

CAPACITY BUILDING FOR GEOINFORMATICS IN AFRICA

AN ITC PERSPECTIVE

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ABSTRACT:

The development of geoinformatics over the last two decades and with that the growing awareness of the role of GDI in civil society imply that professionals of different types are required by organisations involved in the production, dissemination and use of GI and with policy development with respect to the roles of the public and private sector in this field. This is a global development, but the different regions and individual countries of the world have to formulate their own ideas and concepts how to deal with this issue, because GDI's should be adapted to regional and local context. Several committees have been involved in shaping these ideas for Africa. In the last four years the ITC educational programmes have been revised so that they better connect to these developments. Furthermore ITC is developing a strategy to decentralise part of the educational programs. We intend to run them in cooperation with educational institutes, preferably universities in the home regions of our students. The objective is to adapt our programs more to the local needs, to create the opportunity for part-time education and reduce the time that our students should spend in The Netherlands far away from their families and jobs.

1. GLOBAL DEVELOPMENTS IN THE FIELD OF GI AND GDI

About thirty years after the large-scale introduction of remote sensing for civil applications and about twenty years after the brake through of GIS these techniques have matured. They are fully accepted as tools for spatial management and form structural components of information infrastructures in both the public and private sectors of society. With this a geo-information community developed world wide with its own journals, conferences and coordinating bodies. This community became aware of the fact further development of this field should no longer rely on spontaneous growth and evolution. The growing importance of this field for civil society requires involvement of governments to set policies and to make and stimulate large investments to create and develop spatial data infrastructures. This issue is manifest nowadays and appears high on the agendas of the international gi-community.

We also observe that with time the character of the gi-community is changing. In the early days of remote sensing and GIS this community consisted of interested experts from other fields and pioneering amateurs who obtained their skills by training and through experience. Nowadays the gi-community consists increasingly of highly educated professionals. These professionals can be divided in three major groups:

1. Experts in the field of spatial information handling (or specialists in certain aspects of this field),
2. Users of geo-information and
3. Professionals and policy makers, who are aware of the importance of geo-information for Civil Society.

Their education requires programs that are carefully designed, based on the mature paradigms of geo-information science and its related disciplines. The design of the educational programs 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 three different types of professionals play in this field.

2. DEVELOPMENTS IN AFRICA

In Africa we see processes in line with these observations. The technological and institutional conditions in many regions are far from optimal for the creation of an information infrastructure so that great investments are required. These should be complemented by Institutional and organisational development to make sure that these investments will be adequate and effective. These issues and the required policy formulation have been reviewed and clearly expressed in a report titled "The Future Orientation of Geoinformation Activities in Africa" (Ezigbalike 2001). This report incorporated the recommendations of the Ad-Hoc Meeting of Experts held in Addis Abeba in November 2000. The report clearly emphasises the transition from merely technological issues to institutional and infrastructure issues:

".... It was established early in the paper that the future orientation of GIS does not lie in the technology itself, but in its use to process data to support spatial decisions and services.

Experience in some African countries suggests that emphasis on the technology might result in the acquisition of hardware, software and peripherals with no clear plans on how to use them. Others might go a step further and use the technology to digitise maps and simply automate map productions, creating large digital databases, which would be locked away for departmental use, with all the flaws of the present manual systems.

Following experience in other jurisdictions, emphasis should be placed on data management and dissemination. The vision is to ensure that spatial data permeates 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 use to make decisions with minimal pre-processing. Also the collected data sets should be put to the maximum possible uses by publicising their existence and making them easily available to the widest possible audience. The most efficient and effective way to achieve these two related objectives is to establish spatial data infrastructures, using GIS technology to maintain and exploit the SDI. The future orientation of GIS in Africa is therefore as a

ubiquitous tool that is integrated into the SDI concept, rather than as an end in itself."

The EIS-Africa recently produced a draft position paper (Gavin, 2002) on the importance of Environmental Information Systems for sustainable development. In this paper the following observation has been made:

"There are several prerequisites for being able to use geo-information to implement Agenda 21 in Africa:

1. **Core data sets** of certain basic geo-information must exist at a national level in African countries to support decision-making in diverse fields....The existence of these commonly used data sets facilitates the use of other geo-information, such as water quality and demographic data.
2. **Data must be available and accessible.** The mere existence of data is not sufficient to ensure its use in Africa by Africans. Potential users must know of the data's existence and have access to **documentation** to assess its reliability and/or relevance for selected uses. This in turn requires that data

providers publicise their information to the public and targeted users.

