Mapping Science, have been widely used in multidisciplinary applications. At present more than 2000 DPWs are employed by photogrammetrists and other geomatics professionals to collect different kinds of geographic information, for example, the digital elevation models (DEM), digital orthoimage maps (DOM), digital line graphs (DLG), photorealistic 3D city models, and so on. This type of multidisciplinary applications is sought by employers and usually translates into good jobs.

As we move into the 21st century, geomatics, composed of the disciplines of geodesy, cartography, photogrammetry and remote sensing, has evolved as a new discipline from the integration of surveying, mapping and GIS curricula. Related to the advanced information and communication technology (ICT), present photogrammetrist must be well versed in ortho image and 3D data acquisition from a variety of source data types: conventional and digital aerial photography, satellite imagery, laser scanning (LIDAR) and radar to name a few. As a provider of data to a wide variety of users, the photogrammetrist will make professional assessments of the spatial accuracy and integrity of these widely varied data types and will make recommendations for the application of these data in engineering and GIS analysis.

2 PHOTOGRAMMETRY DEGREE EDUCATION

2.1 Undergraduate and Graduate Program

Traditionally, most of the photogrammetric professionals are trained through the university degree education in China. After more than 70 years' development, multi-level photogrammetric programs have been changed greatly. As illustrated in Figure 1, the Chinese photogrammetry education is changed from only a few courses, then a well-developed independent specialty , and to a direction of integrated specialty at present.

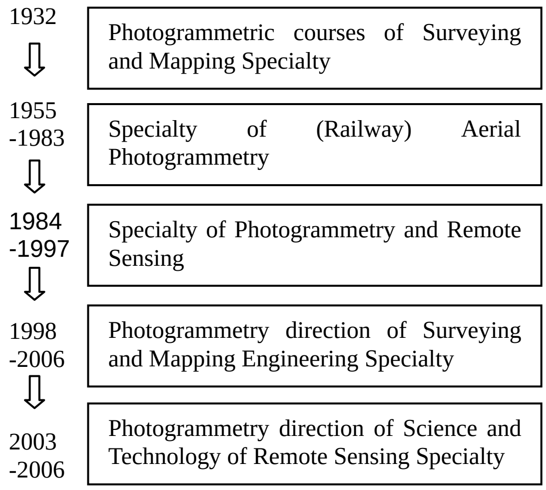

Figure 1. The time line of Chinese undergraduate photogrammetry program

In 1932, the photogrammetry was firstly included as one of the major courses in the department of Surveying and Mapping, Tongji University, Shanghai, China. In 1952, the specialty of aerophotogrammetry was established in Tongji University. In 1956, the then Wuhan Technical University of Surveying and Mapping (now merged into the Wuhan University) was founded based on the collection of related specialities in Tongji University, Tianjing University, Tsinghua University, Nanjin Institute of Technology, South China Institute of Technology and Qiangdao Institute of Technology, and the specialty of aerophotogrammetry was set up in 1957. Almost during the same period, similar specialty is set up in the then Zhengzhou Institute of Surveying and Mapping (now Information Engineering University) and the then Tangshan Railway College (now Southwestern Jiaotong University) respectively (Li et al., 1987). With the development of remote sensing technology, the specialty of aerophotogrammetry was reformed as Photogrammetry and Remote Sensing in 1984. At present it is well-known that the photogrammetry is a part of remote sensing, which involves viewing objects stereoscopically to make accurate measurements. As an independent branch, photogrammetry and remote sensing becomes one of the most active and evolving fields in China. From 1984 to 1998, the Chinese photogrammetry education possessed its golden time. The past development of Chinese surveying and mapping discipline was referred to the specialty subdivision mode of Soviet Union, which plays important role in the planned economy of China (Ning, 2003).

In the decade, along with the rapid development of GIS and other geotechnologies, the traditional surveying and mapping disciplines, including cartography, photogrammetry and remote sensing, and geodesy, have evolved as a new discipline Surveying & Mapping Engineering similar to geomatics of other countries. Part of photogrammetry and remote sensing has been included in the specialty of Surveying & Mapping Engineering as Photogrammetry and Cartography direction since 1998 (Ning, 2000). Especially, the main photogrammetry direction is included in a new specialty named Science and Technology of Remote Sensing, which has been established for undergraduate major in five universities since 2003, even it is still not included in the catalogue. Since then, the systematic photogrammetry education has been weakened across the country, while it has been extended to multidisciplinary geomatics. Up to now, different levels of photogrammetric courses can be found in more than 50 universities and colleges of China.

As a training mode of broad-caliber specialized education based on comprehensive education, there are 8 fundamental professional courses designed for Surveying & Mapping Engineering undergraduate program, i.e. introduction to geomatics, the principles and methodology of digital mapping, error theory and surveying adjustment, geodetic foundation, spatial positioning technology and applications, photogrammetry and remote sensing, cartography, geographic information system and applications (Ning, 2000). From specialty subdivision to multidisciplinary integration, more and more geomatics professionals are able to acquire the photogrammetric knowledge and skills through university education, while the undergraduate program in photogrammetry as an independent degree education is hardly available.

For advanced-degree programs, i.e. M.Sc. or Ph.D. degree in photogrammetry and remote sensing, 10 universities and institutes were granted the power of awarding the Ph.D. degree, and more than **20** universities and institutes for master degree. In order for the emerging and developing of cross-disciplines, more and more strong enough universities have been granted to independently award the M. Sc. and Ph.D. degrees of all the second-class disciplines under certain first-class discipline since 1996. For example, under the first-class discipline of the science and technology of surveying and mapping, at present there are **8** universities can award the Ph.D. degrees of all the three second-class disciplines, i.e. geodesy and surveying engineering, cartography and geomatics, photogrammetry and remote sensing.

In China, all the undergraduate programs in photogrammetry specialty require students to pursue four-year full-time studies in education. However, the graduate programs provide the mobility of 1 degree structure Dipl.(1 to 2 years) and Ph.D.(3 years), and the tradition of 2 degree structure M.Sc. (2 to 3 years) and Ph.D. (3 to 6 years). Since 2004, a flexible M.Sc. degree program based on 2 years has become the main stream of photogrammetry education. Compared to the traditional 3 years' program, this program just decreases the credit hours for academic research and thesis, but it benefits graduates' earlier employment. In fact, this is a great change of education idea. When the Ph.D. students are enough to satisfy the requirements of academic research and education, the M.Sc. students are expected to be skillful in the solution of practical photogrammetric problems. Especially, in order to satisfy the increasing requirements of training qualified engineers for industrial and mining enterprises, the engineering graduate education (2 to 3 years' part-time studies) is also offered by universities together with the local organizations for skillful professionals.

Because Wuhan University provides the largest and the most important geomatics education for China, the recruit students number of each year is very typical to the development trend of whole China. In order to get an impression about the total number of phogrammetric students every year from Chinese Universities, see Figure 2 to 4. Even the demand for geospatial skills is growing worldwide, the undergraduates number keep a little change, and similar to Germany job market for a geomatics professional shown as in Table 2 (Konecny，2002), the photogrammetric undergraduate is also a small part of whole geomatics in China (about 10%). However, the number of geomatics M.Sc. and Ph.D. graduates has nearly doubled in the last five years (Figure 3 and Figure 4). This is the reason that growing market for M.Sc. and Ph.D. graduates is academia in the past, most of the graduates are selecting the faculty positions at universities, R&D positions at institutes or hi-tech companies, with the rapid development of science, technology and education in China the graduates number therefore rise more quickly than undergraduates. Even so, as GIS and remote sensing become two of the most important emerging and evolving fields in the decade, increasing M.Sc. theses and Ph.D. dissertations in photogrammetry and remote sensing are tightly related to GIS and remote sensing topics. As shown in Figure 5, only 12% M.Sc. and 23% Ph.D. are really in photogrammetric themes (aiming at the 3D geometric measuring from imageries).

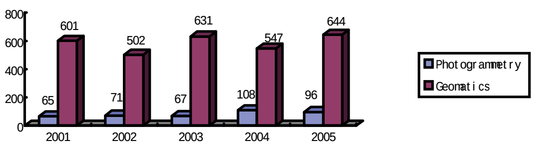

Figure 2. Recruit undergraduates number of Wuhan University

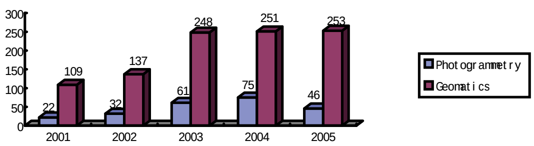

Figure 3. Recruit M.Sc. graduates number of Wuhan University

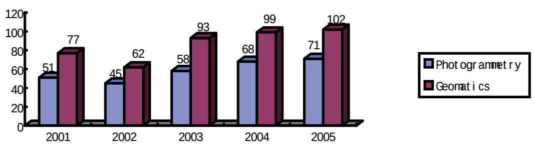

Figure 4. Recruit Ph.D. graduates number of Wuhan University

Employment sector	Percentage
Terrestrial surveying	40%
Geodesy	5%
Photogrammetry and remote sensing	5%
GIS	30%
Land managenet	20%

Table 2. German job market for surveyors

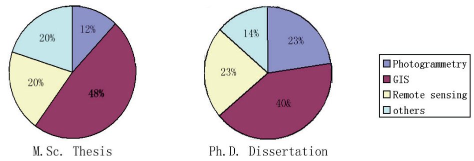

Figure 5. The research themes for M.Sc. and Ph.D. graduates in photogrammetry and remote sensing

2.2 Curriculum Development

According to the undergraduate program in photogrammetry of Wuhan University, there are five different layers of courses as listed in Table 3. From 1996 to 2005, there are obvious curricula changes in the photogrammetry program as the specialty changed from photogrammetry and remote sensing to science and technology of remote sensing.

So many changes of curricula not only reflect the up-to-date contents of same courses (such as, various digital products and the evolving workflow of digital photogrammetry), but also coincide with the advanced geotechnologies as well as the information technologies. Such as the LiDAR, InSAR, Virtual Reality, image compression and database management system are included as standard courses. At the same time, the practice training is also strengthened in the integrated processing of multi-source data and multi-type digital production, the productions of DEM and DOM have become the basic contents of digital photogrammetry course.

The undergraduate photogrammetric curricula are designed into six parts, and the corresponding credit hours are listed in Table 4. Where, each credit hour equal to 18 lecture hours. In basic courses of comprehensive education, there are at least 12 credit hours for interdisciplinary options. These comprehensive curricula enable students to equally and comprehensively learn and foster with trainings in arts, social sciences, natural sciences and life sciences to substantiate the integral personality education. From this credit hours distribution, it is obvious that there are more than 50% credit hours designed for the common and fundamental courses, and only less than 15% credit hours for specialized courses. So more and more photogrammetric graduates can undertake other geomatics tasks, for example, the spatial database building and management, image processing and its applications, an so on.

Course Item	1996	2005
Basic courses of comprehensive education	advanced maths, linear algebra, probabilities and statistics, college physics	advanced maths, linear algebra, probabilities and statistics, college physics, C language programming
Disciplinary basic courses	topographic drawing, geodesy, computer language, computer graphics, surveying adjustment foundation, data structure and database, aerial and spacephotography	introduction to geomatics, computer graphics, surveying, GIS principle, database principle, aerial and spacephotography, error theory and surveying adjustment foundation, digital image processing, pattern recognition, GPS principle and applications
Specialized courses	photogrammetry foundation, digital photogrammetry, non-topographic photogrammetry, GIS, remote sensing, image processing	photogrammetry foundation, digital photogrammetry, principles and methods of remote sensing, close-range photogrammetry, remote sensed image interpretation
Optional courses	artificial intelligence & expert system, database principle,	virtual reality, computer vision, laser scanning system, microwave remote sensing, InSAR
Practice training	topographic surveying, field and office photogrammetry, remote sensed image processing	GPS application, digital surveying and mapping, remote sensed image processing, closerange photogrammetry, GIS and database design, digital photogrammetry and DEM/DOM/DLG production

Table 3. Part curricula description of photogrammetry undergraduate program

Course item	Credit hours	Percentage
Basic courses of comprehensive education	62.5	39.94
Disciplinary basic courses	29	18.53
Specialized courses	16.5	10.54
Optional courses	32.5	20.77
Practice training	10	6.39
Graduation project (thesis)	6	3.83
Total	156.5	100

Table 4. Credit hours distribution for 2004

2.3 Quality Teaching Resources

As we know, the implementation of good education program and curricula design greatly depends on quality teaching resources, such as the teachers' level of knowledge and ability, the text books, the teaching methodology and laboratory. In Wuhan University and Information Engineering University, the course content covers the entire photogrammetry field and full 3 degree structures (B.Sc., M.Sc., and Ph.D.) based on their perfect faculty and other teaching resources, but the emphasis of certain aspects of the discipline differs from university to university as shown in Table 5 and Table 6.

At Wuhan University, there are 12 full professors and 11 associate professors in photogrammetry, and most with Ph.D degrees. Therefore, the research and education cover almost all the photogrammetry field, such as photography, position and orientation system (POS) for sensors, automatic aerial triangulation, image matching and 3D reconstruction, close-range photogrammetry and mobile mapping, integration of "3S" (remote sensing, GPS and GIS), digital photogrammetric workstation, and so on. Especially, a full digital photogrammetric system Virtuozo, which is made in Wuhan Technical University of Surveying & Mapping (**WTUSM** , now is merged in Wuhan University), have been sold more than 3000 suites all over the world. VirtuoZo continues to earn a great deal of appreciation and respect from customers and competitors worldwide.

However, at other "poor" universities, there are very few faculties specialized in photogrammetry for only one or two general photogrammetric courses. In "adequate" universities, multi-level photogrammetry programs are provided, most universities offer the M.Sc. or Ph.D. degree education programs. In Table 5, part B.Sc. stands for the photogrammetry is not a specialty but a direction of geomatics, and only the "true" photogrammetry teachers are accounted for the 9 major related universities of China. In other words, the remote sensing and GIS teachers are not included. To exclude the first two "excellent" universities, there are 3 universities offer the M.Sc. degree program in photogrammetry as a direction of science and technology of remote sensing specialty. In fact, the photogrammetry education has been continued about 50 years in Southwest Jiaotong University, while started by 1998 in

Chang'an University and until 2005 in Shandong University of Science and Technology.

After more than 50 years' development, a series of up-to-date teaching materials in Chinese or English have been published for multi-level photogrammetry education. Such as: Aerial Photogrammetry, Close-range Photogrammetry, Photogrammetry Foundation, Analytical Photogrammetry, Digital Photogrammetry, Error Process and Theory of Reliability, Digital Elevation Model, and so on. Especially, both the Chinese and English versions of 《Principles of Photogrammetry》 have been widely used as the text book all over the world, which was authored by Prof. WANG Zhizuo (the Honorary Member of ISPRS) in 1990. This book is highly appreciated at home and abroad. Book《Digital Terrain Modeling: Principles and Methodology》, published by CRC Press (Taylor & Francis Group), is also world widely used as teaching material.

University	Prof.	A. Prof.	Lecturer	Degree
Wuhan University	12	11	4	B.Sc. M.Sc. Ph.D.
Information Engineering University	9	8	17	B.Sc. M.Sc. Ph.D.
Southwest Jiaotong University	3	4	2	B.Sc. M.Sc. Ph.D.
Chang'an University	2	3	2	B.Sc. M.Sc.
Shandong University of Science and Technology	2	2	2	B.Sc. M.Sc. Ph.D.
Tongji University	3	2	1	Part B.Sc. M.Sc. Ph.D.
Central South University	1	1	2	Part B.Sc. M.Sc. Ph.D.
China University of Mining and Technology	1	1	3	Part B.Sc. M.Sc. Ph.D.
LiaoNing Technical University	2		2	Part B.Sc. M.Sc. Ph.D.

Table 5. University education resources for photogrammetry

University number	Coverage
2	excellent
7	adequate
40	poor

Table 6. Emphasis of Chinese photogrammetry programs

In the decade, as one of the Chinese economic development achievements, all the university facilities, such as the classroom and laboratory, the teaching methods and devices, have been greatly improved. Based on the multi-media and network technologies, computer aided education becomes the important part of photogrammetry education all over the country. It is very popular to use the DPWs, various remote sensed image processing softwares, as well as GIS softwares for teaching and research purpose.

2.4 International Cooperation

The international academic cooperation and exchange in photogrammetry education are very active in China. We have signed many agreements on cooperation with governments or universities all over the world. More and more teachers and students have the experiences of oversea study and / or research. Especially, in recent years the joint M.Sc. and Ph.D. programs in photogrammetry or geospatial information science have been carried out among Chinese universities and foreign universities, such as, the ITC (International Institute for Geo-Information Science and Earth Observation) of Netherlands, the Stuttgart University of Germany, AIT (Asian Institute of Technology) of Thailand, and so on. At the same time, increasing world-known photogrammetrists become the guest professor or honorary professor of Chinese universities, and are invited to China to give presentations or lectures every year. Under the umbrella of training section of national remote sensing center, since 1988 the foreign students have been trained in Wuhan University each year for the outer space committee of UN and Asia Pacific Economy and Society Council. At present, even in Wuhan University, there are more and more oversea students studying for M.Sc. or Ph.D. degrees in photogrammetry.

3 PROSPECT OF PHOTOGRAMMETRY EDUCATION

New technologies require new concepts in education. Today's technology trends towards fully automated (such as aerial triangulation, generation of DEMs and DOMs have been taken for granted) and real-time photogrammetry systems which reduce the role of traditional hard work of operator whose skill can be provided by reading a well-written manual. This holds true for hard- and software systems. These new technologies may be summarized into two categories (Gruen, 2005):

(1) Photogrammetry today is developed from point positioning and 2.5D mapping to an integrated, unified technology, encompassing satellite, aerial and terrestrial sensor platforms. The development of suitable curricula and implementation of programs therefore have to across traditional boundaries between photogrammetry, remote sensing and computer vision. While photogrammetry is employed as one of the most significant technologies for 2D DLG, DOM or 2.5D DEM data acquisition and updating, photogrammetry education is keen towards professional qualifications of photo-realistic 3D city modeling and augmented reality. Virtual city models are increasingly required to become a standard product of photogrammetric data collection. It is well-known that complete sets of 3D building models can be provided efficiently using airborne data collection. The collected 3D models usually represent not only the footprints of the buildings, but also the roof shapes. While the 3D geometric surface reconstruction becomes the main topics of photogrammetric courses, professionals are also required to acquire the skills of texture mapping for building facades, as well as the new technology for on the fly processing of multiple 3 line aerial and space image. As more and more 3D reconstruction from uncalibrated image sequences, the principle of 3D reconstruction based on projective geometry has become textbook knowledge.

(2) Photogrammetry today is also developed from single

sensor/multiple processing instruments to multiple sensors/single processing platform technique. The traditional separate tasks of ground control, photography, data acquisition, processing and analysis will increasingly become complementary components of a single measuring and computing system, such as the POS technologies are being integrated into sensor frameworks. And the long feedback loop is shortened substantially: what used to be an elaborate cycle of data acquisition, analysis and visualization is being compressed into real time monitoring and control. The courses would cover the fusion methods of multi-source data, such as the GPS, GIS, POS, LIDAR and InSAR.

The photogrammetric technology is really evolving quickly, more and more opportunities is creating for the university education. In the meantime, only the rich universities offer up-to-date photogrammetry education (such as about the applications of LiDAR and digital cameras) because of the high cost of the technology and a shortage of expertise. In fact, it is also very essential to hire knowledgeable faculty all over the world for specific courses or workshops in time. Such as in Wuhan University, there is an annual summer school which consists of 2 to 3 training courses by world-known professors. This program aims at enhancing Geo-ICT (geospatial information and communication technology) related curriculum development and talent cultivation. At the same time, more and more foreign photogrammetric scholars are invited to give Chinese teachers and students a great way to stay informed about the latest knowledge and its future trend.

4 CONCLUDING REMARKS

We have seen that digital photogrammetry has become the pervasive technology in modern mapping. we can expect significant progress in the next few years.

Photogrammetry education towards professional qualifications has frequently been named as a key factor towards extending the reach of the geospatial industry, with the idea that qualified specialists ranging from IT-focussed via methodology-centered analyst to application experts. While this observation is certainly true and needs to be supported through the development of suitable curricula and implementation of programs across traditional boundaries between disciplines.

Current DPWs easily handle any type of imagery, including satellite, digital camera and video camera photography. Increasing photogrammetric solutions are designed for the GIS user with minimal or no photogrammetry training so they easy to learn and use and importantly offer a cost effective way for 2D/3D data collection. Accurate data creation and 3D object extraction for various GIS databases from digital imagery therefore become more and more popular since its high efficiency, low cost and greater accuracy. According to the economic and political plan of China, the creation of large scale of national and regional multidimensional spatial data infrastructure makes an entire market emerging around acquiring and selling photogrammetry-based data and is attracting an increasing number of graduates not only in photogrammetry but also in multidisciplinary geomatics. The new pretty face of photogrammetry education will attract more people to use it and it will transform the way multidimensional geospatial information acquisition.

Of course, a university education must prepare graduate with intellectual versatility in which the graduation is only the first step in a lifelong learning process, as technologies develop further, the pretty face of photogrammetry education will be constantly changing.

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ANALYSIS OF PHOTOGRAMMETRY AND REMOTE SENSING EDUCATION IN SLOVENIA AND PROSPECTS FOR THE FUTURE

M. Kosmatin Fras

University of Ljubljana, Faculty of Civil and Geodetic Engineering, Jamova cesta 2, SI-1000 Ljubljana, Slovenia – mfras@fgg.uni-lj.si

Commission VI

KEY WORDS: Photogrammetry, Education, Aspects, Experience, Future, System

ABSTRACT:

Fast technological development, globalization and society change highly affect education contents and styles. An efficient education system is of vital importance for every state politics as well. The most current topic of education reorganization in Europe is the so called Bologna reform. Slovenia has been a member of European Union since 2004 and has also signed the Bologna declaration. This paper focuses on analysis of the existing education of photogrammetry and remote sensing in the Slovenian national framework and discusses problems and dilemmas referring to education reform. The existing curriculum is thoroughly presented and discussed in the paper, focused on photogrammetry and remote sensing. The author's suggestions for improvement of the curriculum that considers Bologna guidelines are given. New technologies are continually emerging, e.g. 3D laser scanning, that influence much the existing techniques of data acquisition. Thus novelties must be adequately integrated in the curriculum. More emphasis should be given to interdisciplinary approach, connection of different curriculum subjects and cooperation with firms and institutions from the field of work in the country. Although conventional methods of education are mainly used for teaching photogrammetry and remote sensing, e-learning is also an option of consideration when preparing new program.

1. INTRODUCTION

Photogrammetry and Remote Sensing (hereafter P&RS) is taught in Slovenia mainly at the University of Ljubljana, Faculty of Civil and Geodetic Engineering (hereafter FCGE). Reorganization of university education according to the Bologna reform is taking place recently at the Faculty. According to plans, new program should start in academic year 2008/2009. In this paper, only regular graduate program is considered (in addition, there is also post-graduate program including master and doctor study, and special study organized at weekends for people that are usually employed).

Only a few years ago, as a result of Phare-Tempus Structural Joint European Project (No11001-96) the Department of Geodesy of FCGE started with new study program. The general aim of Phare-Tempus S-JEP program was to reform university education systems in some central and East European countries in order to assure the comparable study programs that are needed for unified labour force market in economically united Europe. The aim of the particular project at the Department was to remodel some general courses of study. The outcomes of the project were two integral study programs: University Degree Study Program (four study years plus diploma thesis) and High Technical Study Program (three study years plus diploma thesis), which started in academic year 1999/2000. New subject areas were introduced: principles of law, business economy, elements of public administration, property law and real estate valuation. There were also essential changes of existing subjects, some being merged or cancelled. New curriculum for each study program was prepared. In order to better support the introduced changes and new subjects an extensive procurement program was implemented. A new computer classroom was formed together with all the necessary equipment and software. In addition, the Faculty library was renewed with the literature that is primary related to the topics of new subjects. However, this relatively new study program has to change now according to Bologna reform.

Currently, in the geodetic University degree study program there are all together approximately 180 regular students per year and in the geodetic High technical study program all together approximately 145 regular students per year. Students finish their University degree study in average in 7.1 years and High technical study program in average in 6.9 years. Duration of the study is much too long, what is one of the biggest present problems. We can find various reasons, however the faculty must improve this situation when entering the Bologna reform.

The results of the investigation that was accomplished within the sample population of students that graduated between 1999 and 2004 are presented in the paper. The topic of the investigation was about all subjects lectured in particular study programs, but in this paper, mainly the results for photogrammetry and remote sensing subjects are presented and discussed.

Further on, the author's suggestions for improvement of the curriculum that considers Bologna guidelines are given. Although conventional methods of education are mainly used for teaching P&RS, e-learning is also an option of consideration when preparing new program.

2. ANALYSIS OF THE EXISTING EDUCATION OF P&RS

2.1 Existing Curriculum

To be able to prepare new program, we must first analyse the existing one. Here, a short description of the existing curriculum is given.

Photogrammetry and remote sensing is taught in both existing study programs: University degree study program and High technical study program. However, the scope and objectives within the programs are different. The subjects are covered with the staff of Chair for Cartography, Photogrammetry and Remote Sensing, with two full time lecturer, one full time assistant, and four colleagues from other institutions partly covering some specific topics.

Generally, the aims of the photogrammetry and remote sensing subjects are the following:

- to acquaint students with different methods and complementary technologies,
- to equip students with basic theory and advanced methods, according to the level of study,
- to stimulate student for self-dependent study and work, as well as permanent update of knowledge,
- to use interdisciplinary approach,
- to stimulate students for research work (at university level).

In High technical study program, photogrammetry and remote sensing is taught yet and only in the 3. study year. Photogrammetry includes 30 hours of lectures and 45 hours of practical exercises, all together valid 5 ECTS. The emphasis is given to data production, as this study program is more practically oriented. The theory of analytical and digital technology is explained in short and most focus is given to current national projects as cyclical aerial survey, digital orthophoto production, topographic data acquisition etc. The implementation of modern photogrammetric technologies in national projects is a necessity today. Thus, a high-quality photogrammetric profession in a country is a key element for the efficiency of the projects. In the last ten years, photogrammetry played an important role in bulk national projects aimed at collecting new spatial data for different products, e.g. DTM, topographic database, record of buildings, etc. Remote sensing at High technical study program includes 30 hours of lectures and 30 hours of practical exercise, all together valid 4.5 ETCS.

In University degree study program, photogrammetry is taught in 2. study year (subject Photogrammetry I, one semester), 3. study year (subject Photogrammetry II, two semesters) and optionally in 4. study year (subject Photogrammetry III, one semester) for students that have chosen the geodetic stream (in addition there is also spatial information stream). Remote sensing is taught in 4. study year (one semester) for students of both program streams.

In academic year 2005/2006 University degree study program attend 36 students in the 2. study year, 46 students in the 3. study year, and 18 students in the 4. study year - geodetic stream. High technical study program attend 43 students in the 3. study year. These students all together attend different lectures and practical exercises in photogrammetry and remote sensing subjects in this year.

Photogrammetry I includes all together 45 hours of lectures and 45 hours of practical exercises arranged in two semesters, all together valid 6 ECTS. The general topics taught are:

- history of development, basic technological periods,
- physical basics of photography/image,
- mathematical basics of photography/image,
- introduction to digital photogrammetry (image enhancement, resampling, filters, image pyramid, compressing data, etc.),
- aerial and terrestrial surveying,
- orientation methods (single image, stereo images)
- photogrammetric equipment.

Photogrammetry II includes 30 hours of lectures and 15 hours of practical exercises in one semester, all together valid 3.5 ETCS. The general topics taught are:

- topographic information systems and bulk data acquisition,
- aerial triangulation (bundle block adjustment, GPS supported AT),
- orthophoto production,
- automation in production process (e.g. image matching),
- quality assurance and quality control in photogrammetric projects.

Photogrammetry III includes 30 hours of lectures and 30 hours of practical exercises in one semester, all together valid 4 ETCS. The general topics taught are:

- camera calibration methods,
- close range applications,
- DTM (acquisition methods, modelling),
- introduction to lidar,
- dynamic methods of data acquisition,
- 3D modelling and visualisation.

Remote sensing includes 30 hours of lectures and 30 hours of practical exercises in one semester, valid 4 ETCS. The general topics taught are:

- physical basics of remote sensing,
- different sensors and processing techniques,
- the production workflow,
- interpretation and classification,
- current satellite systems.

The way of lectures is still traditional in the classroom, mainly with slide projection but sometimes also using blackboard and chalk. In the Photogrammetry II subject, students prepare a seminar research work in small groups and than present them in the classroom. They get knowledge on how to organize their work and how to prepare presentation. The results so far are amazingly very good and their interest for the topic increases significantly.

In addition to lectures in classroom students make their practical exercises in computer rooms and on photogrammetric equipment. Students are divided into smaller groups of maximum 3 students for individual practical exercises, however some introduction lectures into practical work are done together in the classroom.

2.2 Equipment

For practical exercises, our faculty possesses the following specific equipment:

- digital camera Nikon D-70,
- digital photogrammetric workstation DVP (DVP Geomatics Systems Inc., Canada) using polarisation monitor and passive spectacles,
- digital photogrammetric workstation StereoExplorer (DFG Consulting Ltd., Slovenia) using Crystal Eyes for 3D observing,
- DOG (Digital Orthophoto Generation; DFG Consulting Ltd., Slovenia) including project managing, automated fiducial points measurements, semi-automated homologues points measurements,
- AeroSys for aerial triangulation,
- MoDiFoto (in-house developed software for digital camera calibration, projective transformation, production of orthophotos of facades, mosaicking).

In addition, students have on disposal different common software in computer rooms (Matlab, Adobe Photoshop, AutoCad, ArcView, etc.).

Faculty cooperates also with enterprises and other institutions in projects as well as graduate students often make their diploma thesis in such cooperation. To our opinion this is a good practice as students get insight into the real working environment and they can use other technical infrastructure that is not available at the faculty.

Although the available equipment covers all the necessary topics for the didactic needs, there are not enough working places for the amount of students. Thus, students must make their practical exercises according to plan which extends over the whole day.

2.3 Investigation results

In order to get some objective parameters about what is good and what bad in the past and existing study programs, an investigation was accomplished within the sample population of students that graduated between 1999 and 2004. Questionnaire was sent to 251 former students of both University and High technical program, 89 (39 %) of them replied. Here, only a general summary of the results is presented, focusing on photogrammetry and remote sensing subjects.

Around three quarters of questioned people arranged the study of geodesy at FCGE as demanding or very demanding study. However, in this study enter average students with respect to their results in secondary school. All of the questioned persons, except one, who study further in post-graduate program, are employed. More than 80 % of them find the first employment in six months or less, 88 % work in geodesy related fields. Almost all are satisfied with their employment placing. However, only 2-5 % (according to the study program) of them is working in particular photogrammetry and remote sensing area. On the other hand, the top working fields are: real estate recording, geodesy survey, engineering survey and spatial informatics.

Most of the questioned people estimates that the general contents of the study is comprehensive and demanding enough for the needs in practice. For University program 88 % and for High technical program 71 % of the population estimate that the knowledge they have received during their study in photogrammetry and remote sensing is useful in the practice. Further on, more than 90 % of the population estimate that photogrammetry and remote sensing will play important role in the future.

The questioned population would introduce more communication and organization skills in the program, as well as foreign profession language (not included in the program at present). They would also advice to implement more practical exercises and practice with more modern equipment. They would like to have more optional subjects, better study literature (in Slovene language) and more interdisciplinary approach.

An additional investigation is being prepared, focused on the Slovenian professional society, public and private enterprises and national administration offices. The aim of this investigation is to find out what are the needs and expectations for new profiles at the existing market. Unfortunately, the results are not available yet, but will be considered in further reform process.

3. COURSE OF THE BOLOGNA REFORM AT FCGE

The Bologna declaration is the document that has been signed in 1999 by the Ministers of education from 29 European states and later adopted by some additional states. Although this states are mostly members of the European Union (hereafter EU), and the declaration considers legal acts of EU for education, this is not a project of EU. The Bologna declaration is only one and the most known document among some others (e.g. Sorbonne, Prague, Berlin). The Bologna process aims at harmonizing high education programs and academic titles in Europe. However, national particularities and university autonomy are considered as well.

The main goals of the Bologna reform are the following:

- acceptance of a system of recognised and comparable university diploma,
- two or three levels study, composed of different numbers of study years,
- mobility of students and high education teachers,
- implementation of European Credit Transfer System (ECTS),
- quality assurance of high educational study programs,
- life-long learning.

In Slovenia, the high educational system is regulated by the Law on higher education and its supplements from 2004. The three level education is introduced:

- first level: high technical study programs and university study programs,
- second level: master study programs,
- third level: doctoral study programs.

In the beginning of 2006, the Faculty of Civil and Geodetic Engineering accepted the model 3+2 (i.e. three study years for the first level, two study years for the second level). In the first level, high technical (called geodetic engineering) and university study (called geodesy and geoinformatics) programs will be organized. In the second level, four different modules are planned in order to specialize in particular fields (geodesy, geoinformatics, spatial management, environmental and urbanism planning). Currently, first versions of particular programs are prepared which will be discussed, improved and harmonized. The formal procedures should be accomplished in the next step (e.g. acceptance by the faculty senate, accreditation by the national authority and European accreditation network). According to plan, the new study program will start in academic year 2007/2008.

4. PROBLEMS AND SUGGESTIONS FOR IMPROVEMENT OF THE CURRICULUM

We are facing many problems in preparing the new program according to the Bologna declaration, regarding human, spatial and financial resources. First of all, the finances available will remain expectedly the same as in the present program for the first level and possibly for the first year of the second level. This means that although there are ideas and needs for some new programs, we should stay realistic and not split too much the present scope of the study in the second level. The nearby faculties that have already implemented the new studies are warning of modest number of students in the second level as the result that students rather go to work after finishing the first level than to continue the study at the second level. Due to this fact, there are intentions to fill the first level consisting of three study years with almost the same contents that were in the old four year programs. There is also a lack of adequate teaching staff for some profession areas and study premises remain the same. However, these are more or less only organizational problems.

According to Schiewe (2005), the transition from the traditional University Diploma towards two level educational model (i.e. Bachelor and Master degree) in several European countries, leads to rethinking of all issues related to education. This means not only organizational but also thematic, didactical and economical aspects.

More important are the real changes in the profession we are currently facing. New technologies are continually emerging, e.g. 3D laser scanning, high resolution satellite imagery, that significantly influence the existing methodologies. Thus novelties must be adequately integrated in the curriculum. Traditional methods are no more enough, we have to combine different sensor systems (e.g. implementation of GPS and IMU in aerial triangulation, combination of lasers scanning and digital images). Subjects, which were taught independently must now be presented more complex and co-dependent. Thus, more emphasis should be given to interdisciplinary approach and connection of different curriculum subjects that this was now the practice. Further on, we should implement more project-oriented work in the new program.

The problem also exists how deeply a particular topics should be taught. For those students who will work in photogrammetry and remote sensing areas, the scope and depth of the current subjects is definitely too small, on the other hand, students who will not work in photogrammetry and remote sensing areas have enough or even too much knowledge. However, we estimate that not much specialised photogrammetrists and remote sensing experts are needed in Slovenia. Some students choose their diploma work from photogrammetry or remote sensing, and can in this way deepen their knowledge of the field.

Another problem that is in practice usually difficult to overcome is how to assure modern P&RS equipment, hardware as well as software for practical exercises of students. This equipment is usually quite expensive. The only possibility we see at present is to cooperate more with private sector and to have common research projects that enables to purchase modern equipment. In addition, the initiative of ISPRS TC VI to support the professional society with web tutorials, free of charge software and other materials is also one of the very positive options.

5. CONCLUSIONS

The need to renew our study program according to Bologna reform could be observed from different perspectives. One can see it as unnecessary work but one can see it as a challenge for introducing new contents and educational tools in the lectures.

We think that new programs should be prepared for the future and not only for next few years. We must consider existing needs and trends of the profession as well as technological and social development of the society.

Most European countries report on decreasing of interest for technical study in general. This is also the case in Slovenia. Our faculty is satisfied with the number of entry students so far and to our information all graduated students get jobs in reasonable time, although not necessarily in the profession. But we are not sure if this remains in the next years.

According to Bähr (2005) information technologies will definitely lead to many structural changes in our education system. When preparing new program we should be aware of this and try to introduce new ways of learning, at least as some case studies. Here, I have in mind especially e-learning program for particular topics. E-learning is without any doubt a good option for the future, although it could not replace completely a teacher. It is an efficient and flexible form of teaching. We think that particularly in photogrammetry and remote sensing subjects some topics could be better presented through interactive examples and tutorials than only with traditional lecture.

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APPLICATION OF THE SIMPLIFIED SPATIAL DATA ACQUISITION SYSTEM K-SCOPE TO EDUCATION AND RESEARCH

Hiroshi TAKEDA [a], Kohei ISOBE [a], Yukio AKAMATSU [a], Ryuuji MATSUOKA [b], Kohei CHO [b],

[a] Kokusai Kogyo Co., LTD, 3-6-1, Asahigaoka, Hino, Tokyo 191-0065, JAPAN
{htake, kohei_isobe, yukio_akamatsu}@kkc.co.jp
[b] Tokai University, 2-28-4, Tomigaya, Shibuya-ku, Tokyo 151-0063, JAPAN
{ryuji, cho}@yoyogi.ycc.u-tokai.ac.jp

Commission VI

KEY WORDS: Photogrammetry, Spatial Data, Acquisition, Stereo Plotter, Beginner, University Education

ABSTRACT:

The needs for spatial information acquisition tools using digital stereo images have been increasing in the popularization of digital sensors. Accordingly, spatial information becomes more popular in the field of application research, more researchers are becoming eager to acquire spatial information by themselves. On the other hand, most spatial information acquisition tools are designed for professional use, and there are few training tools for beginners. There are another problems in educational institutions in Japan. Since a professional tool is too expensive, it is difficult to arrange enough tools for students. Moreover, there are few trained instructors necessary for training 3-D measurement using a professional tool in educational institutions in Japan. In order to train engineers and part-time employees in-house, Kokusai Kogyo Co., Ltd. has developed a simplified spatial information acquisition system (K-Scope) under the concepts of anyone, easily, exactly and simple, small, compact. Although K-Scope was designed originally for business use, we believe that K-Scope has potential to be a good training system for beginners. In this paper, we introduce the outline of K-Scope and demonstrate the experimental results of K-Scope for the university level education.

1. INTRODUCTION

1.1 Needs for Photogrammetry Education

In recent years, the needs for 3-D measurement and spatial information acquisition tools using digital stereo images have been increasing in response to the current of digitization of aerial photographs and the trend to higher resolution of satellite images. Accordingly, it is urgent to train many engineers capable to execute 3-D measurement. Moreover, as spatial information becomes more popular in the field of application research, more researchers are becoming eager to acquire spatial information by themselves.

On the other hand, Japanese photogrammetry industries are worried about lack of talent resources. Most photogrammetrists never had a chance to receive any photogrammetry education when they were university students in Japan. Accordingly, not a few employees have to get on-the-job training (OJT) at their companies to become a photogrammetrist. These situations are imposing a burden on Japanese aerial photogrammetry companies. Therefore, it is important to conduct photogrammetry education in Japanese university.

1.2 Problems of Current Photogrammetry Education

Almost all spatial information acquisition tools in the current market are designed for professional use, and there are few training tools for beginners. Functions of a professional tool such as a digital stereo plotter are too excessive for education or application research. Furthermore, it is too complicated and difficult for beginners to operate a professional tool, and a long-term training is necessary to master 3-D measurement techniques using a professional tool.

In the practice of photogrammetry education, the abundant verification data is necessary to understand the behavior of stereo plotter correctly. However, it is difficult for the students to gather the abundant verification data by themselves.

If the students only use stereo plotter, they never know its principle and workflow. In this case, it is difficult to keep their motivations. It is quite important to use good manual books along with practical machines to understand the basic theory.

1.3 Action Plan for Photogrammetry Education

Kokusai Kogyo Co., Ltd. (KKC for short from now on) has developed a simplified spatial information acquisition system (K-Scope) for training in house engineers. In order to solve the above problems of photogrammetry education, we have made action plans to evaluate effectiveness of K-Scope as a training tool in an educational institution. The experiments are conducted under the collaboration with Tokai University (TU for short from now on). Our action plans are as follows:

(1) KKC will provide K-Scope as a simple and low cost stereo plotter system to TU for student education.
(2) KKC will provide stereo photo datasets around the university. It is important to use the datasets of well-known place for students. Since the dataset are familiar to the students, they can verify the accuracy of their products by comparing with field surveying data.
(3) We will determine the fascinating curriculum to teach photogrammetry skill efficiently to students with keeping their motivations and easy understanding.

