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).

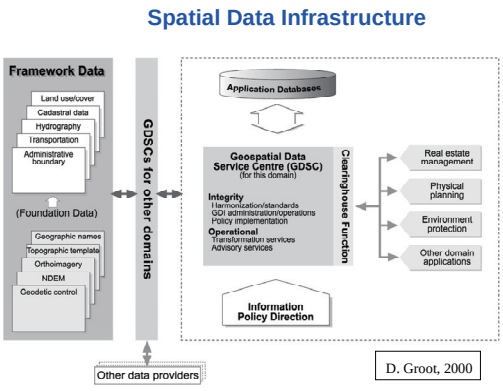

Figure 1. Spatial Data Infrastructure (Groot, R & J. McLaughlin, 2000)

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?

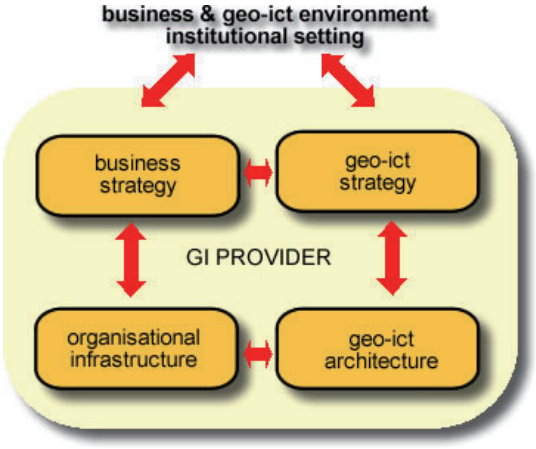

Figure 2. The operational environment of GI-organisations (Georgiadou and Kuma, 2002 / Kraak, 2005)

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.

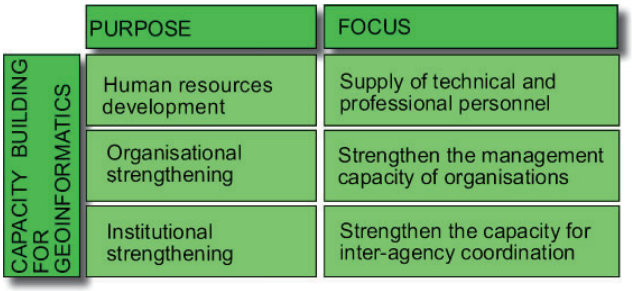

Figure 3. Components of capacity building (Courtesy Georgiadou and Groot, 2002 / Kraak, 2005)

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

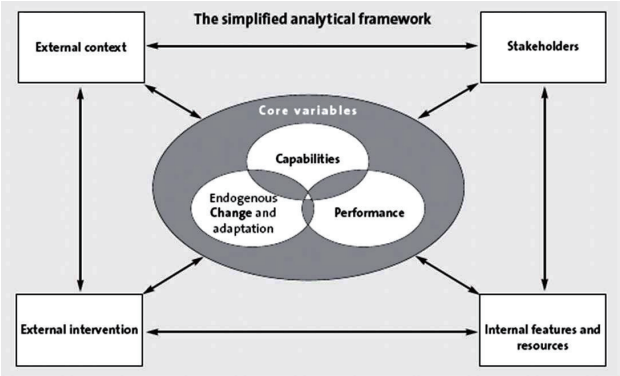

Figure 4. Simplified analytical framework for analyzing organisational capacities (Morgan 2003)

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.

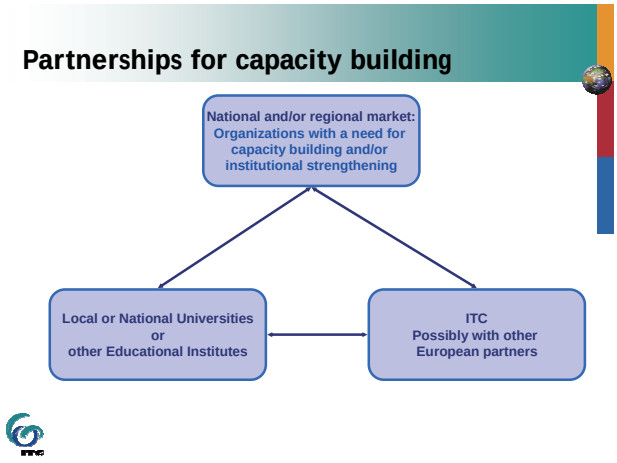

Figure 6. ITC tri-partite relation in capacity building

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.