3. **There must be standards** enabling integration of data sets.

....
4. Policies and practices promoting the exchange and reuse of information also are critically important.In some instances, policies now actively prevent the distribution of information. In other cases, the absence of a definitive policy may make data holders uncertain about the consequences of sharing data.

5. Sufficient human and technical resources must be available to use geo-information. Information already available to an African organisation can remain unused or under-utilised due to a lack of human or technical capacity."

The paper concludes with recommendations to invest in information infrastructure and to develop policies and institutional environments for implementing these. Special attention is drawn to capacity building in this respect.

Context	Process	Data acquisition	Storage & retrieval	Processing & presentation	Dissemination & use
Application domain					
Technology					
Information management					
Institutional setting & policy					

Figure 1: aspects of spatial information handling processes and the context of these processes (Molenaar and Kraak, 2000)

3. NEEDS FOR EDUCATION

3.1 Expertise requirements

These observations imply that capacity building in the context 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 and the three types of roles, identified earlier, that experts play in this context.

We will look at geo-informatics from two angles:

a) The structure of processes for information handling and

b) The context in which these processes should be seen

Experts from one specific disciplinary background can seldom address all aspects involved; therefore Geo-informatics should always be seen in an interdisciplinary setting.

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 in this field. 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.

3.2 Education and training

The importance of GDIs for governance has implications for the national (public) organisations responsible for establishing and operating these GDIs. Hence, besides the education of individuals, capacity building of the entire organisation is required. The goal of education is to prepare (young) professionals for their tasks ahead, while the goal of capacity building is to simultaneously shake up the organisation that will employ them. The aim is to strengthen an organisation so that it can assume responsibility for designing, managing and sustaining development. For this, not only are thematic professionals required but also staffs that can formulate, design, manage and negotiate with other organisations and central government in order to address organisational and institutional issues in support of the acceptance of technological

solutions. Hence capacity building comprises human resources development, organisational strengthening and institutional strengthening – of which education is part and parcel. We have seen here above that we should think of coherent families of

programs that cover the different aspects of the field presented in Figure 1, we see now also that for capacity building the three levels of Figure 2 should be covered.

CAPACITY BUILDING FOR GEOINFORMATICS	PURPOSE	FOCUS
	Human resources development	Supply of technical and professional personnel
	Organisational strengthening	Strengthen the management capacity of organisations; institutionalise geo-ICT solutions (systems and processes) as well as strategic management principles
	Institutional strengthening	Strengthen the capacity of organisations to develop & negotiate appropriate mandates and modus operandi as well as appropriate (new) legal and regulatory frameworks

Figure 2. Three levels for capacity building (Groot and Georgiadou, 2001)

Finally, the rapid technological developments, as well as developments in demand for information, imply the continuous upgrading of professionals as part of the “lifelong learning” principle observed throughout present-day society. This in turn challenges the education and training institutions themselves to keep up to date with scientific and technological developments while simultaneously dealing with the proliferating variety in demand.

ITC has a long tradition in the field of capacity development and during the fifty years of our existence we have always continued to adjust our educational programs to the needs of our clients. Recently we reformulated the mission and name of the Institute and we initiated a new research program.

4. ITC's NEW MISSION AND NEW NAME

4.1 Mission of the Institute

ITC is an institute for international education through international knowledge exchange. The knowledge exchange activities of ITC aim primarily at capacity building and institutional development in countries that are economically and technologically less developed (LDC's). We continuously adapt this position to modern developments in the two components of our core business i.e.: the field of geo-informatics and its related topics and the field of international education.

International education for capacity building and institutional and organisational strengthening should more and more be embedded in professional, scientific and education networks with nodes in our target countries and nodes in the Northern world. This implies that ITC acts as a two-directional *gateway*. On the one hand we provide access for organisations and individuals from LDCs to knowledge and professional institutes in the Western world. On the other hand our extensive international relation network is

made available to scientific and professional organisations from the Netherlands. Therefore ITC operates as:

- An *internationally recognized Centre of Excellence*, i.e. recognized both in the LDCs (our traditional market) and in the Western world, the Netherlands in particular.
- A *node in an international knowledge network* between on the one hand scientific and professional organizations in LDCs and on the other hand scientific (both academic – universities – and technological – research) organisations and professional organisations in the Western world, principally the Netherlands.
- An organisation: with a *demand- and client-oriented approach* to delivering research, education and project services, which is to be realised in a dialogue-driven way.