2. OUTLINE OF K-SCOPE

2.1 Features of K-Scope

KKC developed K-Scope as an easy and useful stereo plotter that was designed originally for business use. However, we believe that K-Scope has a potential to be a good training tool for beginners at universities. Major features of K-Scope are as follows:

(1) Easy operation: The major advantage of K-Scope is that it is easy for beginners to operate. Short-term training allows beginners to execute digital stereo measurement.

(2) Small scale and low cost hardware: The second advantage of K-Scope is that necessary hardware is compact and not expensive. The hardware system components are mainly a personal computer, a stereo viewing device such as 3-D LCD glasses and a 3-D pointing device.

(3) Provision of products of the requested quality: K-Scope can provide highly precise spatial information. Precision of spatial information acquired by K-Scope depends on the skill of an operator.

(4) Cooperation with Stereo-Set-Manager: K-Scope cooperates with the image-database management system Stereo-Set-Manager (SSM for short from now on) which manages stereo pairs of digitized aerial photographs. K-Scope is able to display a pair of stereo images around the specified point immediately with the assistance of SSM.

(5) Points cloud processing function: K-Scope can process points cloud data acquired by a laser scanner.

(6) No orientation function: K-Scope has no orientation function for easy operation and system simplification. Orientation parameters will be provided with stereo image datasets by KKC.

2.2 Hardware Configuration of K-Scope

The hardware configuration of K-Scope is shown in Figure 1.

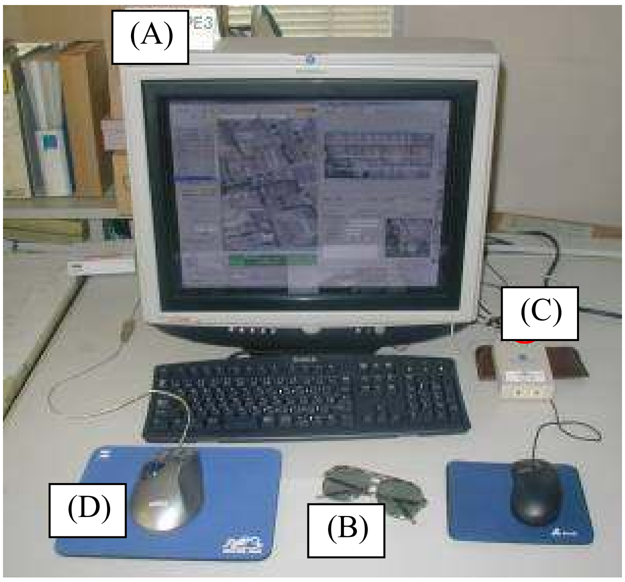

Figure 1. Hardware Configuration of K-Scope

2.2.1 Personal Computer: K-Scope works on a personal computer with a keyboard, a pointing device such as a mouse, OpenGL graphics card and CRT display. The graphics card and CRT display are required to be able to display with vertical refresh rate of 120Hz.

2.2.2 Stereo Viewing Equipment: K-Scope will provide stereo viewing equipment for operators. We have two types of crystal stereo shutter for stereo viewing. One is the monitor type as shown in Figure 1 (A). It attaches a crystal shutter filter to the front of the CRT display and it can provide stereo viewing for several persons wearing polarizing glasses (Figure 1(B)). Another one is the glasses type (stereo3d.com, Shutter-glasses Comparison Chart, 2005) as shown in Figure 2. It can use for only two persons at the same time.

Figure 2. Glasses Type of Stereo Shutter

A crystal shutter controller (Figure 1(C)) should be used to provide stereo viewing. It serves to make a synchronized signal for a stereo liquid crystal shutter. Some vendors provide stereo projectors as shown in Figure 3 (Cyviz, viz3D, 2005). If it can be used in a university classroom, quite a few students can take a lesson efficiently.

Figure 3. Stereo Projector

2.2.3 3D Pointing Device: K-Scope can utilize 3D pointing devices such as a 3D handle, a normal 2D mouse or a 3D mouse (Figure 1(D)). A 3D handle is used by most photogrammetrists. It is a very efficient device for professional. However, it is difficult to master operating it for beginners. Normal 2D mouse can be used as a 3D pointing device. However, it is not useful for all operators. We recommend using a 3D mouse as a 3D pointing device on K-Scope.

2.3 Software Configuration of K-Scope

The software configuration of K-Scope is shown in Figure 4.

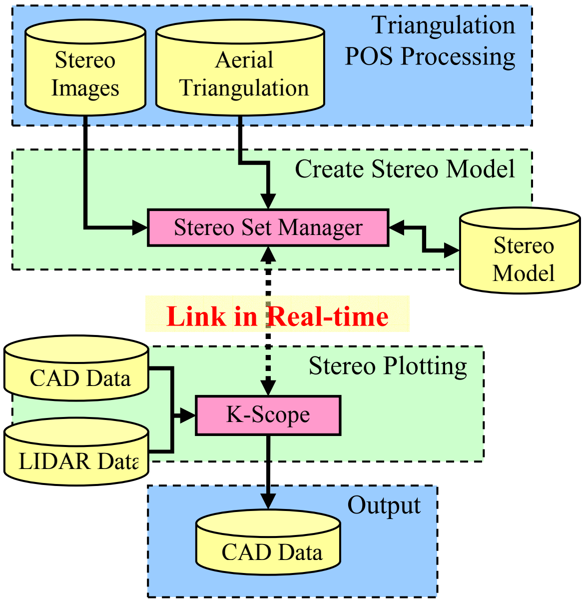

Figure 4. Software Configuration of K-Scope

2.3.1 Stereo set manager (SSM): SSM can manage stereo data sets. SSM shows thumbnail images as an index map by using digitized photographs and results of POS (Position and Orientation System) processing or aerial triangulation. K-Scope will be launched from SSM directly and immediately provide a stereo viewing. SSM can avoid annoying procedures to create stereo datasets.

2.3.2 K-Scope: K-Scope shown in Figure 5 provides stereo viewing for spatial data acquisition. We developed K-Scope that can start from SSM directly by clicking a stereo pair of images. Therefore, we can adjust the function design of K-Scope to fit the purpose. K-Scope's basic functions are the layer management function, the display graphics function and the spatial data input and edit function.

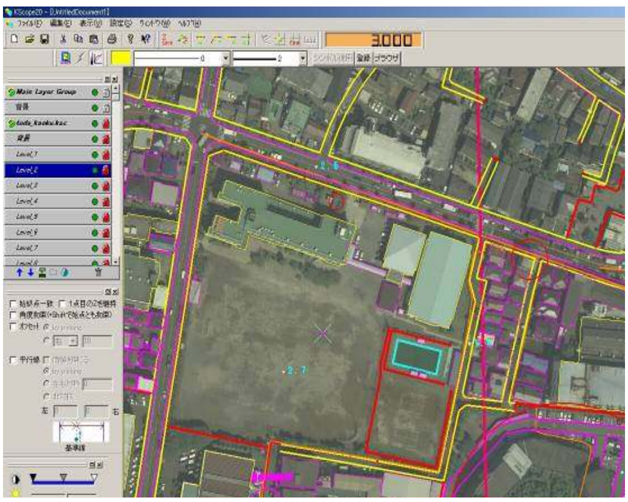

Figure 5. Screen of K-Scope

2.4 Workflow of Spatial Information Acquisition

Workflow of spatial information acquisition is as shown in Figure 6. The workflow divides into three steps such as the pre-processing step, the SSM and K-Scope step, and the post-processing step.

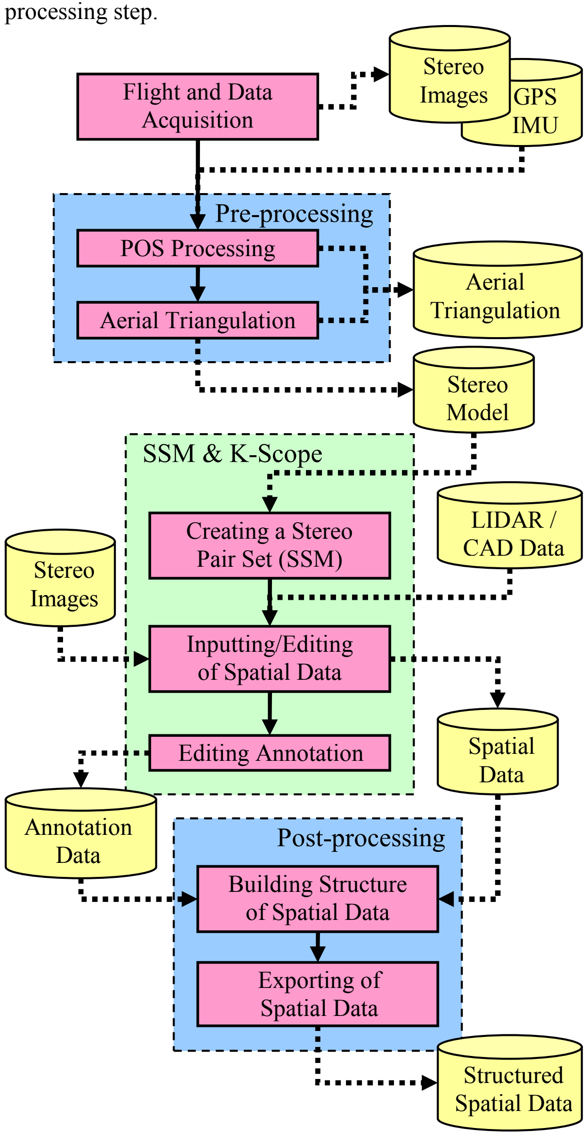

Figure 6. Workflow of Spatial Data Acquisition

2.4.1 Pre-processing Step: The main task at the pre-processing step is preparation of image data and annotation data of digitized aerial photographs.

(1) Flight and data acquisition: First, we should obtain stereo pairs of aerial photographs and GPS and IMU data. The analog aerial photographs should be digitized.

(2) POS processing: In this process, the position and attitude of each image will be obtained from GPS and IMU data with POS-Pac of Applanix Inc.

(3) Aerial triangulation: In the case of lack of GPS and IMU data, or inaccurate POS processing results, we should conduct an aerial triangulation by using ground control points with ImageStation of Intergraph Inc.

2.4.2 SSM and K-Scope Step: This section shows the main step of spatial information acquisition.

(1) Loading of stereo model data: SSM can load stereo model project files that are created with ImageStation. SSM can load many stereo images at a time. After loading the stereo model project file, SSM can show the index map of all stereo images. Then SSM shows the annotation information such as project name, area name, course number, photo number, flight date and remarks.

(2) Creating a stereo pair set: A stereo pair set is created by manually. One can set a pair of link between two images by using drag and drop from index map of SSM. This operation is necessary once. KKC will provide stereo pair datasets to a university without a fee or at a marginal cost.

(3) Layer and window management: Layer Manager can manage the layer of raster and vector datasets. Then the changing layer order is conducted with drag and drop. It has the function of show and hide, or lock and unlock for each layer. Window Manager can save the status of working window into a file and restore from the stored file. It is easy to restart working from the last status of the window placement.

(4) Graphics displaying: Figure 7 shows some screens of K-Scope. K-Scope has three graphics modes such as the ortho view mode, the perspective view mode and the stereo view mode. The ortho view mode (Figure 7(A)) is fixed vertical viewing that is not stereoscopy to see 2D map images. The perspective view mode (Figire 7(B)) can see from any viewpoint. The stereo view mode (Figure 7 (C)) can see from any viewpoint with stereoscopy. Stereo view mode can help to check the 3D object of spatial data.

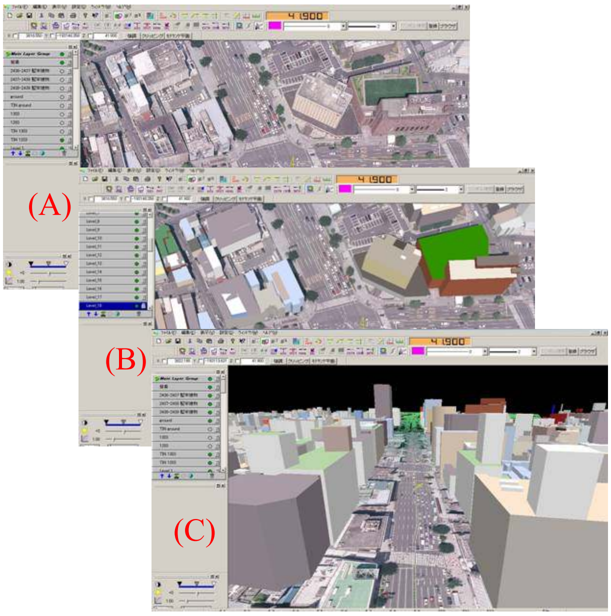

Figure 7. Screens of View Mode

(5) Inputting and editing of spatial data and annotation data: K-Scope can input and edit the various types of spatial data. K-Scope processes three types of objects such as primitive objects, parametric objects and informative objects. Primitive objects include the types of point, points cloud, vectors and poly-lines / polygons. Parametric objects include the types of circle, arcs and sectors. Informative objects equal to the text objects that can add to some explanation on the layer as an annotation.

(6) Snapping to existing vector data: It is necessary to join the editing vector data to existing vector data or grid points. It can snap to a line, a vertex, an end point of a poly-line, an intersection point and so on. The grid parameter setting is defined the grid interval from original coordinates is available.

(7) Symbol manager: Symbol Manager can design the original symbol marker by oneself. It includes a fishing port, a police station, a ruin of castle, a temple, a hospital and a city office and so on. Symbol Manager will provide management function that is selection of symbol and adjustment scale.

(8) Editing of LIDAR points: Figure 8 shows a editing screen of LIDAR points. Editing function of LIDAR can be conducted to remove and clustering by using stereo view mode. LIDAR points and 3D objects can be seen as digital mapping data or DEM date.

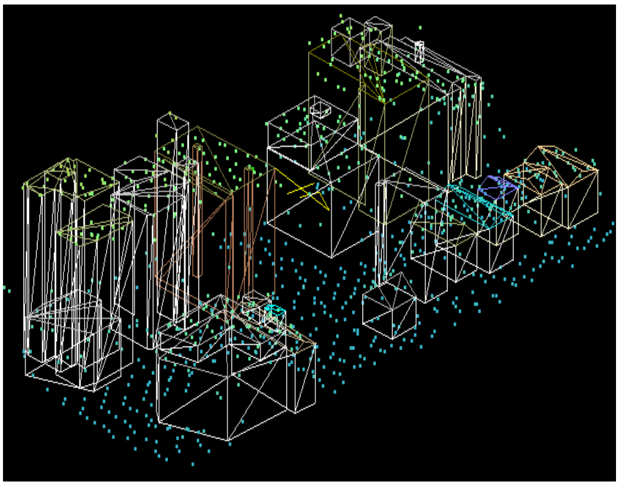

Figure 8. Editing of LIDAR Points

2.4.3 Post-processing Step: After acquisition of spatial data by using K-Scope, it is necessary to build a structure of acquired spatial data and convert structured spatial data into the desired file format depending on the application software.

(1) Building a structure of acquired spatial data: We should build a topologic structure of spatial data acquired by using K-Scope. This process can be conducted continually using geographical script language such as ArcGIS.

(2) Exporting of structured spatial data: Finally, we should convert the structured spatial data into the desired file format in order to use it in the application software Most geographical script languages have many data conversion functions.

2.5 Processing Result of K-Scope

A processing result is shown in Figure 9.

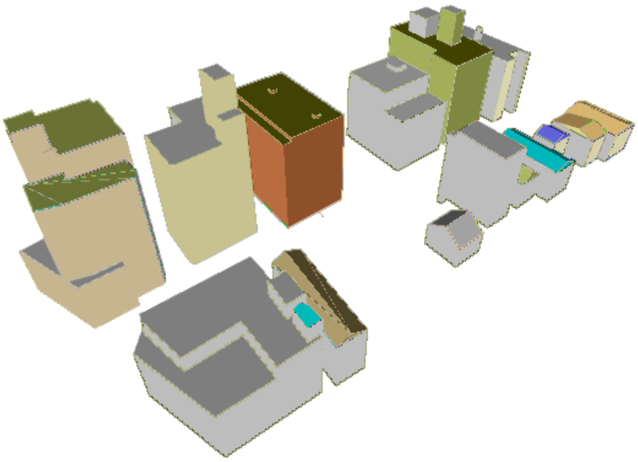

Figure 9. Processing Result of K-Scope

3. PHOTOGRAMMETRY EDUCATION PROGRAM

3.1 Planning of Educational Program

3.1.1 Exercise Experiment: TU and KKC are discussing the contents of exercise experiment for photogrammetry. The discussing points are as follows:

(1) The current K-scope is too complicated to use at classrooms or for private study. Therefore, the function of K-Scope should be limited for easy operation by the beginners.
(2) As the first step for introducing K-Scope for education at the university, some master course students will be assigned for learning K-Scope. Both teachers and students are going to have experience to use K-Scope.
(3) KKC plans to provide stereo images around the campus of TU. The students are going to use them to plot the buildings of university of which they known very well. It is important that the student can keep motivations to compare the plotted results with existing building design data.
(4) The original curriculum is planed to be applied to the students of Department of Network and Computer Engineering (DNCE) at which department students' interests are more on image processing, remote sensing and GIS. However, the curriculum is planed to be expanded in the future to be applied also to the students of department of architecture at which department students' interests are more on architecture and CAD.

3.1.2 Lecture Class: It is not easy to use a tool without understanding the basic theory. TU and KKC are also discussing about the curriculum of photogrammetry for the lecture class. The discussing points are as follows:

(1) A textbook will be used to explain the principle of photogrammetry.
(2) In this lecture, the students will create simulated images as simple models. Through this process, they may understand the principle of stereo viewing method.
(3) Step by step, the students will learn the principle of photogrammetry including stereo model, lens distortion, triangulation, etc.
(4) Finally, the teacher will set the problems on the report and check the achievements of learning.

3.1.3 Practice and Evaluation: After the exercise experiment and the lecture class, it is important to give the students chance to use the learned skill in the actual situation. Then the teacher could rightly evaluate the student's outcome. The practice and evaluation plans are as follows:

(1) KKC will order jobs related to acquisition of spatial data to TU. The students of TU will be able to try their skill and/or to skill up through the part time jobs. At the same time, this will allow KKC to be able to solve lack of operators.
(2) KKC will check the student's outcome and will report the result to the teachers of TU.
(3) The teacher will evaluate the achievement of students due to the record of spatial data quality from KKC.

3.2 Step of Lecture Implementation

The lecture implementation steps are shown in Figure 10.

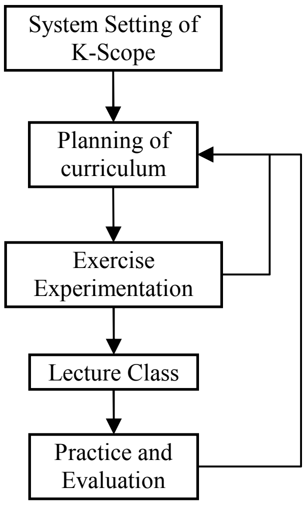

Figure 10. Step of Lecture Implementation

3.2.1 System Setting: The Department of Network and Computer Engineering at TU equips two sets of K-Scope in the laboratory for initial investigation. TU prepares two sets of PC hardware that has components (see in 2.2) for K-Scope. KKC provide software of K-Scope and its USB key for license. In addition, KKC installs the software onto the PC by using installer software.

3.2.2 Planning of curriculum: More discussion should be performed to finalize the plan of curriculum for the exercise experimentation.

3.2.3 Exercise Experiment: Several trial of exercise experiment will be performed using master course students. By evaluating the results, we will feed back to improve the curriculum.

3.2.4 Lecture Class: The curriculum of the lecture class will be finalized according to the results of exercise experiment.

3.2.5 Practice and Evaluation: By performing the practice of part time jobs of KKC after the exercise experiment and the lecture class, the achieved skills of students will be clear. We plan to evaluate the results, and will feed back them to improve the curriculum.

4. CONCLUSION

4.1 Development of Simplified Stereo Plotter

KKC have developed a simplified stereo plotter K-Scope. K-Scope has good features as training system for beginners such as easy operation, small scale and low cost hardware, provision of products of the requested quality, etc. Accordingly, SSM can avoid annoying procedures to create stereo datasets. Moreover, Stereo view mode of graphics displaying can help to check the 3D object of spatial data.

4.2 Apply to the University Education

K-Scope was originally designed for business use. However, we think that we can apply K-Scope to the university level education. We have made experiment plans to evaluate effectiveness of K-Scope as a training tool in an educational institution. Experiments are conducted under the collaboration with TU.

4.3 Future Works

In this paper, we have made a plan for learning photogrammetry technique by using K-Scope. More consideration is needed for creating efficient curriculum. Especially, it is difficult to teach the principle of functions such as lens distortion correction, triangulation and bundle adjustment and so on. Additional software development is necessary.

Moreover, in order to strictly evaluate the spatial data sets created by the students, we should establish the method of QA/QC (Quality Assurance and Quality Control) with sampling inspection. Evaluation of both quality of results and working time are important for grasping their achievements of skills as engineers.

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DIGITAL AERIAL CAMERAS

Masoumeh Kheiri

National Geographic Organization, Azadi, Meraj, Tehran 13185-1684, Iran
Email: m.kheiri@ncc.neda.net.ir

KEY WORDS: Sensor, Digital, Aerial, Specification, Evaluation, Geometric, Model

ABSTRACT:

Airborne digital sensors are about to widen the choices in photogrammetry. The transition from analytical to digital photogrammetry is well advanced. Recent technology developments provide new solutions for high-resolution image acquisition for photogrammetric applications. These sensors are based on CCD-matrices as well as CCD-line sensors and fulfill both. The emphasis is placed on general problems of developing new sensor systems. The necessity of detailed information about their technical specifications, geometric evaluation, geometric models and also their advantages on analog photogrammetric cameras, at a very early stage of camera development has been proved.

1. INTRODUCTION

For a long time, images acquired from analog film and digitized by scanners were used for digital image processing purposes. Now digital cameras are replacing analog ones. They are two kinds: 1) Digital aerial Frame sensors can be handled in common digital photogrammetric work stations. 2) CCD-line sensors scan the same ground area with three or more panchromatic sensors at different angles to acquire forward, nadir and backward scenes. After the raw imagery and metadata are downloaded, determination of exterior orientation parameters and subsequent image rectification, enable stereo viewing in different possible geometric combinations.
The well known advantage of digital cameras over film frame cameras is that film processing and scanning are not required. A big problem in their marketing is that their specifications and advantages are not always too apparent to the user. So this research focuses on the introduction famous commercial digital aerial sensors, their technical specifications, geometric models and their accuracy based on some performed investigations and possibility of using them in map production.

2. AIRBORNE DIGITAL SENSORS

Airborne digital cameras are based on large CCD-matrices as well as CCD-line sensors. The first has geometry the same as analog cameras. The technology of second one has been used in Single or multi-line cameras for spaceborne sensors to provide high-resolution wide angle or even panoramic imagery.

2.1 Airborne matrix cameras

These matrix cameras have defined, rigid, central perspective image geometry and a simple interfacing to existing photogrammetric software. Based on the size of the array of detectors, they will be considered here under three main headings: small-format cameras (between 1 and 6 Megapixels), medium-format cameras (around 16 Megapixels) and large-format cameras (36 Megapixels or larger).
In multiband images production Single cameras (equipped with a mosaic filter, rotating filter wheels, three CCDs with a beam splitter) and multiple cameras (coupled together and equipped with the appropriate color filters) can be used for more information refer to (Petrie , 2003).
The most famous airborne matrix cameras are shown in figure 1. Their technical specifications exist in table 1. Till now available CCD arrays used in commercial digital airborne cameras are not so large. To extend the swath of the matrix camera, multiple camera heads are necessary. As you see in figure 2, DMC and UltraCam-D provide large format images by combination of multi images. DSS is small format camera. DiMAC has four independent cameras which can be combined in different ways.

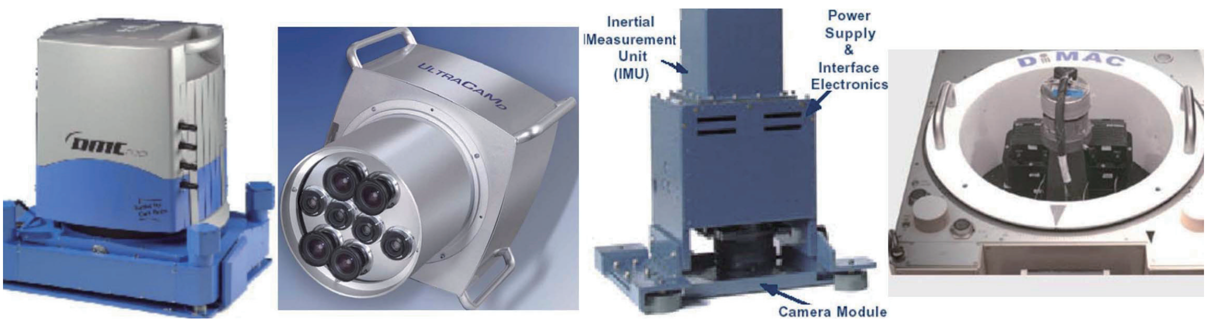

Figure 1: Airborne matrix cameras

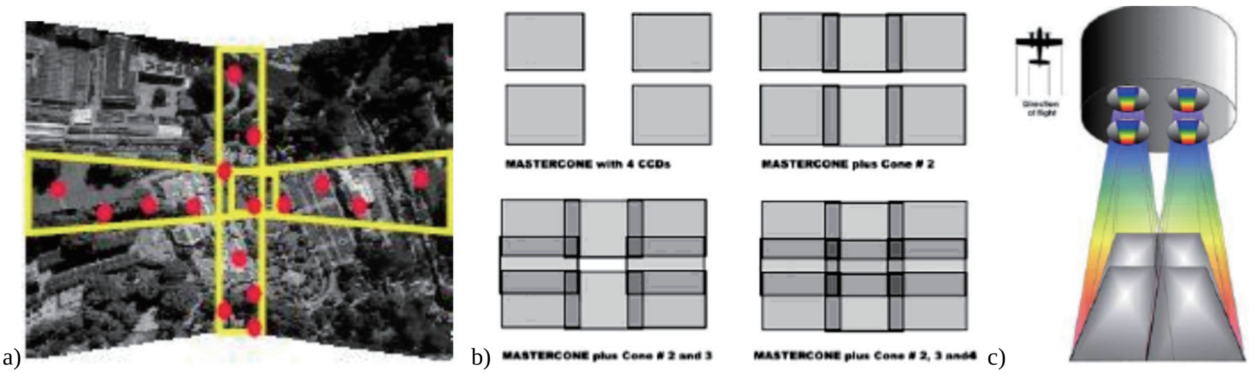

Figure.2: a)DMC and b) UltraCam-D large format images provided by combination of multi images. c) A combination of DiMAC independent cameras.

Table 1: Airborne matrix cameras specifications

Camera Parameter	DMC	UltraCam	DiMAC	DSS
Panchoromatic Focal length (mm)	120	100	________	______
Multi spectral Focal (mm) length	25	28	60,80,100, 120, 150	55, 35
Pixel size (µm)	12	9	9	9
Panchromatic line (pixels)	13500 ×8000	11500 × 7500	________	______
Color lines (pixels)	3000 × 2000	4000 × 2700	5440 × 4080	4029×4077
Field of View	77×44	55 × 35		55/4 ,37
Dynamic range	12	12	16	12
Imaging rate (frame/second)	2	1	0/5	0/4
Compatible GPS/IMU	POS/AV 510	Aerocontrol AC by IGI Applanix POS AV	Aerocontrol AC by IGI Applanix POS AV	Applanix POS/AV

2.2 Airborne pushbroom scanner

The various types of airborne mapping pushbroom scanners are panchromatic scanners, Multi-spectral scanners with multiple linear arrays designed to produce color or false-color images and 3-line scanners pointing to forward, nadir and backward. The third is used in the Leica ADS40 camera.
Larger sizes of linear arrays mean much higher cost. Linear arrays with up to of 14,400 pixels long are now on offer. These longer CCD arrays are supplied by various specialist manufacturers such as Kodak, Fairchild Imaging and Perkin-Elmer in the U.S.A.; E2V in the U.K.; Atmel in Grenoble, France (formerly owned by Thomson CSF) besides various facilities in the U.S.A.; Dalsa with manufacturing facilities in Canada and in the Netherlands, the latter formerly owned by Philips; and Sony in Japan. (Petrie, 2005)
Using *multiple linear arrays* to wide swath of the pushbroom scanner causes some difficulty in comprising butted CCDs together. To solve these problems there are some solution such as: a dual-lens to implement the wider swath or staggered but overlapping position linear arrays to give the required wider coverage by using a single optical mirror.
The manufacturer produces these in a standard length exist with a trade-off between detector size and the number of detectors in the array. (Table 2)

Table 2: number of detectors in the array in relation with detector size (Petrie, 2003)

detector size (µm)	number of detectors in the array
5	14400
7	10200
9	8000
12	6000

The smaller-sized detectors have a smaller surface area available for collection of the radiation coming from the ground and this may require the use of larger aperture lenses to ensure a sufficient exposure. To increase the image resolution, paired linear arrays can be used, with each array offset by half-a-pixel relative to the other. This mode of imaging (Supermode) has been utilized the Leica ADS40 camera (Figure3).

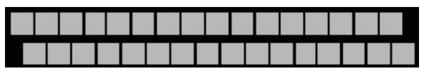

Figure.3: Staggered CCD line arrays of ADS40

The most famous airborne pushbroom cameras are shown in figure 4. their technical specifications exist in table 3. The arrangement of line arrays for each of them are in figure 5.

Figure.4: Airborne Linear Cameras: ADS40-HRSC-AX-StarImager

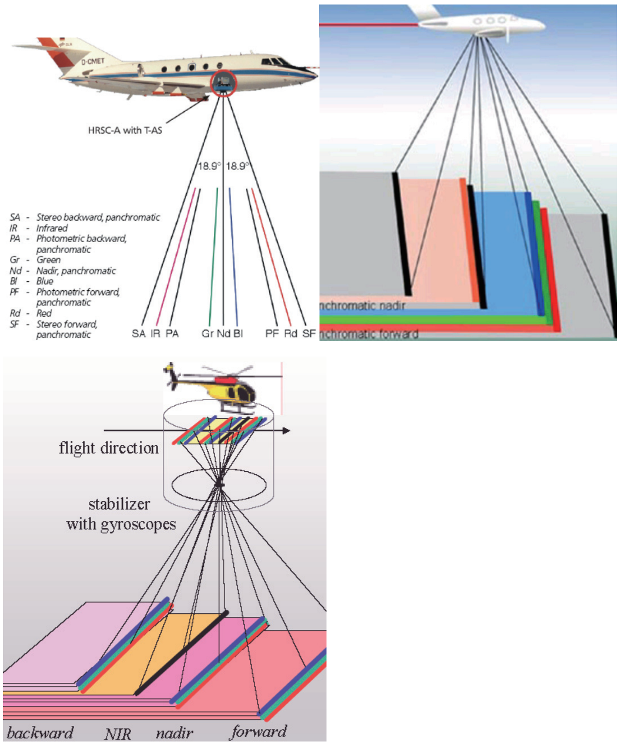

Figure.5: The Imaging in the first row ADS40, HRSC-AX and in the second StarImager

All line scanners need to be operated from a very stable imaging platform to avoid gaps and double imaging. Airborne platforms are unstable in comparison with spaceborne one. Unpredictable changes in the attitude and altitude of the platform decrease with the use of gyro-stabilized mounts but still substantial geometric displacements will remain.

A single scanner image comprises many hundreds or thousands of discrete lines at different moments with different positions and attitudes. It is quite impractical to utilize a pushbroom sensor without *DGPS/IMU system*, for measuring very good estimates of the position of the projection centre and the corresponding set of attitude (tilt) values. The obligatory use of a DGPS/IMU system with a pushbroom line scanner increases the cost of the overall scanner system.

Table 3. Parameters of the Linear sensors

Camera parameters	ADS40	HRSC-AX	StarImager
Focal length (mm)	62.5	150	65
Pixel size (µm)	6.5	6/5	5
Panchromatic line (pixels)	2×12.000	12000	14400
Color lines (pixels)	12.000	12000	14400
Imaging rate (line/second)	830	1640	500
Field of View	64°	11/81° 37/8°,	68°
Forward Stereo angles	28°	12/8	30
Backward Stereo angles	14°	20/5	20
FB Stereo angles	42°	33/3	51
Dynamic range	14 bit	12	11
Compatible GPS/IMU	Applanix POS AV	Applanix POS AV	Applanix POS AV or other DG systems

3. THE GEOMETRICAL MODELS

These mathematical models describe the transformation of a point from the image coordinate system to the ground coordinate system. The most famous 3 dimensional model is collinearity equations.

3.1 The geometrical model of matrix cameras

These cameras have central perspective geometry like analog cameras and the mathematical models are the same. But in some large format digital frame cameras we use composite of several images like DMC and UltraCam-D. At the top of Figure 6 you can see the projection center of composition of DMC in relation with backward and forward views. The bottom of this figure shows composite image in red and its component in black.

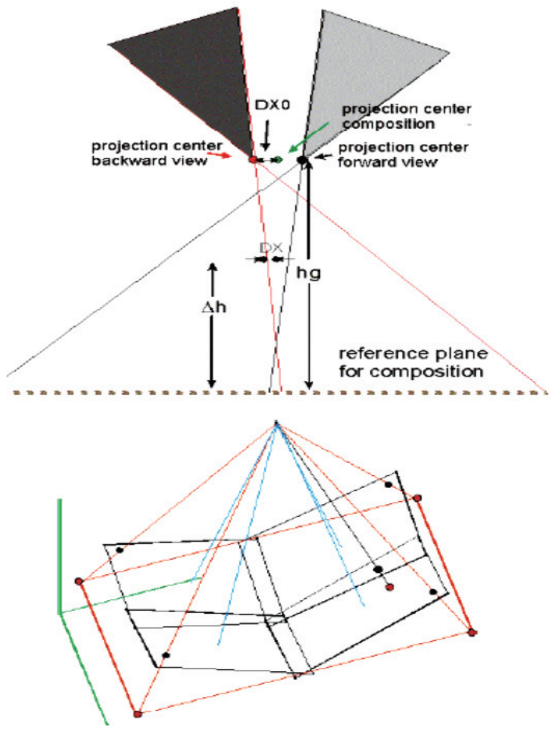

Figure6. Ground coverage of 4 head camera system

Resulted image is compatible with existing photogrammetric procedures and software. The post processing to form the composite (virtual) image includes the following tasks for every image exposure:

• Mounting angles of the panchromatic heads are determined by a bundle block adjustment technique (= "platform calibration")
corrected image coordinates after The laboratory calibrations of the single camera heads are used in this step.
• Transformation parameters using the four sets of exterior orientation parameters are computed to map from the single images to the virtual image.
• The single panchromatic images are projected to the high resolution virtual image using the computed transformation parameters.
To composite images accurately: (a) all raw images must be acquired synchronously in time, (b) the systematic effect resulting from the different perspective centers must be negligible, and (c) the relative orientation of the camera heads must be stable (Madani, Dörstel, Heipke, Jacobsen, 2004).
So to achieve accurate virtual image, Releasing the shutters of the camera heads with a precision of less than 0.01 msec is required. Systematic displacement of the generated central perspective image composite requires the exact knowledge of the height of each point on the ground that is not generally available; the horizontal reference plane is used as an approximation instead. Thus, there is a residual relief displacement effect, depends on the height variation in object space to the flying height above the ground. Tang showed that the resulting error in the central perspective image composite could be neglected, even for very high accuracy requirements if the height variation is not extreme. (Tang, Dörstel, Jacobsen, 2000)

3.2 The geometrical model of pushbroom cameras

Rectification based on position and attitude data from the integrated GPS/IMU unit provides stereo viewable images and both manual measurement of ground control points and automatic measurement of tie points. (Fricker, 2001)
To utilize the GPS/IMU exterior orientation values without triangulation, the coordinate transformation between the GPS/IMU system and the photogrammetric system must be known. The axes of the gyro system which represent the axes of the IMU cannot be perfectly aligned with the axes of the photogrammetric system and GPS antenna centre doesn't coincide with the projection centre. The remaining misalignment and offset is determined *by the bundle adjustment* roughly which divided into 2 stages:

- The analysis of GPS/IMU data process: the exterior orientation parameters are calculated from the position and attitude of the airplane at the time of image capturing.
- The block adjustment: the accuracy of the block is improved by simultaneous bundle adjustment with the exterior orientation parameters from the former process and tie point by automatic point measurement. Furthermore, by the adjustment with self-calibration and ground control point, systematic error between GPS/IMU, sensors and systems are also adjusted simultaneously.

The number of unknown would be too large with respect to GPS/IMU system data collection rate, a large number of Ground Control Points (GCPs) and Tie Points (TPs) is required. For this reason the main problem for CCD linear scanners georeferencing is to define a suitable time dependent function for example Lagrange Polynomials with variable orientation fixes that models the exterior orientation. (Figure7)

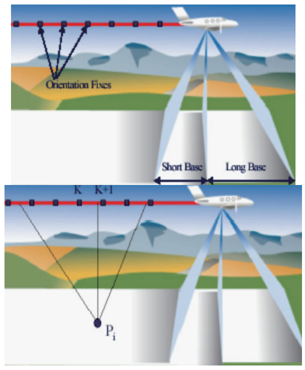

Figure.7: Orientation fixes that are used to model the exterior orientation

The image coordinates are expressed as a function of the ground point (**P**$_i$) and the orientation parameters of the two neighbouring orientation fixes (k) and (k+1). The mathematical model is given in full detail by Müller (1991).

$$x_i = F(X_i, Y_i, Z_i, X_k, Y_k, Z_k, \omega_k, \varphi_k, \kappa_k, X_{k+1}, Y_{k+1}, Z_{k+1}, \omega_{k+1}, \varphi_{k+1}, \kappa_{k+1})$$
$$y_i = G(X_i, Y_i, Z_i, X_k, Y_k, Z_k, \omega_k, \varphi_k, \kappa_k, X_{k+1}, Y_{k+1}, Z_{k+1}, \omega_{k+1}, \varphi_{k+1}, \kappa_{k+1})$$

The orientation parameters $(X_j..\kappa_j)$ are computed from their neighboring orientation fixes plus a correction term $(\delta X_j..\delta\kappa_j)$ derived from the GPS/IMU observations. The interpolation coefficients (c_j) are a function of the time differences from the neighboring orientation fixes. (Hinsken, Miller, Tempelmann, Uebbing, Walker, 2001)

$$X_j = c_j X_k + (1-c_j) X_{k+1} - \delta X_j \qquad c_j = \frac{t_{k+1} - t_j}{t_{k+1} - t_k}$$
$$...$$
$$\kappa_j = c_j \kappa_k + (1-c_j)\kappa_{k+1} - \delta\kappa_j$$

$$\delta X_j = c_j X_k^{GPS} + (1-c_j) X_{k+1}^{GPS} - \delta X_j^{GPS}$$
$$...$$
$$\delta\kappa_j = c_j \kappa_k^{GPS} + (1-c_j)\kappa_{k+1}^{GPS} - \delta\kappa_j^{GPS}$$

Finally the orientation parameters $(X_j..\kappa_j)$ are introduced into the well known collinearity equations to transform the point from the ground system to the sensor system.

4. DIGITAL IMAGING OPPOSITE TO ANALOGUE IMAGING

4.1 The usefullness of digital and analogue imaging systems

The comparison between digital and film-based data is done taking into account photographic and photogrammetric issues. Not only radiometric quality, but also the geometric performance of digital and analog cameras is investigated.
In comparison of the quality and the information content of panchromatic digital images versus analog film, different film types and a digital sensor and their output have been investigated by Perko and Gruber Some criterias like noise, edge response, image matching and Siement test have been used for measuring image quality. The results tell that digital image quality is more. (Perko, Gruber, 2002)

4.2 The cost of digital imaging in comparision to analogue imaging

Digital cameras in comparison to analog ones have only the fixed costs of the digital system; no additional costs per image exist (with the exception of additional flying time if

60% side-laps are used). What differs in using analog cameras is the cost for: film, photo processing, certain labor such as scanning and film management, maintaining a photo lab and a film archive. Based on surveys in US using digital imaging technology for mapping of large area is more economic in relation to analogue imaging. (Leberl, Thurgood, 2004) So a very important advantage is the ability to increase overlaps freely.

4.3 Geometrical evaluations of digital cameras

Images of these cameras have been analyzed and tested in different areas. In these investigations of digital aerial cameras good results achieved (Table.5) and the ability of them in large scale map production (with respect to their high radiometric quality) have been proved.