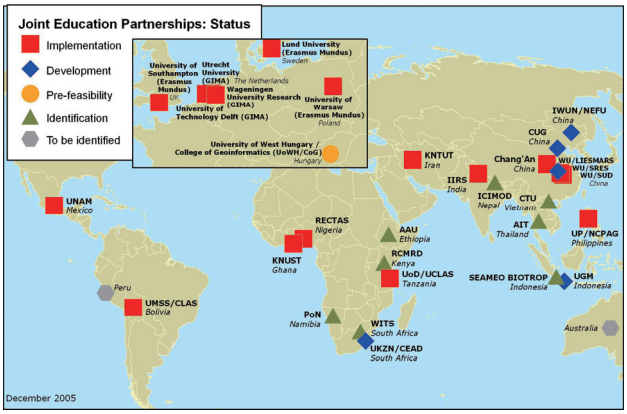

Figure 7. ITC Joint Education Partnerships (December 2005)

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.

REFERENCES

Beerens, I.J.J. 2004 Building capacity in geo-information handling for sustainable development in Africa, paper presented in 5th AARSE Conference in Nairobi, Kenya

CGI (Bregt, A.R. van Lammeren, I. Kemmeling) and Ministry of Economic Affairs (M. Botman), 2003, Geomatica Sector Netherlands reviewed, VI-Matrix 77.

ESRI, Inc. Geographic Planning Collaborative Inc. and ESRI (Thailand) Co. Ltd, 2004, Thailand National Spatial Data Infrastructure – Feasibility Study.

Georgiadou, Y. and R. Groot, 2002: Beyond Education: Capacity Building in Geo-informatics, GIM International, February 2002, Volume 16, pp 40-43

Georgiadou, Y. and G. Kuma, 2002, The business of Survey of India & GEO-ICT (Power Point Presentation).

Groot, R. and J. McLaughlin, 2000, Geospatial Data Infrastructure, Concepts, cases and good practice.

Kraak, M.J. Geospatial Capacity Building, 2005, Best Applications and Practices. Proceedings Eight United Nations Regional Conference for the Americas, New York.

Ministry of Foreign Affairs, 2004a, Kingdom of the Netherlands, June 2004, "Naar een verantwoordelijk Europa" (*Towards a responsible Europe*).

Molenaar, M. and M.J. Kraak, 2000, Geoinformation in the ITC context. Workshop on Education, Netherlands Commission for Geodesy, Delft, 10 pp.

Molenaar, M. Capacity building for the global geo-information community – an ITC perspective, 2004 Paper presented at ISPRS Congress XX, Istanbul, Turkey July 2004.

Morgan, 2004, What is Capacity? Going beyond the Conventional Wisdom, written for the News from the Nordic Africa Institute 2/2004.

Morgan, P. T. Land & H. Baser, 2005, Study on Capacity, Change and Performance, Interim Report, ECDPM Discussion Paper No 59A.

Richards, S.M. 1993, Review of the Australian Geological Survey Organisation, Canberra, 127 p.

Westerhof, A.B and C.V. Reeves, 2004, Geo-infrastructure, geological survey organisations and geo-science databases: some relevant trends with examples from China and Eastern Africa (Invited lecture at the "End-of-Project" workshop INDIGEO Project Geological Survey of India Training Institute, Hyderabad, India)

ACKNOWLEDGEMENTS

I like to express my sincere gratitude to my colleagues Dr. Yola Georgiadou for sharing her thoughts on the use of metaphors to explain complicated terms and systems and Prof. Dr. Ir. Martien Molenaar and Prof. Dr. Menno-Jan Kraak for allowing me to use their elaborations on the processes and context of educational programmes in geo-information.