EFFECTIVE APPROACH FOR CAPACITY BUILDING IN GIS AND REMOTE SENSING TECHNOLOGIES IN DEVELOPING COUNTRIES

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ABSTRACT:

Geospatial technologies including remote sensing and GIS have become very effective tool and information system in various applications reducing costs and bringing in timely information. Satellite data are becoming more close to everyone's life with the launch of sensors by public and private sectors bringing down the cost of data and providing vast selection in terms of spatial, temporal and spectral resolution. With these developments it is necessary to bring the space technology close to day to day life of people through well designed and appropriate capacity building programs. This paper summarizes attempts made by Geoinformatics Centre of Asian Institute of Technology with the sponsorship of Japan Aerospace Exploration Agency and generous support of ISPRS WG VI/6 in helping to strengthen individual capacities by specially designed program through various training programs. Brief discussion of various programs, contents of the programs and benefit of individual programs are discussed.

1. INTRODUCTION

Capacity building is often referred to mean training to advance individual knowledge, in some cases introducing new infrastructure, or quite often exposing staff to better environment through study tours to improve resource management skills and capabilities. On most of developing countries, these activities are being carried out within their national sponsorship and as an integral part of most of funded projects. In reality, overcoming the barriers to enhance capacity is usually more difficult, requiring a major change in the attitude of institutions and individuals who belong to the organization.

In general context capacity can be expressed as the ability of individuals and institutions to make and implement decisions and perform functions in an effective, efficient and sustainable manner. At the individual level, capacity building refers to the process of changing attitudes and behaviours that provides an opportunity to enhance the knowledge developing skills while maximizing the benefits of participation, knowledge exchange and ownership. At the institutional level it focuses on the overall organizational performance and functioning capabilities, as well as the ability of an organization to adapt to change. It aims to develop the institution as a total system, including individuals, groups and the organization itself. Capacity development further emphasizes the overall policy framework in which individuals and organizations operate and interact with the external environment, as well as the formal and informal relationships of institutions. Therefore capacity development can be considered at three levels, the individual, institutional, and the systemic. Interactions between these levels are also important to improve the overall capacity. Therefore capacity building program whether conducted as a short term endeavours or as a long term exercise, it is required to address all these three areas; individual, institutional, systematic, to make the outcome successful.

Geoinformatics Centre (GIC), a self funded outreach centre of Asian Institute of technology (AIT) has been involving in capacity building in Geoinformatics and related disciplines since 1995. The centre was established in the same year with the financial collaboration of United Nation Environment Program of Asia and Pacific. Japan Aerospace Exploration Agency (JAXA) previously known as National Space Development Agency (NASDA) of Japan has been supporting GIC since its inception providing funds, satellite data and personnel contributing to capacity building in remote sensing and related space technologies in Asian region. 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 in the region. With the success of the first course conducted with the collaboration of GIC, JAXA continued to support the region with more training courses related to remote sensing, GIS, GPS and application of these technologies.

GIC has been conducting various forms of training programs for various clients and these programs can be categorized in five groups as below;
   a. Structured training programs
   b. Caravan training programs
   c. Mini-Projects
   d. Tailor-made training programs
   e. 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, accommodation and living expenses in Bangkok, and the training fee. This activity was continued until 2003 satisfactorily training more than 400 people. This training provides additional benefits to participants as they have a chance to access all the facilities of AIT access to the library and opportunities to meet faculty members of AIT to further exchange information and develop future collaborative activities.

Caravan training is another type of training program supported by JAXA. Since 2006, ISPRS WG VI/6 was collaborating with GIC and JAXA in conducting these programs providing expertise of the members of the working group. 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 twenty Caravan training programs were conducted in eleven countries.

Tailor-made training courses are conducted on the request of various governmental and international agencies. In most of the cases these training programs are conducted for participants who are sponsored through a project that has been taking place and Geoinformatics is considered as a tool in completing the work. The last tailor-made training course conducted was to Mongolian Remote Sensing Centre to develop MODIS data receiving and handling capacities of their staff.

Workshops too considered as a way of capacity development, specifically institutional capacity development. With the support of JAXA a seminar referred to as Eco-Seminar was conducted. This was a 2-3 day workshop organized 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 in 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 GIC/AIT. Due to relatively high cost involved in sponsoring participants, these courses were limited for two weeks though they 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 GIC/AIT and conducted with the sponsorship of JAXA. Through these training courses technical assistance was provided 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 priority in the selection explaining 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 their administration procedures in nominations. Thailand has enjoyed most number of participants due to the marginal cost involved and the interest in participation by Thailand national agencies.

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

Table 1. Distribution of structured training program participant

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 end to end knowledge of the application of remote sensing and GIS on a real-world applications selected for the particular program. Generally, 70% of the time was spent for hands-on training. Appropriate resource persons were selected globally considering expertise as well as experience in teaching short-term courses. Table 2 shows the themes of 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.