Table.5: Horizontal and vertical accuracy of digital cameras

Camera parameters*	*ADS*40[1]	StarImager[2]	DMC[3]	UltraCam[4]	DiMAC[5]	DSS[6]
Pixel size (μm)	6/5	5	12	9	9	9
Scale	32000	30000	13000	15000	16667	20000
Ground Pixel size (m)	0/2	0/15	0/156	0/135	0/15	0/18
Horizontal accuracy (m)	0/17	0/10	0/036	0/12	0/07	0/16
Vertical accuracy (m)	0/27	0/19	0/06	0/39	0/06	0/22

5. CONCLUSIONS

With respect to this brief we can count the benefits of digital aerial cameras as follows:

• Black and white, color and false color images without extra charge.

• Digital sensors –high radiometric quality, high signal-to-noise ratio and linear response to incoming radiation provide detailed information for image interpretation.

• More coverage and more redundancy – ideal for image matching as well as stereoscopic viewing.

Insufficient redundancy is the major reason that automatically created Demos using stereo matching of scanned film images have significant errors and miss data, and occlusions due to a lack of redundancy are the major limitation of orthophoto products.

• Reduced ground control owing to tight integration of focal plate, IMU and GPS and the complete absence of film errors.

• End-to-end digital flow line — no chemical film processing or scanning.

• High quality DTMs from stereo sensor data.

• Smooth data flow.

• More geometric accuracy

• Quality control during flight

In addition, map production cost will decrease with digital camera. So we can say map production with these cameras will be faster, easier, cheaper with more quality. There is very clear trend to digital cameras because of these obvious advantages that causes the fast development of this technology. So replacing of analog aerial cameras by digital aerial cameras is predictable.

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2. (Tsuno, Murai , Shibasaki , 2004)
3. (Madani, Dörstel, Heipke, Jacobsen, 2004)
4. (Smith, Qtaishat, 2004)
5. (test_flight_for_accuracy.pdf of dimacsystems)
6. (Ip, Mostafa, El-Sheimy, 2004)

Project Proposal Writing

Gottfried Konecny

Universität Hannover
Nienburger Straße 1
D-30167 Hannover
Tel: **+49-511-762-2487, Fax: +49-511-762-2483**
E-mail: konecny@ipi.uni-hannover.de

Thesis Writing

Armin Gruen

Institute of Geodesy and Photogrammetry
Swiss Federal Institute of Technology (ETH)
8093 Zurich, Switzerland
Tel: +41-1-633-3038, Fax: +41-1-633-1101
E-mail: agruen@geod.baug.ethz.ch

Presentation Techniques

Shunji Murai

University of Tokyo
4-21-9 Mejirodai, Hachioji, Tokyo 193-0833, Japan
Tel and Fax: +81-426-63-0858
E-mail: sh1939murai@nift5y.com

ECOLOGIAL AWARENESS MAPPING BY COMMUNITY PARTICIPATION

Shiro OCHI, Yutaka MATSUNO, Nobumasa HATCHO

Department of Agriculture, Kinki University
3327-204, Nakamachi, Nara, 631-8505, JAPAN
ochis@nara.kindai.ac.jp

Commission VI

KEY WORDS: Mapping, GPS, Environmental Conservation, Community participation

ABSTRACT:

Agricultural fields in suburban area are decreasing and the environmental degradation including ecological diversity are damaged. Not only the new residents in the region but also the farmers on the land do not understand the current ecological status of the region. The authors provided an opportunity for the residents to make an ecological awareness map by using simple equipments such as a handy GPS, a digital camera and a free mapping software. The participants went around the area and take photos at points where he/she thinks environmental problems exist. After making the ecological awareness map, the ecological awareness to the region were improved, and the outcome is helpful to make land use guidelines by administration.

1. INTRODUCTION

Tools for gathering spatial information such as GPS and Digital Cameras become popular, and people can utilize them for environmental assessment and safety life establishment. However, if people try to process the information about the regional environment by combining with maps, very high resolution satellite images, complicated methods are required. Even though machines and tools are popular, the information utilization are limited. In this study, a comprehensive method to observe and measure the ecological and agricultural environment due to land use change is proposed considering residents participation for gathering the information using these spatial information tools for a region where urbanization is in progress in the southern part of Kyoto, Japan.

2. STUDY SITE

Oguraike is a drained farmland with 1,310 hectares area locating in parts of cities of Kyoto, Uji, and Kumiyama, Japan(Figure 1). There are various kinds of farming due to their locations in suburb. The farmland locates on the land with 9 to 13 m altitude and with fertile soil of alluvium on flat plain(less than 0.1%). At the lowland locating in the center of the area, rice paddy is dominant, however crop farming and vegetable farming using green houses are increasing because the water supply system as well as the waste water system have been developed by projects for water quality improvement and farmland disaster mitigation. On the other hand, a lot of farmlands have changed to residential area and commercial area because the area includes convenient transport accessibility such as railway, highway and national road.

Because the land uses have changed rapidly, the risk for floods, the water pollution and the damage of underground water are proceeding. The local government encourage the community to preserve the landscape of the area, however there seems no end of illegal dumping along the roads and the cannels. Most of the dumping were carried from the outside of the region, and the residents do not have responsibilities for cleaning and the local government expect the community effort to clean them(Figure 2).

The channels are maintained and managed by the land development district of the region. The water supplying channels are well maintained because its maintenance influences the water management of the area directly. On the other hand, the waste water channels are not maintained so much. So that the water quality and river environment is not clean and disturbed(Figure 3).

From the ecological view point, the supply water channels are covered with concrete structure and have high water velocity and no vegetation in or along the channels because the farmers

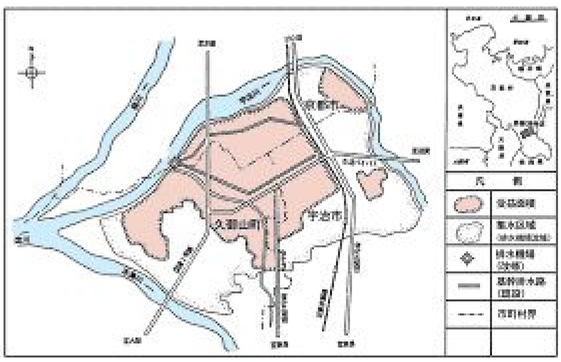

Figure 1. Study Site

make them clean for their farmland. by weeding so on. Moreover water does not flow in some periods in a year for saving the water consumption. So there are few living thing in the channel. For waste water channels, even though the water quality is not so good, there are a lot of vegetation in or along the channel and various kinds of animals such as fish, frog, fresh-water snail and turtle and birds to catch these small animals. The paddy fields and its waste water channels form a few levels of food chained ecosystem in this area.

Figure 2. Dumping along road

Figure 3. Dumping in the river

Figure 4. Community activity for cleaning

3. LAND USE CLASSIFICATION

3.1 Data

In order to make land use classification, IKONOS image of pan-sharpen image was used. In this study the data was captured on 21 of June, 2005. Fig.2 shows the false-color images of the study area. The image include most parts of the study area except a part of Kumiyama city and surrounding area of urbanized area within the Oguraike farmland. The northern area than Uji river which is shown as main river in the images is out of the Oguraike claimed farmland.

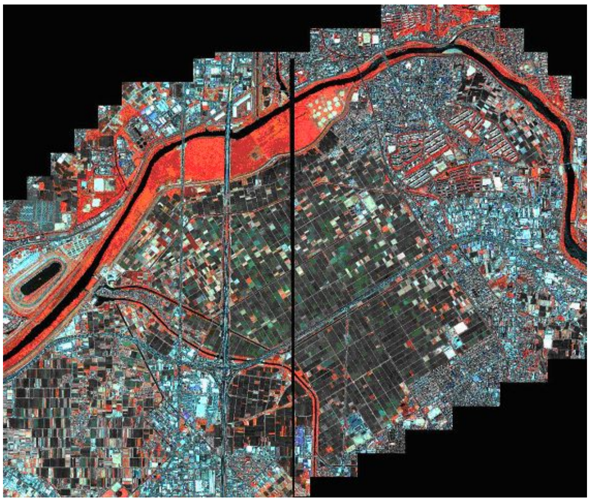

Figure 5. IKONOS pansharpen image of the study area

3.2 Land Use Classification

The land use classes are defined as (1)Paddy field, (2)Crop/Vegetable field, (3) Urban, (4) Road, (5)Rivers and water, and the classification was made by visual interpretation and ground investigation. There are four main waste water cannels in the area, and farmland blocks for each waste water cannel are easily delineated and distinguished each other. The land use for each farmland blocks is summarized as Table.1.

4. ENVIRONMENTAL CONSCIOUSNESS

4.1 Objectives

The Oguraike farmland was originally water area where Uji, Kizu and Katsura rivers meet together. The area had functioned as flood control pond as well as the fishing place. There were many flood disasters on the area and the pond was separated from the rivers by flood mitigation projects in Meiji era. However the area was suffered with floods and water pollution, the government started to reclaim the pond in 1933 and completed the drained farmland in 1941. The land is now not only the field of agricultural production but also the field growing ecological diversity. Recently, the urbanization of the area has changed the hydrological balance in the area and there

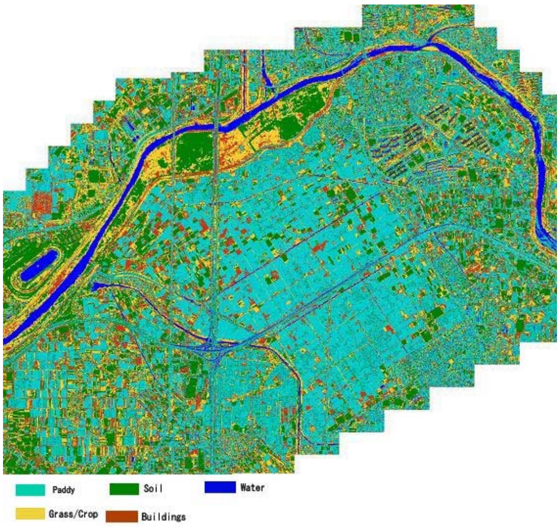

Figure 6.　Land Use Classification Map

happed serious agricultural damages due to the inundation by floods. The government have restructured the water supply and drainage system from 2005.

But the chucked garbage and illegal dumping to the cannels makes trouble for agricultural activities and facilities maintenance. The area will be maintained as the field of agricultural production as well as the community field for ecological understanding and environmental education for the people.　So, the consciousness of the residents who live in the area was surveyed to clarify the needs of the farmland in suburb and the idea to create ecological community field.

4.2 Method

Field surveys were made at the community events on both 23 of November, 2005 and 8 of April, 2006. A questionnaires survey was made on 23 Nov. 2005 and about 200 answers were collected. Ecological mapping using GPS and digital cameras was carried out by some participants on 8 of April, 2005. By synchronizing the time of digital cameras with the time of GPS, the location of a picture by the digital cameras can be set by picking up the location information of corresponding time. The participants carried a pair of GPS and digital camera for a group

Figure 7. GPS and Digital Camera

Figure 8. Field Investigation

and investigated the field to record their ecological or environmental awareness(Figure 8).

4.3 Results

Following items are analyzed from the questionnaires survey.

(1) Current status of the area

The main purpose of the area is agricultural production field, however various activities such as fishing, some festivals, lightning bug watching in summer, bird watching and flower observational learning are promoted in the area. Most farmers who own the farmland　the area is private land and they do not like other people to come in their farmland and walk around the area during their cultivating season. Non-farmers residents understand that the area are owned by farmers, however, the landscape is public properties and they like to share the space with farmers.

2) Functions of the farmland

Many non-farmers group expect the farmland and cannels to function as buffer area for disaster and water management. They think the farmland the channels are important for the ecosystem of the area, and for refreshing people around the area. Not many farmers answered it has functions for ecological conservation and water clarification, however most of them understand that there should be more animals such as frog and fishes except harmful insects.

3) Current evaluation to the area

a) About the farmland:　Many people answered the farmland is familiar in their life, and give good impression to the people. Many people think that the landscape of the area is disturbed by dumping and unplanned land development, and expect the local government to control the land use of the area. In order to conserve the farmland, the government should control the agricultural activities not only for the area but also for the country.

b) About the cannels: Most of the residents recognize that the cannels are not clean and are disturbed by dumping. Many people think the situation should be improved by the local government policy. The water quality of the waste water channel should be improved by the government control.

4) The future farmland development

a) About the farmland: Almost half of the people answered to conserve it as it is, and 1/4 of the residents want to enhance the public facilities such as park and artificial river terrace to enjoy the rivers environment. Many people eager to participate the community activities for mowing and cleaning of the area and cannels to improve the landscape of the area.

b) About the cannels: 1/3 of the people want to keep the surface of the cannels as they are, 1/3 of the people want to develop a biotope in the channels, and 5% of the people want to have cannels with concrete structures to prevent soil erosion and weed.

5) Ecological awareness mapping was made using freeware(Figure 9). The software to combine digital camera images with GPS location information was provided within this study. Not only the participants of the mapping survey but also other residents easily to notice the ecological awareness points from this map and everybody can participated the mapping program when digital camera image with GPS location are joined.

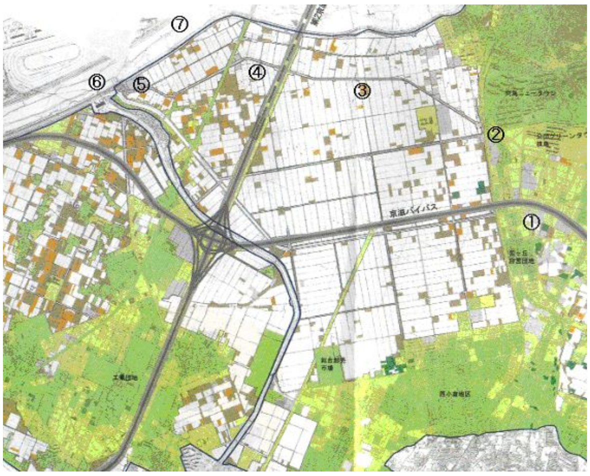

Figure 9 Ecological Map of the study area

5. DISCUSSIONS

The ecological consciousness to the suburb farmland of the residents in the area was analyzed by this survey. The purposes of utilization of the farmland are limited for agricultural production and enjoying the cool evening breeze as community event. There is some gap between the farmers and non-farmers living in the area. The farmers have difficulties to continue the agricultural activities in this area due to urbanization, aging of farmers and lack of successors. If non-farmers can participate some agricultural activities, the situation can be improved in community scale. We found that the ecological awareness map can help farmers to understand that there is rich ecosystem in the farmland. And at the same time, the map help non-farmers to understand there is many ecological disturbed points in the area and they should be recovered to conserve the ecosystem in the area.

The willingness for environmental conservation for the area and citizens participation for that were strong among the residents. However not a few people did not pay any attention to the ecological environment to the area. And many people do not understand the ecological functions of the cannels in the farmland. Many residents are interested in environmental conservation and ecology in the area by making field investigation using spatial information tools, however analytical software with easy handling are necessary to promote residents consciousness for the ecological conservation.

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GLACIER CHANGE ESTIMATION USING LANDSAT TM DATA

Magsar ERDENETUYA[a], Pandi KHISHIGSUREN[b], Gombo DAVAA[c], Moondoi OTGONTOGS[d]

[a,d] National Remote Sensing Center/Information and Computer Center
m_erdenetuya@yahoo.com, motgoo@yahoo.com
[b] Agency of Land Affairs, Geodesy and Cartography
khishigsuren25@yahoo.com,
[c] Institute of Meteorology and Hydrology
watersect@magicnet.mn,

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KEY WORDS: ecosystems, land cover, glacier, spatially and temporally changes

ABSTRACT:

The Mongolian territory includes various ecosystems as, taiga forest, high mountains, width steppe and gobi desert, through North to South. The glacier is most important land cover type to keep the freshwater resources and as indicator of the climatic temporal variability. In this paper have been included some results research work on integrating of glacier observation data and satellite imagery from the space. The remotely sensed data has an advantage of real estimation of the glacier condition spatially and temporally. The results of climatic and hydrologic scientists showed that during last several decades the glacier is melting due to global warming and we have tried to approve this result using Landsat TM data of 1990s and beginning of 2000s of some mountains of Western Mongolia.
The results were obtained by utilizing the all bands of Landsat TM data and the NDSI (normalized difference snow index) images as input to a maximum likelihood classification approach. Also we have used the SRTM/DEM in order to calculate the area of the glaciers.

1. INTRODUCTION

By the geographical position and "ecotone" formation whole territory of Mongolia was selected as main part of study areas in Northeastern Asia. In Mongolia located Altai, Khangai and Khuvsgul high mountains and formulated permanent snow and ice. As mentioned the glacier is most important land cover type to keep the freshwater resources and as indicator of the climatic temporal variability.
Since the middle of the last century, the global climate is changing drastically and as a result the current climate experiences more frequent extremes in Mongolia causing big losses amongst animal and land degradation. Also the National Program on Climate Change mentioned that for every increase of 3 degrees in air temperature, there will be a 10 percent reduction in carbon (C) and nitrogen (N) contents of the plant-soil ecosystem, a 3-10 percent reduction in pasture vegetation and a biomass reduction of 21.5 percent[1]. Nowadays, the air temperature has already increased by 1.9 degrees[2]. The global warming factor could strongly influence to melt the permanent snow and ice on top of higher mountain system in Western Mongolia at the same time to decrease fresh water resources.
In order to estimate glacier area we have used the Landsat TM data from different period and applied NDSI (normalized difference snow index) calculation method and maximum likelihood classification approach. Also the SRTM/DEM data have been used for 3 dimensional processing and for calculation of the glaciers area.

2. THE STUDY AREA AND DATA

There have been used Uvs lake hydrology data of 1970-2002 and meteorological data observed at Ulaangom and other stations, located in the basin.
For estimation of glacier area dynamics have been used Landsat of 3 different time period data for glacier massifs as Kharkhiraa, Turgen Tsambagarav, Munkhkhairkhan and Sair Mts. The Landsat TM and ETM+ scenes were selected from 141-144 paths and 26-27 rows and obtained on following dates.

- 16 September 1990 (used for only Munkhkhairkhan Mt. Noted with in Table 1)
- 25 June 1992
- 10 Sep., 2000 /Kadota and Davaa, 2003/
- 08 August 2002

3. METHODS

For mapping the glacier area from the satellite image we have applied several approaches such as,

- To identify spectral characteristics of glacier in each Landsat band
- To apply bands combination method for glacier extraction
- To apply both supervised and unsupervised classification methods
- To calculated normalized difference snow index
- To analyze three dimensional view of images

[1] National Program on Climate Change, 2000

[2] L. Natsagdorj – Assessment of Climate factors to Mongolian pasture degradation, 2006

- To compare calculated areas

In order to distinguish snow from similarly bright soil, rock and cloud we have calculated NDSI (normalized difference snow index) by following formulae:

$$NDSI = \frac{(TM2 - TM5)}{(TM2 + TM5)} \qquad (1)$$

where: TM2,TM5- Landsat TM band data

In Fig. 1 shows Landsat TM data fragments of 2 mountains in different periods.

A.
B.

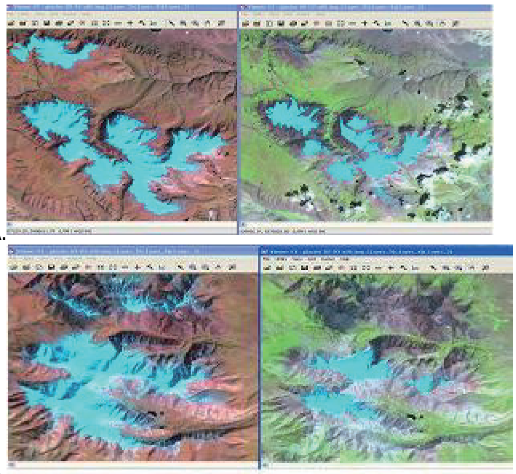


Fig. 1. Landsat TM, ETM+ images of glaciers in 1990 and 2002 (A – Tsambagarav, B – Sair mountain)

4. RESULTS AND DISCUSSION

On the background of the paleoclimate data, more precise climatic chronology has been given by the research on reconstruction of climate data with tree ring indices.
One (Khalzan Khamar) of the tree ring chronology sites were selected in the Altai Mountains. It has permanent snow fields, ice and permafrost and located near the timberline where temperature appears to be limiting factor for growth. Similar fluctuations have been derived from the tree-ring width indices record, taken from the sample of the Turgen Mountain. Reconstructed with 5 year moving average of tree ring width indices (r=0.60) of the Turgen and instrumental, annual temperature at Ulaangom station were well correlated and show that highest temperatures are in last decades.
Melting of the ice masses in the mountains, the end of pediment formation on the lower mountain slopes and the slow regeneration of plant cover owing to rising temperatures and increased precipitation all lead to a relative quick rise in lake level, since the basins filled up with both rainwater and melt water from the rapidly melting glaciers. Therefore, pretty good relationship exists between 5 year moving average of tree ring width indices and annual average of water level of the Uvs lake for the period of 1970-2002.
Reconstructed with 5 year moving average of tree ring width indices (r=0.76) of the Turgen and observed water level of the Uvs lake were well correlated and show that highest water levels are observed in the last decade.
It is obvious that dynamics of the water balance elements of the Uvs Lake were following water level fluctuations. However, it is possible to estimate water balance elements in last 40 years.

Spectral characteristic of glacier

The maximum, minimum and mean spectral values of each of land cover class were calculated from high resolution Landsat images, based on that spectral reflectance of each land cover types is different in each wave length of electro-magnetic radiation .
On Landsat ETM+ data the glacier spectral values accounted as 255, 145-255, 191-255, 116-217, 20-31 and 3-18 in each spectral bands 1-5 and 7 respectively. The calculated spectral values of land cover classes used as a reference value for glacier classification.
Also for identification of glacier have been used band combination method and the glacier was extracted in each 3,2,1 and 4,3,2 and 5,4,3 combinations of bands as showed in Fig. 2.

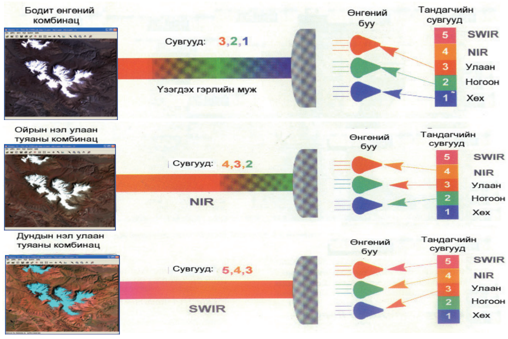


Fig. 2 Landsat ETM+ data combination
(Tsambagarav mountain)

For extraction of glacier area we have used the NDSI (normalized difference snow index) calculation to distinguish snow from similarly bright soil, rock and cloud from entire images.

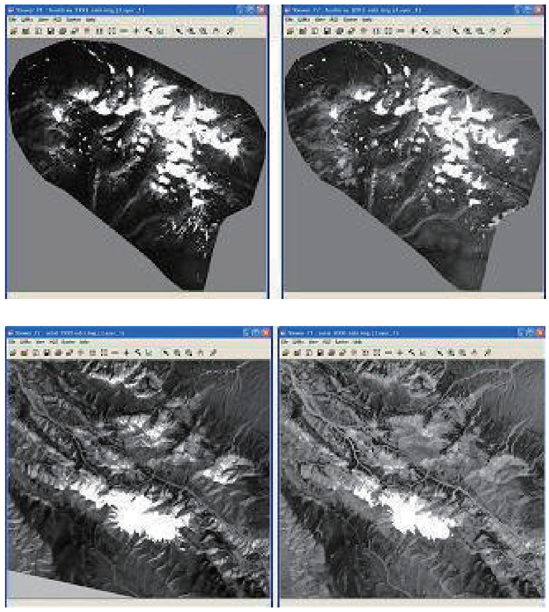
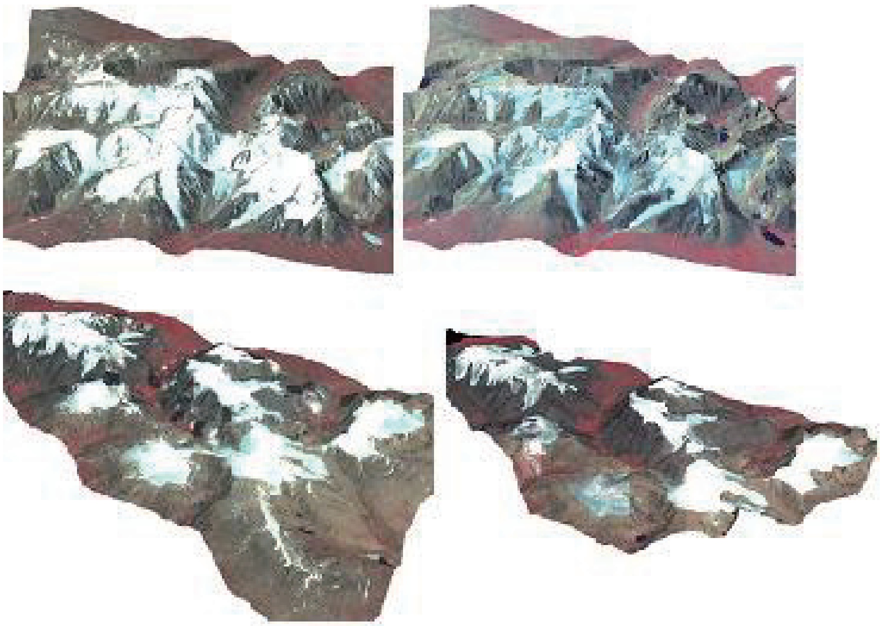


Fig. 3 NDSI images of Kharkhiraa and Sutai mountains

Also the SRTM/DEM data have used for 3 dimensional processing and identification of the glaciers area.



A B

Fig. 4 Three Dimensional Landsat images (A – Kharkhiraa, B – Tsambagarav mountains)

Reason of reduction of evaporation from water surface area of the lake can be the decrease in water temperature due to the increase in melt water, draining to the Uvs Lake primarily in the form of underground flow. Retreat of Kharkhiraa and Turgen glaciers is drastically increasing since 1940s. Kharkhiraa, Turgen, Kharkhiraa, Tsambagarav and Tavanbogd glacier areas were 50.13, 43.02, 105.09 and 88.88 sq.km, estimated from topographic map, scaled as 1:100 000 and compiled in 1940s. Areas of the Kharkhiraa, Turgen, Munkhkhairkhan, Tsambagarav and Sair glaciers were decreasing by 45.5, 33.7, 25.8, 21.4 and 42.5 percent since 1992 till 2002, respectively (Table 1).

Glacier massif	1940-th topo map	25 June 1992	10 Sep 2000	8 Aug. 2002
Kharkhiraa	43.02	57.37	36.08	31.29
Turgen	50.13	51.03	34.74	33.83
Munkhkhairkhan	-	36.96*	-	27.42
Tsambagarav	105.09	90.98	74.8	71.52
Sair	-	11.51	-	6.62

Table 1. Changes in glacier areas

Retreat of glaciers is intensified in last decades and many of glacier peaks got ice free especially in very dry year 2002.
We have analyzed Landsat TM, ETM+ data from 1992, 2002 and compared their massif changes (Fig. 5).

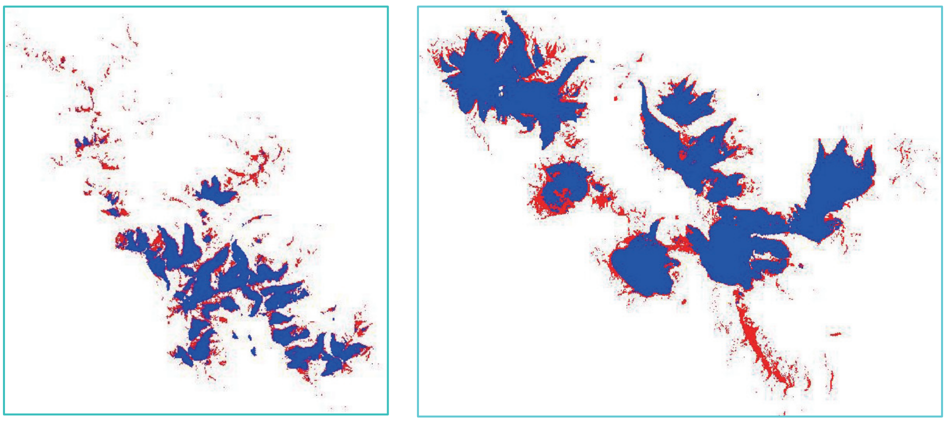


Fig. 5 Comparison of Turgen and Tsambagarav mountains glacier massif in 1992 (red) and 2002 (blue)

5. CONCLUSIONS

Comprehensive investigation focusing on glacier mass balance, ground and surface water interaction, dating and the environment changes are desired in the near future.
Compilation of glacier inventory is important issue, using remote sensing and ground observation data, especially vertical air photographs, which are basic information for development of hydro-climate-glacier and integrated water resource management studies.
For satellite data application on glacier mapping we still need fresher (2005 and 2006) and higher resolution satellite (ASTER, IKONOS) imageries.

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EXPERIMENTAL STUDY ON THE EFFECT OF CHEONG-GYE STREAM RESTORATION ON URBAN ENVIRONMENT (LONG-PATH MEASUREMENT OF ATMOSPHERIC POLLUTANT SPECIES WITH AN OBSTRUCTION FLASHLIGHT)

Yohei SHIRAKI [a], Ippei HARADA [a], Hiroaki KUZE [a], Toshiaki ICHINOSE [b]

[a] Center for Remote Sensing, Chiba University, 1-33 Yayoi-cho, Inageku, Chiba 263-8522, JAPAN - shiraki@graduate.chiba-u.jp

[b] National Institute for Environmental Studies, 16-2,Onogawa, Tsukuba, Ibaraki 305-8506, JAPAN - toshiaki@nies.go.jp

Commission VI

KEY WORDS: Pollution, Spectral, CCD, Environment, GIS, Urban, Research

ABSTRACT:

The expressway was dismantled in Seoul in July, 2003, and the municipal river was restored in October, 2005. In this study, it is intended that the atmospheric pollutant data and the air temperature data are accumulated in the proof of the relaxation effect of the heat island phenomenon in Cheongecheon.

As a method of researching the atmospheric pollutant, the astronomical telescope was used. Furthermore, as a method of the meteorological observation, an observation data of air temperature at 19:30-20:30 in September 24th 2005 was used in Cheongecheon.

The purpose of this study is twofold. First, we compare the long-path result with the point data simultaneously measured at ground-based monitoring stations. Second, we analyze quantitative evaluation of the effect of Cheong-gye stream restoration on air quality.By publishing the result of being obtained in this study, it is thought it is useful to the improvement of the consciousness for the environment of the citizen.

1. Introduction

The expressway was dismantled in Seoul in July, 2003, and the municipal river (Cheong-gye stream) was restored in October, 2005. In this study, it is intended that the atmospheric pollutant data and the air temperature data are accumulated in the proof of the relaxation effect of the heat island phenomenon in Cheongecheon.

In the monitoring of atmospheric pollutant species such as NO_2, SO_2 and O_3, conventional point measurements at ground sampling sites lead to concentrations for local environments. It is also valuable to obtain additional information of regional concentrations measured over a certain distance, e.g., several hundred meters to several kilometers. Differential optical absorption spectroscopy (DOAS) in the visible and near-UV region is more suitable to monitor horizontally averaged concentrations of pollutants (Edner *et al*., 1993).

In the conventional long-path DOAS method, a continuously emitting light source is employed , and the source (or occasionally a retroreflector) is placed at a certain distance from the observation site. Then the combination of a monochromator and a detector such as a photomultiplier, photodiode arrays, or a charge-coupled device (CCD) serves to spectrally analyze the transmitted light. In the present paper the Center for Environmental Remote Sensing, Chiba University, reports a novel DOAS spectrometer based on a white flashlight source and a compact CCD spectrometer (Yoshii *et al*., 2003). The motivation of this study is to utilize white flashlights (obstruction lights) installed on tall constructions such as towers, bridges, and stacks for the DOAS measurement. Such white flashlights are widely used for the safety of aviation traffic in many countries. In Japan, it is mandatory for tall constructions (higher than 60m) to operate highly illuminant (more than 2×106cd) white flashlights during the daytime that are detectable in every direction from several kilometers away. Normally, xenon lamps are used for this purpose, giving a strobe emission every 1.5s. Compared with the conventional DOAS measurements, the advantage of the present scheme is evident; if one can find an appropriate obstruction light, as is the case in cities or industrial areas, the DOAS measurement can be carried out without bothering to prepare light sources. After transmission in the atmosphere, the spectral analysis is easily attained by use of a commercially available CCD spectrometer, which enables us to measure the spectrum of the pulsed signal.

Additional advantages associated with the present pulsed DOAS are as follows. First, the background from the sky radiation is easily subtracted because the spectra with and without the strobe flash are distinguished straightforwardly from the difference in the observed intensity. Second, simultaneous observation of several trace gas species is feasible if the relevant spectral features fall within the considered wavelength interval of the lamp and the CCD. Third, when the spectral intensity of the flashlight is known at the strobe site, the transmitted spectra bring about the information on the aerosol extinction along the optical path.

The purpose of this study is twofold. First, we compare the long-path result with the point data simultaneously measured at ground-based monitoring stations. Second, we analyze quantitative evaluation of the effect of Cheong-gye stream restoration on air quality.

2. Study area and Experiment

2.1 Study area

Seoul city is located in the northwest of Korea. The area of the city is 605.52km^2, and its population about 10,000,000

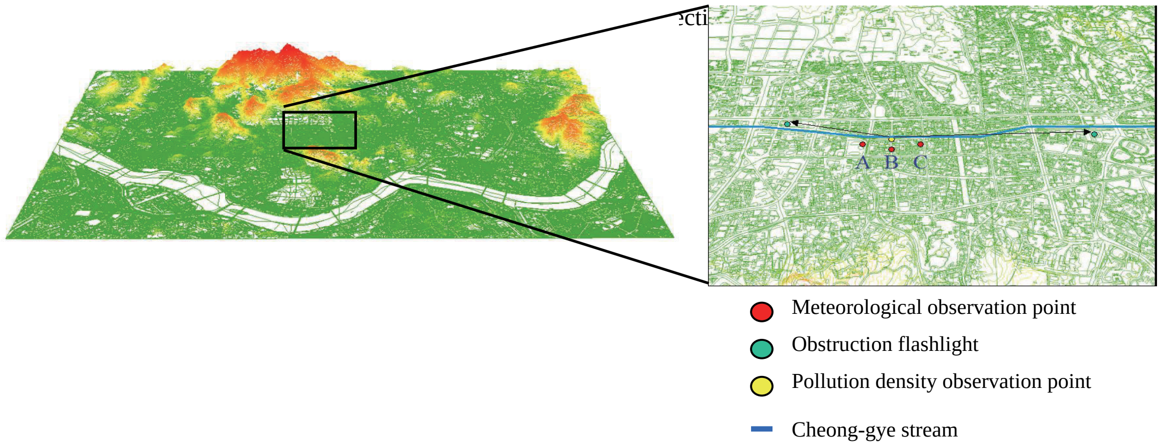

Fig. 1 Study area (Seoul city)

inhabitants. The topography of the study area is steep range of hills mountain land. In short, ups and downs of land are steep. The study area is around restored a cheong-gye stream in 1 October, 2005. The cheong-gye stream flowing from west to east in the city center of Seoul was an inner-city river with the length of 10.92 km joining to the Han-gang river.

2.2 Experimental method

(a) Measurement of atmospheric pollution

Fig. 2 shows a schematic of the experimental setup. An astronomical telescope (Meade, DS-115), with an aperture diameter of 115 mm and a focal length of 910mm, is employed to focus the image of a point light source located at a far distance. The image is formed near the eyepiece location (the eyepiece itself is removed from the telescope) where the entrance slit (1 mm high and 5 μm wide) of a CCD spectrometer (Ocean Optics, USB2000) is placed. The CCD consists of 2048 elements and is sensitive in a wavelength range of 200-800 nm, resulting in an average resolution of 0.3 nm/pixel. This CCD spectrometer is composed of a fixed grating and a linear CCD array with a mechanically stable, crossed Czerny-Turner design. No moving parts are incorporated, resulting in high reliability and compactness (89 mm wide × 63 mm deep × 34 mm high). The CCD gate duration is set at 300 ms in the experiment. Between successive gate periods, there exists a time lag of 7 ms, in which each spectral data is sent to a personal computer (PC) through the universal serial bus. The data acquisition can be attained successfully even when no trigger (synchronous with the flashlight) is applied to the CCD spectrometer.

(b) Meteorological observation

In September 24th 2005, an observation data of air temperature at 19:30-20:30 was used in Cheongecheon. The goal of the observation was to know change in air temperature at sunset. All the observation points are on the paving of asphalt.

3. Result

3.1 Analisis of the DOAS spectrum

The quantitative analisis of trace compounds is based on Lambert Beer's law (e.g., Fuqi, 2005).

$$I_1 = I_0 \cdot e^{-\alpha LC} \quad \cdots \textbf{(1)}$$

where I_1 and I_0 denote the light intensity at a specific wavelength with and without absorption, respectively. In addition, α,L and C denote the absorption coefficient, the length of open path, and the mixing ratio of trace gas,

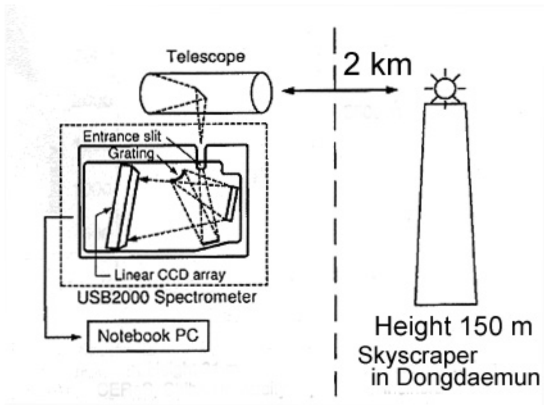

Fig. 2 Experimental setup for measuring NO_2

broad band absorption has little spectral structure, the DOAS technique only considers the narrow band structure. Therefore, for the derivation of concentrations, the differential cross sections ($\Delta\alpha$) over several wavelength channels are taken into account. The cross sections for the wavelengths (gases) of interest has been pre-recorded by the manufacturer and stored in the analyzer's memory. The strength of absorption for each trace gas however, varies as a function of wavelength. Thus, to optimize the detectibility of each gas for the DOAS system, wavelength region of the strongest absorption was selected and used for each gas such as: 265.7-304.4 (O_3), 280.7-319.3 (SO_2), and 406.2-444.2 nm (NO_2). Fig. 3 shows for the two data spectrums compared in the analysis. The difference in the bias level between the two spectra is ascribed mainly to the difference in the aerosol optical thickness. Fig. 4 shows monthly average of NO_2 during January, 2001 to October, 2005. However, the air quality standards of NO_2 in Seoul is 0.05 ppm (the value of annual average), the value of NO_2 in Chongae 4 ga is more than 0.05 ppm during July 2003 to June 2005. The influence of construction is stronger than the influence of the autoexhaust. However, it is worth observing atmospheric pollutant species, since the value of NO_2 in Chongae 4 ga is low after restored a cheong-gye stream.

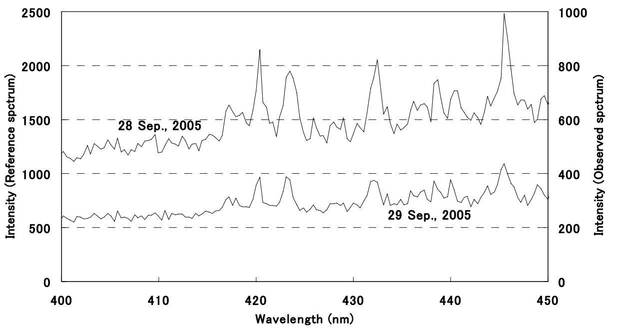

Fig. 3 Observed spectrum (28 September, 2005 16:00-17:00 JST) and reference spectrum (29 September, 2005 9:35-9:40 JST).