We observe a changing attitude with respect to both the public and political support for development cooperation with potentially far reaching implications for international education. This is an extra reason for us to ensure a firm position as a centre of excellence also in the Netherlands' (and European) scientific community. Consequently an will be pursued that will be mutually beneficial to both LDC's in view of the increased demand for current western science and technology and the Netherlands' setting in view of the internationalisation policy

4.2 Knowledge field

ITC's activities concern the knowledge field centred on a core identified as “Geo-information Science and Earth observation”, operationally defined as follows (ITC, 2001):

“Geo-information Science and Earth Observation concerns a combination of tools and methods for the collection, storage and processing of geo-spatial data,

and for the dissemination and use of these data and of services based on these data.

- This implies the development and application of concepts for spatial data modelling, for the information extraction from (measuring and) image data and for the processing, analysis, dissemination, presentation and use of geo-spatial data.*
- It also implies the development and implementation concepts for the structuring, organisation and management of geo-spatial production processes in an institutional setting."*

We mention earth observation explicitly to emphasise the fact that, in the context of our knowledge field, data collection is predominantly based on aerospace survey techniques. The expertise of our Institute focuses on issues related to this theme, and our educational programmes, research and advisory services deal with two types of problem area:

1. Problem areas where geo-information science and earth observation play an essential role in finding solutions. This first type deals with the use of geo-spatial data for the management of space and resources.
2. Problem areas that need solutions to guarantee relevant, economic, timely and reliable information provision. This second type deals with organisations and the processes to provide geo-spatial data for the user community. Here, problems might refer to conceptual, technical, management and policy issues related to data provision.

4.3 Name

The development of our knowledge field has since our creation in 1950 under de name "*International Training Centre for Aerial Survey*" necessitated changes of our name. The incorporation of earth science applications resulted in the name "*International Institute for Aerial Survey and Earth Sciences*" in 1968. The use of data derived from satellites caused the name to change into "*International Institute for Aerospace Survey and Earth Sciences*" in 1985.

In correspondence with the developments in our core knowledge field, as from January 2002, the official name of our institute is

"International Institute for Geo-information Science and Earth Observation".

The abbreviation "**ITC**" will remain our brand name the way it has been since 1950.

5. ITC's RESEARCH PROGRAM

To provide the scientific framework and basis for realising the strategic goal, a solid new research programme has recently been developed. This program should keep our expertise up front at a high level. It should be instrumental in developing knowledge that is highly relevant for our partners in the target countries, but it should also help to maintain or improve our position as a partner in professional and scientific networks in the northern world. The research program meets the following criteria/conditions:

- Fit within the context of ITC's knowledge field*
- Problem-oriented*
- Problem areas where geo-information science and earth observation play an essential role in finding solutions*
- Problem areas that need solutions to guarantee relevant, economic, timely and reliable information provision*
- Inter- or multi-disciplinary character*

- Embedded in the national and European scientific network*

- Link up to networks in client countries*

- Output-oriented*

- Governed by scientific quality, publications and PhD awards.*

Programme formulation was embarked on by the end of 2000 and, in the course of 2001, resulted in a research programme that meets the above criteria and comprises five, partly overlapping spearheads with the shared overall aim of strengthening civil society:

- Geo-information provision for strengthening civil society*
- Geo-information provision for the multifunctional use of space*
- Geo-information provision for natural disasters and environment*
- Geo-information provision for food and water security*
- Geo-information provision for global change monitoring.*

This programme is being implemented as an integrated set of programmes/projects in which ITC scientists (ITC staff and PhD researchers), post-doctoral fellows and visiting scientists collaborate. Experiences and results are incorporated in the educational programme and project services. The results of this research programme are published as PhD dissertations and as scientific articles in a selected group of international peer-reviewed journals. They are further publicised in scientific events organised at ITC and through participation and presentations at international conferences, congresses, etc. Furthermore, information is made available in particular to our alumni via the ITC library Internet page as a gateway to knowledge.