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

Table 2. Themes of structured training program conducted

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 being made to draw the attention of a larger audience to increase the awareness of remote sensing, GIS and GPS technologies and their potential applications. While conducting a Caravan program in a given country, attempt was made to select 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 being 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.

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
2006	Geospatial Technologies for Disaster Mitigation – Cambodia Perspective	Cambodia
2006	Geospatial Technologies for Disaster Mitigation – Philippines Perspective	Philippines
2007	New Trends and Potential of Geospatial Technologies	Bhutan

Table 3. Themes and places that conducted Caravan training

Table 3 summarizes the Caravan training programs conducted by GIC with the sponsorship of JAXA until 2005. Some of these programs are actively participated by ISPRS WG VI/6 member providing expertise to make these events further proficient and successful. As mentioned earlier, selection of a venue is on rotational basis but preference is given to least advanced countries to increase awareness through promotion among national agencies. GIC considers that Caravan programs as an effective vehicle in addressing Geoinformatics issues in a given country, specifically demonstrating the strength of these technologies to politicians, decision makers and administrators. Continuous efforts are being made to secure funding for the continuity of Caravan training programs.

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-base technical expertise, and at the end of a program 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, these programs 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, it was considered to embark on capacity development adopting these technologies in operational basis. With this aim, a new capacity building program called 'Mini-Project' was launched with the financial sponsorship of JAXA. 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 through JAXA. 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 since 2005. Most of them were very successful but it is not possible to say that all projects 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.

Theme	Country
Water Induced Disaster Management - A case study on Application of Remote Sensing and GIS Techniques for Flood Mitigation (2005: SPARSSO)	Bangladesh
Development an Accurate Flood map by Integrating satellite data and MIKE-11 Model (2006: FFWC, LGED, BDPC)	
Flood Forecast Improvement RS/GIS and Flood Models. (2007: SPARSO & FFWC)	
Spatial data Infrastructure for Disaster Management using WEB-GIS (2007: Survey & Land Records)	Bhutan
Land Use Change in Modol Seima District (2005:LMUPC Ministry)	Cambodia
Flood hazard mapping in Three Provinces in Cambodia in Mekong Basin (2006: MRC, DHRW, Geography Dept.)	
Use of ALOS Data for DEM Generation, Building Extraction (2007: Geography Dept)	
Flood Risk Assessment using RS/GIS and Hydrodynamic Model (2006: BNU)	China

Tsunami Hazard Assessment Integrating Remote Sensing and Numerical Models (2007: LAPAN & BPPT)	Indonesia
Forest & soil mapping using RS/GIS (2005: ICTA & NAFRI)	Lao PDR
Flood Risk Map using RS/GIS – Case Study in Champsak Province (2006: ERI & DMH)	
Flood Hazard Mapping Using HEX-RAS, RS and GIS. (2007: ERI & DMH)	
Application of Remote Sensing and GIS for Urban Land Use in Katmandu (2005: Survey Department)	Nepal
Rainfall-Runoff Modeling of Bagmati River basin & Flood Loss Estimation in Gaue Municipality (2006: Survey, DWIDP, DHM	
Flood Risk Assessment in Kamala River using RS/GIS (2007: Survey Dept.)	
Rice Area Mapping and Backscatter Analysis Using Multi-temporal Radarsat Images in the Rainfed Areas of Pangasinan and Nueva Ecija (2005: PhilRice)	Philippines
Detecting drought prone areas using RS/GIS & Metrological Approach in Iloilo Province (2006: PhilRice)	
Modeling Rain & Earthquake Triggered Landslides using RS/GIS based Slope Stability Models (2006: PHIVOLCS, NAMRIA)	
Lahar Danger Characterization on the Southern Sector of Mayon Volcano. (2007: NAMRIA & PHIVOLCS)	
Slope Stability Index Based Prediction Tool for Landslide Hazard Mapping (2006: NBRO & Survey Dept.)	Sri Lanka
Flood Hazard Mapping in the Lower Reach of Kelani River (2007: Survey & Irrig Dept.)	Sri Lanka
Application of Multi-Temporal Satellite Data for Land-Use/Land-Cover Change and Flood Mapping in the Coastal Zone of Vietnam (2005:STI)	Vietnam
Application of RS/GIS for Landslide Hazard Mapping in Mountainous Area on Vietnam (2006: VAST & MONRE)	
Forest Fire Risk Zone Mapping using RS & GIS(2007: STI, Geography/VAST, FPD)	

Table 4. Themes of Mini-Projects conducted from 2005-07

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. Also, GIC expects the generous collaboration of ISPRS WG VI/6 for advancement of Geoinformatics technology in 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. Asia strongly recognizes the potential of satellite remote sensing and associated tools in various applications including disaster mitigation, monitoring 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. Mini-Project could address the capacity development of individuals as well as institutional development.