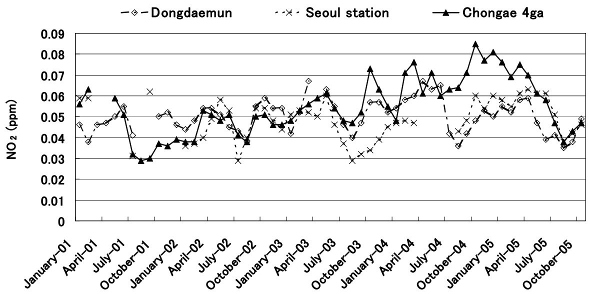

Fig.4 Monthly average of NO_2 around the road

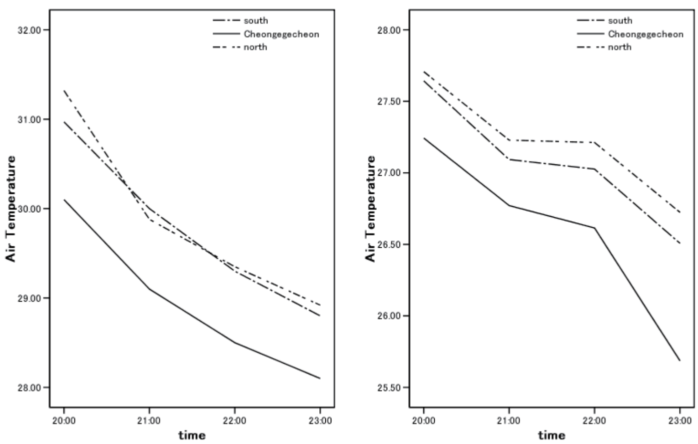

Fig. 5 Daily variation of air temperature (Left:2004, Right:2005) (North-South)

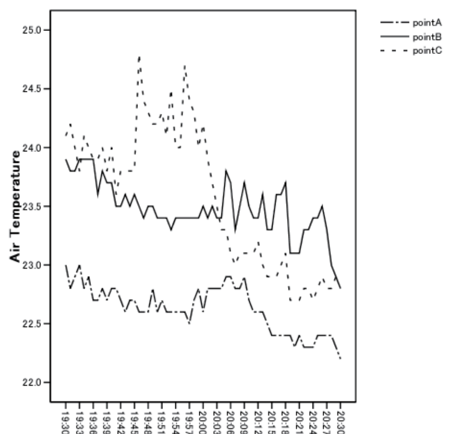

Fig. 6 Daily variation of air temperature (2005) (East-West)

3.2 Relation of building form and air temperature

Fig. 5 (North-South) and Fig. 6 (East-West) show the change in air temperature obtained according to the air temperature measurements. At first the decreases in the air temperatures are seen in Cheongecheon according to Fig. 5. In general, there is relaxation effect of air temperature in the river, and away from the river, the air temperature tends to be high. Next, the air temperature of point A is the lowest according to Fig. 6. It is thought that the density in the building influences the air temperature.

Radiant quantities R from the ground surface when there is an obstacle are shown by the next formula.

$$R = \sigma T^4 - \gamma \ \sigma T_1^4 - (1 - \gamma) \Gamma \ \sigma T_\alpha^4 \cdots (2)$$

where, σ: Stefan constant, T: Ground surface temperature, T_1: Ground surface temperature of obstacle, T_a: Air temperature, Γ: The emission absorption quantity by the atmosphere and the emission absorption quantity by the planckian radiator ratio, γ: The spatial ratio which the obstacle occupies.

In addition, $0 < \gamma < 1$ and $0 < \Gamma < 1$ is. At the early morning of the city, it is thought $T_1 > Ta$ and $T > Ta$. If the value of R decreases, cooling rate of the ground level becomes small. As a result, ground surface temperature of the city becomes high in comparison with suburb. In addition, when altitude of the building is high, in order to reflect multiplex with the wall surface, the structure of the city is likely to be heated

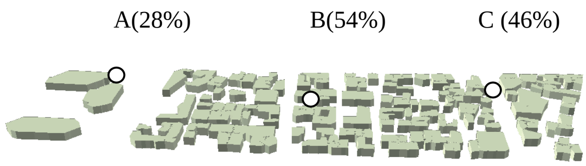

Fig. 7 pattern diagrams of building (Density in the building of 120m in radius from observation point).

(e.g.Kawamura, 1964). In this study, it thought about the relation of the density of the building and the air temperature.

As a result, there is a proportional trend between the air temperature and the density in the building, in other words when the air temperature is high the density of the building is also high, and vice versa. It is necessary to investigate an accurate architectural form in order to examine the relation of a detailed architectural form with the air temperature in the future. The atmospheric pollutant species observation and the meteorological observation in Seoul will be studied, and the relaxation effect of the heat island phenomenon of the municipal river will be clarified. Thus, it is possible to contribute to the creation of the municipal river and the promotion of maintenance in Asian cities.

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EDUCA SeRe II PROJECT – ECOSYSTEMS ATLAS OF SOUTH AMERICA AND ANTARCTICA THROUGH SATELLITE IMAGES

T.M.Sausen[1] ; S.M. F. da Costa [2] ; A. C. Di Maio [3] ; F.V.Barbosa[4]

[1]Instituto Nacional de Pesquisas Espaciais, C.P. 515 CEP 12245-970 São José dos Campos, SP, Brasil;
tania@ltid.inpe.br
Universidade do Vale do Paraíba-UNIVAP/IP&D; Av. Shishima Hifumi, 2911; URBANOVA – CEP 12244-000; São José dos Campos, SP, Brasil;
sandra@univap.br
[3]Universidade Federal Fluminense-UFF-departamento de Cartografia
adimaio@ig.com.br
Fernanda Viana Barbosa
[4]viana_fernanda@yahoo.com.br

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KEYWORDS: Remote sensing, ecosystems, Atlas, education, South America, Antarctica

ABSTRACT

This paper is about the EDUCA SeRe PROJECT II-Ecosystems Atlas of South America and Antarctica through satellite images, which main objective was to develop an Ecosystems Atlas, in CD ROM format, using satellite images and the results of remote sensing researches, to be used as educational material in grammar and high schools. The Atlas was developed in partnership with 17 institutions, in 11 countries in South America, and it will be distributed, free, to grammar and high schools, in the region.

1. INTRODUCTION

In May 1997 was held the I Conference in Remote Sensing Education in Mercosul, in Camboriú city, Southern region in Brasil. One of the results of this conference was the Camboriú Document, which presents the state-of-art of remote sensing education activities in the region.

One of the most important discussion topics in the Conference was the lack of educational material for remote sensing teaching in Portuguese and Spanish, the regional languages, besides the high cost and the difficulty to get satellite image to use as educational material in classroom. For this reason INPE decided to create the EDUCA SeRe Program in 1998, through its Dissemination and Education Space Activities Area.

The objective of this Program is to create educational material for remote sensing education, in all level, at low cost and available to everyone. This program is divided into four projects; one of them is designed to create educational CDROMs. The EDUCA SeRe PROJECT II- Ecosystems Atlas of South America and Antarctic through satellite images is an atlas about twenty-two ecosystems in South America and Antarctic.

The ecosystems preservation is very important for the biodiversity. In order to preserve the different ecosystems around the world it is necessary to know their main characteristics, location and their relation with the surrounding area, besides the man activities impact in the ecosystem itself.

The remote sensing data are very useful for environmental studies and could help to develop actions in order to preserve the ecosystems. For this purpose it is necessary to create a critical mass in the region through education and dissemination actions. One of these actions is to show to the grammar and high schools teachers and students the some ecosystems in South America, how to use remote sensing data to get information about them, and motivate this community to be concern about environmental issues.

This Ecosystems Atlas and its wide dissemination in South will give to the school teachers and students the opportunity to know about remarkable ecosystems in the region, to know about their dynamics, the current preservation status e how to manage them. Moreover, the schoolteachers and the students will have the opportunity to learn about remote sensing through the nice satellite images available in the Atlas.

2. OBJECTIVE AND GOALS

2.1- Objective:

The objective of this Project was to develop an Ecosystems Atlas, in CD ROM format, using satellite images and the results of remote sensing researches, to be used as educational material in grammar and high schools.

The specific objectives were:

- To adapt the scientific language used in remote sensing researches to the school teachers and students language, in order to use their as information to develop educational material;
- To disseminate the use of remote sensing data as educational material in grammar and high school, mainly in geography and science areas;
- To put available, widely and a low cost, educational material for remote sensing teaching for natural resources;
- To bring to schoolteachers and students notice about important ecosystems in South America and Antarctic.

2.2-Goals:

- To have this Atlas as part of school educational material collection, in order to be widely used in classroom;
- To raise teachers and students awareness about the utility of remote sensing data for the environmental preservation;
- To improve the student's knowledge about remarkable ecosystems in the continent where they live.

3. METHODOLY AND MATERIAL

3.1-Methodology:

This project was totally develop trough Internet, the projects participants never met in order to develop the Atlas; everything was discussed and developed by internet, even the exchange of satellite data.

To develop the Atlas the following steps were done:

- Contact and invitation to remote sensing professionals and institutions from South American to take part in the Educa SeRe II Project;
- Ecosystems selection-each country has to choose one or two remarkable and well-known ecosystems for the Atlas Project. One of the rule to select the ecosystems was to have already been developed a remote sensing research in this ecosystems;
- Data collecting like images, maps, photos about the ecosystem selected in each country;
- Satellite images definition-this step was concerning to select satellite images, from different satellite sensor systems to be used in the Atlas, according to the research developed in the ecosystems;
- Definition of the Atlas rules- all members of Atlas executive team have to follow these rules (such as font, size, format an shape of the images, photos, maps, etc) in order to have a homogeneous material
- Development of the Atlas topics, in each country according the rules defined;
- Each country has sent the documents about their one ecosystems for the Project coordination, through FTP or internet;
- Revision and integration of Atlas documents;
- CD ROM development.

3.2-Materials:

There were used the around 250 images from LANDDSAT 5/TM (temporal data); LANDSAT 7/ETM; SPOT (temporal data); CBERS (WFI, CCD e IRMS-temporal data); NOAA/AVHRR; Aqua and TERRA (MODIS and ASTER); SAC-C and GOES satellites. Besides were uses several maps on scale 1:100.000 e 1:250.000, field work and local photos, books, texts, and wheatear, climate, statistic, economic and history information.

Some satellites images were given by the institutions that were involved in the project, such as CONAE, INPE, ESA, CLIRSEN and IGEOMINAS, some images were gotten from Internet websites. These images are available in JPG format, they are free download for educational issues, if is the educational material is distributed with no cost.

4.ATLAS TOPICS

The Atlas was coordinated by the National Institute of Space Research-INPE in partnership with the Vale do Paraíba University-UNIVAP. Forty-four professionals from seventeen institutions from Argentina, Bolivia, Brasil, Chile, Colombia, Peru, Ecuador; French Guiana, Venezuela and Uruguay took part in this Atlas. These professionals are geographers, ecologists, biologist agronomist, cartographers, forest engineering, oceanographers, meteorologist, geologists and from computer area (Figure 1).

Figure 1. Atlas cover

The Atlas is in Portuguese and Spanish version. There are 147 texts about the following topics:

- General information about the Atlas and the CD ROM (Figure 2);
- General information about the EDUCA SeRe Program-objectives, goals and educational materials;
- General information about the South American countries and Antarctica-history, language, economy, rivers, relief, vegetation, fauna, traditions;
- Fundamentals of remote sensing-espectro-eletromagnetic, radiation, spectral behavior;
- Satellites programs (LANDSAT, CBERS. SPOT, TERRA, AQUA, NOAA, ERS,etc);
- Satellite track stations in South America-Cuiabá-Brasil, Cotopaxi-Ecuador and Falda del Carmen-Argentina
- Fundamentals about ecosystems;
- Biomass in South America;
- Climate of South America;
- Antarctica-History, Climate, Environment, Fauna;
- Ecosystems:
    - Llancanelo lagoon-Argentina;
    - River Plate estuarine and Parana river delta-Argentina;
    - Peninsula Valdes-Argentina;
    - Uyuni Salar-Bolivia;
    - Titicaca lake-Bolivia
    - Alto Valley-Bolivia;
    - Caatinga-Brasil;
    - Pantanal-Brasil;
    - Malvinas and Brasil Ocean Streams-Brasil/Uruguay;
    - Lençóis Maranhenses-Brasil (Figure 3);
    - Serra Interandina-Ecuador;
    - Galápagos-Equador;
    - Vilcabamba Valley-Peru;
    - Atacama Desert-Chile;
    - Chiloe Archipelago-Chile;
    - Maracaibo lake-Venezuela;
    - Bañados del Este-Uruguay;
    - Colombian vulcan's
    - Ecoregions;
    - Deforested areas in Amazonia-Brasil;
    - Atlantic forest-Brasil;
- Links to homepage and websites about remote sensing, satellite images and educational materials
- Globe 3D

Figure 2. General Information about South America-Terrain map

Figure 3. Lençóis Maranhenses Ecosystem

THE ATLAS DISSEMINATION ACTIVITIES:

In November 7th the Atlas was officially presented to the remote sensing professionals and educators in South America, during a ceremony in the National Institute for Space Research-INPE, São José dos Campos, São Paulo State, Brasil (Figure 4).

Figure 4. Atlas presentation in INPE main Auditorium in November 7th, 2005

In November 11th the Atlas was presented to remote sensing professionals and educators from Mercosul during the 5th Conference on Remote Sensing Education in Mercosul, that was held in the CONAE Space Center "Teófilo Tabanera", in Falda del Carmen, Cordoba Province, Argentina (Figure 5).

Figure 5. Atlas presentation in the 5th Conference on Remote Sensing Education in Mercosul

Since that the Atlas has been distributed, free, to grammar and a high school in South America, this dissemination is in partnership with INPE and the Education Committee of the Latin American Remote Sensing Society-SELPER and SELPER National Chapters.

In order to get an Atlas the schools have to fill a registration form, with some information about the institution, such as:

- Identification and full address;
- Information about the school status-public (county, state or national) or private
- Level: grammar or high school
- Which topics the school will use the Atlas-geography, science, environment, history, chemistry, physics, biology, others;

The school has to nominate a teacher focal point to be in touch with the Atlas project coordination. The project coordination will contact these focal points after latter in order to know additional information about the school and the way they are using the Atlas in classroom and to get their critics and suggestion about this educational material.

The BRADESCO, ATECH and VITAE Foundations have supported the Atlas. The BRADESCO Foundation supports 40 grammar and high schools in Brasil. The teachers and schools from this foundation will be the test areas for the Atlas. A first test was accomplished in 2005, as part of the Pilot Project "Validation of the Use of Digital Ecosystems Atlas of South America and Antarctic in High School", developed by Fernanda Viana Barbosa, geographer, during the 18th International Course on Remote Sensing and SIG, specialization level, held in partnership with INPE, Campus Brasil/ Regional Center for Space Science and Technology Education for Latin America and the Caribbean-CRECTEALC, the National Council for - CNPq and United Nations University-UNU. The Atlas was tested in two BRADESCO Foundation high schools and the results of this test were very successful.

During the test the teachers have accomplished some practical exercise, in classroom using the Atlas, and at the end the test two questions were answered students and teachers:

What you considered is the most interesting in the Atlas?

"... The wonderful, easy, fast and detailed approach about geographic topics..." (Marcel Vieira Pereira, E. E. M. E. P. J. A. Embaixador Assis Chateaubriand-Fundação Bradesco).

"... it is a program quite advanced program that makes easy the learning among other Atlas…." (César Carobrez, E. E. M. E. P. J. A. Embaixador Assis Chateaubriand-Fundação Bradesco).

"... I liked because it is easy to get in, it is easy to use. I liked the videos about the topics and the illustration in the text, with photos..." (Leandro Cerqueira Lemos, E. E. M. E. P. J. A. Embaixador Assis Chateaubriand-Fundação Bradesco).

"... The satellites despite of the complexity, was the topic I liked most....." (Felipe Otaviano Gonçalves, E. E. M. E. P. J. A. Embaixador Assis Chateaubriand-Fundação Bradesco).

"... The Atlas versatility..." (Thalita Tavares de Freitas, E. E. M. E. P. J. A. Jardim Conceição-Fundação Bradesco).

"... Hole the content is more then interesting..." (Laís de Souza Secundino, E. E. M. E. P. J. A. Jardim Conceição-Fundação Bradesco).

"... The images their applications, are approached in a very easy way..." (Geisa Priscila de L. Santos, E. E. M. E. P. J. A. Jardim Conceição-Fundação Bradesco).

"...The Atlas content visualization, and the interactive way was approached..." (Tiago de Lima Silva, E. E. M. E. P. J. A. Jardim Conceição-Fundação Bradesco).

"... The way the hole topics were approached..." (Nadya Nathaly Vicente da Silva, E. E. M. E. P. J. A. Jardim Conceição-Fundação Bradesco).

Your suggestions to improve the Atlas:

"... The Atlas is educational and different from other Atlas, because have satellite images......." (Josiane Barbosa Aliste, E. E. M. E. P. J. A. Embaixador Assis Chateaubriand-Fundação Bradesco).

"... The Atlas is excellent, any change would be only to have additional topics..." (Watusi F. dos Santos, E. E. M. E. P. J. A. Embaixador Assis Chateaubriand-Fundação Bradesco).

"... No suggestion, because the Atlas fit for the students interests..." (Priscila Soares Brandão, E. E. M. E. P. J. A. Jardim Conceição-Fundação Bradesco).

Up to now 342 educational institutions in Brasil, 30 in Argentina, 50 in Bolivia, 3 in Colombia and 1 in Uruguay have registered to get the Atlas. Concerning to the Brazilian institutions:

- 47% are from São Paulo State (the state where INPE and UNIVAP University are located);
- 10,2% are from Minas Gerais State (the reason of this amount is because a professor from University of Uberlandia; located in Uberlandia city-Mina Gerais State, has attended the XI Brazilian Remote Sensing Symposium where the Atlas was presented in an education technical session. This professor disseminated the Atlas to all grammar and high school in Uberlandia city)
- 7,60% are from Brasilia, the Federal District (The Brazilian Space Agency-AEB is located in Brasilia, and they have disseminated the Atlas through the AEB School Program);
- 6,7% are from Rio Grande do Sul State (the Atlas General Coordinator is developing educational activities in remote sensing area in this state);
- 4,67% are from Goiás state (the Atlas dissemination was through the XI Brazilian Remote Sensing Symposium that was held in April 2005 in Goiânia city);
- 3,80 are from Pernambuco state (a local newspaper published an article about the Atlas);

From the 342 schools:

- 48% are publics
- 36% are privates
- 17% did not answer the question;
- 35% are grammar schools
- 58% are high schools
- 5% are graduation courses

These educational institutions intend to use the Atlas as educational material in the following subjects:

- 73% in geography;
- 54% in science;
- 42% in environmental issues;
- 34% in history;
- 22% in physics;
- 17% in chemistry;
- 13% has answered others (cartography, topography, Spanish, tourism, mathematics, remote sensing, astronomy, climatology, Portuguese, geology, etc)
- 5% in biology;

Concerning to the foreign educational institutions:

- 32% are publics schools;
- 5,8% are county schools;
- 26,4% are state schools;
- 3% are national schools;
- 23,5% área grammar schools;
- 79,4% área high schools;
- 6% are universities;

These educational institutions intend to use the Atlas, as educational material in the following topics:

- 76,4% in geography,
- 44,1% in sciences;
- 23,5% in history;
- 12% in chemistry;
- 12% in physics;
- 38,2% in environment;
- 18% in others (technology, cartography, tourism)

The BRADESCO Foundation has disseminate this Atlas to all BRADESCO associated schools, that are located in 20 Brazilian states, and it is helping in the dissemination to other educational institutions in Osasco city, São Paulo State, where the Foundation is located.

At this moment the Atlas has been disseminating in Argentina, Bolivia, Chile, Colombia, Ecuador, French Guyana, Paraguay, Peru and Venezuela with the help of Atlas executive team members, SELPER Educational Committee members and the SELPER National Chapters. In each country it has been holding a one-day seminar to disseminate the Atlas and to teach the schoolteachers how to use it in classroom.

The National Commission of Space Activities-CONAE from Argentina is helping the Atlas dissemination in this country, through its educational program. In November 2005 the Atlas General Coordinator was invited by UNESCO and the Minister of Education from Colombia to take part in Space Education Workshops, designed for grammar and high schools teachers and students, in Barranquilla, Cali, Medellin and Bogotá cities, where the Atlas was presented. As a consequence the Minister of Education is helping in the Atlas dissemination in Colombia.

In Cochabamba, Bolivia, one member of the Atlas executive team is organizing one-day seminar for 50 schools in partnership with Lions Club. In Santiago city, Chile, another member is organizing, in partnership with Chilean Space Agency a one-day seminar for 40 schools. In Lima city, Peru, the SELPER National Chapter is organizing a seminar 60 schools. In Quito city, Ecuador, the SELPER Chapter in partnership with education authorities Peru, is organizing a seminar for 60 schools. In Montevideo city, to members of Atlas executive team, together with SELPER National Chapter is organizing a seminar to 70 schools.

INPE, together with local's authorities and universities is organizing similar seminars in many Brazilian states with emphasis in the cities where INPE regional centers are located Cuiabá-Central West region, Natal-Northeast region, Santa Maria-South region).

The VITAE Foundation has supported the CD ROM development and the first 2000 copies. The Brazilian Remote Sensing Symposium is supporting additional 1000 copies, and the Project coordinator has applied in the BOTICARIO Foundation in order to get the support for more 3,000 copies. The goal is to have 10,000 copies to distribute free to South American schools. In the beginning the Atlas was planned to be distributed only for grammar and high schools, but many coordinators and professors from graduation courses from geography, science and biology areas, responsible for the graduation of schoolteachers have ask for the Atlas. So, the project coordination has decided to give a free copy to these graduations courses as well.

E-LEARNING EXPERIENCES AND SUSTAINABILITY: A PILOTING OF DISTANCE M.SC. THESIS SUPERVISION AT ITC, THE NETHERLANDS

D. R. Paudyal [a]

[a] Survey Department, Minbhawan, Kathmandu, Nepal
paudyal05259@itc.nl

Commission VI, WG VI/4

KEY WORDS: e-Learning, Distance Education, ICT, Internet, Strategic Plan, SWOT

ABSTRACT:

In most of the developing countries the blackboard and chalks are quite common teaching materials to deliver the knowledge to the students. Students cannot think about virtual learning techniques. Teaching means teacher should be physically presented front of students with chalk and duster and delivered their lectures to the students. But now, the use of computer technology and ICT tools are making possible for virtual learning. The concept of distance learning is emerging in each of the academic institution. Within this distance learning environment, the mode of teaching as well as learning has been shifted from physical to virtual environment. The e-learning has become a part of education system in most of the renowned academic institutions. The physical presence is becoming less significant and the earth is becoming a global village due to web technology and development in ICT.

This paper commences with background and describes the evolution of distance education. It then, illustrates the development of e-learning activities in Geoinformatics subjects of various academic institutions. After that It elaborates the ITC's strategic plan 2005-2009 "From building capacity to the building on capacity" and its focus for distance learning mode. A piloting of distance M.Sc. Thesis supervision and author's own experience about it is explained in the next section which also describes how the piloting was structured and the students were supervised their thesis from Europe to South Asia. A summary of SWOT (Strengths, Weaknesses, Opportunities and Threats) of this distance thesis supervision has outlined. Finally, the paper provides some guidelines and recommendations for distance thesis supervision through ICT tools for the success of the study.

1. INTRODUCTION

1.1 Motivation

I was born in a remote village of Nepal and had started my primary education with local chalk and wooden slate (pati). I was extremely glad when my father gave me a bamboo pen and local ink for writing in a local paper (pahadi kagaj). We used kerosene oil (tuki) and some times special fire woods (diyalo) to study in night. In my childhood my dream was once in my life to go to Kathmandu to see King's village as it took more than 3-4 days to reach in capital city from my village in those times. But, now days, we are living in King's village (Kathmandu). In dream also, I was never thought that I would be graduated from European Institution. But, now, due to the advancement of technology and infrastructure, I stayed in my house and completed my M.Sc. Degree from ITC, The Netherlands with securing good marks. It's just like a miracle comparing to my childhood times. Now days, the physical presence is becoming less significant and the earth is becoming a global village due to web technology and development in ICT tools.

1.2 Background

In most of the developing countries, the blackboard and chalk are the common teaching materials in a classroom. Students cannot think about the virtual learning environment. Teaching means the teacher should be physically presented front of students with chalk and duster and delivered the lectures to the students. But now due to the advancement of technology, the mode of teaching has changed from physical learning to virtual learning environment. In most of the universities and colleges some sort of distance learning scheme has developed. In developed countries, the e-learning is becoming very popular under this distance learning model. Thus, the concept of a 'virtual university' has been internationally accepted as a viable educational model. Like other renowned academic institution, ITC has embraced these virtual academic developments and adopted different tools (ranging from blackboard learning system to distance thesis supervision) in its distance learning platform. It has changed the mode of teaching from traditional hierarchical educational structure to a more flexible, open, networked configuration educational structure. A team is actively involving in ITC to explore new innovative ideas to deliver and share its knowledge to it's partner institutions. ITC was getting request from the students to do research works in the subjects related to local circumstances from distance. As a piloting, ITC has provided the opportunity for two students from GIM having different background and infrastructure to do their M.Sc. thesis work from distance. The author himself was getting this opportunity. This paper explained the evolution of distance education and the author's own experience on it in details and provide some guidelines for success of distance thesis supervision.

1.3 Evolution of Distance Education

Taylor (1999) has developed a schema and divided the distance education phases into five models. According to his schema, the first model is 'correspondence model' based solely on print technology; the second model is the 'multimedia model' based on print, audio and video technologies; the third is the 'tele-learning model' based on the application of telecommunications technologies and the fourth, is the 'flexible learning model' based on on-line delivery via internet. The fifth model is "intelligent flexible learning model" that will enable a quantum leap in economies of scale and cost effectiveness beginning to emerge. It will use automated response systems that scan the text of incoming e-mail and respond intelligently without human intervention. The fourth model based on ICT is becoming very popular and on the practice. The development of interactive broadband communication technology is providing a new opportunity for sharing, learning and broadcasting academic events. Shea-Schultz and Fogarty (2003) explored that e-learning solutions could cater to the learner by facilitating the delivery of the right information and skills to the right people at the right time. It is now possible to study a variety of subjects, ranging from Business Management to Marine technology (www.cvu.strath.ac.uk, 2003), without ever entering a classroom. The Geo-Informatics subject is also not the exceptional in this regards. There are varieties of courses ranges from short course to full graduate level courses developed by universities in this Geoinformatics subject. The following paragraphs describe the various modules of Geoinformatics subject developed under this flexible learning model from different universities of this world.

1.4 E-learning in Geoinformatics

The e-learning is an innovation for teaching and learning through ICT tools. Nowadays it is becoming a very important node of distance education. The concept of distance learning is emerging in each of the academic institution. Within this distance learning environment, the mode of teaching as well as learning has been shifted from physical to virtual environment. The e-learning has become a part of education system in most of the renowned academic institutions. Like other subjects, the Geoinformatics subject is also touched with this innovation. Basically, in the e-learning procedure under Geoinformatics subject the knowledge has been delivered to its clients in two ways: individually and in a network. UNIGIS (www.unugis.net) and USDLA (www.usdla.org) are the examples of networking programme supported by an international network of qualified academia and professionals. There are various courses ranges from short courses to graduate level courses which are specially designed to satisfy the local needs under this scheme. Tutoring and assessment is done by mail, phone and email. Students use digital and online study materials. In most of the cases, the assessment is done through coursework. Likewise, individually also some universities are attempting to deliver their knowledge through e-learning. A literature review has done to understand how the e-learning scheme has been structured and implemented according to the user's need. The following section describes the mode of e-learning scheme of some academic institutions.

Leeds Metropolitan University

School of the Built Environment under Leeds Metropolitan University has four post graduate level courses that are delivered by distance learning scheme. They are Civil Engineering Commercial Management, Quantity Surveying Commercial Management, Building Surveying and Facilities Management. Students can complete the courses without attending the University. The course materials could deliver to the students through CD's/videos and web technology. They have developed unitized distance learning framework (Rodgers, D. and C. Garbett, 2003). This is an innovative approach to break subject theme into a small unit and deliver the knowledge.

Dublin Institute of technology

The Department of Geomatics, in the Faculty of the Built Environment in Dublin Institute of Technology (DIT), provides a four-year full-time degree course in Geomatics. Besides this, it also recruits the staffs of National Mapping Organization (Ordnance Survey of Irelands i.e. OSi) as a tool of Continuous Professional Development (OPD). An agreement was made between DIT and OSi to train a group of fifteen staff members of OSi and the theme of the course was 'Co-ordinate Reference Systems for Spatial Information'. The piloting was started in January 2002 and was successfully completed. The second pilot course was conducted to train twenty two personnel and completed in April 2003. They have used WebCT® e-learning platform (Martin, A., K. Mooney, et al., 2003). From this piloting this type of e-learning is found an appropriate and potentially effective medium for the CPD and skills upgrading of personnel of National Mapping Organization where the staffs are very busy to their professional works and scattered all over the country.

University of West Hungary

There are various distance learning courses designed at University of West Hungary, College of Geoinformatics to deliver the knowledge to the students. The NODE (Networked Open Distance Education) MINERVA project was one which was launched to deliver the knowledge to the individual learner through distributed networks. According to its clients desire a three-tiered system containing authors, educational gateways ('brokers') and points-of-learning has been envisaged, with the latter institutions serving as interfaces with individual learners (Markus, B., 2003).

University of the South Pacific

The University of the South Pacific (USP) is a truly regional university, serving twelve member nations (Cook Islands, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, and Vanuatu). USP is by its nature offering hundreds of its courses by distance and flexible learning (DFL) modes. The key to the USP Virtual Academy is USPNet which was established in 1974 to provide a communications system between main campus in Suva with the other USP campuses in Samoa and Vanuatu. Now the USPNet has modernised with VSAT telecommunications network and connected with USP member campuses. USPNet provides the opportunity to participate in audio tutorials, (conducted from any campus), communicate by e-mail with a lecturer/tutor or another student; access the World Wide Web, watch a live video broadcast of a lecture from any of the three campuses and take part in video conferences (and tutoring) with the Laucala Campus in Suva. Also, university administration has used this USPNet to communicate with other USP locations (Boydell, S. and B. Curley, 2005). The use of video conferencing saves time and money of university administration to meet the people.

University of Stuttgart (IAGB)

In university of Stuttgart, The e-learning project gimolus (GIS- und modellgestützte Lernmodule für umweltorientierte Studiengänge) is a learning module for GIS and modelling in environmental courses which is designed to create a internet based e-learning platform for GIS study. It was started at the Institute for Applications of Geodesy to Engineering (IAGB). Together with the Institute for Photogrammetry (IfP) at University Stuttgart, the basics of GIS for the environmental disciplines involved into the project were treated. The following environmental university institutes and groups were integrated into the project (Schwieger, V. and T. Kaufmann, 2005).

1. Institute for landscape-planning and ecology (ILPÖ) – University Stuttgart
2. Institute of Hydraulic Engineering – University Stuttgart
3. Landscape Ecology Working Group – University of Oldenburg
4. Field Station Fabrikschleichach - University of Würzburg

Besides it, the University Stuttgart is engaged in the field of e-learning. The projects launched by the rectorate are named as 100-online and self-study-online.

2. DISTANCE LEARNING AT ITC

2.1 ITC strategic plan for distance learning

Since its establishment (in 1950), ITC has accommodated dynamic behaviour to the development in its knowledge field, and developments in its knowledge policies according to the need of its client. It has revised its strategic plan every four years. The new strategic plan 2005-2009 is the continuation of previous strategic plan 2001-2004 with some modifications according to its clients need. The new strategic plan starts with the theme "building capacity to building on capacity" and partnership with qualified education and training organizations in ITC's target countries for the transfer of knowledge and expertise in geo-information science and earth observation. The leading theme is building partnerships that will deliver joint education programme building a network of partnership. The distance education is one of the approaches to deliver knowledge to its partner institution. Distance education powered by e-learning is one of the agenda of this strategic plan. This e-learning scheme was developed according to the need of its client student as they were unwilling to be away from their work and family and need European degree (ITC, 2005). Hence ITC has explored an innovative approach to deliver the knowledge and satisfying its clients utilizing modern ICT tools. ITC offers several short courses and components of degree courses through e-learning scheme under distance education. The following are the courses offered by ITC in 2005-2006 in its distance education mode.

2.2 Distance short courses

The following are the distance short courses a combination of part time self study and extensive online support by ITC staff. Several other courses are on being developed. Each short course is based on a module in one of ITC's degree or short courses (www.itc.nl). The duration of each of the course is equivalent to the duration of ITC's module courses.

1. Principles of Geographic Information Systems
2. Quality of Geospatial Data and Related Statistical Concepts
3. Environmental Impact Assessment
4. Spatial Decision Support Systems
5. Principles of Remote Sensing

2.3 MSc research at a distance

ITC offers the opportunity for non NFP fellowship MSc students who have studied the first twelve months of the MSc course at ITC's premises in Enschede, The Netherlands to undertake their research and write the thesis in their home country with supervision provided at a distance. Participants in the M.Sc courses will stay five months period in the home country with supervision provided at a distance and one month at ITC. This offer was granted to the participants after the piloting for distance supervision. To qualify for MSc research at a distance the participant should full fill the criteria/conditions set by ITC course management.

2.4 Other distance learning course at ITC

Master of Science course in Geographical Information Management and Applications (GIMA)

This two-year course is offered by ITC, Delft University of Technology, Utrecht University, and Wageningen University and Research Centre. The course is mainly distance learning in combination with one ten-day face-to-face workshop per semester in the Netherlands.

EuroSDR EduServ4

EduServ is the education service of European Spatial Data Research and the services are offered with strong input from ITC. It consists of the following four two-week distance eLearning courses.

1. Quality of Geospatial Data and the Related Statistical Concepts
2. Co-ordinate systems and transformations for spatial position
3. Positional Accuracy Improvement in GI databases
4. Methods for checking and improving DTMs

3. EXPERIENCE AND EVALUATION

3.1 Experience of Distance Thesis Supervision

Most of my senior level officers were graduated from ITC, so I have chosen ITC for my graduate degree. Initially, I was admitted for the Professional Master's (PM) Degree Programme in Geoinformation Management (GIM3) at ITC, the Netherlands through Netherlands Fellowship Programme (NFP). The PM Degree does not have research component. On the way of my study, my interest changed towards the research degree. One of the reasons to change my interest was the possibility of research degree to open the door for further study and I could enhance my research skills to solve various issues in my professional works. Hence I approached to Program Director (PD) M.C. (Kees) Bronsveld of GIM programme. He was agreed for my study extension to Master of Science Degree in Geoinformation Management (GIM2 Programme). But there was problem of funding for another six months more. Due to the new policy of NUFFIC, the fellowship could not be extended for longer period. Kees (PD) explored the way for my interest. After the discussion with ITC management team, he offered us distance thesis supervision scheme as a piloting for the same course. I and my friend A.S. Padmavaty from ISRO, India got the chance for our extension to GIM2 programme. Before awarding us the extension we got the consent for extension from PM to M.Sc degree from our home organisation. A contract document was signed after our research proposal was accepted by the Degree Assessment Board (DAB). It was a test case so no tuition fee was charged to us. We stayed 15 more days at ITC for the preparation. We got the financial support from ITC for our fieldworks and later travel cost too. In the agreement it was agreed that we have to work for average of 45 hours per week on the thesis. We made a time table for our six month period and approved from supervisors and before leaving ITC for thesis work.

In the contract document it was agreed that we have to send our progress report in every two weeks. We strictly follow the agreement. I met my supervisors through e-mail and chat (yahoo and msn) to discuss about research theme. If I sent an e-mail to my supervisors they would answer me within three days and the same was followed from my side too. The GIM secretary Laura was always online and she was the clearinghouse to bridge the contact with ITC personnel through internet. Theoretically, I spent one month period for field work and five month period for thesis work but in practice I was near the research area so I went to the research area whenever it was needed. The mid term presentation was done using telephone line. The presentation slides were already sent to the ITC. After presentation, I got feed back and valuable remarks from supervisors and professors.

Photograph 1: In M.Sc. Day Mr. Paudyal is delivering his remote presentation from Nepal to his audience at ITC.

I also got the chance for MSc day presentation as I was qualified as one of the four students of GIM for that presentation. The MSc day is organised in the context of best M.Sc thesis award every year (Teuben, J., 2005). Those students who have presented their work at M.Sc day would only be qualified for best thesis award at ITC. The M.Sc day was memorable and exciting event for me as I was delivering my presentation from Nepal and my audiences were in the auditorium hall of ITC, The Netherlands. The presentation was made live broadcasting through internet. Two telephone lines were used for presentation; one for presentation and another for internet connection. A web camera was connected and MSN Messenger was used for chatting. After my presentation, whole day I observed other presentation through internet. In this way, I engaged myself fully for each and every activities of ITC as an ITC regular student from distance. I finished my research work on the scheduled time and submitted through e-mail attachment. I returned to ITC to defend thesis and completed successfully my M.Sc degree with distinction. The pilot was very successful, both from ITC perspective and student perspective. ITC was very satisfied with the level of the produced theses. The possibility to do the thesis at a distance is now a regular product of ITC.

Photograph 2: Mr. Paudyal is receiving his M.Sc. Degree from his supervisor Ir. Water de Vries

Photograph 3: Mr. Paudyal is enjoying with Prof. Dr. Martien Molenaar, Rector (right) and Prof. Dr. Menno-Jan Kraak, chair of DAB (left) after graduation.

3.2 Evaluation of distance thesis supervision

For evaluation of this distance thesis supervision, SWOT method is used. The following paragraphs give the strengths, weaknesses, opportunities and threats of the distance thesis supervision programme. The views are purely from the author's own experience and report from ITC news (ten Dam, I., 2005).

Strengths of distance thesis supervision

- Not being far from family members (not the problem of being homesick) and more concentration on the research work
- Fewer funds necessary for study (living, insurance, food etc.)
- Not wastage of time for cooking, shopping, washing etc
- Not wastage of time for fieldwork preparation and returning from fieldwork
- Good food and weather for research works
- Being near to the research area (local circumstances) the research output could be tested with the local experts whenever it is needed
- Chances of very good research output from study
- Chances of research output implementation in home organisation to solve the problem

Weaknesses of distance thesis supervision

- Less access of library and resources
- For solving the technical problems the transaction cost will be very high
- Disturbance from family members and friends
- Feeling of isolation for the study
- Cannot benchmark the progress
- Cannot share the ideas with fellow students
- More time should be devoted than at university
- Less chances to discuss/meet with relevant professors
- Not the chances of attending research seminars and less aware for research activities

Opportunities of distance thesis supervision

- Advancement of ICT and GIS (development of cable internet and optical fibre) and the internet cost is affordable
- The Bologna declaration for higher education in Europe (standardization and networking)
- Powerful virtual digital library in web (like OICRF, ITC library, etc.)
- Dynamic supervisors at university (prefer digital learning)
- Skilled managerial manpower and ICT people in university
- Motivation of students towards research degree
- Could access intranet and web mail from distance
- Recognition of e-learning in strategic plan
- The concept of virtual learning is emerging
- Local supervisors/experts are interested to guide and available
- Availability of necessary HW/SW and other research materials in the local market at affordable cost
- The home organisations are ready to support the candidate and local university are ready for the partnership
- Provision of ftp and local website for big data sharing from distance
- Availability of funds (travel fund) from home organisation for data collection

Threats of distance thesis supervision

- Deficiency of personnel (at university) who can understand the local circumstances of research area
- Lack of defined research methodology for distance thesis supervision (probably the action research methodology may be more relevant for distance thesis supervision)
- Load shading and limited electric back
- Limited internet connection
- For solving the technical problem, the transaction cost is very high
- Students may not aware about the research topics when they have selected it
- Lack of recognition of degree awarded from distance education (local people are not much aware about virtual learning)
- Inconvenient data access from distance due to security/firewall policy
- Work load for female candidate both from domestic as well as office side (in South Asia)

4. GUIDELINES AND RECOMMENDATIONS

From my own experience and evaluation through SWOT, the following guidelines and recommendations are suggested for the sustainability of distance M.Sc thesis supervision.

1. The student should have very good academic performance in the research related modules and his research proposal should have approved by the Degree Assessment Board (DAB)
2. The written and spoken English language of the student should be very good
3. The student should have sufficient work experience and the research topics should be related to his professional work; finalized consultation with his home organization
4. The Organization should be ready to provide access of necessary data resources at their local office and if necessary to provide the full leave or 50% time to work for his thesis at their office.
5. The participants should be very serious and has a proven ability to work independently. Also he should have the value for his study.
6. The communication infrastructure of students' home country should be very good.
7. The institution should have made available the local website or blackboard environment to share the data and literatures to the student. There should be the provision of easily intranet access from distance.
8. Video-conferencing would be more effective for remote presentation and discussion. It is affordable in local market.
9. Access of library materials should be made from distance and provision for long term loan of library materials should be made.

10. There is a need to make both of supervisors equally responsible/ devoted (The contribution should be made the same) to support the student.
11. It takes more time to discuss through chatting. More time should be devoted by the supervisors.
12. The supervisor should have the knowledge of local situation of home country of the participant.
13. There should be a one person always ready to make available to bridge students with Program Director, Supervisors and other staffs.
14. The student should allow spending the first one month of the thesis period at the Institution for preparation and the last one month for compilation of documents and come back defend the thesis at the institute. There is a need to test whether the candidate can defence their thesis from distance.
15. There is a need to develop chatting language (code and catchy words) for chatting. It will shave the time at the time of chatting.
16. The student should aware about the progress and problems of regular fellow students.
17. It is necessary to explore the appropriate research methodology for distance thesis supervision (the topics not much technical side may be action research is appropriate)
18. Some cost should be shared by the student such that he can understand the value of his study.
19. The provision of local supervisor is good; good understanding between local supervisor, main supervisors and student. Local supervisor should have qualification, in-depth knowledge and research interest.
20. Still there is a need to test this scheme in another geographical location like Africa.