6. ITC's EDUCATIONAL PROGRAMS

Transfer of knowledge by ITC has been undertaken mainly by providing mid-career professionals between 30 and 40 years of age with post-graduate education and training (in English) through an academic degree programme exclusively in the Netherlands. Initially, education consisted of post-graduate training of short to medium duration. To address the requirements resulting from technological developments (processes) and the incorporation as well as application of geo-spatial information management principles (context), education has developed over the years into the current set of six separate programmes covering a range of 25 specialisations.

In addition to adjusting the content, we have also accommodated changes in demand for the type of training. Our educational programmes currently comprise:

- An 18-month Master of Science programme that provides a scientific basis. Graduates are assumed to be able to develop, and assess the performance of new methods and techniques. These new methods and techniques are directed towards improving existing processes and enhancing/expanding applications. Successful completion of the MSc programme affords access to ITC's PhD research programme.*
- A 12-month Professional Master programme. Graduates are assumed to be able to operationalise new technologies and methods within their organisations. This may require certain adjustments in information needs and processes within these organisations.*
- Besides academic degree programmes, ITC also caters for the needs of individual organisations through short tailor-made courses. These are carried out at ITC or on site*
- ITC annually organises some six refresher courses for alumni, employers and colleagues. These courses deal with new*

developments in geo-information science and earth observation, take about two weeks and are carried out in the home countries of our alumni in collaboration with local partner organisations, i.e. universities or professional organisations.

A major step forward has been the introduction of a modular system, with each programme/specialisation consisting of three-week modules, all starting at the same time. This system includes elective modules, thus allowing course participants to select a subject/topic that best fits their own professional requirements. This modular system also allows participation in individual modules without the obligation to follow the entire course.

We will use the diagram of Figure 1 to give a short review of the educational programs at ITC and the topics they emphasise.

6.1 Geoinformatics (GFM)

This program concentrates on the technological aspects of spatial data handling. Core issues are imaging systems and information extraction from images, spatial information systems and information processing and the dissemination and visualisation of spatial information. The technological knowledge and skills are complemented by topics on the management of spatial information in an organisational Figure 3. indicates for this program what emphasis is given to the aspects and contexts specified in Figure 1.

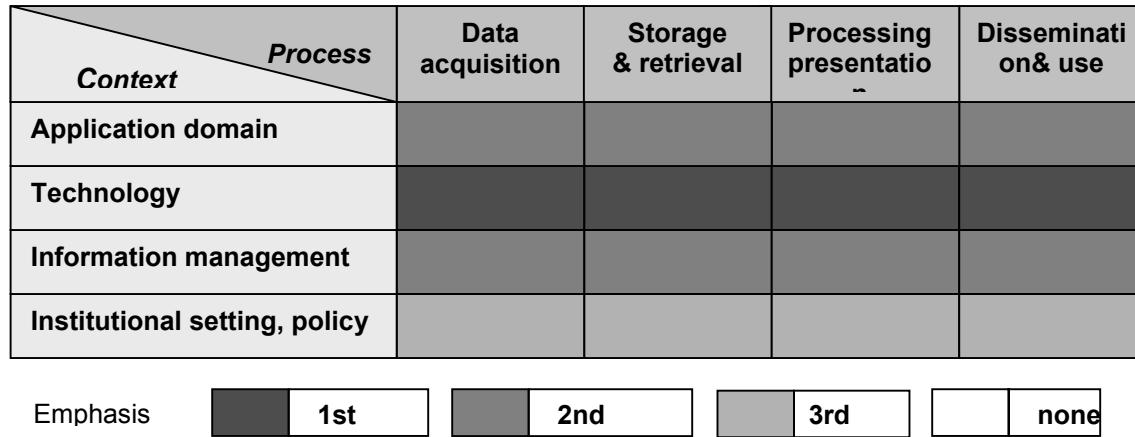


Figure 3. The emphasis of different topics in the Geoinformatics programme

6.2 Geoinformation management (GIM)

The GIM program deals with the problems which organisations meet when dealing with information management like: methods for the identification of information needs, information systems design, information flow management, process reengineering. Presently the program is redesigned to focus on organisations producing and handling large volume data like NMA's and

cadastral surveys. Specialisations will be developed for organisations involved in urban planning and management, land use development, soil and geological surveys. In this context issues like data acquisition, data fusion and exchange will be dealt with. Figure 4 illustrates the topics that are emphasised in this program.