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STORYTELLING APPROACH FOR VIDEO DEMONSTRATION OF VRS SERVICE

J. Järvinen [a,*] , J. Puupponen [b], T. Valtari [b], A. Ropponen [b] and R. Järvinen [c]

[a] Dept. of Surveying, Helsinki University of Technology, 02015 Espoo, FINLAND – jaakko.jarvinen@iki.fi
[b] Dept. of Surveying, Helsinki University of Technology, 02015 Espoo, FINLAND – (jyrki.puupponen, antti.ropponen, tommi.valtari)@tkk.fi
[c] Centre for Translation and Interpreting, University of Turku, 20014 Turku, FINLAND – rikyja@utu.fi

Commission VI

KEY WORDS: Video, Visualization, Teaching, Method, RTK, VRS, DVD

ABSTRACT:

This paper will introduce to you the process and purpose of making demonstration video for promoting the VRS (Virtual Reference Station) service in Finland area. VRS service provides possibility to make high-accuracy, RTK (Real-Time Kinematic) GPS positioning, without setting up a reference station to known control point first. In Finland service is provided by Geotrim Ltd. and it is based on Trimble's VRS™ system. Since VRS service is still fairly new system in Finland, it needs to be promoted among the surveyor students in different levels and the current users of normal RTK applications. Therefore we students decided to prepare a demonstration video in cooperation with Geotrim Ltd., which clearly describes the major advantages and the potential of this new VRS system. Starting point for this video is to demonstrate how easy and fast this new VRS service is compared to the traditional methods of RTK GPS positioning.

The project started in the beginning of August 2005, when the idea for the demonstration video emerged. The first phase was to establish the idea in storytelling form, formulate manuscript for the story, make a production plan and find suitable actors for it. All the material was filmed during four days in the beginning of September, by using Sony DRS-PD150P MiniDV -camera. Editing and postproduction took place in three different phases during the four last months of year 2005.

The final version of the demonstration video was released in the beginning of year 2006. It will be now used for various educational purposes in different educational levels and among the users of the traditional RTK GPS measurements. Some smaller parts of this video will used for promoting our surveying profession in other contexts as well. All the makers of this video are current students of the Department of Surveying in TKK (Helsinki University of Technology).

1. INTRODUCTION

VRS (Virtual Reference Station) service is fairly new system in Finland. As a new method, service and its' capabilities need to be promoted to potential user groups. For instance surveyor students and current users of RTK applications form important groups of potential users of VRS service in future. Therefore we decided to prepare a demonstration video of VRS service in cooperation with Geotrim Ltd. to increase general awareness of the service in Finland area.

Instead of using direct marketing methods we decided to use longer storytelling approach in our demonstration video. Basically there were two reasons for that. First of all we thought it would be more effective to show the viewers concrete examples of how much easier things can be done by using VRS service. Instead of just listing technical details and accuracies of the system we decided to concentrate more on efficiency of this new system and tried to do it all in humorous way. After all, this was supposed to be a marketing video, trying to arouse interest in using product in Finland area.

On the other hand we thought that this kind of filming project might be good change to produce suitable video material for other purposes as well. The same material can be used for educative purposes as well, when demonstrating RTK and VRS based measurements for students in various education levels. Nowadays it is not so self evident for people that what land surveyors are doing in society. Therefore it's also good to have some practical examples of basic surveying activities, when introducing our profession to others. In the long run this kind of documentation can also work as a picture of surveying methods of the current time.

2. DESCRIPTION OF VRS SERVICE

VRS is a network RTK (Real Time Kinematic) system, developed by Trimble Ltd. In normal precise GPS measurements you need at least two receivers. By using VRS service you can make same measurements with only one receiver, and still receive same accuracy. VRS system consists of several GPS-network stations, which are located about 50 to 100 kilometres from each other and they collect GPS-data continuously. Each of stations sends received GPS-data to a main computer once a second. The main computer calculates then corrections for various errors caused by for instance atmosphere, ephemeris and multipath reflections. Then

* corresponding author

combined model for all these errors will be created, (Landau et al, 2002).

2.1 Surveying with VRS-RTK method

Surveyor must have RTK-GPS-receiver, modem (internal or external) and license to be able to use VRS-RTK method. When receiver has been turned on, it takes a while until receiver has found a sufficient number of satellites. After this user takes connection to the VRS-server for example via internet using GPRS (General Packet Radio Service).

VRS-server gets approximate location from RTK-receiver and calculates virtual base station nearby surveyor. Then server begins to send virtual GPS-data to RTK-receiver and surveyor can start measurements, like there would be a real base station nearby. Therefore surveying is just same to traditional RTK-measurement except you do not have to put up your own base station at first (Landau et al, 2002).

2.2 VRS service in Finland

In Finland VRS service is provided by Geotrim Ltd. and it is based on Trimble's VRS™ system. At the present moment service consists of some 90 base stations in Finland area and it is not dependent on users' location or a specific type of equipment.

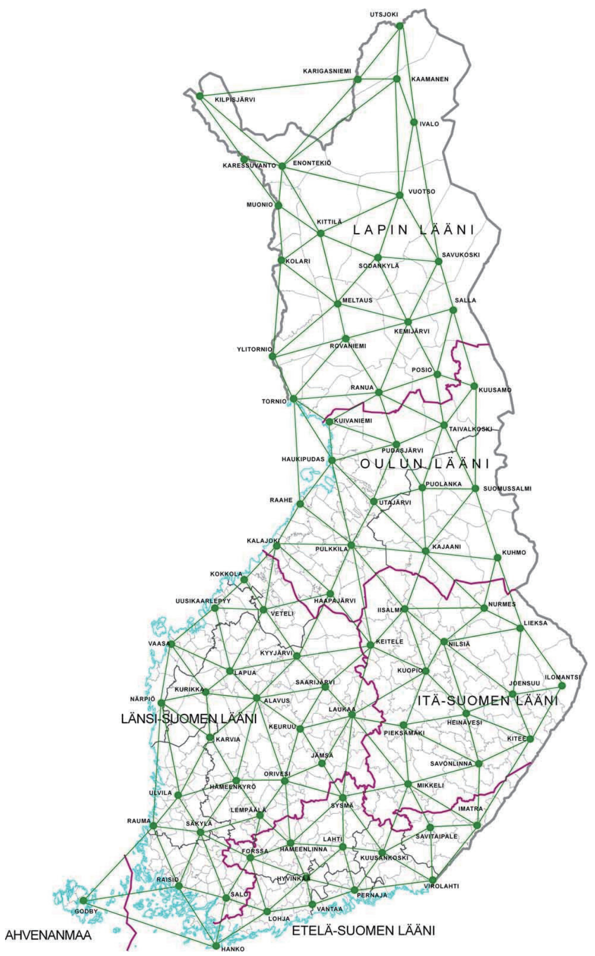

Figure 1. VRS-GPS Network stations in Finland, from 50 to 100 kilometres from each other (www.gpsnet.fi)

2.3 Accuracy of VRS-RTK method

Finnish Geodetic Institute researched accuracy and usability of VRS-RTK method in Finland. They found out that VRS-RTK measurements can be done in centimetre level if certain factors are taken into account. In same research they found out that the choice of equipment is irrelevant, (Häkli, 2004).

VRS service can also be used in DGPS measuring. DGPS operates in same way than VRS-RTK-System. Surveyor uses modem to lock in service and gets correction data from server. DGPS-corrections can be also calculated afterwards by using internet service. Accuracy of VRS-DGPS is in one meter level (Häkli, 2004).

National Land Survey of Finland, some of the municipalities and private companies have started to use VRS-service in RTK measurements in Finland.

3. STORYTELLING APPROACH AND FILMING ARRANGEMENTS

In this chapter we will go through preparations before and during filming process.

3.1 Aim survey

The whole production started with aim survey. From the very beginning the basic idea of the demonstration was quite obvious – to make comparison between VRS service and traditional way of making same measurements with RTK GPS positioning. Before starting preparations and actual action phase it was important to first prepare a written production agreement including detailed information of budget, schedule and properties as well as extent on the end product.

3.2 Manuscript

When we had agreed the main contents and storyline of the video with Geotrim Ltd., it was time to write more detailed manuscript for it. Storyline consists of three parts: 1) preparations, 2) fieldwork and 3) processing of measurements. Throughout the video we tried to bring out the better productivity and cost efficiency of the VRS system. We also tried to include quite much humour in our story to make it catching.

3.3 Casting of the characters

Casting is always quite important part, when trying to make film believable and make it follow desired atmosphere. This time we had two main characters in our story and the actors could be found from our fellow surveyor students from TKK (Helsinki University of Technology).

3.4 Production planning

After production agreement, manuscript and casting were done we still needed to a make production plan before we could carry on towards actual filming process. In practice this production planning included detailed lists of what, where and when we should do? Which equipments we should have with us, how to handle logistics? And how to manage everything within planned budget?

We also prepared some backup plans, if something would have gone wrong during shooting. Luckily everything went just fine. For example weather happened to be just fine during whole filming season.

3.5 Filming arrangements

Filming session took place in the beginning of the September 2005, which lasted four days. Most of that time we spent at summer cottage and surrounding areas in place called Lohjansaari. This place is located in southern part of Finland, about 70 kilometres west from Helsinki. We also spent one filming day in Vuosaari harbour area in Helsinki, (http://www.vuosaarensatama.fi).

We used Sony DRS-PD150P MiniDV video camera, which turned out to be very suitable for this kind of production. In some sequences we had to use additional external microphone and PD150P camera model made it possible to record two soundtracks simultaneously when needed. The actual microphone of the camera proved out to be very effective by itself. Video camera worked well in twilight circumstances as well.

Some of the takes needed to be recorded up to ten times, but most of them were done with 2-3 takes. Altogether we filmed about six hours of raw material, from which we finally edited 15 minutes long video in postproduction phase.

4. POSTPRODUCTION OF THE VIDEO

When all the material was filmed, it was time to move to postproduction phase, which formed definitely the largest part of the project. When filming was carried out mainly during four days, the postproduction phase took almost four months. Of course we did not work as intensively during these following months, but as conclusion we might say that postproduction took almost 80 percent of the whole time spent on this project, when preparation and filming phases took 10 percent both.

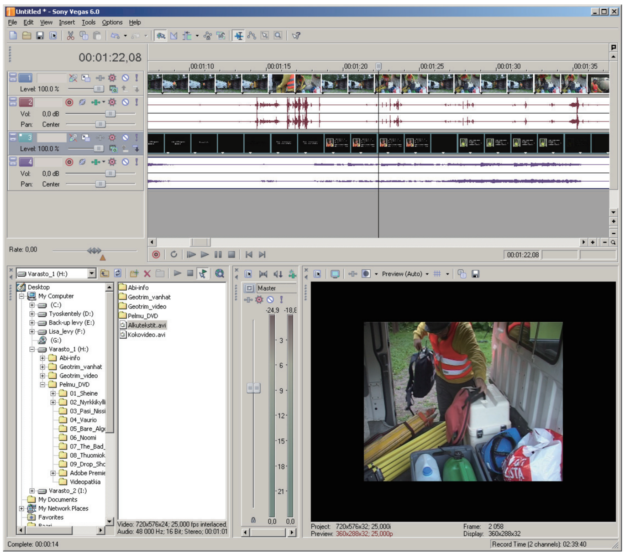

Figure 2. Sony Vegas 6.0 was used for video editing

Most of the postproduction work consisted naturally of actual film editing. First part of the editing was choosing of the best takes from several alternatives. Then these takes were first combined into individual sequences and further into entire story following manuscript. Editing was done with Sony Vegas 6.0 software, which provided good selection of different editing tools, transitions, colour adjustment tools and things like that needed for this kind of project, figure 2.

Postproduction was divided into three different parts to secure that we would stay in the schedule.

4.1 Primary production control

This phase followed right after the filming and in it we prepared some edited example scenes of the video for the representatives of the Geotrim Ltd. This way they could get a better idea of how this demonstration video would look like when it would be ready. It was also a control for the quality of the video and how we had succeed with filming part. Representatives of the company were satisfied with the results. They gave us some comments and suggestions and together agreed to continue editing to next phase.

4.2 Editing whole story

After the primary control, where we had only a few of selected and edited scenes of the film ready, we now concentrated in building the whole story. Still we did not finalize all the scenes into final shape and length, but tried to at first assemble all the separate sequence together. This way we hoped to be able to create more continuous and harmonious atmosphere for the whole video.

This seemed to be a good decision, as we shortly noticed that some sequences worked just fine as separate pieces, but they did not quite fit into the whole project as such. We made some modifications inside individual sequences and also rearranged the order of sequences defined in original manuscript. But altogether we did not have to make any big changes for original plans during the editing process.

Once again we presented our accomplishments to personnel of Geotrim Ltd.. They gave us some change suggestions and we continued into the final part of the postproduction.

4.3 Final editing, soundtrack design and DVD creation

In the final editing phase we did the last adjustments for the individual sequences and decided the definitive structure of the story. In many cases this meant simplifying things even further and removing unnecessary repetition. Some texts were also added to clarify the actions of the characters and to give more technical information of the VRS service.

Soundtrack is also very important part of the movie and it gives a lot of bearing, structure and character for it. Therefore we paid extra attention for the music and sound effects of our film. Music is self composed by using Propellerhead's Reason 3.0 software, controlled by keyboard via midi interface, figure 3.

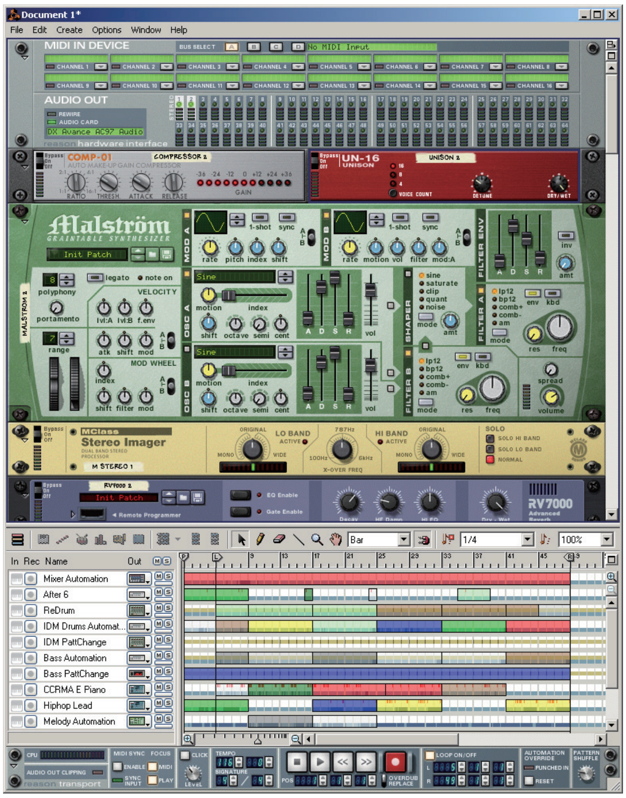

Figure 3. Reason 3.0 was used for composing soundtrack

Some of the bird singing effects were bought from the archive of the YLE (Finland's National Broadcasting Company). When video and soundtrack were combined together and mastered with Sony Vegas 6.0, it was time to convert the whole product into DVD format. This operation was done Sony Architect 3 software, figure 4.

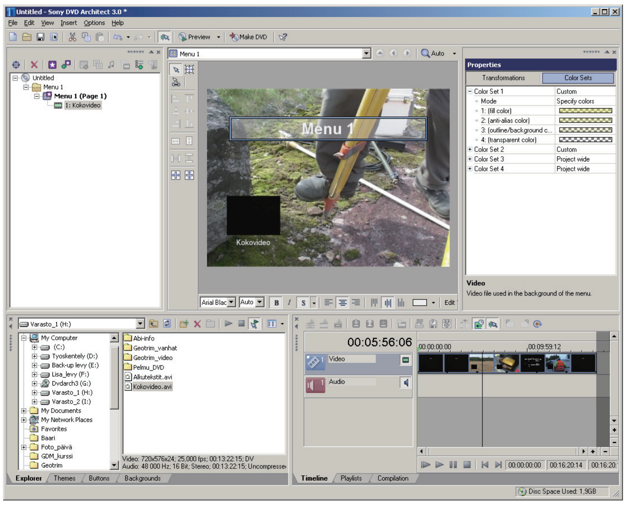

Figure 4. DVD presentation was compiled with Sony Architect 3 software

Also the cover material was designed for the DVD. This work was done with Adobe Illustrator.

5. CONCLUSIONS

In this paper we have described the main phases of making a demonstration video of VRS service. Hopefully we have managed to give you sufficient description of the system itself, used methods as well as equipment and software used in this project. Of course the best way to determine how well we have succeed with the project is to watch to our demonstration video. And then consider if you can understand the essential facts and advantages of using VRS service from it.

Because the original language of the demonstration video is Finnish, we had to prepare subtitles in English for international version of the video as well. This translation work was carried out by translator student from University of Turku.

After all this has been a great opportunity for us students to approach our profession by using quite uncommon method. This project has especially taught us good project planning and management. As well as working in cooperation with various associates. It will be interesting to see what kind of reactions our video will bring out among the representatives of different cultures.

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JICA NET Distance Education on Remote Sensing and GIS for Developing Countries

Shunji Murai* and Hideki Murayama**

* Professor Emeritus, University of Tokyo; sh1939murai@nift5y.com

4-21-9 Mejirodai, Hachioji, Tokyo 193-0833, Japan, Tel and Fax: 0426-63-0858

** Japan International Cooperation Agency (JICA), Tokyo International Center; Murayama.Hideki@jica.go.jp

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Related topics: WG VI/3

ABSTRACT

Japan International Cooperation Agency (JICA) has initiated JICA NET Distance Education on remote sensing (RS) and GIS for developing countries since 2004 in cooperation with Japan Society of Photogrammetry and Remote Sensing (JSPRS). The teaching contents were prepared by the project team of JSPRS which are consisted of 12 modules each of remote sensing and GIS.

JICA NET Distance Education has been implemented five times since 2004 as follows.

1st Round: October-December, 2004: Thailand, Malaysia and Turkey

2nd Round: January-March, 2005: Vietnam, Philippines and Laos

3rd Round: May-July, 2005: Kenya, Sri Lanka and Thailand

4th Round: October-December, 2005: Jordan, Turkey, Vietnam and Philippines

5th Round: January-March, 2006: Malaysia, Cambodia and Laos

Three more rounds are scheduled up to the end of March 2007.

A module of the distance education is composed of 30 minutes lecture presented with power point images with video and voice, 30 minutes video conference for question and answer (Q&A) session. Three modules will be provided in a session of three hours and half. On the fourth day of each RS and GIS course, an examination is implemented in cooperation with a site facilitator in each country.

So far, the JICA sponsored distance education is successful in terms of systematic education to governmental staff in developing countries who are working in the field of remote sensing and GIS with a focus of better management of natural resources and environment.

INTRODUCTION

JICA initiated RS course once a year since 1978FY with full sponsorship to invite 10-15 trainees per year from developing countries. JICA expanded to mapping & surveying, hydrographic survey, GIS etc. However JICA has changed the policy to introduce partially e-learning system in 2004 to improve the cost-efficiency. The reason is that the cost to invite a person from a developing country used to be 10,000 US dollars per month in average.

JICA plans to expand JICA NET, a telephone-line based communication system to about 30 developing countries to enable TV conferences between Japan and developing countries. They include Indonesia, Cambodia, Thailand, Philippines, Vietnam, Malaysia, Laos, China, Sri Lanka, Pakistan, Bangladesh, Turkey, Jordan, Palestine, Kenya, Argentine etc.

The objectives of JICA Distance Education are;

1) To supplement or replace "Face to Face" training courses which had been adopted by JICA in the past.
2) To increase cost performance with respect to number of trainees, high quality lecture materials and lecturers.
3) To promote advanced education using IT.
4) To support capacity building in developing countries.

JICA contracted with Japan Society of Photogrammetry and Remote Sensing (JSPRS) in 2003 that the fundamental frame work should be proposed by Technical Committee on Strategic Plan for JICA NET Distance Education under the chairmanship of Prof. Shunji Murai on remote sensing and GIS including the mission and goals, modules and contents, teaching methods etc. In 2003 FY, JSPRS prepared six CDs in total with 3 CDs for RS and another 3 CDs for GIS respectively including power point teaching materials with video and voice and English text for explanation.

JICA started JICA NET Distance Education from 2004 FY in cooperation with JSPRS, JICA Offices in developing countries and a site facilitator representing from each developing country. Until now, five rounds have been implemented and the sixth round is being executed.

PROBLEMS OF CONVENTIONAL JICA TRAINING COURSES

The conventional "face to face" teaching style in a class would be the best if the teacher and the teaching materials were perfect. But this condition will be difficult to acquire in many cases.

The following problems are recognized by the Technical Committee.

1) It is too expensive for JICA to continue to invite trainees from developing countries to Japan. The cost as mentioned before will be about

10,000 US Dollars per person per month, which makes about 200,000 US Dollars if JICA invites 10 trainees for two month course.

2) There will be a limitation in term of the number of trainees; say 10 to 15 trainees per year for a course.
3) As there is also a limitation that JICA can find Japanese resource persons who can speak English fluently, some instructors prepared poor teaching materials without the aid of IT, which resulted in low quality lectures without inspection.

In order to overcome those problems, JSPRS recommended JICA to prepare high quality teaching materials and select eminent lecturers or resource persons, who can speak English well.

GOALS OF JICA DISTANCE EDUCATION ON RS AND GIS

Realizing the requirements of developing countries particularly in Asia, JICA and JSPRS agreed to set up the following two goals.

1) To promote capacity building for human resource development to support sustainable development of natural resources and environment using RS & GIS.
2) To provide self learning materials through e-learning to upgrade the capability of applicability.

The main target of trainees will be governmental staffs, who are operating RS and/or GIS on daily base or are going to introduce RS and GIS in their technical projects. Teaching faculty and researchers of universities will be also accepted as trainees.

BASIC DESIGN OF A COURSE

1) Power Point materials: 25-35 slides per module for 11 modules in total. The 12th module is a special module on application of RS or GIS which is composed of 20 applications respectively. Each module except the 12th module will take about 30 minutes lecture with voice and video. The lecture will be delivered at each site using CD and LED projector. The text of explanation in English is distributed to each participant.
2) After watching the power point materials with voice and video, about 30 minutes will be given to Q&A session through TV conference for three or four developing countries. A resource person should be responsible for answering questions on site. E-mail services will be also provided in case when there are some more questions which are not accepted at TV conference due to time limitation.
3) The contents of Q&A session are recorded in writing materials and distributed to the participants afterward. Q&A session will be supported by a facilitator at each

site, whose knowledge will be high enough to bridge between the resource person and participants.

4) A course on a day will be three hours and half which accommodate three modules including Q&A sessions. In consideration of time difference between Japan and a developing county, the time difference of six hours in maximum will be the limitation to accept the JICA NET Distance Education. Those limited countries include Kenya, Jordan, Turkey etc.
5) 12 modules each for RS and GIS can be managed for four half days including examination on the fourth day.
6) Those who attended 75 % and more the lectures and passed examination with more than 60% completion will be conferred Certificate of Successful Completion in the name of JICA and JSPRS.
7) Three or four developing countries are selected under the condition that JICA local office is requested by the developing country and a facilitator can be assigned who will call for participants and serve as an assistant through all courses.
8) The maximum number of each country will be less than 40.

OUTLINE OF RS and GIS COURSE

RS Course:

Module 1: Fundamentals of RS
Module 2: Remote sensors
Module 3: Platforms for RS
Module 4: Microwave RS
Module 5: Data to be used in RS
Module 6: Image interpretation
Module 7: Image processing system
Module 8: Image processing (1)
Module 9: Image processing (2)
Module 10: Image processing (3)
Module 11: High Resolution Satellite Imagery (HRSI)
Module 12: Applications of RS (20 applications)

GIS Course

Module 1: Fundamentals of GIS
Module 2: Data model and structure
Module 3: Input of geospatial data
Module 4: Spatial Database
Module 5: Required hardware & software
Module 6: Plan for installation
Module 7: Spatial analysis
Module 8: Coordinate transformation
Module 9: Interpolation techniques
Module 10: DTM
Module 11: Output of GIS products
Module 12: Applications of GIS (20 applications)

A full course of RS and GIS, which are given once a week are as follows.

1st Day: Module No. 1, 2 and 3 of RS
2nd Day: Module No. 4, 5 and 6 of RS

3rd Day: Module No. 7, 8 and 9 of RS
4th Day: Module No. 10 and 11 of RS, and examination for RS
5th Day: Module No. 1, 2 and 3 of GIS
6th Day: Module No. 4, 5 and 6 of GIS
7th Day: Module No. 7, 8 and 9 of GIS
8th Day: Module No. 10 and 11 of GIS and examination for GIS
9th Day: Applications of RS and GIS

COURSE FOR APPLICATIONS OF RS AND GIS

The application module has been added since 2005 FY. This module was designed without a pressure of examination.

The objectives of application module are as follows.

1) To follow up those courses on theories and techniques from Module No. 1 to No. 11,
2) To introduce a variety of examples of typical and interesting applications in remote sensing and GIS for better management of environment and natural resources,
3) To demonstrate how remote sensing and GIS have been successfully used in the actual projects as well as research and development, and
4) To make decision makers, managers, scientists and graduate students understand how remote sensing and GIS can be applied with success.

The list of applications for RS and GIS is shown below.

RS Applications

1. Land Cover Map based on Satellite Imagery
2. Countrywide Land Cover Mapping
3. Monitoring of Urban Growth in Hanoi
4. Urban Change Study in Mongol
5. Updating Forest Map
6. Height Measurement of Trees by Lidar Data
7. Flood Damage Map in Bangladesh
8. Flood Damage Mapping for Rice Fields
9. Monitoring of Water Quality
10. Monitoring Shrimp Farming
11. Application to Fishery
12. Topographic Mapping from IKONOS Stereo Imagery
13. Automated Extraction of Roads
14. 3D Measurement of Volcanic Crater
15. Monitoring Earthquake Damage
16. Earthquake Damage Detection using HRSI
17. Monitoring Rice Growth by SAR
18. Global Mapping
19. Assessment of Desertification in Arid Area
20. Image Mapping System using Kite Balloon

GIS Applications

1. Suitable Land Selection for Agricultural Development
2. Optimum Vehicle Routing
3. Real Time GIS Data Capturing

4. Environmental Study with GPS, Digital Camera and GIS
5. Flood Hazard Map
6. Flood Free Route Location
7. Flood Simulation with Lidar Data
8. Shelter Suitability Analysis
9. GIS Database for Management of Irrigation Facilities
10. Drought Risk Assessment
11. Height Measurement of Buildings with Lidar Data
12. Contour Mapping with Lidar Data
13. 3D City Model with IKONOS and Lidar Data
14. Superposition of Historical Maps onto Present Map
15. Visibility Analysis of Mt. Fuji
16. Crime Mapping and Analysis
17. Disaster Management System for City Gas Network
18. GIS Map for 1995 Kobe Earthquake Damage Assessment
19. Time-space Mapping
20. Scheduling for Day Care Service

IMPLEMENTATION

The following five rounds were implemented since October 2004 until now.

1st Round: October to December, 2004 for Malaysia, Thailand and Turkey
The total participants: 68 participants for RS and 64 for GIS
The ratio of successful completion for RS: 50/68=75%
The ratio of successful completion for GIS: 55/64=88%

2nd Round: January to March, 2005 for Vietnam, Philippines and Laos
The total participants: 77 participants for RS and 79 for GIS
The ratio of successful completion for RS: 58/77=65%
The ratio of successful completion for GIS: 67/79=85%

3rd Round: May to July, 2005 for Kenya, Sri Lanka and Thailand
The total participants: 71 participants for RS and 77 for GIS
The ratio of successful completion for RS: 57/71=80%
The ratio of successful completion for GIS: 75/77=95%

4th Round: October to December, 2005 for Jordan, Turkey, Vietnam and Philippines
The total participants: 92 participants for RS and 91 for GIS
The ratio of successful completion for RS: 78/92=85%
The ratio of successful completion for GIS: 89/91=98%

5th Round: January to March, 2006 for Malaysia, Cambodia and Laos
The total participants: 55 participants for RS and 46 for GIS
The ratio of successful completion for RS: 26/55=47%
The ratio of successful completion for GIS: 36/46=78%

Figure 1 Class rooms shown in TV screen

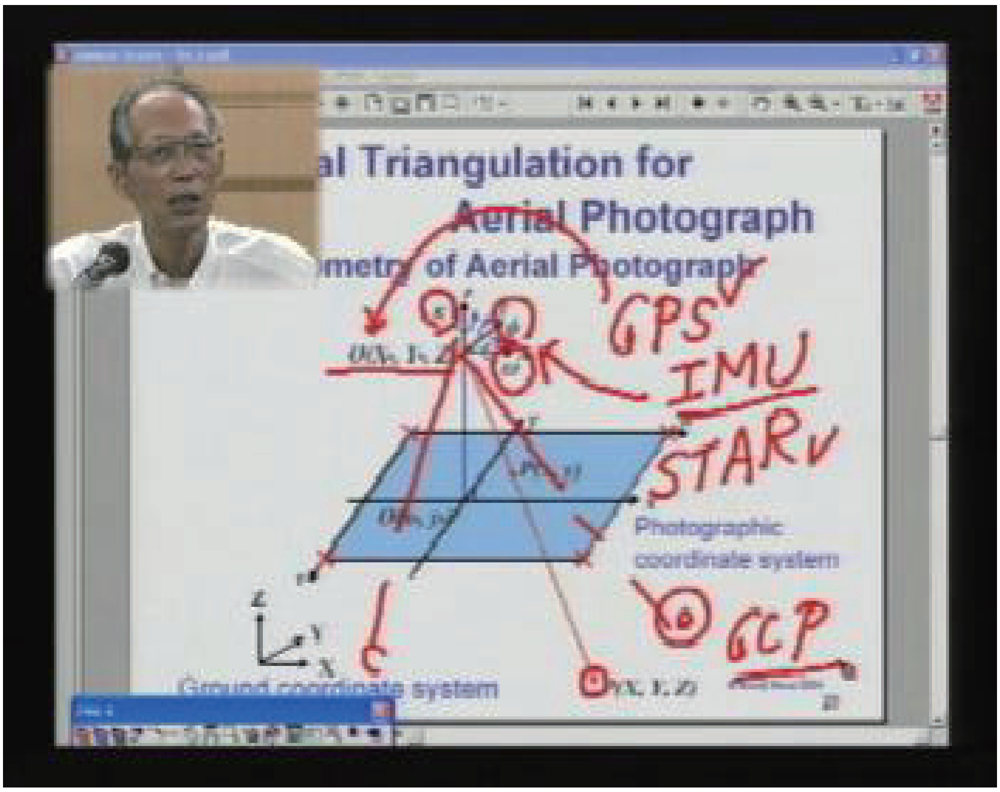

Figure 2 Answering for a question using touch panel

The lecturer of the above courses was Prof. Shunji Murai, who answered more than 400 questions for RS and 300 questions for GIS in total.

ADVANTAGES OF JICA NET DISTANCE EDUCATION

According to the questionnaires answered by participants, the following advantages are recognized.

1) It will be possible for beginners to study RS and GIS systematically.
2) Many participants from different organizations and different countries can share knowledge and experience through the distance education. Particularly TV conference was appreciated by participants for the interactive communication between the lecturer and participants in cooperation of facilitator. Figure 1 shows a big TV screen which showed class rooms of four countries.
3) The record of Q&A session in written form was evaluated very useful to understand many parts and items which are not mentioned in the lectures and the text.
4) The examination with the submission of certificate for successful completion had become incentive to concentrate into the lecture and Q&A session.
5) Those participants can repeat self-learning with given CDs at any time and anywhere.
6) E-mail service for extra Q&A session after ordinary session was sometimes useful for those participants to make special questions to the lecturer.
7) IT technology such as touch panel can be applied as shown in Figure 2.

COCLUSIONS

1) JICA NET Distance Education contributed to developing countries in terms of capacity building of remote sensing scientists, technicians, engineers and/or managers who are engaged in governmental projects and university lecture and research.
2) JICA NET Distance Education proved successful with respect to the cost effectiveness as compared with the conventional “face to face education”. The number of trainees in the distance education will reach about 200 for three courses in a year, while the conventional training just 10 to 15. Until now since 2004, more than 400 trainees have completed the Distance Education with less than 20 times expenses..
3) The interactive TV conference for Q&A session is highly appreciated to supplement the mechanical feeling of “video show type” lecture.

E-TUTOR FOR LEARNING GIS

P.Venkatachalam, B.Krishna Mohan, M.Pandya, D.Choksi and J.K.Suri

Centre of Studies in Resources Engineering
Indian Institute of Technology, Powai, Bombay- 400076, INDIA
Tel (91-22-25767665) Fax. (91-22-25723190)
Email : pvenk@iitb.ac.in

KEY WORDS : Multimedia Tutor, Hypertext, Animation, Geographic Information System

ABSTRACT:

Economic development of a country depends on a well formulated and effective strategic planning. Most of the data used for resources planning and management are spatial in nature. Geographic Information System (GIS) today is one of the major decision making tools in the areas of resources planning and management. One of the spin-offs of space research is Remote Sensing Technology. Remote Sensing is always viewed as an integrated field with GIS technology. Integration of Remote Sensing with GIS can play a pivotal role in strategic efficient planning, resources monitoring, allocation and management, environmental impact assessment studies etc. Understanding the capabilities of GIS technology, many planners and administrators are coming forward to adopt this technology in their planning processes. The problem in adopting this technology is not the cost of hardware or the availability of GIS software but the acute shortage of trained manpower to handle the technology. Steps have been taken by universities throughout the world to introduce GIS and Remote Sensing technology at undergraduate and graduate level degree programmes. Research organizations and commercial companies conduct a number of tailor made training courses in these areas. Developments in Internet technology have made the GIS capabilities accessible to wider audience globally. In additional to the conventional class room based education and training, there is a good demand for the demonstration kits and self-learning tutors. These tools can provide an effective way for putting across the spatial concepts, intrinsic analytical capabilities and a range of applications. Several technical books and self learning demonstration kits built around commercial packages are available to strengthen GIS education. This paper discusses the details of an E-Tutor for learning GIS developed at the Centre of Studies in Resources Engineering, Indian Institute of Technology, Bombay, India. It is built using Macromedia Director MX. The topics on GIS are hierarchically grouped into main sections and subsections. Text materials are supported with illustrations and examples to improve the presentation and understanding. Uniqueness of this tutor is that it gives interactive exercises to provide hands-on training on various functions of GIS.

1. INTRODUCTION

One of the spin-offs of space research is Remote Sensing Technology. Remote Sensing is always viewed as an integrated field with GIS technology. Integration of Remote Sensing with GIS can play a pivotal role in strategic efficient planning, resources monitoring, allocation and management, environmental impact assessment studies etc. Understanding the capabilities of GIS technology, many planners and administrators are coming forward to adopt this technology in their planning process. The problem in adopting this technology is not the cost of hardware or the availability of GIS software but the acute shortage of trained manpower to handle the technology. Steps have been taken by universities throughout the world to introduce GIS and Remote Sensing technology at undergraduate and graduate level degree programmes. Although public investment in GIS research such as Regional Remote Sensing Laboratories in the (U.K.) and the National Center for Geographic Information and Analysis (NCGIA) in the (USA) has added to the pool of skills, there is still a considerable unmet demand for GIS education (Raper and Green, 1992). The efforts of NCGIA are worth noting, as it is one of the few organizations that has attempted to establish and promote GIS education with core curriculum materials. Additionally, NCGIA is facilitating the development of the Secondary Education Project, a curriculum designed to develop and pool instructional materials and disseminate them through teacher workshops. Similar efforts have been undertaken by the University Consortium for Geographic Information Science to create a standardized GIS curriculum (Baker, 2001). Several technical books and self learning demonstration kits built around commercial packages are available to strengthen GIS education. This paper discusses about an attempt made by CSRE, IIT, Bombay to build an E Tutor for learning GIS.

2. REVIEW OF GIS TUTORS

A number of GIS tutors working standalone or built around commercial GIS packages are available internationally. One of the early GIS tutors was ARCDEMO developed at Birkbeck College, London, U.K. (Green, 1987). This demonstrator worked around Arc/Info GIS package and illustrated the capabilities of map editing, projection changes, map overlay, buffering and network analysis. Map Analysis Package MAP (Tomlin, 1983) was one of the earliest simple GIS tools demonstrating the raster based techniques in GIS. Many enhanced versions of MAP were released subsequently. IDRISI (Eastman and Warren, 1987) developed at Clark University, USA provided simple techniques to handle raster maps along with tutorials. IDRISI became one of the best training tools internationally for raster based GIS with recent upgrades to Windows platform. With the availability of PC based GIS packages in the Nineties, vendors started releasing self-learning demonstrators around commercial GIS products.

The first comprehensive computer aided learning tool for GIS was created in the Department of Geography, Birkbeck College, London, U.K. (Raper and Green, 1989) and was named GISTutor. This tutor ran standalone on a PC without the need for a full fledged GIS package, presented an overview of GIS functions, provided illustrations through animations and had a flexible structure for all types of users. Detailed descriptions of GISTutor version I and II are given in (Raper and Green, 1992). GISTutor II is a hypertext based system allowing a user to explore a series of linked screens of information covering the basic and advanced topics. A review of GISTutor II has been given in (Stuart, 1995). Geocube 1.5 is one of the well-developed GIS tutors in France by Michel Bernard at SIAGE SABM, and Frame and Phillipe Miellet at Ted-Aliter in 1996. It provides an interactive introduction to GIS and gives a clear understanding of GIS technology. GeoCube is an application developed with Tool book version 3.0 hypermedia authoring system. (Tool Book is a product of Asymetrics Corporation and a run time version of Tool book is provided along with GeoCube.) GeoCube runs on MS DOS and Windows. The topics are categorised under Geographic Information, GIS functionality, GIS Implementation and GIS Technology. GeoCube is very well organized with graphical illustrations, icons and help functions. Clicking on a cube and moving it along the panel to a desired level can control the speed of the illustrations and animations. Some of the texts contain hyperwords, which are highlighted. By clicking on them one can get detailed information on these words. The hypertext approach used in GeoCube provides a framework in which a range of tools can be used to create dynamic teaching material to educate users about GIS. Geocal is a Windows based GIS tutor developed by Roy Alexander and group at CIT, Centre for Geography, Geology and Meteorology, Dept. of Geography at the University of Leicester, U.K. It is a good tutor for the beginners in the field of GIS. The tutor comprises four units - Introduction to GIS, GIS for utilities, GIS for business and GIS in agriculture. The number of illustrations and examples are very few but self-explanatory with hypertext links for detailed information. After every unit/subunit a simple quiz is provided on important aspects of the topic. Introduction to GIS is given in detail but the other three application units do not provide complete understanding of GIS capabilities. Keeping into view the need for GIS training in India and the availability of indigenous GIS tool GRAM++, an attempt was made to build a GIS training tool around GRAM++ (Venkatachalam et al.. 2001). UNIGIS international Organization is offering distance learning courses in GIS since 1980. UNIGIS is a network of universities cooperating in the design and delivery of courses in GIS and has sites in fourteen countries. UNIGIS offers post graduate certificate, diploma and master's courses in GIS (unigis.org).

3. DEVELOPMENT OF E TUTOR FOR GIS

The E Tutor has been designed taking into view the requirement of wide range of users. The system has been made fully interactive and the users can proceed step by step. GIS theory is explained through a series of technical topics. Under each technical topic, text materials are explained supported by graphical illustrations and hands on exercises. Context sensitive help has been provided on technical words for understanding further details. A few GIS applications are given as show cases explaining the data used, methodology and the results. In addition to spatial theory, a few GIS functions such as network analysis, data base query etc. are explained through graphical animations. A bibliography covering GIS related literature and GIS glossary are also provided. Macromedia Director MX has been used in the development of the training tool as it supports hyperlinks between topics, display of graphical images and text with animations. The spatial data theory is categorized under 21 broad sections and each section has a series of subsections. At every level graphical illustrations and examples are given to enhance the presentation and understanding. The technical layout and the hierarchical structure adopted in the GIS training tool is presented below.

I. Introduction
- Overview and definition
- Contributing disciplines
- Components of GIS
- GIS and other information systemS
- Applications

II. **History of GIS**
- Stages of evolution
- Motivation for GIS development
- North American contribution
- British experience
- Academic and research sectors
- Commercial sector

III Concept of GIS Data
- Definition of space
- Representing reality
- Modes of spatial data
- Components of spatial data
- Scales of measurement
- Spatial objects
- Nonspatial attributes
- Spatial dimension
- Spatial relations
- Georelational data model
- Object relational data model

IV Spatial Data Sources
- Primary data collection
- Sampling methods
- Secondary data sources

V Map Projections
- Geographical coordinate system
- Datum
- Scale
- Conical projection
- Cylindrical projection
- Azimuthal projection

VI Spatial Data Modelling
- Data Model definition
- Raster data model
- Raster data encoding
- Vector data model
- Vector data structure and topology

VII Spatial Data Input and Editing
- Scanning and digitization
- Spatial data editing
- Error Removal and topology creation
- Rasterization
- Data base creation

VIII Geometric Transformation

IX Attribute Data Management

- Database models
- Relational database management system
- Normalization

X Spatial Data Analysis

- Attribute query
- Vector analysis
- Vector operations of two layers
- Vector operations of single layer
- Raster analysis
- Display operations
- Local neighbourhood operations
- Extended neighbourhood operations
- Zonal operations

XI Spatial Data Interpolation

- Global interpolation methods
- Local interpolation methods

XII Digital Terrain Mapping

- Digital elevation model
- TIN model
- Terrain mapping methods
- Slope and aspect

XIII Watershed Delineation

- Preprocessing DEM
- Flow Direction and Flow Accumulation
- Derivation of drainage
- Watershed delineation

XIV Network Analysis

- Short path analysis
- Service area mapping
- Location allocation analysis

XV Spatial Statistics

- Descriptive statistics
- Point based statistical measures
- Area based statistical measures
- Spatial patterns
- Gravity model

XVI Remote Sensing

- Principles
- Data sources
- Preprocessing
- Enhancement
- Classification
- Integration of remote sensing with GIS

XVII Spatial Data Visualization

- Output devices
- Use of colour schemes
- Types of maps
- Map layout
- Tables and charts

XVIII GPS

- GPS data generation
- Types of GPS
- Applications

XIX Spatial Decision Support System

- Definition and Concept
- Application

XX Spatial Data Accuracy

- Sources of errors
- Accuracy estimation
- Meta database

XXI Applications

The technical sections are explained briefly with examples and assisted with graphical illustrations. (Figures 1, 2, 3, 4, 5 and 6)

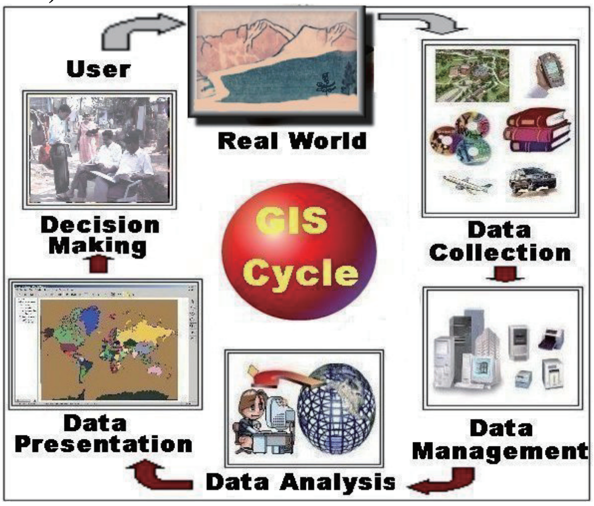

Figure 1 – Components of GIS

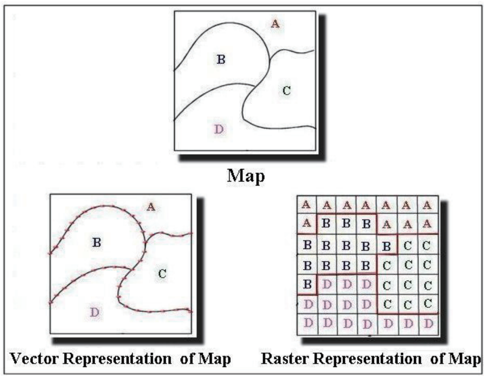

Figure 2 – Vector and Raster Representastion

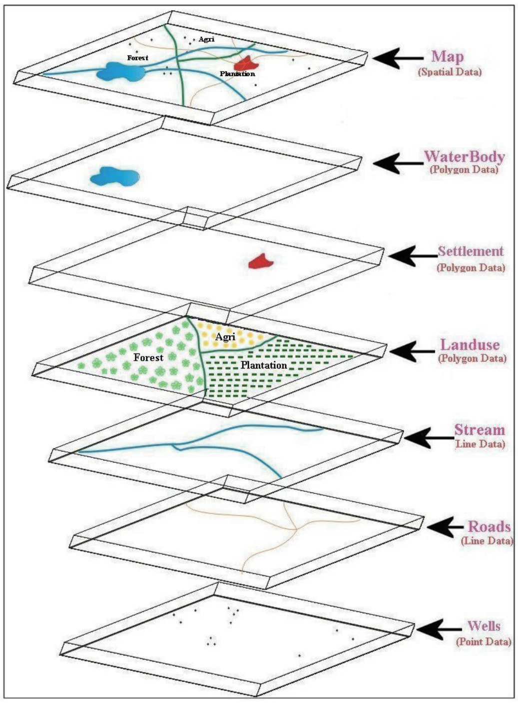

Figure 3 - GIS Layers

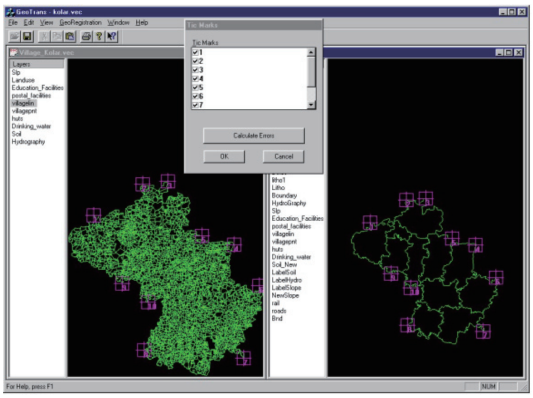

Figure 4 – Geo-registration of maps

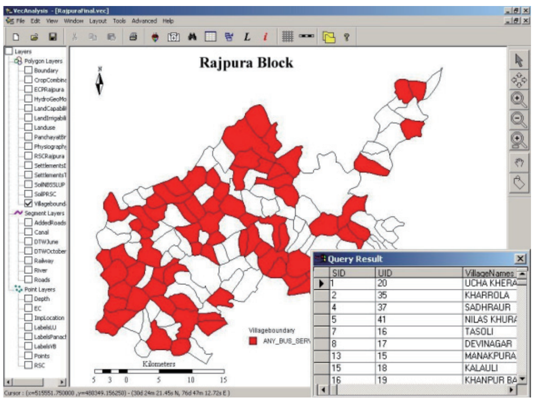

Figure 5 – Example of attribute query

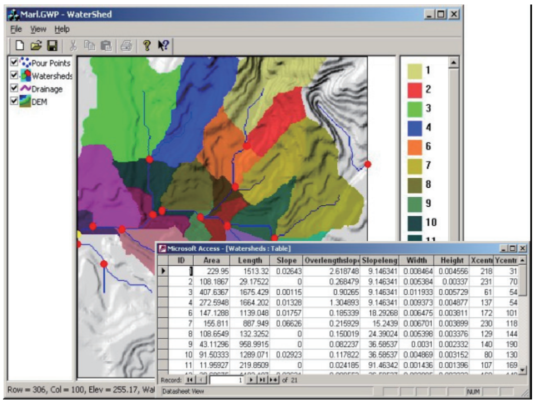

Figure 6 – Example of watershed delineation

Some of the functionality are also explained through animations. Hands-on exercises with test data sets are provided to the users to enhance their understanding on GIS functionality. Following the technical sections, case studies on waters resources management, rural land management and spatio-temporal analysis are given as show cases. The training tool also covers a list of GIS journals, books, magazines, internet resources on GIS and a glossary on GIS terminology.

4. CONCLUSION

GIS applications are growing rapidly. With the availability of high resolution remote sensing data, desk top GIS and Internet based GIS, awareness is increasing among the user community on the capabilities of GIS technology. The development of an E Tutor for learning GIS provides exposure to the technology minimizing the initial learning curve. This Tutor can become a powerful motivator for understanding and using GIS technology in varied applications.

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CONSTRUCTION OF GIS EDUCATION SYSTEM VIA DISTANCE LEARNING

Toshikazu SAKAI [a], Shintaro GOTO [b], Michinori YAMASHITA [b]

[a] Open Research Center, Graduate School of Geo-Environmental Science, Rissho University, 1700, Magechi, Kumagaya-City, Saitama 360-0194, JAPAN - sakai@gaia.ris.ac.jp
[b] Faculty of Geo-Environmental Science, Rissho University, 1700, Magechi, Kumagaya-City, Saitama 360-0194, JAPAN - (got, yamasita)@ris.ac.jp

Commission VI

KEY WORDS: GIS, Education, Learning, Computer, System

ABSTRACT:

The objective of this study is to introduce GIS education system via distance learning system in Rissho University. The campuses of Rissho University are located in two places, and it takes 1.5hr by train between two campuses. Some of students take courses at both campuses. In order to get over such handicap, Rissho University has examined distance learning system. This system was complete in 2005 and will be used practically in 2006. This system can transmit/receive computer screen images, videos, images and sounds of classroom with low delay and high quality. In addition, it can record lectures, and students can review lectures. Faculty of Geo-Environmental Science in Kumagaya campus has a plan to teach GIS and remote sensing for students and for other faculties are interested in GIS. However, it is difficult to support the students in distant campus frequently. For this reason, we are enabled to use GIS via distance learning system. In computer rooms, one of three monitors on each table for students is used to display the images of teacher computer. If students cannot understand operations just referring middle monitor, teacher operates student computer from teacher computer. Thus, this system can teach how to operate GIS software for students in distant campus as they are the same class. We will use this system for teaching GIS classes in cooperation with other faculties, opening GIS classes of Faculty of Geo-Environmental Science to other faculties and making content of GIS lectures using recording function and so on.

1. INTRODUCTION

The campuses of Rissho University are located in two campuses, Osaki Campus in Shinagawa-ku, Tokyo, and Kumagaya Campus in Kumagaya City, Saitama, and it takes 1.5hr by train between two campuses (Figure 1).

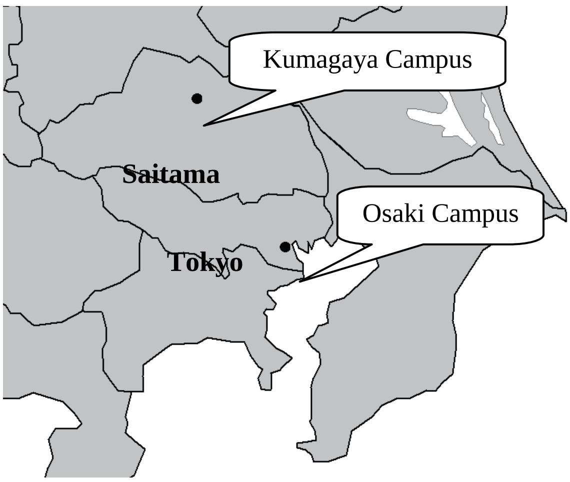

Figure 1. Location map of Rissho University

Osaki campus has Faculties of Psychology, Business Administration and Economics (all section), Faculty of Letters (freshmen, juniors and seniors) and Faculty of Buddhist Studies (juniors and seniors). Kumagaya campus has Faculties of Geo-Environmental Science, Social Welfare and Law (all section), Faculty of Letters (sophomores) and Faculty of Buddhist Studies (freshmen and sophomores). Some of students have to take courses at Osaki campus and Kumagaya campus both. Furthermore, students desire to take classes and units of other faculties at distant campus for their career plan such as finding employment, acquiring qualifications and improving knowledge of languages (Yamashita, et al., 2006). However, it is difficult to take classes in distant campus for students.

The university establishment standards was revised, and we can give classes (lectures and experiments etc.) using multimedia at another place in addition to usual classroom.

Thus, Rissho University had examined distance learning system and this system was complete in 2005.

The objective of this study is to introduce the GIS education system via distance learning system in Rissho University.

2. OUTLINE OF DISTANCE LEARNING SYSTEM

We use distance learning system in six rooms (two classrooms and a computer room at each campus). Each campus is connected with high speed network (100Mbps). In this system, Digital Video system (DV over IP) and Video Conference system (H.323) are used. Digital Video system can transmit/receive images and sounds with low delay and high quality. In order to connect to distance learning system of other universities in the future, we adopted standardized Video Conference system.

Figure 2 shows overview of classroom. One classroom has two projector screens in front of the room and four plasma displays at the back of the room. These screens and displays can show students computer screen and other images.

Figure 3 shows overview of computer room. Computer room has a projector screen and a plasma display in front of the room. In addition, there are three monitors on each table for students. Left and right monitors are used for student computer. Middle monitor is used to display the images of teacher computer. The images of teacher computer are also displayed in the middle monitor of distant computer room. Students take classes while referring operations by the teacher. If students cannot understand the operations just referring the middle monitor, teacher can operate student computer from teacher computer.

Figure 2. Overview of classroom

Figure 3. Overview of computer room

In classrooms and computer rooms, this system can record lectures synchronizing images of classroom and content such as Microsoft PowerPoint slide, and students can review the lectures anytime using internet browser.

3. GIS EDUCATION SYSTEM VIA DISTANCE LEARGING

3.1 Introducing GIS Software

GIS software has been installed on all computers of computer rooms, and we have constructed GIS education system via distance learning. GIS software has been installed on twenty student computers and a teacher computer for each campus.

3.2 GIS education plan

We are planning the following GIS education via distance learning system.

(1) GIS education for other faculties
Faculty of Geo-Environmental Science in Kumagaya campus has about forty GIS software licenses and about thirty remote sensing software licenses, and has taught GIS and remote sensing since opened the faculty. We have a plan to teach GIS and remote sensing for students and for other faculties that are interested in GIS, such as Faculty of Economics, Faculty of Business Administration and sociological division etc. . However, it is difficult to support the students in distant campus frequently. We can get over such handicap by this system.

(2) GIS training for citizen groups such as NPO
In Japan, citizen groups such as NPO (Non-profit Organization) are beginning to use GIS, not just municipalities, companies and educational institutions. For example, an NPO is distributing the result of water quality survey using Web-GIS in collaboration with us. In order to popularize GIS to citizen groups and NPOs, we have a plan to give GIS trainings for them.
The members of citizen groups and NPOs with wide area activities such as river-related NPO may gather from wide area. This system enables them to take GIS trainings at the same time between two campuses.

(3) GIS training for public such as company
We will give GIS trainings about not only GIS software operations but also analysis examples (e.g. analysis of heat-island and bird habitat etc.) for public such as company considering introduction of GIS or studying how to use GIS.
Faculty of Geo-Environmental Science has given GIS trainings about ten times for public in Kumagaya campus. Because some participants came from distant place, we believe that GIS training using distance learning system is helpful for them.

When students cannot understand operations by teacher just referring middle monitor, teacher has to operate student computer directly on general computer classes. In this system, teacher can operate student computer from teacher computer remotely. Thus, this system can teach how to operate GIS software for students as if teacher and students are in same room.

(4) Making content of GIS lectures
Distance learning system can record lectures synchronizing images of classroom and content such as Microsoft PowerPoint slide. We have a plan to make GIS learning environment for students who do not take GIS courses by accumulating content of GIS lectures.

4. SUMMARY

This paper introduced distance learning system in Rissho University and GIS education plans using this system. This system can give GIS education for more students by one teacher at the same time between two campuses.
In the demonstrations of distance learning system for teachers, there are the following comments, “we are unsure about mastering this system” or “we need to prepare digital documents such as Microsoft PowerPoint slide for this system”. In order to reduce their workloads, we need to develop support systems for them.

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A MULTIMEDIA TUTOR FOR DIGITAL IMAGE PROCESSING FOR REMOTE SENSING

Krishna Mohan BUDDHIRAJU[1] , S. KARTHIK, Vijendra NAYAK and G. ANU

Centre of Studies in Resources Engineering
Indian Institute of Technology, Bombay
Powai, Mumbai - 400076, INDIA
Corresponding author's email: bkmohan@csre.iitb.ac.in

KEY WORDS: Tutor, Digital Image Processing, Remote Sensing, Multimedia, Educational Content

ABSTRACT:

The advances in remote sensing and geographic information systems technologies make it possible to deploy them in diverse applications for planning, resources management, environmental monitoring, and optimal urban/rural development activities. At the same time, the lack of availability of trained manpower in these areas is a concern, that can impede the penetration of these technologies. In particular, the high resolution digital imagery generated by sensors onboard spaceborne platforms require knowledgeable users to exploit their potential. One of the recent approaches to provide digital image processing training is based on detailed educational content along with other tools on CD-ROM or on web-servers for self-paced learning. The other tools include demonstrations, interactive exercises, case studies, software package to support most of the techniques discussed, sample datasets, glossary and bibliography. Such resources also help the teaching and training institutions, where even the instructors can benefit from the teaching aids in the form of CD-ROM and web-based tools. Students can benefit from access to lecture notes, software, exercises, short descriptions in the form of glossary and pointers to further reading through bibliography. In this paper, a CD-ROM and web-based digital image processing tutor DIPTORS (Digital Image Processing Tutor fOr Remote Sensing) developed at the Centre of Studies in Resources Engineering, Indian Institute of Technology, Bombay is described.

1. INTRODUCTION

Recent advances in remote sensing and geographic information systems technologies are immensely beneficial in diverse applications for planning, resources management, environmental monitoring, rural and urban development programs. At the same time, the lack of availability of trained manpower in these areas is a concern, that can impede the penetration of these technologies. In particular, the high resolution digital imagery generated by sensors onboard spaceborne platforms require knowledgeable users to exploit their potential. This is particularly true in developing countries, where maps at large scales (1:10,000 and above) are not easily available to the resource managers and planners, and such products need to be generated by interpreting and analyzing remotely sensed images. Further, many colleges in the developing countries may not have extensive teaching aids for instructors, or multiple licenses of expensive commercial packages to deploy in teaching laboratories while providing senior sophomore or Master's level education in the area of digital image processing for remote sensing.

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Many approaches are adopted in practice in this context to train manpower including classroom based short intensive courses, distance education through telecast/webcast programs among others. One of the recent approaches is to provide a software with sample images with image processing books so that readers can also experiment with the images to get a feel of the algorithms implemented. Mather (2004) is a classic example in this context, where he provides a software package, sample data, case studies, links to useful web pages etc. to supplement the material in the book. However, the material in the book is static, in the sense that there is very little interactivity while reading a hard copy. Another problem with books is that they may be without much mathematical detail (in the context of image processing algorithms) as can be seen in Mather (2004), Jensen (2004), Richards and Jia (1999) or full of mathematical content (e.g. Haykin, 1999 on neural networks) that may be too involved for a remote sensing student. An electronic reader can be designed to enable the user to select content, multimedia demonstration and explanation, interactive exercise, mathematical details etc.

[1] Corresponding author

while reading about any topic. This is the approach in DIPTORS that we developed on digital image processing for remote sensing at CSRE, IIT Bombay.

2. BRIEF REVIEW OF EDUCATIONAL MATERIALS

Gan and Kuo (2006) developed teaching content to teach Digital Signal Processing Software Development where various issues in implementation using fixed point arithmetic was discussed. Sarkar and Craig (2006) adopted a Wireless-Fidelity (Wi-Fi) project based approach to teach wireless communication and networking concepts to students. More attempts can be seen in Kuo and Miller (1996), Gan (2002), Lopez-Martin (2004) discussing the educational aspects of digital signal processing, random signals and noise. Abdel-Qader et al. discuss the curriculum for undergraduate signal processing courses. Rogers et al. (1995) discussed a multimedia tutor for manufacturing education that was used at Boeing company. Woolf et al. (1996) at the University of Massachusetts built Design for Manufacturing (DFM) computer modules which instruct students on efficient procedures for designing parts for manufacture. The intended use of these modules is to provide the student with the knowledge of design as well as the actual injection moulding and stamping. Cho et al. (2003) discuss the development of a multimedia tutor to teach microcontroller principles to students of bio-medical engineering. The tutor included movie clips, narration, animations, graphics and text to communicate the concepts.

Venkatachalam et al. (2001) developed a basic tutor on Geographic Information Systems whose framework was adopted in major part of the content development here. They divided the tutor into several parts:

a. Subject Content (more than 15 topics briefly discussing the introduction to GIS, components of a GIS, concepts of map, spatial data models and data structures, spatial analysis, raster analysis, cartography, and GIS applications)
b. Animated Demonstrations (to illustrate for principle of a few selected GIS operations)
c. Case Studies (to demonstrate potential of GIS in real world applications)
d. Glossary (of common technical terms used in GIS and remote sensing)
e. Bibliography (list of useful websites, books and journals)

The early version of this tutor does not have any bundled software for the user, nor any interactive facilities.

3. DESIGN OF DIPTORS

The design of the tutor can be captured in Fig. 1 that illustrates the entire philosophy, structure and components. The most important component of the tutor is the subject content, divided into 35 topics covering both the basic and advanced areas of digital image processing for remote sensing.

3.1 Topics

The topics covered in the tutor include introduction to digital images, remote sensing, preprocessing and enhancement, up to classification and accuracy assessment.

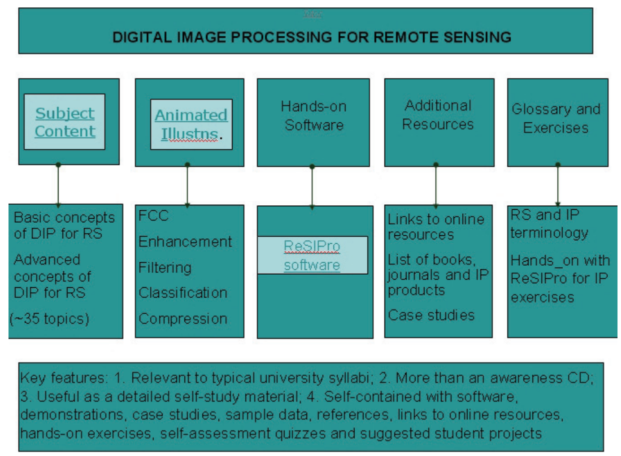

Fig. 1 Layout of the DIPTORS

Coverage of basic topics

Introduction to remote sensing and international remote sensing programs
Image acquisition by imaging sensors
Resolution
Distortions in remotely sensed images and image corrections
Image Enhancement and transforms
Introduction to texture analysis
Feature selection
Image classification and accuracy assessment

The advanced topics predominantly discuss image segmentation and classification, with additional coverage including image compression, data compression and mathematical morphology.

Coverage of advanced topics

Neural networks and fuzzy logic
Genetic algorithms

SAR image processing and interferometry
Image segmentation principles
Thresholding
Edge and texture based segmentation
Mathematical morphology and region segmentation
Contextual classification and refinement
Image compression
Image data fusion
Support Vector Machines

The content can be covered over a period of two semesters, where the advanced topics may be of interest to those students who are mathematically well equipped. The subject content is supplemented by links to interactive illustrations and experiments where the student can actually verify some of the basic operations using a hand-held electronic calculator on small (8x8 or 16x16) datasets or by executing programs to see the original and processed images one by the side of the other. Certain tasks such are illustrated with automatic / user-controlled animations so that the results are easily understood. The authors feel that once the basic concepts are understood, then the advanced topics are easily handled. An example of the above is shown in Fig. 2, where the linear contrast enhancement is defined, and explained. The user has links to an example that can be hand-calculated for verification, and a demonstration where the enhancement can actually be executed on an image.

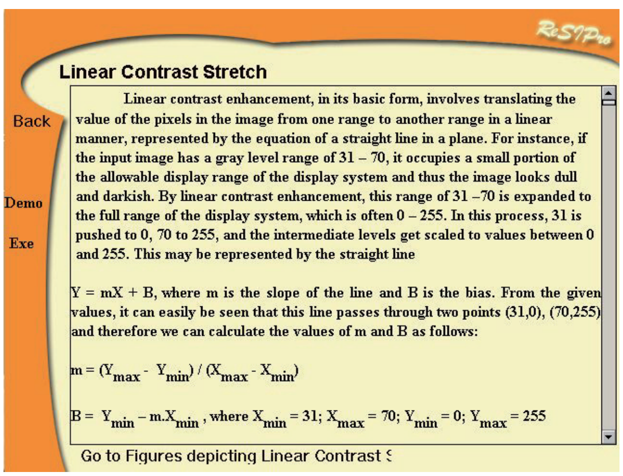

Fig. 2 View of the coverage of the content

Where figures are present, there are links to another page so that the main screen is not cluttered with too much text and figures.

The content is developed in such a manner that those well equipped with mathematical background can benefit from the mathematical equations to gain a better understanding of the actual computations involved, while others can skip the mathematics and yet understand the underlying principles. It is our view that one of the shortcomings with current textbooks on digital image processing is the absence of enough mathematical detail to attract students of electrical engineering, computer science and such disciplines for whom the theory of image processing and analysis are of greater interest compared to the applications. It is therefore necessary to develop the tutor that can provide material to address the needs of both types of students. At the same time, we make no pretensions to building a comprehensive tutor that has equal coverage of digital image processing for remote sensing and applications to natural resources management and environmental monitoring. Some of this material can be found in the Case Studies part of the tutor. Also, the bibliography section has pointers to a wide range of books and papers addressing this aspect.

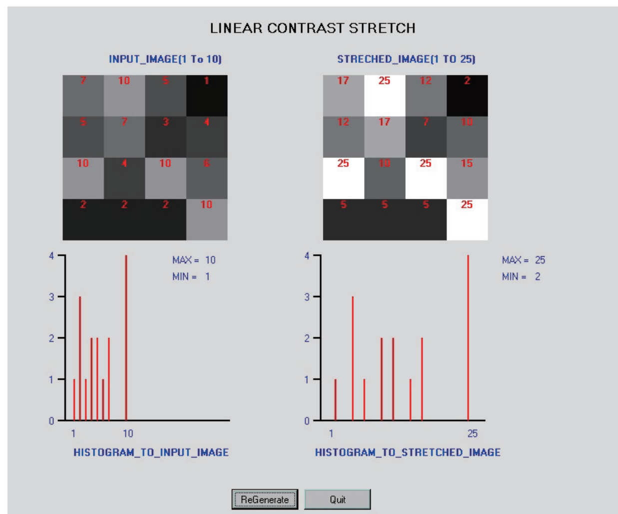

Fig. 3. Interactive example for Contrast Stretch

The entries in the above example are generated using random numbers, and by clicking on the "regenerate" button, the user can repeatedly generate new sample matrices and evaluate the technique manually. Similar functions are built for image display, enhancement, filtering, band arithmetic, parallelepiped and minimum distance from mean classification methods.

Once the concept is understood using small numerical examples, the student can use the program to display the input image and process it using the embedded executable programs (based on ActiveX). This example is shown in Fig. 3. This example illustrates the interactive tool where the user is able to choose one from among a few images available, choose the size of the window, and perform the median filter operation on the image. The filtered image can optionally be saved on the disk. The user can vary the size of the window, and in each case view the degree of smoothing introduced by the filter. Using similar principle, a large number of executables are embedded into the tutor so that the examples, demonstrations can be taken right at the point where the content is browsed in the tutor.

In this manner, the user is assisted in understanding the image processing concepts based on simple hand-verifiable examples, followed by their visual impact on real images.

Fig. 4a. Original Image

Fig. 4b. Median Filtered Image

4. ReSIPRO SOFTWARE PACKAGE

The tutor is accompanied by a software package ReSIPRO (Remotely Sensed Image PROcessing) that is a standalone desktop image processing software package, that can be invoked from inside the tutor or externally. This package is used to enable the student to actually try out numerous image processing and analysis operations, such as:

Image geo-referencing – geometric transformation and resampling using nearest neighbor / bilinear / cubic colvolution
Contrast Enhancement – linear / logarithmic / exponential / histogram equalization

Filtering – Mean filtering / Median Filtering / Edge enhancement using Sobel / Prewitt / Laplace

Transforms – Principal Component Transform / RGB-HIS transform / NDVI / DFT / DWT

Band arithmetic – band difference / band ratio / band multiplication / band addition

Supervised classification – maximum likelihood / minimum distance from mean / parallelepiped / multiplayer perceptron neural network classifiers

Unsupervised classification - conventional k-means and fuzzy c-means clustering

Texture analysis – Cooccurrence matrix based texture feature extraction

Contextual classification – probabilistic relaxation labeling

Segmentation – Canny operator based edge detection, morphological watershed segmentation

Connected Component labeling – to label all the regions in an image after segmentation / classification

A limited number of images are provided along with the software to enable the user to gain experience in image processing.

Some of these programs are too involved to be built into the tutor through ActiveX and therefore the standalone software package is provided along with a few images. This package is simple to use and functionally rich, yet it is not meant to be used as a substitute for commercial products like Geomatica and ERDAS Imagine. The interface of this software is shown in Fig. 4. The package is developed in Microsoft Windows environment using

Visual C++ compiler. The tutor itself is built using Macromedia Authorware software. Macromedia Flash software is used for the animations. Most of the subject content discussed in this tutor is actually covered by the first author as part of two Master's level courses taught at IIT Bombay to the students of M.Tech. Natural Resources Engineering (NR-607 and NR-602; see www.csre.iitb.ac.in) for details.

5. OTHER TOOLS

The other tools present in this tutor include detailed glossary of remote sensing and image processing terms (alphabetically organized) and bibliography of books on remote sensing and image processing, references to key papers on each of the topics discussed, important websites of courses taught at different universities, webpages of commercial products, and links to useful resources on internet. The instructor's resources in the tutor include presentations on most of the lectures, suggested student projects, and brief notes for laboratory sessions. Another interesting feature here is a collection of case studies on the use of image processing techniques in different remote sensing applications.

A set of question papers is provided to help the instructor to test the understanding of the students. The questions are of three types: a) objective type questions that can be answered in one line b) short questions that can be answered briefly in 2-3 sentences and c) problems that need to be worked out based on a clear understanding of the concepts covered in the content.

Key websites such as the Canada Centre of Remote Sensing, the famous Remote Sensing Online Tutorial by Nicholas Short, Remote Sensing Core Curriculum website at the University of British Columbia, Paul Mather's website at the University of Nottingham are among those included in the tutor to help the reader to get access to material not covered in this tutor.

6. MULTIMEDIA PRESENTATIONS

In order to supplement the textual and graphical content in the tutor, selectively audio / video content is provided where certain concepts are explained by a human tutor. For instance, the concept of edge enhancement is explained using the text and graphics illustrating the intensity gradient and the edge, while the commentary through audio / video emphasizes the relationship between the intensity gradient and the location of the edge. Beginners to the field do not realize the fact that the intensity gradient is perpendicular to the orientation to the edge, and therefore high gradient magnitude in a given orientation points to the presence of edge in an orientation orthogonal to the gradient direction. Further, edge magnitude is adequate to get an edge map, while edge orientation is required for analysis purposes, as well as to improve the edge map using the principle of edge connectivity, thinning, filling etc. Similarly the concept of histogram equalization as a tool for image enhancement also requires some explanation, since the process of reassignment of gray levels is tricky. Users who click on the appropriate button in a software tool to equalize the image often do not understand how the equalization occurs, or may not appreciate the fact that sometimes histogram equalization can lead to loss of detail in the tails of the histogram, leading to excess contrast than necessary.

7. CONCLUSIONS

We presented an image processing tutor specifically for remote sensing applications, and along with it a framework for a collection of tools to make it self-contained, catering to the needs of working professionals as well as Master's level students. For a full-time student, this tutor is a useful supplementary learning aid, while for the professional who cannot take time off to undergo classroom training, this can help as an introductory learning tool, till he is able to receive training by an expert in the field. The instructors can take advantage of ready teaching material, instructor's resources and software that can be used by each student for hands-on purposes in case expensive commercial tools are unavailable. The tutor is evolving, and we propose to continue working on this for several years to come, continuously refining the content, software, and ancillary tools discussed above. Our plans include development of a matlab version as well as a platform independent version using Java. The first author may be contacted regarding access to the tutor materials.

ACKNOWLEDGEMENTS

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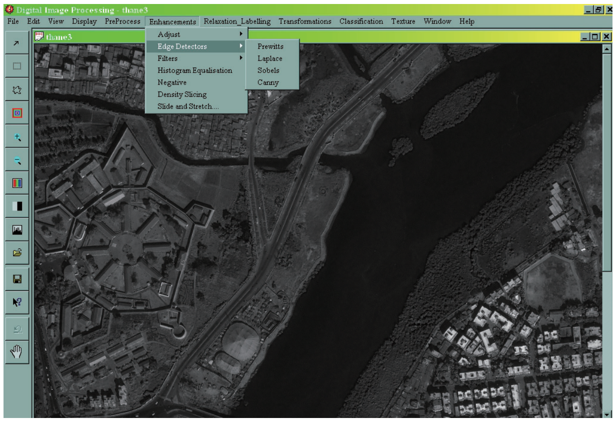

Fig. 5. Layout of ReSIPRO image processing software

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DIRECTION OF DIGITAL IMAGE ANALYSIS TRAINING THROUGH THE 28 YEARS EXPERIENCE

Tsutomu Yamanokuchi, Setsuko Negishi, Tamotsu Igarashi, Aya Yamamoto and Riiko Ueno
Remote Sensing Technology Center of Japan (RESTEC)
12th floor, Roppongi First BLDG., 1-9-9, Roppongi, Minato-ku, Tokyo, 106-0032, JAPAN
tsutomuy@restec.or.jp

Commission VI

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ABSTRACT:

Remote Sensing Technology Center of Japan (RESTEC) has been organizing various kinds of remote sensing training programs since RESTEC was established in 1975. Among them, remote sensing training course intended for engineers of developing countries has been organized, under the trust of JICA (Japan International Cooperation Agency) since 1978. This course mainly consists of 4 parts. First is classroom lecture about basic principles and various kinds of applications of remote sensing. Second one is practical hands-on training of digital image analysis using MS-Windows PC and analysis software developed on our own and free of charge. Third one is focused on local area hands-on training. Participants visit Japanese local universities and execute a practical training, ground truth and sea truth. Last one is presentation of action plans based on the application of remote sensing. The curriculum design is required to be changed due to the popularization of Information Technology (IT) and Internet. Before spreading of the Internet, engineers in developing counties almost had no chance to take a lecture and training except for attending such kind of training. Though it was able to learn on one's own PC by using textbook, it was impossible to discuss interactively with lecturers. Therefore, the lecture took important position in the training course. However, it is able to have interactive lectures through Internet called as "e-learning". JICA have started remote lecture system in 2005. However, digital analysis and ground truth training is still difficult to be executed through cyber space. Inevitably, our training courses' proportion of lecture and hands-on training were forced to increase the hands-on training course. This paper describes the historical changes and a new aspect of our training course including the application usage of Japanese new earth observation satellite ALOS.

1. INTRODUCTION

Remote Sensing Technology Center of Japan (RESTEC) has been holding various kinds of training courses of remote sensing technology. We have 2 kinds of courses in domestic training course, which are fundamental remote sensing course and Synthetic Aperture Radar (SAR) course. We hold 10 times above courses per annum. International course are held 2 or 3 times per annum. Main course is executed under the trust of JICA. It holds over 2 and half months and be held in Japan. Other course is held irregularly, which takes a caravan style to go around Asia region. Both courses we instantaneously adopted PC-based training in 1987 and analysis software are developed on our own. Hardware and software are taken into account to adopt the newest trend. Also curriculums are changing due to popularization of the new infrastructures, which is Internet and IT. Based on such circumstances, we describe our now and future framework of training courses taking into accounts Japanese newest satellite "ALOS".

2. TRAINING ENVIRONMENT

2.1 Hardware Environment

Computer environment is dramatically improved in this recent 10 years. At the incunabula of digital image analysis training, computer was mainframe system and 3 or 4 trainees used at one computer's terminal. Next generation, computer system was changed to UNIX system. Also it is difficult to prepare the X window consol for each trainee due to the problem of cost. The third generation is windows PC. Nowadays, the potential power of windows PC is enough to execute not only image display but also executing heavy image processing like SAR image reconstruction from raw SAR data. Therefore, PC environment prepared for our training course is sustainable for such kind of image processing. Due to the low price of windows PC's hardware, we can prepare PC for each trainee and they can comparatively be easy to create the same PC environment as our training after they back to their countries. It is big improvement because the trainee can use the learned knowledge and techniques directly at their office without preparing anything. The following items show the spec of PC we used in this training course;

- OS : Windows XP Professional (English)
- Style : Laptop PC
- CPU : Pentium4 2.0GHz
- RAM: 512MB SDRAM
- DISPLAY:12 inch 1024x768pixels, Full Color display
- LAN : IEEE802.b/g Wireless LAN

2.2 Software Environment

The commercial software for remote sensing data analysis is too expensive for not only people in developing countries but also people in developed countries and this price prevent us from using commercial software for all trainees. Though it has very easy to use and have good GUI human interface, the essentials of analysis theory cannot appear clearly and sometimes it seems to be a "BLACKBOX". Therefore, we mainly use the software of which developed our own for training. The name of software is "Remote-10/Win". Basic components of this software was made in the middle of 80's for MS-DOS PC/AT compatible machine and has been developing to adjust current remote sensing techniques and Windows OS environment. This software has following functions;

- Display image in full color
- Import CEOS image
- Geometric Correction
- Land Cover Classification
  (Supervised and Unsupervised)
- Band Operation (Ex.: Calculation of NDVI)
- Resolution Merge (Use HIS conversion)

We also develop the SAR data analysis training software on our own. This software focuses on the Japanese SAR satellite JERS-1 and ALOS. This software has following functions;

- Image reconstruction from RAW SAR data.
- SAR Interferometry Processing
- Differential Interferometry Processing
- Orthorectification of SAR image using DEM

Fig.1 shows the software interface of InSAR processing.

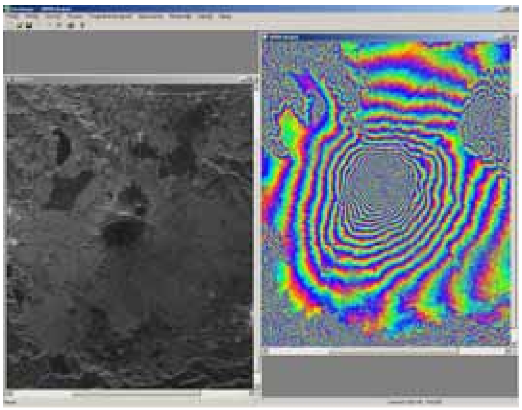

Fig.1 InSAR processing software

2.3 Other Environment

It is necessary to prepare the surrounding environment of training as well as hardware and software. Especially Internet environment is imperative nowadays. Because trainee use Internet not only for research but also as dictionary, making report and sometimes writing e-mail to their families or stuffs in their office. We prepared wireless LAN system to each trainee's PC and it can use freely. However, it needs careful operation to open Internet freely to the trainee due to the damage of computer virus.

Fig.2 Classroom lecture

3. CURRICULUM OVERVIEW

Training course curriculum mainly consists of 4 parts: classroom lecture, ground truth / sea truth, hands-on training, designing action plan. The period of our remote sensing training course is more than two and half months and the number of trainee is about 10 people / Year in average. This section describes the characteristics of each curriculum contents. Typical curriculum schedule is shown in following items;

Day 1-5 <Classroom Lecture>

- Introduction of remote sensing
- High resolution optical sensor remote sensing
- Thermal InfraRed remote sensing
- Hyperspectral sensor
- SAR remote sensing
- Atmosphere and Ocean remote sensing
- Satellite Data structure and Format
- Land environment monitoring
- GIS and remote sensing

Day 6 <Ground truth training>

- Ground truth training

Day7-24 <hands-on training at RESTEC>

- Interpretation of Satellite image
- Geometric Correction and HSI data fusion
- Land Cover classification and Field Evaluation

- SAR Interferometry
- SAR and Optical sensor data fusion
- Disaster monitoring using remote sensing data
- Searching satellite image through internet

Day25-26 <Application oriented training to governmental institutes>

- Geographical Survey Institute
- Public Works Research Institute
- National institute for Rural Engineering

Day27-33 <Hands-on training at Japanese local area>

- Sea Truth training (At Kanazawa)
- GIS and disaster management (At Hiroshima)

Day34-39 <preparation of action plan report>

- Discussion with lecturer and making a report

Day40 <action plan presentation>

3.1 Classroom lecture

There were 10 kinds of classroom lectures in 2006. Before the popularization of Internet, the numbers of the classroom lecture were maximum 20. However, each trainee can learn basic principles of remote sensing using e-learning system through cyber space. JICANET, which have started in 2005 is the remote education system through Internet and trainee can join the lecture through the Internet. They have no reason to come to Japan only to learn the classroom lecture. Therefore, we reconstructed curriculums to reduce the number of classroom lecture and only essential lectures are remained.

The target participant of this training course is for the first time to use satellite image data. Therefore, the lecture starts from fundamentals and introductions of remote sensing at first. Then, basic lecture about theory of optical and microwave remote sensing and next is lecture about land, atmosphere and ocean remote sensing applications. Then, lecture about GIS and satellite data format are held at last. These contents are readjusted in every 5 years. The first time of this training course, this course had many hardware introduction and analog photo interpretation lectures. However, such contents were reduced to adjust current remote sensing technologies.

Fig.3 Ground truth training

3.2 Hands-on training

Hands-on training is the most important part of this program. Because it is almost impossible to communicate the technical know-how and to discuss with trainee about analysis results through Internet. The new training made recently is “Disaster monitoring using remote sensing data”. In recently, the huge natural disasters are occurred so many times in this several years on all over the world and they are something related with global earth environmental change. The remote sensing techniques have a potential to prevent and reduce the damages from such kind of disasters. Therefore, we adjusted such trend to make use of our remote sensing data analysis experience as Sumatra tsunami event in 2004 (Tanaka et al., 2005).

Fig.4 Hands-on training

3.3 Make Action Plan report

It is very essential to confirm how trainee acquired the knowledge and techniques from the training. To examine this, we imposed a report about hands-on training and ground truth training on each trainee until 3 years ago. However, this confirmation style could only check the improvement of trainee’s proficiency. Also, we are sometimes required estimation about the cost-effectiveness of training course. Therefore, we changed the confirmation style to impose action plan report on each trainee and finally we hold an action plan presentation meeting. We can check not only their improvement of proficiency but also how the learned techniques are useful for their job. However, it is very difficult to make a complete action plan report. Therefore, we prepared one week for making action plan at RESTEC’s training room. At least one lecturer always remain in this room and if the trainee has a question or problems which is difficult to solve on their own, lectures can discuss and advise every time. Trainees can use the same PC as used in their training for making action plan report. This PC can use also wireless LAN system to connect Internet and trainee can use Internet freely for research and making action plan. We lead them to make an action plan that other staffs in their office can understand what they want to do to use remote sensing techniques when they go back to their country and write as concrete as possible. For example, budget and times for achieving their plan, the number of person to need, infrastructure to promote the plan, and the problem to be expected.

Through the discussion between trainee and lecturers at the action plan presentation, more constructive and concrete future plans for the application of remote sensing technologies can be effective for each trainee, we hope.

4. METHOD FOR EFFECTIVE USE OF ALOS DATA IN OUR TRAINING

On January 24, 2006, Japanese new satellite named " ALOS" was launched successfully. ALOS is the abbreviation of "Advanced Land Observation Satellite" and Japanese name is "Daichi" meant the "Mother Earth". ALOS have 3 kinds of sensors that are PRISM (Panchromatic Remote-sensing Instrument for Stereo Mapping), AVNIR-2 (Advanced Visible and Near Infrared Radiometer-2), and PALSAR (Phased Array type L-band Synthetic Aperture Radar). One of the main purpose of ALOS is to make a world map of 1:25000 scale. PRISM has 3 different observation sensors at the same time, which is forward view, nadir view and backward view. Its spatial resolution is 2.5m. It is hoped that quite precise Digital Surface Model (DSM) can be created by PRISM sensor. AVNIR-2 is a multispectral sensor, which equipped RGB and Near InfraRed (NIR) observation spectral bands with 10m spatial resolution. PALSAR is the only sensor spaceborne SAR sensor that equipped L-band. To enhance these features of ALOS data in our training, we are planning following training training subjects;

- Resolution merge (Pansharpen) of AVNIR-2 and PRISM
- DSM extraction and Stereographic view training using PRISM data
- SAR Interferometry processing of PALSAR data
- Orthorectification of PALSAR image using DSM created by PRISM stereo pair

Now ALOS satellite is under the Calibration and Validation phase and goes to normal operation phase on October 2006. Therefore we have been preparing above training curriculums for the training program of fiscal year 2007.

5. CONCLUSION

We have been holding satellite data utilization training for foreign engineers during 28 years. To keep the quality and quantity of training, we struggled to improve not only software and hardware but also training environments and effective curriculum arrangement. The software and hardware are needed to be improved along with the advance of technical trends. Curriculums also need readjustment to technical trend and circumstances of training environments. Also, we impose each trainee to make action plan to see clearly the use of what they learned in this training course. Summarizing what they learned in the action plan report style is very effective for both trainees and lecturers because trainees can remind how to use what they learned and lecturers can understand what they want to do to the remote sensing techniques and what is lacked in our training course, and to prove the high cost-effectiveness of this training course.

The world-wide promotion of Japanese satellite data, especially ALOS is also our important task. There are so many developing countries, which have insufficient 1:25000 scale maps. We continue to dedicate the world-wide capacity building of remote sensing techniques through the use of ALOS data for our training curriculums in a positive way.

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Improving Capacity Building in Earth Observation and Geo-information Science in Africa through Educational Networking

Olajide Kufoniyi
Regional Centre for Training in Aerospace Surveys (RECTAS)
Obafemi Awolowo University Campus
P.M.B. 5545, Ile-Ife, Nigeria.
e-mail: kufoniyi@skannet.com.ng; jidekufoniyi@yahoo.com, kufoniyi@rectas.org
URL: http://www.rectas.org

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ABSTRACT:

In geospatial information (GI) production and management, advances in space and information technologies have impacted positively on critical capacity globally through availability of geospatial information technology (GIT) tools. To be fully utilized however, the acquisition of GIT must be fully complemented by readily available skilled manpower and an enabling infrastructure. Unfortunately, in Africa at the moment, majority of all professionals, technologists and technicians in various organizations involved in geospatial information activities were trained in the obsolete methods of map production whereas, the introduction of GIT demands a critical mass of well-trained staff at all levels in a reasonable time frame. This has led to the widening of the digital divide between the developed countries on one hand and the less developed countries on the other. Given that many organizations in African countries are unable to afford the costs to send their staff abroad for training programmes except through external funding support from donor countries and agencies, and considering the number of persons to be trained before achieving capacity utilization, it is necessary to provide alternative solutions through educational networking of institutions in developed and African countries. This paper examines the factors driving GI capacity requirements in Africa and the role of educational networking in improving the situation. It further discusses the roles and expectations of the partners in such a network.

1.0 INTRODUCTION

The need for capacity building in geoinformation production and management in Africa cannot be over-emphasised as geospatial information is definitely the sine-qua-non for sustainable national development.

As expressed in UNECA (2001), the future orientation of geo-information activities in Africa is "…to ensure that spatial data permeate every aspect of society and that they are available to people who need them, when they need them, and in a form that they can be used to make decisions…." and that "…the collected datasets should be put to the maximum possible uses by publicising their existence and making them easily available to the widest possible audience". These statements clearly imply the need for capacity building in all aspects of geo-information production, management and use. Furthermore, in addition to the relevant declarations in regional developmental policy structures such as the New Partnership on Africa's Development (NEPAD) and the World Summit on Sustainable Development (WSSD), a number of GI-specific issues and events, which are discussed in the paper, have brought to the front burners the need for pro-active capacity development efforts in Africa. The required capacity deals with the development of a critical mass of skilled human personnel, organizational reforms, technological capacity and institutional strengthening.

But this has been generally difficult to achieve in less developed countries due to a lot of constraints some of which have been addressed by various authors in different forums e.g., Ruther, 2001; UNECA, 2001; Kufoniyi et al, 2002. These include:

(i) Obsolete curricula and facilities: Many of the institutions of higher learning are running obsolete programs with analogue-dominated, or completely analogue equipment, methods and academic staff such that moving from this phase to a completely digital domain will require a huge capital outlay and human resources, which are lacking in most African countries.

(ii) Continued use of obsolete production techniques: Some of the GI-related production organizations still operate in the analogue domain, which means that new graduates who have been trained in a completely modern technology become "misfits" in such organizations due to lack of appropriate equipment and environment for them to work. This creates dilemma for institutions in deciding on whether to go the whole hog of modernizing their curricula or to "hybridize" the obsolete programs.

(iii) Difficulty of releasing many officers for long-term training even when majority require re-training: Serving career officers that require retraining are many whereas it is not feasible to allow more than a few to go for a long-term training (within or outside the country), making short-term training a very important component of our education programs.

(iv) Lack of cooperation and networking among relevant departments even in the same Institution: This leads to duplication of effort and uncoordinated programs and courses.

(v) Lack of financial resources for overseas training: Many organizations in African countries can no longer afford to send many members of staff to more developed countries for training due to financial constraints, especially considering the number of persons to be trained before achieving capacity utilization. Consequently, with the small ratio of lecturers that are trained in the modern technology to those that are yet to be trained, developing new curricula may end up being a mere paper exercise that will not produce graduates who are genuinely trained in the new technology.

(vi) Absence of uniform academic standard and lack of networking: Uniform academic standard and proper networking would have facilitated sharing of human and other training facilities, which would have addressed the problem of inadequate number of trained lecturers.

(vii) Lack of provision for continuing education and training: This makes African geoinformatics lecturers to be out of date quickly and therefore unable to sustain a dynamic curriculum.

(viii) Inadequate enabling technologies: Many of the enabling technologies for modern geoinformatics curricula are in various stages of development in Africa. For example, even though internet is commonplace in some countries, the bandwidth is often too narrow while there are still countries where it is still very difficult to come by.

Capacity building for the production, management, dissemination and use of GI is therefore of immense importance, which requires focused and concerted efforts towards strengthening of national and regional capacity building institutions including harmonization of GI curricula within a mutually beneficial GI capacity building network.

In the context of human capacity building, three major groups of required GI-professionals have been identified (Molenaar, 2002): Experts in the field of spatial information handling (or specialists in certain aspects of this field); Users of geo-information; and Professionals and policy makers.

The required human capacity development should therefore be geared towards the following four levels in order to provide the three groups of the afore-mentioned GI professionals (Kufoniyi, 1999):

(a) High-level policy-makers: This can be achieved through short-term intensive training in the fundamental aspects of geoinformatics particularly when GIS implementation is being initiated.

(b) Management and Professional staff: New employees in this category should be already educated in the modern technology while opportunity must be also provided for mid-career (re)training of those already in employment to keep them up to date on modern developments in geoinformatics.

(c) Technical Support Staff: Education and (re)training of technicians and technologists for efficient production, management and use of geospatial information.

(d) General Public: through mass media and public lectures, to sensitise the public on the benefits derivable from geospatial information.

2.0 SOME CURRENT DEVELOPMENTS DRIVING GI CAPACITY REQUIREMENTS IN AFRICA

A number of GI-specific issues and events have brought to the front burners the need for pro-active capacity development efforts in Africa. These include increasing interest of African countries in Space Science and Technology development and geospatial data infrastructure development (GDI).

2.1 Space Science and Technology Development

Within the last 3 years, two African countries, Algeria (2002) and Nigeria (2003) launched their own earth observation satellites (EOS) thereby joining the league of ‘sensing’ countries, moving Africa out of the former class of being totally a ‘sensed’ continent. It is however noted that South Africa has been involved in space technology development before then. Due to the successful launch of the AlSat-1 (Algeria) and NigeriaSat-1 (Nigeria) there has been a significant increase in the awareness of decision makers and civil society in the applications of EOS and GIS. It is therefore essential to match these developments with a proactive manpower development for R&D and applications, in addition to necessary institutional reform.

2.2 Expanding adoption of GDI

Another factor is the increased interest in GDI. At regional and national levels, the need for the implementation of GDI has been recognized and is being pursued more vigorously now. Key factors in this process are adequate provision of skilled manpower, improved organizational capacity and institutional reforms. To underpin the importance of capacity, Working Group on capacity building is usually one of the Working Groups or sub-committees set up by the national GDI Committees (e.g. Nigeria, Mali and Namibia). This is also the case at the regional level under the Executive Working Group (EWG) inaugurated by the UN ECA Committee on Development Information, Geoinformation sub-committee (CODI-Geo) (http://geoinfo.uneca.org). The main task of the EWG is to facilitate the implementation of GDI in Africa; to achieve this task the EWG has set up the five working groups including capacity building to drive the process.

To give example at the national level, the Nigerian National Geospatial Data Infrastructure (NGDI) Committee has also set up the following six subcommittees: Geospatial Datasets, Metadata & ClearingHouse, Standards, Capacity Building and Awareness, Sustainability & Funding, and Legal.

It is axiomatic to note that central to the realization of GDI initiative is the production of fundamental datasets. After a recent survey conducted by the CODI-Geo WG on Fundamental datasets and Mapping Africa for Africa (funded by South Africa's Directorate of Survey – the Chair of the WG on Fundamental Datasets), the following datasets have been proposed as the regional fundamental datasets for Africa: geodetic controls, administrative boundaries, land management units, hypsography (DEM, contours, spot heights), aerospace imageries, geographic names, transportation, Hydrography, Utilities and Natural Environment (land use/land cover).

An example of adopted fundamental datasets at national level is that of Nigeria. The datasets as defined in the Nigerian GI policy are: geodetic control, topographic/DEM, digital imagery and image maps, administrative boundaries, cadastral, transportation networks, hydrographic datasets, land use/land cover, geological, and demographic datasets.

With the completed and on-going regional and national definition of fundamental datasets in Africa, follow-up activities would include: inventory of existing data, developing data model for these data layers, production of non-existing data layers, per inventory, and developing the metadata for all data layers.

The question then is do we have the necessary human, organizational and institutional capacities to ensure that these datasets are produced and other necessary activities are performed?

To further underpin the importance of capacity building, the Nigerian GI Policy provides among other policy statements that:

- Every GI project must include a training component.
- Institutions of learning offering geoinformatics-related programmes should review their curricula on regular basis in line with advances in GIT.
- GI projects shall be locally implemented to a minimum level of 75% to strengthen local capacity.
- GI producers shall provide evidence of the local contents of their production activities in compliance with Government policy on local content.
- Impact assessment of GI projects shall be conducted on regular basis.
- Government should encourage research on new innovations in geoinformatics and its various applications.
- Introductory geoinformatics should be introduced in secondary school to enable faster permeation of GI applications in the society.

The question then is: do we have a critical mass of skilled manpower and efficient organizational and institutional set-up to drive this process? Although we do not yet have a documented study of the current state of capacity in GI in Africa, an informal appraisal of present situation (through contacts at conferences, Council meetings of regional centres, visits to GI-related organizations in member states, discussions at workshops, informal interview with trainees every year) vis-à-vis what GDI implementation requires can only receive a negative answer to that question.

For example, during a regional workshop on geospatial data infrastructure held in RECTAS from 28 November to 2 December 2005 for Chief Executives of National Mapping Agencies and representatives of private sector from 17 west and central African countries, on recognizing the enormous work that they still have to do to ensure that GI is made adequately available vis-à-vis the current inadequate state of their human, organizational and institutional capacities, strong request was made by majority of the participants for both long-term postgraduate level courses as well as short-term courses for different cadres of GI personnel in the various countries.

To facilitate rapid capacity building in GDI in Africa, the CODI-Geo Working Group has been set up to, among other terms of reference:

- Encourage basic training on SDI and its components at regional and national levels
- Promote research into resources and development opportunities being lost, due to absence of GI and SDI and disseminate findings on them
- Promote research on success stories with respect to implementation of SDI
- Encourage development/review/standardisation of geoinformatics curricula in higher institutions of learning
- Promote continuing professional development programme on SDI concepts & Geo-information Science by relevant professional bodies
- Promote international cooperation in the area of building GI/SDI capacity
- Facilitate institutional reforms in GI organizations to ensure assimilation of NGDI initiative.

3.0 WAYS OF ACHIEVING THE TRAINING NEEDS

The situation report summarized above indicates the daunting tasks that institutions of higher learning in Africa must address. The education and training needs can in principle be undertaken in a University, polytechnic, or specialized institution. Examples of the specialized institution are the regional centers and the national survey training institutions.

While the Universities and Polytechnics concentrate mainly on regular education courses mostly leading to the production of new graduates, the specialized institutions focus more on manpower development through the education, training and retraining of serving officers. Furthermore, flexibility is possible in the specialized institutions, facilitating running of their programmes in short modules to permit continuing education of serving officers through short courses that are part and parcel of the regular programmes.

Unfortunately, many of these institutions are hardly ready for the tasks. In Nigeria for example, there are 10 Universities and 18 Polytechnics running surveying and geoinformatics programme (Solesi, 2005). But all these universities, due to inadequate training facilities produce on the average, less than 300 geoinformatics graduates at all levels per year while the polytechnics produce less than 500 technicians and technologists per year. Even then, the new graduates require further training before they can be usefully engaged in modern production work. In some countries, the departments face the threat of being closed down due to lack of equipment and personnel to meet accreditation standards. RECTAS in the last one year gave out analogue photogrammetry plotters to 12 of the 18 polytechnics and 2 Universities in Nigeria in a situation where RECTAS is getting rid of the equipment in line with the Centre's modernized training curricula.

What then can be done to ensure development of the needed critical mass of human capacity?
It is obvious from the foregoing that apart from production organizations, training institutions themselves require capacity building to enable them to meet the training requirements of the various countries. In fact to make significant impact through multiplier effect, enhancement of the capacity of the training institutions must receive priority attention than the production organizations.

4.0 EDUCATIONAL NETWORKING

Consequent upon the afore-mentioned inadequacies, various authors have argued in favour of educational networking as the most efficient way of achieving rapid capacity building on continual basis that moves in tandem with advances in technology. This author supports this position. The educational network in this case can be categorized into two (Kufoniyi et al, 2002): South-South and North-South networks.

4.1 South-South Educational Network

The south-south education network is limited to collaboration among two or more institutions of learning in the south carrying out joint research and training programmes thereby sharing facilities. The collaboration can be among institutions that are located in the same country (intra-national) or in different countries (international) but only in developing countries, African countries in this case. Examples of intra-national collaborations exist in various countries. In Nigeria for example, working collaborations exist between RECTAS and various Nigerian Universities while similar ones are being developed with institutions in other member states of RECTAS. One of the existing collaborations is between RECTAS and Obafemi Awolowo University, Nigeria for Masters Degree programmes (MSc and Professional Masters) in Remote Sensing and GIS, which started in 2003.

Nkambwe (2001) also gave two examples of south-south education network: the South African Network for Training on the Environment (SANTREN) and the SADC EIS Training and Education sub-programme (SETES), both of which cuts across many countries in Southern Africa.

4.2 North-South Educational Network

This involves the collaboration of one or more institution(s) in the south and one or more institution(s) in the developed countries. This type of network has the advantage of regular update of curriculum including north-south staff and student exchange programmes.

An example of an evolving North-South educational network is the International Capacity Building Network on Geo-information Science and Earth Observation code-named 'GI-NET' involving some 43 partner-tertiary institutions and initiated/piloted by ITC. The ITC-RECTAS collaboration described in the next section is one of the partners in the network.

The network will contribute to rapid national and regional development by:

- Providing qualified graduates for immediate employment and productivity.
- Retraining existing personnel for improved productivity and introduction of modern production techniques.
- Retraining academic staff of other institutions so as to be able to modernize their curricula in line with modern trend.
- Significant saving in foreign exchange through efficient local training and reduced stay abroad.
- Assisting production organizations through well-equipped consultancy services.

The network aims at increasing the critical mass of trained manpower in the less developed countries (LDCs). By having part of the training in the home partner institution of the students thus shorter stay in the Netherlands, it follows that more people will be trained when compared to when the student carries out the entire programme in ITC. The example of the ITC-RECTAS joint MSc course in section 5 indicates that the course fee drops to 40% when the course is fully run in RECTAS, which means that at least two persons can then be trained at the present cost of training one person. In addition to this is the multiplier effect resulting from the trainers that participated in the programme training the others in their institutions thus leading to rapid increase in capacity. The network will also facilitate faster technology transfer by running part of the education programme in partner institutions by taking advantage of the strengths of the partners.

5.0 ITC-RECTAS JOINT EDUCATION PARTNERSHIP

The ITC-RECTAS joint education programme is a bilateral link within the multilateral educational network described above. The partnership has been fully endorsed by all the member states of RECTAS and the UNECA. The collaboration focuses on joint education, joint research, joint consulting as well as exchange of staff. The education component of the partnership targets the mid-career professionals. It will facilitate institutional strengthening and building of capacity of the home partner institution (RECTAS) while increasing the number of personnel trained by ITC with the same level of financial resources.

The programme focuses on education and training in geoinformatics at the MSc level including refresher courses of duration of one to four weeks. Under this partnership, the joint MSc programme commenced in September 2004, while three refresher courses each of two to three weeks duration had been run to date.

RECTAS is a legally recognized bilingual (English and French) education and training institute established in 1972 as a regional Centre of the UN ECA to provide education and training, research and advisory services, and consultancy in the field of geoinformatics, including photogrammetry and remote sensing, cartography, and geographic information systems (GIS), and their various applications (see www.rectas.org). The Centre runs regular long-term training courses in geoinformatics at technician (18 months), technologist (18 months) and postgraduate diploma (12 months) levels as well as joint MSc in Geoinformatics (18 months) with ITC, and Masters (12 months) and MSc (18 months) in Remote Sensing and GIS with Obafemi Awolowo University, Nigeria. In addition, the Centre runs short courses as modules of the regular courses and customised training on request.

5.1 The Joint Education Programme Structure and Formats

The joint MSc course has a modular set-up with 23 modules of three weeks with the last 8 modules being the MSc research project. The joint MSc course has been developed in four phases as shown in Table 1.

Table 1: Implementation Format of the Course

Phase	Period	RECTAS Provides	ITC Provides
One	2004 and 2005	• Modules 1 – 10 (7.5months)	remaining course including defence (10.5months)
Two	2006 and 2007	• Modules 1 – 13 (10.5months)	Remaining course including defence (7.5months)
Three	2008 and 2009	• Modules 1 – 11 • Completion at RECTAS including defence (15months)	Modules 12 – 15 (3months)
Four	2010 and onward	Full programme runs at RECTAS (18months)	Quality control & staff exchange

5.2 Award of Degree and Diploma

The joint programme will result in Master of Science degree issued under the auspices of ITC as “Master of Science degree in Geo-information Science and Earth Observation with specialisation in Geoinformatics” together with a course record with logos of ITC and RECTAS.

5.3 Quality assurance

The entrance requirements of the courses are designed to satisfy the rules and regulations of both partners. In the first two years, the PG Diploma students at RECTAS undergo the same course as the MSc stream for the first 10 modules except the module on research skills. The quality and quality assurance of the joint programme are designed to meet the internal requirements of both Partners as well as the criteria of the accreditation bodies in the Netherlands.

5.4 Course Fees

With gradual increase in the number of modules to be run in RECTAS, the course fees decrease from one phase to the other. For phase 1, total fee (including monthly stipend and air ticket to and from Netherlands) is Euro 16690. For phase 2: Euro15944; phase 3: Euro 14575; and phase 4 (fully in RECTAS): Euro 6401(see details in www.rectas.org). This indicates that the course fee reduces to about 38% of the starting fee when the programme is run fully in RECTAS.

6.0 SUSTAINABILITY REQUIREMENTS

For the sustainability of the programme and in deed the multilateral partnership, some critical issues must be fully addressed. Some of these issues are summarized in this section.

6.1 Accreditation of the programme

Without doubt, the education network will rapidly increase trained manpower, but this will happen only if the user community and organizations are convinced that the graduates of the programme and those of the fully-ITC programme possess the same knowledge after their education. This requires the recognition and accreditation of the joint education by the Netherlands Organisation for International Cooperation in Higher Education (NUFFIC) as being at the same level as a degree obtained in Netherlands. This will assure the credibility and acceptance of the course by the society and the international community. NUFFIC’s acceptance of the course into its fellowship programme will also make immediate positive impact in the number of beneficiaries of Netherlands assistance to developing countries as can be adduced from section 5.4. A significant increase in the number of trained personnel will also lead to successful implementation of Netherlands Government funded projects in Africa as there will then be a critical mass of skilled manpower to facilitate provision of GI services for these developmental projects.

In addition, the partner institutions should ensure that the course is accredited by relevant organizations in the region. For example, RECTAS is processing the accreditation of all its courses by CAMIS (Conseil Africain et Malgache de l’Enseignement Superieur – Africa and Madagascar Council of Higher Education). With these accreditations, organizations will not hesitate to send their personnel to the partner institution nearest to them; it may even be easier to have budget lines for the training arising from the lower cost. It will also encourage fellowships from other organizations and thus enhance sustainability of the partnership.

6.2 Standardisation of Curriculum

Having a uniform and standardized curriculum will also greatly contribute to the sustainability of the network. The standardization should not only be in terms of the curriculum but also in the course calendar as well as in the training facilities. This will encourage flexibility and mobility of course participants i.e. students exchange. For example, it would then be possible for an itinerant course participant to do some parts of his/her course at RECTAS, some parts in another partner institution while finishing in ITC. Apart from the cultural mix implied in this arrangement, it has the potential of facilitating fellowship in full or in parts by different donors for the course.

6.3 Logisitics

Another important issue which looks innocuous but can deter the success of the network is the aspect of travel logistics. The most important of this is the key support of the participating institutions countries' embassies. The visa procedure in some of the countries are so stringent that a candidate may lose a lot of valuable time running after visa rather than concentrating on his/her academic programme while still in his/her home country's partner institution. The spin-off effect of this is that the affected institutions may then start to consider other education network options including viable south-south collaboration.

6.4 Mutual Trust and Respect

Without prejudice to quality assurance, partner institutions of the network have to ensure that the relevant staff members in their institutions have mutual respect for their counterpart in the other institutions. It is only when this is the case that the products of the joint programme will be accepted by all as having the same qualification and skill at the end of the programme irrespective of the scheme they followed.

7.0 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

An attempt has been made in this paper to assess GI capacity building requirements in Africa. The need for improved GI capacity and factors affecting notable achievement are highlighted. The paper concludes that to achieve a rapid capacity building in geoinformatics in African countries, it is essential to put in place education networks and partnership at national (intra-national network) and international levels with the latter involving both south-south and north-south networks. Example of such partnership is the ITC-RECTAS joint education programme which has been presented in this paper. Such collaboration will facilitate the training and retraining of personnel at various levels in order to bridge the digital divide between the developed countries on the one hand and developing countries on the other hand. The partnership will be further invigorated if the joint education can be run on multi-lateral basis such that a student will be able to take courses from different partner institutions according to the education requirements of the student.

7.2 Recommendations

To ensure that the joint education network achieves its aim of rapidly increasing the human, organisational and institutional GI capacities in Africa and indeed in all less developed countries, some recommendations have been made in the paper some of which are itemised below

- That ITC and other interested GI institutions in developed countries should pay greater attention to joint education network in order to facilitate institutional strengthening of the partner institutions and lead to training of more personnel at the same subsisting cost.
- The joint education courses should be recognised and accredited by NUFFIC and included into its fellowship programme thereby increasing the number of fellowships even without increasing the budget.
- Effort should be made to standardise the course curriculum, training facilities and calendar in all partner institutions for accreditation purposes and to facilitate student exchange programme.
- Partner institutions must ensure that the courses are accredited by relevant organisations and that the quality of the programme is assured.
- Embassies of countries of partner institutions need to identify with the programme to facilitate travel schedules of students and staff, which may even be at short notice; this may require that foreign ministries are well acquainted about the programme to obtain their approval for special guidelines for visa application to enable smooth running of the programme.
- There should be mutual respect and trust by staff members of the partner institutions without prejudice to quality assurance.

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REGIONAL CENTRE FOR MAPPING OF RESOURCES FOR DEVELOPMENT (RCMRD): GEO-INFORMATION CAPACITY BUILDING ACTIVITIES IN AFRICA

Dr. Wilber K. Ottichilo
Regional Centre for Mapping of Resources for Development (RCMRD), P.O. Box 632-00618 Ruaraka, Nairobi, Kenya
Ottichilo@rcmrd.org; www.rcmrd.org

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ABSTRACT:

Geographic information or geo-information is very important and crucial in social-economic development and well being of mankind. About 80% of geographic information is used in all forms of development planning and decision making at local, regional, national, continental and global levels. Thus when information about the geography, social and economic conditions and the policies and institutions is readily accessible, creative problem solving can lead to sound decisions with a lasting positive impact on people's lives. Sustainable development requires access to data, information, knowledge and understanding about the environment and natural resources including socio-economic opportunities. Prior to the advent of earth observation satellite technology in the early 1970s, geographic information was mainly collected using a diversity of ground and aerial based conventional methods. With the rapid development in satellite technologies, most of the geographic data and information is currently acquired through earth observation satellites in real time and on a continuous basis. This data and information is important and crucial for sustainable development of developing countries particularly African countries. However, the use of this data and information in Africa is still limited due to numerous reasons. Among the reasons are lack of awareness among planners and decision makers of the importance of geo-information in sustainable development, inadequate capacity (qualified human resources and facilities-hardware & software), lack of institutional and policy arrangements, data accessibility problems, uncoordinated application of geo-information technologies in sustainable development as well as in the development Spatial Data Infrastructures (SDI) etc. The Regional Centre for Mapping of Resources for Development (RCMRD) whose mission is to promote the use of geo-information in sustainable development in Africa has adopted a partnership strategy to achieve its mission. The strategy entails collaborating with international, regional and nation institutions and organizations as well private sector in addressing the above constraints in an effort to promote the use of geo-information in sustainable development in Africa. This paper presents some of the Centre's on-going geo-information capacity building activities.

INTRODUCTION

The Regional Centre for Mapping of Resources for Development (RCMRD), previously known as Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS) was established in Nairobi, Kenya in 1975 under the auspices of the United Nations Economic Commission for Africa (UNECA) and the then Organization of African Unity (OAU). Its founder members are Kenya, Uganda, Somalia, Tanzania and Malawi and the Government of the Republic of Kenya hosts it. It is a non-profit intergovernmental organization and currently has 15 contracting member States, namely: Botswana, Comoros, Ethiopia, Kenya, Lesotho, Malawi, Mauritius, Namibia, Seychelles, Somalia, Sudan, Swaziland, Tanzania, Uganda and Zambia. Apart from the member States the following countries are affiliated to the Centre: Angola, Mozambique, Zimbabwe, Rwanda, Burundi, Madagascar, Djibouti, Eritrea, Zaire and South Africa.

The operations of the Centre are funded in part by contributions from contracting member States and revenue generated from sales of its products and services.

The original objectives of the Centre were:

- To provide services in the fields of surveying and mapping including aerial photography, photogrammetry, photo-interpretation, first order geodesy, remote sensing, calibration and maintenance of surveying and mapping equipment;
- To provide training for nationals of contracting parties in surveying, mapping and remote sensing, and;
- To provide advisory services upon request

on problems relating to surveying and mapping to the governments of member States.

The new mission of the Centre is, **"To Promote the Development and Use of Geoinformation in Sustainable Development in Africa"** and its key objectives are:

- To develop and constantly update harmonized and standardized land resources and urban development digital data and information infrastructure for the region, based on demand;
- To develop a regional early warning system for food security, environmental monitoring and disaster management using mainly satellite technology;
- In collaboration with member States, national institutions, undertake projects for creation of spatial information system suitable for development planning at national, regional and community levels;
- Coordinate the harmonization of the fragmented regional and African datum using accurate geodetic GPS techniques and research into the field of data processing methodologies;
- Develop capability and capacity in the maintenance of surveying and mapping equipment and offer advisory and maintenance services to the member States; and
- In collaboration with national and international institutions, undertake research and training in the application of geo-information in land resources and urban development mapping and assessment for sustainable development.

The promotion of geo-information entails capacity and capability building and provision of advisory and consultancy services to member states and other clients. The main geo-information technologies promoted by the Centre are Geographic Information System (GIS), Satellite Remote Sensing (SRS), Global Positioning system (GPS) and Information Technology (IT). The Centre is also vigorously involved in the promotion of the development of National Spatial Data Infrastructure (SDI) in its member States. SDI is defined as an "umbrella" of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management and production of geo-spatial data.

This paper presents a brief on the Centre's geo-information capacity building strategy and activities.

GEO-INFORMATION CAPACITY BUILDING STRATEGY

Our geo-information capacity building activities mainly focus on awareness creation among decision makers on the importance of geo-information in sustainable development, conducting of various short-term applications oriented training courses for different clients and implementation of geo-information related projects.

There are many institutions, companies and initiatives in the world that are involved in geo-information capacity building programs or activities. Since geo-information is a new emerging discipline that is rapidly developing and is being embraced by various institutions, its promotion requires collaboration with various relevant partners. Our centre has chosen to collaborate with various partners in its effort to promote the use of geo-information in sustainable development in Africa.

Partnerships are usually established through identification and initiation of discussions with prospective partners as regards to agreement on areas and modalities of collaboration. This is then formalized through signing of a Memorandum of Understanding (MOU) whose implementation is evaluated and monitored periodically. Among our current partners are:

- International Institute for geo-Information Science and Earth Observation (ITC)
- Clarke University, U.S.A
- University of Texas A & M, U.S.A
- University of Trieste, Italy
- University of Dar es Salaam, Tanzania
- University of Nairobi
- Jomo Kenyatta University of Agriculture and Technology
- United Nations Environment Programme (UNEP)
- United Nations- Habitat, Nairobi
- United Nations Economic Commission for Africa
- US Geological Survey, FEWSNET and EROS Data Center
- Environmental systems Research Institute (ESRI)
- International Centre for insect Physiology and Ecology
- IGAD-Drought Prediction Centre
- International Cartographic Association (ICA)
- Maps Geo-systems Ltd, UAE
- Creative Associates Ltd, U.S.A

We also promote geo-information capacity building through promotion of Public Private Partnerships.

GEO-INFORMATION ACTIVITIES

The main geo-information capacity building activities undertaken by the Centre are:

- Awareness creation on the importance of geo-information
- Promotion of GIS as a planning tool
- Conducting of various short term training courses
- Implementation of geo-information related projects
- Promotion of establishment of Spatial Data infrastructures (SDI)
- Building capacity in the use of satellite data in early warning for food security, environment and disasters
- Coordinate the activities of the African Reference Frame (AFREF) and UNEDRA Initiatives
- Research and Development

Awareness Creation

Geo-information is vital for sustainable development. Thus when information about the geography, social and economic conditions and the policies and institutions is readily accessible, creative problem solving can lead to sound decisions with a lasting positive impact on people's lives. Geo-information is particularly vital for optimizing the productive use of a country's human and natural resources. It can also help direct development in ways that meet maximum human needs at lowest environmental cost by, for example, identifying key land, water and wildlife resources and how to maintain their productive capacity. Lastly important social benefits are derived from using geo-information to make decisions about provision of services in a manner that is transparent and fair to all.

Because of the importance of geo-information in sustainable development, our Centre conducts awareness activities in our member states that are aimed at sensitizing the decision makers and planners on the need to develop and use geo-information in all planning and decision making processes. The activities entail mainly presentations and demonstrations at workshops, seminars and meetings normally attended by decision makers, planners and politicians.

Promotion of GIS as a Planning Tool

GIS is a tool that has the capability to integrate complex data sets (physical, economic and social) in order to facilitate the rational exploitation of such data in decision-making, development planning, environmental monitoring and resource management. Since most African countries have not embraced the use of this tool in their planning and decision-making processes, the Centre has formulated a strategy for GIS promotion and application in its member States, which entails:

- Creation of awareness among planners and decision makers;
- Preparation and demonstration of prototype applications of GIS for both public and private sectors;
- Capacity building of relevant member state nationals; and
- Working collaboratively with its member states and development partners in the creation of spatial information systems suitable for development planning.

Training Courses

Training of nationals from our member States in the application of geo-information in sustainable development is our core business. We undertake short courses (two weeks to three months) that focus mainly on the application of geo-information technologies in resource mapping, planning and management; environmental management and monitoring; database development and management and servicing of surveying and mapping equipment. We also undertake customer tailored training courses. The following are our general training courses, which are conducted throughout each year:

- Land Use, Land Degradation Assessment and Monitoring using Remote Sensing and GIS (February and July)
- Application of Remote Sensing and GIS to Early Warning Systems for Food Security and Environmental Monitoring (March and August)
- Application of Remote Sensing and GIS in Natural Resources Assessment and Management (April and September)
- Geo Spatial Database Development and Management for use in planning process and decision making (May and October)
- Introduction to the principles of Geomatics (Integrated course in RS, GIS and GPS)
- GIS and Digital Cartography (June and November)
- Fundamentals of Modern Land Surveying and Positioning Systems (March and August)
- Maintenance of electronic and optical-mechanical surveying instruments (throughout the year)

Apart from these courses we also undertake customer tailored training courses.

Promotion of the Development of Geo-spatial Data Infrastructure (SDI)

SDI is defined as an "umbrella" of policies, standards and procedures under which organizations and technologies interact to foster more efficient use, management, and production of geo-spatial data. The Centre will assist African countries to develop fully-fledged and coordinated SDI, in order to improve planning and rationing management of resources and access to information.
To promote the development of SDI, the Centre in collaboration with other development partners (e.g. UNECA, USGS, Global Mapping, GSDI, national Mapping Agencies etc) organize workshops in which planners and decision makers are sensitized on the importance of SDI. Also the Centre in collaboration with development partners the Centre trains relevant nationals in the development of SDI. The ultimate goal of the Centre is to promote the establishment of SDI in its Member States and SDI as a "business investment".

Implementation of Geo-Information Related Projects

The Centre in collaboration with its partners and member

States prepares and implements various geo-information related projects. Normally these projects have capacity building components which include training packages for the project clients and relevant hardware and software. Among the projects implemented are:

- Land cover mapping of eastern African countries (FAO-AFRICOVER Project)
- Preparation of National Wind Atlas for the Ministry of energy, Kenya (2002-3).
- Preparation of Landover Database and Maps for South Sudan (Contracted by GIBB (Africa) and Yam Consultants Ltd, Sudan)(2003-4)
- Development of Somalia Hydrological Database for FAO, Nairobi office (2003).
- Preparation and dissemination of Greater Horn of Africa (GHA) Bulletin on Food Security. The bulletin is prepared in collaboration with FEWSNET, DMC, ILRI, WFP, USGS, DLCO and USAID.(on-going)
- The coordination of African Reference Frame (AFREF) Project in collaboration with IAG, ECA, AOCRS and other Regional Centres (on-going).
- Development of Digital Urban Databases for Nairobi, Kisumu, Eldoret and Malindi in Kenya. (2003). Contracted by Physical planning Division of Ministry of Lands and Settlement, Kenya;
- Lake Victoria Wetland Mapping (2005), funded by Lake Victoria Environmental Programme
- Development of Djibouti Spatial Database (2005), funded by USAID
- Gums and Resins Resource mapping in the Greater Horn of Africa, funded by FAO (2005)
- Mapping of 11 towns in Southern Sudan, funded by USAID (2005-2006)
- Mapping of 14 towns on the shores of Lake Victoria, funded by UN Habitat (2006)
- Creation of Digital Spatial database for Mumias Sugar Company, Kenya (2006)

Building Capacity in the Use of Satellite Data in Early Warning for Food Security, Environment and Disasters:

In collaboration with its partners (USGS, ILRI, LEWS, DLCO, ICPAC, FEWSNET etc), the Centre continues to train government and NGO officials in the use of satellite data in early warning for food security, environment and disasters in the Greater Horn of Africa. Also in close collaboration with its partners produces and disseminates monthly early warning for the Greater Horn of Africa.

Coordination of African Reference Frame (AFREF) and University Network on Disaster Reduction in Africa (UNEDRA)

The Centre coordinates the AFREF initiatives whose main objectives are:

- Define a continental geodetic reference frame for Africa
- Establish precise and uniform African geoid
- Establish permanent GNSS base stations such that each nation and users have free access to GNSS data and product from such stations
- Establish an in-country expertise for implementation, operation, management, analysis and presentation GNSS data and products.
- Determine transformation parameters between GNSS and ITRF to/from local reference systems
- Understand the necessary geodetic requirements of participating nationals and international agencies
- Promote the use and application of GNSS technology for African development
- Promote African development through GNSS and ICT products and technology transfer within the continent and at international level

This initiative is supported by African countries and various international organizations including UN Economic Commission for Africa (UNECA), International Association of Geodesy (IAG) etc. For more information visit the website: http://geoinfo.uneca.org/afref/

The Centre also coordinates the activities of UNEDRA. The main objective of the network is to forge interaction amongst universities in Africa with interest in capacity building in disaster risk reduction through teaching, seminars and workshops, sharing information and collaborative research with emphasis on the use of geo-information. For more details about the network, see the document enclosed herewith and the visit the website: http://www.itc.nl/unu/dgim/unedra/default.asp

Research and Development

In collaboration with its partners, the Centre is involved in the formulation and implementation of various research and development projects. The projects focus mainly on the different applications of satellite data. These applications include but not limited to food security and early warning, environmental and disaster monitoring, mapping of socio-economic activities, poverty, diseases etc.

To promote research capacity in geo-information, the Centre in collaboration with various universities provides data and research facilities for students undertaking M.Sc. and PhD studies that entail the use of modern geo-information technologies.

CONCLUSION

Due to the increasing awareness of the importance of geo-information in sustainable development, the demand for capacity building in the same is increasing in Africa. Since it is a new and fast evolving discipline, most institutions in Africa have yet to introduce it as a fully fledged discipline in the academic programs. Instead the subject is taught on unit basis in some of the faculties. The full introduction of geo-information training at most universities in Africa is hampered by lack of hardware and software as well as qualified human resources. It is therefore important that these institutions have to be supported in building their capacity to offer training in geo-information technologies and their applications in sustainable development. Equally regional Centres like RECTAS, RCMRD should be supported to continue offering their training courses and advisory services which focus mainly on geo-information application in sustainable development in Africa.

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JAXA's Capacity Building Activities in Asia-Pacific Region

Chu ISHIDA, Lal SAMARAKOON, Yoko INOMATA, Minako OZAWA

Satellite Application Center, Office of Space Applications
Japan Aerospace Exploration Agency (JAXA)
Shin-Otemachi Building, 2-2-1, Otemachi, Chiyoda-ku, Tokyo 100-0004 JAPAN
ishida.chu@jaxa.jp, inomata.youko@jaxa.jp, lal@jaxa.jp or lal@ait.ac.th, ozawa.minako@jaxa.jp

KEY WORDS: Asia-Pacific Earth Observation Pilot Project, AIT, GISTDA, LAPAN, ALOS, Sentinel Asia

ABSTRACT:

Japan Aerospace Exploration Agency (JAXA) started its capacity building activities for the Asia-Pacific region in 1995 in cooperation with Asian Institute of Technology (AIT), in Bangkok, Thailand. In addition, JAXA has been carrying out two different pilot projects with Thailand and Indonesia as a part of its capacity building activities. Main objectives of these projects are (1) to provide necessary technical know-how to RS & GIS users in the region as a contribution by the Government of Japan to capacity building recognized in WSSD*, EO Summit**, CEOS***, GEOSS**** and UNWCDR*****; (2) to use Japanese satellite data archived for more than last 25 years for sustainable development, planning and monitoring purposes in the region; (3) to develop in-house capacities of prospective users of the region by working on project-based training programs; and (4) to identify future space technology needs in the region for better service of forthcoming Japanese satellite programs. Through the pilot project with AIT, JAXA has so far succeeded in training 1,006 government employees of the region for last 11 years from 1995 to 2005.

It is expected that JAXA's capacity building activities will be more active with the data acquired with the Advanced Land Observing Satellite (ALOS) which was launched by JAXA's H-IIA launch vehicle on January 24, 2006. The ALOS aims at obtaining data useful for topography mapping, local environment observation and disaster monitoring. Furthermore, in February 2006, JAXA started the Joint Project Team Meeting (JPTM) for establishing a disaster management support system, called "Sentinel Asia", involving the regional space agencies, disaster management organizations and international entities. Capacity building activities in the region is considered as one of the focuses of JAXA's activities for next 10 years.

WSSD*: World Summit on Sustainable Development (known as the Johannesburg Summit held in South Africa in 2002)
EO Summit**: Earth Observation Summit (so far held in Washington D.C, Tokyo and Brussels, Belgium, since 2003) ,
CEOS***: Committee on Earth Observation Satellites
GEOSS****: Global Earth Observation System of Systems
UNWCDR*****: United Nations World Conference on Disaster Reduction (held in Kobe, Japan, in 2005)

1. WSSD Type-II Partnership Activities

At the WSSD held in September 2002 in South Africa, the following three activities were proposed by the Government of Japan and they were registered as the "WSSD Type-II Partnership Activities" of Japan: (1) Capacity Building Activities through AIT in Bangkok, Thailand; (2) Pilot Project with Thailand's GISTDA (Geo-Informatics and Space Technology Development Agency); and (3) Pilot Project with Indonesia's LAPAN (National Institute of Aeronautics and Space). "Asia-Pacific Earth Observation Pilot Project" is the registered title.

Since 1995, JAXA has been entrusting responsibility to AIT of providing technical training on Remote Sensing (RS), Geographical Information System (GIS) and Global Positioning System (GPS) in the Asia-Pacific region. As a result of the 11-year (1995~2005) training activities fully supported by JAXA and carried out by AIT, the number of trainees reached 1,006 from 27 countries.

The contents of the training programs at AIT have, of course, changed by the request in the age.

2. JAXA/AIT's 2005 Training Programs

To accomplish the above-mentioned 4 objectives of JAXA's capacity building activities, JAXA/AIT conducted the training programs consist of the following 3 different types of activities during the JFY2005 (1 April 2005 – 31 March 2006):

1. Caravan Training Programs;
2. Mini-Projects; and
3. Workshops.

2.1 Caravan Training Programs

The purposes of the Caravan Training Programs are to promote basic technology, to transfer knowledge and to publicize JAXA activities by conducting those training programs in various countries of the region.

The Caravan Training Programs' distinctive characteristics is having a larger audience compared with inviting trainees AIT so that these are considered cost-effective. Topics are selected after considerable discussions with a respective RS/GIS organization in each country.

Characteristics of Caravan Training Programs are;

1. Duration: 5 days
2. Trainees: Technicians and middle level managers of respective agencies
3. Number of Countries Caravan Training Conducted: 2

4. Expected Number of Trainees: At least 25 participants in each country

For 20005, JAXA/AIT conducted the caravan training in the following 2 countries:

1. Sri Lanka
   Dept. in charge within Government of Sri Lanka: Survey Department
   Title of Training: "Coastal Mapping using High Resolution Satellite Data"
   Number of Participants: 28
2. Lao PDR
   Ministry in charge within Government of Lao PDR: Ministry of Science & Technology
   Title of Training: "RS & GIS for Watershed Mgt.
   Number of Participants: 38

2.2 Mini-Projects

Mini-projects are designed to contribute to JAXA's capacity building for the Asia-Pacific region through training programs and field work in a topic most relevant to each participating countries.

Mini-projects are also considered as an object-oriented training in RS, GIS and GPS. Participants are requested to carry out a project suitable to their needs. Consequently, necessary basic training and field work are carried out in order to achieve their respective goals.

Unlike conventional training programs focused on a particular topic, this new method can facilitate the participants to work in their own areas for a considerable amount of time and apply RS in their day to day work.

As unique characteristics of Mini-Projects, its duration is 9 weeks through the year as below:

1. First Term: 5-week classes and research work at AIT
2. Second Term: 1-week fieldwork at participant's own country
3. Third Term: 3-week Final-Report Making at AIT

For 2005 Mini-Projects, the number of trainees participated in the 2005 object-oriented mini-projects were 23 from 9 organizations.

8 out of 9 mini-projects were focusing on disaster management. Only exception which was unrelated to disaster management was Philippine Rice Research Institute (PhilRice)'s mini-project titled "Paddy Area Mapping and Yield Estimation."

The followings are the list of the 2005 Mini-Projects:
(1) Bangladesh: Space Research and RS Organization (SPARRSO)" Flood Mitigation"
(2) Cambodia: Department of Land Management "Land Use Planning Resource Management"
(3) Cambodia: Dept. of Geography "Drought, Flood"
(4) Nepal: Survey Department "Urban Planning for Earthquake Disaster Management"
(5) Philippines: National Mapping and Resource Information Authority (NAMRIA) "Landslide, Flood"
(6) Philippine: Rice Research Institute (PhilRice) "Paddy Area Mapping and Yield Estimation."
(7) Sri Lanka: Central Engineering Consultancy Bureau (CECB) "Landslide"
(8) Vietnam: Space Technology Application Center (STAC), Institute of Physics "Mangrove Forest Management for Flood Mitigation"
(9) Vietnam: Department of Dyke Management "Landslide"

2.3 2005 Workshops

JAXA conducted two workshops through AIT in 2005 as below:

1. One-Day Workshop titled as "Capacity Building in Asia - JAXA Collaboration" was held in Hanoi, Vietnam on 8 November 2005 in conjunction with Asian Conference on Remote Sensing (ACRS). Some selected mini-project participants made a presentation to appeal the fruit of their efforts.

2. Two-Day Workshop on Disaster Mitigation in collaboration with ASEAN SCOSA was conducted from 14 to 15 February 2006 in Vietnam. At this workshop, discussion was carried out on technical aspects of conducting the Mini Projects especially focusing on disaster management with selected countries. This workshop was also a coordinating meeting with Asian Disaster Reduction Center (ADRC), UNESCAP and ASEAN SCOSA (Sub-committee on Space Technology and Applications.)

3. Pilot Projects with GISTDA and LAPAN

JAXA, GISTDA of Thailand and LAPAN of Indonesia have been implementing a series of pilot projects aimed at improving the use of satellite data by government agencies in those countries.

This Asia-Pacific Earth Observation Pilot Project also aims at greatly contributing to promoting capacity building for wider use of satellite data in the region as a whole.

3.1 Japan's Contribution to Pilot Project with Thailand

JAXA launched the Advanced Earth Observing Satellite-II (ADEOS II) in 2002 and the Advanced Land Observing Satellite (ALOS) in January 2006.

Since those satellites can provide new opportunities of using satellites data, JAXA, AIT, GISTDA and LAPAN decided to continue the pilot project as the "WSSD Type-II Activities."

History of Pilot Project with Thailand is as follows;

1986-: Cooperation program in MOS-1 and JERS-1
 Established data receiving, recording and processing system
1997-2002: JERS-1 Pilot Project
 Researched satellite data utilization possibility in a few fields
 Improved Thai users' skill
2001: Agreement for earth observation and satellite Application
2002: Transfer of the data receiving, recording and processing system

2003.12-:ALOS Pilot Project
Land management and city planning
Practical use and various fields

Participating departments of Thailand are;

- **Department of Public Work and Town and Country Planning (DPT)**

・To extract DEM and DTM from ALOS data.
・To improve and update the building in city area by using the ALOS data.
・To compare and monitoring for the urban change and urban trend.
・To evaluate the damage area from disaster.
・To create 3D city model.

- **Land Development Department (LDD)**

・Land use/ land cover monitoring.
・Application of ALOS images and GIS technology for farm pond mapping.

- **Royal Irrigation Department (RID)**

・Irrigation Management in Provincial Irrigation Project.
・Application of Satellite Imagery for inundation area.

- **Department of National Park, Wildlife and Plant Conservation (DNP)**

・Forest resources assessment, forest cover monitoring and forest inventory on forest resources information and biodiversity of vegetation.
・Forest fire assessment.

- **Department of Fisheries (DOF)**

・Mapping and monitoring aquaculture areas and stationary coastal fishing gears.
・To distribute the information derived from ALOS the satellite data to relevant provincial fisheries offices.
・To assess the significance of using ALOS satellite data for other fisheries applications.

- **The Department of Disaster Prevention and Mitigation (DDPM)**

・Utilization of Satellite Data: to transform satellite data to be valuable and usable products such as Early Warning Messages, Hazard Map, Damage Assessment, Situation Evaluation of the disaster event and related issues.

3.2 Pilot Project with Indonesia <ADEOS-II>

The agreement was concluded between JAXA and LAPAN in September 2003 on the use of ADEOS-II Data, and it lasted until March 2006. The objectives of the Pilot Project with Indonesia were as below:

・Utilization verification of the ADEOS-II archive data or alternative data in the fishery field.
・Utilization verification of the ADEOS-II data through the marine and fishery projects, and the contribution to Indonesian
・ Training of the remote sensing engineers in Indonesia.

The following researches and utilization verification were conducted at Udayana University using JAXA-provided data:
・Fishery sea area data making and presumption of fishery sea area by GLI.
・ Marine resources management such as oceanic basic production.
・Multi-dimensional mapping by sea color and temperature.
・Examination of GLI analysis data distribution procedure in developing countries.
・Watch of coast and seawater pollution by remote sensing, etc.

To present the final result of the above pilot project public, the event titled the "JAXA Pilot Project Symposium in Indonesia 2006 - ADEOS-II Data Utilization Report – was held at the Sanor Plaza Paradisa Hotel Bali on 23 February 2006 having 85 participants.

3.3 Pilot Project with Indonesia <ALOS>

In February 2006, an agreement was concluded through the adjustment among JAXA, LAPAN and the other participating organizations, and the pilot project was substantially begun with the training program carried out by JAXA and LAPAN from 6 to 10 March 2006. The contents of the training were such as the basic RS for ALOS data use, the three dimensional chart making with stereo images obtained by an optical sensor onboard ALOS, and the lecture on SAR use, etc. Consequently, 32 people (8 out of 32 were observers) attended, and the most participants evaluated that profitable technological training was obtained.

Objectives of the Pilot Project with Indonesia using the ALOS data are as below:

(1) Utilization verification of the ALOS data in order to make the regular use of the data possible in fields of the environment, forestry, mapping, and disaster management at the administrative level in Indonesia.

(2) Training for the data use is executed to make each participation organization to be able to use the ALOS data on their own in the future in order to satisfy the participants' technical support demand. Moreover, the utilization proof in each field is advanced by individually making the thematic map using ALOS real data. It is assumed to be the final purpose that these technologies to be established in Indonesia, and to improve the frequency level of the data use at the administrative level.

The following shows the ALOS Pilot Project structure with Indonesia:

- **Indonesian SOil Research Institute (ISORI), Center for Soil and Agro climate Research (CSAR), Ministry of Agriculture (MOA)**
  - Assessment of Land Degradation and Mass Movement Using ALOS Satellite Data
- **Geology Development and Research Centre (BPPT), Ministry of Energy and Mineral Natural Resources (DESDM)**
  - Modeling For Natural Resources Mapping
- **National Coordinating Agency for Surveying and Mapping (BAKOSURTANAL)**
  - Topographic Map Production using ALOS Data-Benchmark test in urban area of Jakarta, rural area of Bogor and forest area of Kalimantan/Papua
- **Center for Remote Sensing and Ocean Sciences**

(CReSOS)
- Development of Algorithms for Coastal Zone Management and Vessels Monitoring by Using ALOS Data

- **Regional Development Study Center (KIMPRASWIL), Bogor Agriculture University (IPB) GIS and Remote Sensing Center of Aceh Syiah Kuala University (UNSYIAH)**
  - Land Use, Land Cover and Terrain Changes in Nanggroe Aceh Darussalam, Indonesia
- **Center for Forestry Mapping, Ministry of Forestry (MOF)**
  - Application of ALOS Satellite Imagery For Indonesian Forest Resources Monitoring

4. Sentinel Asia (SA) Project

Based on UN statistics, the Asia and Oceania region has the largest proportion of natural disasters in the world. The Asia-Pacific Space Agency Forum (APRSAF) was established in 1993 for promotion of space technology and applications in the region. The 11th APRSAF, November 2004 in Canberra, Australia recommended starting a pilot project among APRSAF members for rapid response to disasters. The Asian Workshop on Satellite Technology Data Utilization for Disaster Monitoring, January 2005, in Kobe, Japan, held at the time of UN World Conference for Disaster Reduction (UNWCDR), and the Disaster Reduction through Effective Space Technology Utilization in Asian Region, May 2005, in Malaysia, further define the concept of the pilot project and recommended “the Sentinel Asia” project. The 12th APRSAF, October 2005, in Kitakyushu, Japan, agreed to initiate the Sentinel Asia project and to establish the Joint Project Team (JPT) to plan and implement the project. The 1st JPT meeting was held in February 2006, in Hanoi, Vietnam.

(1) Concept

The Sentinel Asia (SA) is to be an Internet-based, node-distributed, information distribution backbone, handling relevant information on multiple hazards, and were satellite imagery is sourced from all possible earth observing geostationary-, or low-earth orbiting satellites, including meteorological satellites providing data to the region. Countries in the Asia-Pacific region will also be able to use the network to “trigger” specialized satellite-data disasters in their countries. The implementation costs of the Sentinel Asia are expected to be very low, since much of the infrastructure in already in place in many countries of the region. This includes satellite reception facilities, satellite pre-processing computers and a public Internet backbone. Routine downloaded satellite data will then be pre-processed in near real-time to key information products which can sent across the Internet. Capacity building is also seen as a critical element for developing this community network, and for making best use of the satellite-derived disaster information across all counties in the region.

(2) Approach

The Sentinel Asia will be developed in a stepwise approach:
- STEP 1 : establishment of SA (2006-2007) with initial focus on wildfires and floods
- STEP2: integration with satellite communication systems (2008-2009)
- STEP3: establishment of comprehensive disaster management support system

(3) Architecture

The SA system is physically to be composed of the following elements:

- Nodes
  - Data Provider Nodes would operate their own satellite reception facilities, and in some cases their own spacecraft, would pre-process the imagery in near real-time into agreed information products, to be made available through the network.
  - Local Service Node (User-Nodes) would automatically pull information products from the network in near real-time , and post it together with their own country’s GIS information on their nodes’ WebGIS server.
  - Research and Training Nodes would be working ‘offline’ from the basic network on development of new products, or adapting standard wildfire and flooding methods to new satellite sensors.

- Information-Sharing Systems

  To help realize the information sharing among NODES, the following platforms can be utilized:
  - Digital Asia by Keio University, JAXA and AIT
  - ALOS Rapid Response System by ADRC and JAXA
  - Others

- Observation Systems

SA will initially use MODIS derived information on wildfires and ALOS derived disaster information, SA is designed to adapt to various satellites missions, especially those of countries in the region. It is envisioned that SA will be used to disseminate information derived from other satellites.

(4) JPT

The first meeting of the Joint Project Team (JPT) of the Sentinel Asia was initiated in Hanoi, February 2006. Participating agencies and their functions were identified in the meeting. Second JPT meeting will be held in June 2006 to elaborate the implementation plan and start implementation of the SA. JPT is open to any interested agency in the region which can contribute to the SA.

5. Conclusions

The Asia Pacific region is the one which has largest portion of people and natural disasters in the world. This is a region where most rapid development and capacity of space technology and applications are taking place. JAXA envisions that space technology can be effectively used in this region for the well-begin of the people and cooperation for responding to the regional requirements can be made. For that, space agencies and related user agencies need to cooperate. JAXA intends to contribute to capacity building in the region through the Asia Pacific Earth Observation Pilot Project in collaboration with GISTDA, LAPAN and AIT, and the Sentinel Asia project.

JAXA/AIT COLLABORATION FOR CAPACITY BUILDING IN ASIA-PACIFIC

Lal Samarakoon[a,] , Chu Ishida [b] and Yoko Inomata [b]

[a]Geoinformatics Center, Asian Institute of Technology, PO Box 4, Klong Luang, Pathumthani, Thailand – lal@ait.ac.th
[b] Japan Aerospace Exploration Agency, Triton Square Office Tower-X 23F, 1-8-10 Harumi, Chuo-ku, Tokyo, Japan– ishida.chu@jaxa.jp, inomata.yuoko@jaxa.jp

Commission VI

KEY WORDS: Capacity Building, JAXA, Training

ABSTRACT:

Use of remote sensing, GIS and GPS becoming operationalize in most parts of the world including Asia-Pacific. One of the main reasons for this increase is ongoing international cooperation in various development projects. Also, with the availability of high-resolution satellite data, most of Asian countries show their enthusiasm in using these technologies for their mapping and resource monitoring activities. With the increase of satellite data usage and use of GIS technology, it is important to develop local knowledge and technical know-how of local expertise use of remote sensing, GIS and GPS in practical applications. Also, it is identified that awareness need to increase not only among technicians, political leaders need to be educated in these technologies to receive their blessing in adopting these technologies in day to day activities in possible fields of applications. JAXA is generous in providing technical assistance to the region with the collaboration of Geoinformatics Centre of Asian Institute of Technology since 1995 to increase the awareness and to develop individual capacities in remote sensing, GIS and GPS technologies. More than 800 were trained from the region either at AIT or locally, depend on the program they participated. This is a remarkable achievement and the support would have certainly helped to increase the knowledge as well as awareness in the region. This paper summarizes various training programs conducted by GIC with JAXA support and present status of JAXA sponsored capacity building activities in Asia-Pacific.

1. INTRODUCTION

Japan Aerospace Exploration Agency (JAXA) previously known as National Space Development Agency (NASDA) of Japan has been contributing to capacity building in remote sensing and related space technologies in Asian region with the cooperation of Geoinformatics Center (GIC) previously named as GIS Application Centre (GAC) of Asian Institute of Technology since 1995. The first training course under JAXA sponsorship was launched in 1995 inviting twenty participants from Asia to GIC. The title of the course was PC based GIS Information System, which was appropriate at that time due to very limited awareness of these new technologies. Further, it is important to say that GIC was established in the same year with the financial collaboration of United Nation Environment Program – Environment Assessment of Asia and Pacific. With the success of the first course conducted with the collaboration of GIC, JAXA continued to support the region with more training courses covering remote sensing, GIS, GPS and application of these technologies.

JAXA supported capacity building and information sharing in the region was carried out in number of initiatives since 1995 as given below;

a. Structured training programs
b. Caravan training programs
c. Mini-Projects
d. Workshops

Structured training programs were carried out at GIC inviting participants from the region who are working in national agencies. Structured courses were conducted for two weeks at GIC with full sponsorship of JAXA. The sponsorship included airfare to AIT in Bangkok, accommodation and living expenses in Bangkok, and tuition fee at GIC. This activity was continued until year 2003 satisfactorily training more than 400 people. During training at AIT, participants were benefited with access to the library of the institute and opportunities to meet faculty members of AIT to further exchange information and develop future collaborative opportunities.

Another type of training program that is conducting by GIC for JAXA sponsorship is referred to as Caravan Training. These programs are being conducted locally with the collaboration of local agencies. It is expected that this program could offer opportunities to a larger audience to increase awareness in remote sensing, GIS and GPS by conducting locally. Generally, the duration is five days targeting a topic that is relevant to the country concerned. Since 1997, after two years of first structured training program, Caravan type training programs were started and the first training program was conducted in Philippines. Since then seventeen Caravan training programs were conducted in ten countries.

One of the other information sharing and capacity building activity that was supported by JAXA was Eco-Seminar conducted since 1992. This was a 2-3 day workshop gathering experts from the region to discuss the sustainable natural resource management and the potential of remote sensing, GIS and GPS technologies in supporting this endeavour. This program started from Thailand in 1992 and conducted in Malaysia, Indonesia, Philippines, Fiji, Vietnam, Bangladesh, Myanmar and concluded the program conducting the last of the series in Thailand in 2000.

2. SUMMARY OF ACHIVEMENTS

2.1 Structured 2 Weeks Training Courses

This programmed was the start of JAXA contribution in Asia-Pacific through AIT. Due to relatively high cost involved in sponsoring participants, these courses were limited for two weeks though these provided most effective method to provide latest development of geospatial technology to selected participants. Since the inauguration, more than twenty training programs were designed by GIS of AIT and conducted with the sponsorship of JAXA. This allowed to provide technical assistance to more than 400 persons belonged to various agencies in Asian countries. Table 1 shows the distribution of participants under these training programs until 2003. Most number of participants has come from Bangladesh, Indonesia, Nepal, Philippines, Sri Lanka and Thailand. These countries could consider as active countries in application of remote sensing, GIS and GPS as well as integrated these technologies in to their national educational programs. Stronger economies like Brunei, Malaysia and Singapore were not given sponsorship describing the smaller number of participants from these countries. Some countries such as Bhutan, Iran, Mongolia, and Fiji represented less due to high cost of transportation involved. Further few countries such as China, Myanmar, and Cambodia are under represented due to difficulties in securing suitable participants as a reason of poor communication and delays in local administration. Thailand has enjoyed most number of participants due to low sponsoring cost and positive participation of national agencies.

Table 1 Distribution of structured training program participant

Country	No of Participants	No of Participants	
Bangladesh	38	Malaysia	07
Bhutan	01	Mongolia	12
Brunei	03	Myanmar	10
Cambodia	14	Nepal	30
China	03	Pakistan	17
Fiji	05	Philippines	26
India	18	Singapore	02
Indonesia	39	Sri Lanka	49
Iran	01	Thailand	67
Lao PDR	17	Vietnam	40

In selecting themes for structured training programs, participants' needs, and appropriate topics for their respective countries were considered. Training programs were prepared based on real-world applications. Also, it was always targeted to provide application oriented training program where participants were given from end to end knowledge of application of remote sensing and GIS in real-world applications. Generally, 70% of the time was spent for hands-on training. Table 2 shows themes used for structured training programs since 1995 with number of participants for each course. At the end of each training program, participants were provided training datasets with training manuals to share among their colleagues once they return back to respective agencies.

Table 2 Themes of structured training program conducted

Year	Theme	No
1995	Introduction to PC Based GIS	20
1996	Forest & Natural Resources Management	20
1997	GIS and Remote Sensing for Watershed Management	20
	Microwave Remote Sensing	20
	GIS in Land Use Planning	20
1998	GIS and Remote Sensing for Watershed Management	15
	GIS and Remote Sensing for Flood Mitigation	15
	SAR Data Potential & Applications	16
1999	Remote Sensing and GIS for Coastal Zone Monitoring & Management	15
	GIS and Remote Sensing for Watershed Management	15
	SAR Data Potential & Applications	15
2000	GIS and Remote Sensing for Watershed Management	18
	SAR Data Potential & Applications	18
	Remote Sensing and GIS for Coastal Zone Monitoring & Management	17
2001	Remote Sensing and GIS for Coastal Zone Monitoring & Management	21
	SAR Data Potential & Applications	15
2002	Open Source GIS for Spatial data Sharing	16
	SAR Data Potential & Applications	16
	Remote Sensing and GIS for Coastal Zone Monitoring & Management	17
	Potential of Low to Moderate Resolution satellite Data (GLI)	18
2003	SAR Data Potential & Applications	15
	Remote Sensing and GIS for Disaster Mitigation	17
2004	Potential of Low to Moderate Resolution satellite Data (GLI)	18

2.2 Caravan Training Programs

The term "Caravan" was the name given to one-week training programs that are conducted in various countries in the region. As the name implies, programs are moved from country to country on rotational basis. Through these programs, attempt is made to draw the attention of a larger audience to increase the awareness of remote sensing, GIS and GPS technologies and their real-world applications. Effort was given to develop a training program on a theme that is relevant to the country where the program is scheduled to carryout. Thorough discussions are carried out with local coordinating agency in selecting a suitable topic and an appropriate study site for development of the training module. JAXA provides satellite data acquired over the site selected and when necessary data are purchased from other available sensor. Participants are selected from various local agencies that are using these technologies or agencies that have possibilities to use these technologies with the collaboration of local coordinating agency. Attempt is made to spend at least three full days for hands-on practices helping participants to become familiar with satellite data and generate few products using commercially available remote sensing and GIS software packages. This program is very successful in disseminating current technology and future development to larger audience. In the meantime, local organizations take this opportunity to promote national Geoinformatics with the collaboration of various organizations who are taking part in Caravan training programs.

Table 3 Themes and places that conducted Caravan training

Year	Theme	Country
1997	Geomatics for Mid-Level managers	Philippines
	RS/GIS for Nepal	Nepal
1998	RS/GIS/GPS Applications	Indonesia
	Mapping from Space	Vietnam
1999	Mapping from Space	Sri Lanka
	RS/GIS for Flood Mitigation	Bangladesh
2000	Mapping from Space	Cambodia
	RS/GIS for Forest Management	Myanmar
2001	Watershed Management for ASEAN	Malaysia
2002	RS/GIS for Watershed Management	Lao PDR
	Potentials of SAR Data Applications	Philippines
2003	RS/GIS for Urban Planning	Bangladesh
	Use of Moderate Resolution Satellite Data	Cambodia
2004	RS/GIS for Urban Management	Indonesia
	RS/GIS for Forest Management	Myanmar
2005	RS/GIS for Watershed Management	Lao PDR
	RS/GIS for Disaster Management	Sri Lanka

Table 3 summarizes the Caravan training programs conducted by GIC with the sponsorship of JAXA until 2005. As previously mentioned, selection of a venue is on rotational basis but preference is given to least advanced countries to increase awareness through promotion among national agencies. JAXA is considering to continue this type of training program as it recognized that Caravan programs are very effective in increasing awareness of technologies and could consider as a better stage for promotion of Japanese contribution to individual country.

2.3 Mini-Projects

Mini-Project based capacity building was launched by GIC under JAXA sponsorship in the year 2004. This applied-research oriented activity has given a new face to past traditional capacity building programs by targeting specific topics, selecting appropriate agencies, providing need-basis technical expertises, and finally achieving tangible results. Structured two-weeks training programs targeting advanced technology transfer had been carried out since 1997 providing training to more than four hundred participants increasing awareness and developing technical ability in the field of GIS and remote sensing. Though the outcome is not readily quantifiable, this generous effort of JAXA definitely boosted the knowledge and use of remote sensing and other related technologies in the region. The positive contribution can be identified by the increase in the usage of satellite remote sensing and GIS in the relevant agencies of the region from where trainees were drawn.

Having helped to create a favourable environment for use of remote sensing information and GIS tools, JAXA further considered continuing the support to develop technical competency in adopting these technologies in operational basis. With this aim, a new capacity building program called 'Mini-Project' was launched with the technical cooperation of GIC. Mini-Project topics are selected by two agencies referred to as "user agency" and "service providing agency" and it is expected both of these agencies nominate participants to work on the selected topic together with GIC staff at least for a year with short term visits. Specific training is provided at GIC, fieldwork will be carried out together and if necessary local support is provided. Ample time is provided to participants to work independently at GIC to use remote sensing, GIS and GPS technologies and other relevant information in brining in best solution for the objective selected by them. This develops self-confidence of participants as the program structure allows them to develop individual skill by working on a project that is relevant to their individual organizations.

Table 4 shows Mini-Projects carried out in the year 2005, which is the second year for the new initiative. Most of them are successful but it is not possible to say that all project yielded good results. Success depends on the participants' basic knowledge, level of education and enthusiasm. Further, available satellite data, field data and time that could spend to integrate the phenomenon with Geoinformatics plays an important role in the success ratio. It is very difficult to control some of the factors such as selection of participants, effective data sharing, and adaptation of new technologies.

Table 4 Themes of Mini-Projects conducted in year 2005

Theme	Country
Water Induced Disaster Management - A case study on Application of Remote Sensing and GIS Techniques for Flood Mitigation	Bangladesh
Land Use/Land Cover Changes and Flood Risk assessment in Cambodia Using RS & GIS	Cambodia
Application of Remote Sensing and GIS for Earthquake Disaster Mitigation in Kathmandu	Nepal
Integration of RS & GIS with Flood Simulation Models for Flood Hazard Mapping and Mitigation - A Case Study of Bagmati River	Nepal
Rice Area Mapping and Backscatter Analysis Using Multi-temporal Radarsat Images in the Rainfed Areas of Pangasinan and Nueva Ecija	Philippines
Modeling the Spatial Occurrences of Rain-Induced Landslides and Identifying Potential Landslide Hazard Zones Using RS/GIS as a Tool	Philippines
Application of RS & GIS Technology for Landslide Susceptibility Assessment	Sri Lanka
Application of Multi-Temporal Satellite Data for Land-Use/Land-Cover Change and Flood Mapping in the Coastal Zone of Vietnam	Vietnam
Application of Conventional and Spatial Data in Detection of Underground Karsticic Formations to Store Excess Extreme Floodwater Flows in the Red River Delta in Vietnam	Vietnam

3. FUTURE ACTIVITIES

GIC recognizes the needs of technological support in the region as there are number of countries lack human resources in Geoinformatics. It is expected that JAXA continue to support for technology transfer in Asia-Pacific region looking at the needs and requirements with resources that could be extended to the region. With the launch of new ALOS satellite and new initiatives in disaster supporting activities of JAXA, it necessary to consider knowledge sharing in object oriented manner rather than traditional capacity building approach. Region recognizes the potential of satellite remote sensing and associated tools in various applications including disaster mitigation and management. In the meantime, there is a demand for capacity building to make use of such system in effective manner. In this aspect, current Mini-Project would be the ideal approach to address the needs of each country disaster management agencies to develop their capacities to receive and use of satellite data or products in their national disaster management projects.

Appendix: Support documentation (Emeritus Prof. Shunji Murai) Volume XXXVI, Part 6 - ISPRS Technical Commission VI

Manual of Presentation

Shunji Murai, Co-chair
Special Interest Group of ISPRS Com. VI

- What is Presentation?
- Four Factors of Presentation
- Basic Knowledge of Presentation
- How to improve your presentation?

What is Presentation?

- Presentation is to make audience understand what the presenter wants to say or propose through media such as letters, sentences, figures, images, voices etc.
- Final goal of presentation is to obtain the satisfaction and agreement of the sponsors

Functions of Presentation

- Presentation is to provide better communication between the presenter and the listeners
- Presentation is to obtain the understanding and agreement of the listeners
- Presentation is to give impact and impression to the listeners in a short time with multi-media techniques

How to get Customer's Satisfaction?

- First Stage: to follow the requirements, to share the direction and to catch the mind of the customer
- Second Stage: to solve those problems of the customer, to propose a new concept and to let the customer feel beneficial
- Third Stage: to let feel larger value than the customer expected

Levels of Customer's Satisfaction

- First Level: cost, quality and function meet the requirements
- Second Level: value exceeds the cost
- Third Level: the customer feels honors and prides when he or she made decision

Size and Scale of Presentation

- Small Size: presentation at a small meeting with a few or several listeners
- Medium Size: presentation at a medium size meeting such as workshop, seminar, tutorials etc. with a few ten listeners
- Large Size: presentation at a large size meeting such as conference, congress, users meeting etc. with a few hundred listeners

Excellent Presentation

- Excellent presentation should be interesting to the majority of listeners
- Excellent presentation should include original ideas as many as possible
- Excellent presentation should not be boring and sleepy, but exciting
- Excellent presentation is based on "punch" and "speed"

Four Factors of Presentation

- Will and confidence (psychological factor)
- Presence (physical factor)
- Scenario (logical factor)
- Presentation technique (technical factor)

Presence

- Looks of face and eyes with confidence
- Clothing (keep clean at least!)
- Relaxed attitude
- Sober style for small size meeting
- Showy style for large size meeting

Scenario Making

- Flow of scenario: title, objectives, contents, method, conclusion should be well highlighted in a story
- Concept: to be represented in a drawing or image
- Logical writing: to get understanding of original ideas and proposal
- Visual aids: to use visual aids for better understanding

Presentation Techniques

- Looking at listeners forward with smile (don't look at screen always!)
- Speak loudly to listeners rather than reading from notes
- Eye contacts to specific listeners to confirm agreement
- Use a pointer to focus onto a specific item with a few seconds halted

Requirements for Logical Writing

- 1) Sentence should be understandable with logical contents
- 2) Own ideas and proposals should not be mixed with the existing facts
- 3) Express clearly own thinking and claims

Title, Concept and Catch Phrase

- Any section and viewgraph should be given title and/or sub-title with a few keywords or concept
- Concept of a proposal should be summarized into a picture or image with a catch phrase
- Concept should be original with new ideas

How to grow originality?

- 1) Think by oneself
- 2) Never make copy of other ideas
- 3) Establish own way
- 4) Don't be tied to tradition
- 5) Promote creative thinking
- 6) Analyze advantages and disadvantages
- 7) Don't mind of others

Design of Presentation with Power Point

- A viewgraph must be explained within a minute (never over 2 minutes!)
- Title and sub-title: one scene
- Introduction: 5-10%
- Problems of existing technologies: 15%
- Concept of proposal: 15%
- Technical method: 30%
- Evaluation: 20%
- Conclusion and future prospect: 10%

Logical Thinking

- Point No.1: Writing based on objective facts
- Point No.2: Put your idea into concrete language and image (or picture)
- Point No.3: Express quantitatively
- Point No.4: Comparative analysis
- Point No.5: Simple and understandable writing

Objective Facts

- 1) News of newspapers and televisions
- 2) Published statistics and numerals
- 3) Past official records
- 4) Proverbs and metaphors
- 5) Published graphs and figures
- 6) Theories and principles written in books

How to make Power Point?

- 1) Use larger letters and symbols than 36 point for title and 28 point for sentence (less than 10 lines in total!)
- 2) Put title in any slide (gothic & bold!)
- 3) Easy understanding in one look
- 4) Explanation of a slide within a minute
- 5) Don't make over explanation
- 6) Use adequate colors

How to make oral presentation?

- 1) Use big and clear voice!
- 2) Don’t speak too fast!
- 3) Use simple words!
- 4) Don’t read but speak!
- 5) Relax and smile during speaking!

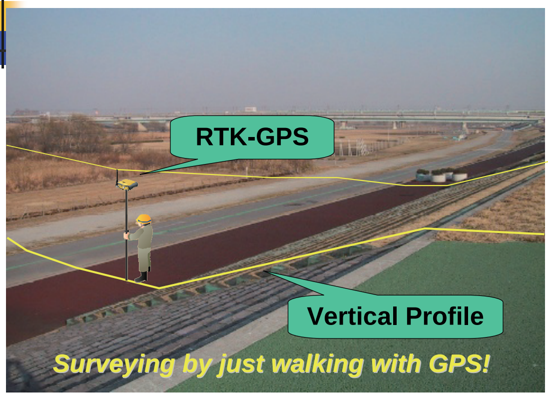
Rehearsal before Presentation

- 1) Prepare adequate materials and contents carefully and strategically!
- 2) Check materials in advance!
- 3) Check and evaluate the rehearsal!
- 4) Rethink and redesign contents from view point of listeners

Examples of Concept represented in a Drawing

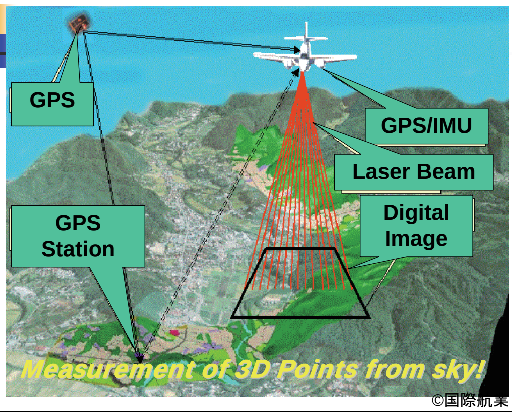
- 1) Vertical survey with RTK-GPS
- 2) GPS Camera
- 3) Airborne Laser Scanner (Lidar)
- 4) Environmental Study with DGPS
- 5) Three Line Scanner (TLS)

Vertical Survey with RTK-GPS



GPS Camera

Airborne Laser Scanner



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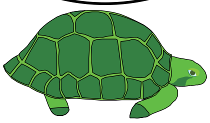
Environmental Study with DGPS

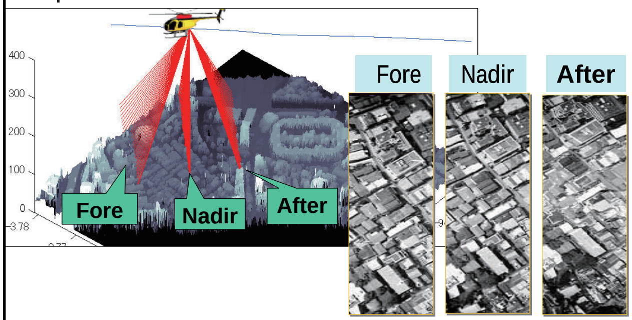
Locate the egg laying of turtle and other animals of scarcity value



Integration of GPS and GIS!

Airborne Three Line Scanner

3 Lines for 3D Measurement !



Conclusions

- 1) Presentation should be recognized as essential ability of scientists too
- 2) Capacity building for improving presentation technique should be promoted
- 3) Proposal / Thesis writing should be tied to oral / visual presentation
- 4) Creative and logical thinking should be more introduced in presentation

Appendix: Authors and Co-authors Index
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Appendix: Sponsors Index
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ESRI Japan Corporation

Higashiyama Bldg. 9F
1-1-2 Higashiyama, Meguro-ku, Tokyo, 153-0043 Japan
URL: http://www.esrij.com

ImageONE Co., Ltd

Shinjuku Daiichiseimei Bldg. 12F
2-7-1, Nishi Shinjuku, Shinju-ku, Tokyo, 163-0712 Japan
URL:
https://mmm1417.rapidsite.net/imijpc/english/index.html

Jicoux Datasystems, Inc.

Chiyoda First Bldg. East 9F
8-1 Nishikanda 3-chome, Chiyoda-ku, Tokyo, 101-0065 Japan
URL: http://www.jicoux.com/

KOKUSAI KOGYO CO., LTD.

2, Rokubancho, Chiyoda-ku, Tokyo, 102-0085 Japan
URL: http://www.kkc.co.jp/english/

NTT DATA ENGINEERING SYSTEMS CORPORATION

7-37-10 Nishikamata, Ohta-ku, Tokyo, 144-8601 Japan
URL:
http://www.nttd-es.co.jp/english/about/hzs/e-index.htm

PASCO Corporation

1-1-2 Higashiyama, Meguro-ku, Tokyo, 153-0043 Japan
URL: http://www.pasco.co.jp/global/english/index.html

RESTEC

Roppongi First Bldg. 12F
1-9-9, Roppongi, Minato-ku, Tokyo, 106-0032 Japan
URL: http://www.restec.or.jp/restec_e.html

RIEGL JAPAN LTD.

Fuji Bldg. 2F
5-11-29 Yayoi-cho, Nakano-ku, Tokyo, 164-0013 Japan
URL: http://www.riegl-japan.co.jp/

TOPCON CORPORATION

75-1, Hasunuma-cho, Itabashi-ku, Tokyo, 174-8580 Japan
URL: http://www.topcon.co.jp/eng/index.html