<i>Context</i>	<i>Proces</i>	Data acquisition	Storage & retrieval	Processing presentation	Dissemination& use
Application domain					
Technology					
Information management					
Institutional setting, policy					

Figure 4. The emphasis of different topics in the Geoinformation management programme

6.3 Urban Planning and Land Administration (UPLA),

The objective of the Urban Planning and Land Administration programme is to improve the institutional capacity of organisations that are involved in urban planning and land administration. This program concentrates on the use of

information rather then on the generic issues of information production and provision. Figure 5 illustrates the topics that are emphasised in this program.

<i>Context</i>	<i>Proces</i>	Data acquisition	Storage & retrieval	Processing presentation	Dissemination& use
Application domain					
Technology					
Information management					
Institutional setting, policy					

Figure 5. The emphasis of different topics in the Urban Planning and Land Administration programme

6.4 Natural Resource Management (NRM) , Water Resources and Environmental Management (WREM), Earth Resources and Environmental Geosciences (EREG)

These are three programs emphasising the use of spatial data in context of three application domains. Remote sensing and

geographic information systems are used to support analysis, planning, decision makings and management in fields like forestry, sustainable land and water management, the exploration of earth resources and disaster mitigation. Figure 6. illustrates the topics that are emphasised in these programs.

<i>Context</i>	<i>Proces</i>	Data acquisition	Storage & retrieval	Processing presentation	Dissemination& use
Application domain					
Technology					
Information management					
Institutional setting, policy					

Figure 6. The emphasis of different topics in the programmes for Natural Resource Management, Water Resources and Environmental Management, Earth Resources and Environmental Geosciences

7. DECENTRALISED EDUCATION

In the past fifty years students from all over the world used to travel to the Netherlands to stay there for 12 to 18 months to complete one of these programs. But recently we observed a growing reluctance of our customers to be away from their jobs and family for such a long time. Furthermore the quality of educational institutes in different parts of the worlds has increased considerably during the last decades.

These are two reasons for ITC to change policy and to develop two options:

- *Decentralisation of education*

The first option will be to offer programmes or parts of the programmes in the home countries (or regions) of the course participants. This can be arranged through joint educational programmes with educational institutes abroad. We intend to do that through establishing joint educational programmes with scientific institutions, implemented in collaboration with and by staff of partner organisations in the home countries or regions of our clients. They may be implemented entirely nationally or partly so with a component at ITC in the Netherlands. For example, 12 months of an 18-month MSc programme may be conducted in the home country and on successful completion of the examinations the six-month thesis writing may subsequently be conducted at ITC. Both the national institution and ITC will accredit academic degrees and certificates, preferably under a double logo.

The activities in Iran (Toosi University) and in Bolivia (CLAS projects) are the first careful steps in this direction, from which much experience is being gained. Partners and parties in other countries have expressed their interest in establishing similar partnerships, both as part of our ongoing institutional development projects, as well as others, i.e. Tanzania (UoD/UCLAS), Philippines, China (WTUSM), India (IIRS), Argentina (Buenos Aires University), Colombia (Medelin, IGAC). For Africa we want to explore the possibility of developing an ITC-Africa network which I will elaborate later.

Decentralisation through an international education network has the potential to improve the effectiveness, flexibility and productivity of the ITC educational system in terms of costs per student and student/staff ratios. But it requires good quality assurance and a monitoring system of the educational programmes. We must work hard to develop methods towards achieving this goal.

A very important aspect will be international accreditation and quality control. For this purpose, use will be made of the experience that other organisations, particularly those from Australia and the UK, have acquired in setting up similar systems.

- *Part-time education*

The second option will be to offer the possibility for spreading the educational programme over a term longer than 12 or 18 months, i.e. course participants should have the opportunity to obtain the required credit points over a period of two or three years. This solution is only practical if part of the programme can be carried out through a distance learning approach, so that participants do not have to be in Enschede for the whole programme. The precondition for affecting this strategy is a more flexible and efficient

educational programme. A start was made to this effect in 1999 through an educational reorganisation. This reorganisation resulted in six programmes with courses at Professional Master's (PM) and MSc levels. These replaced the large variety of programmes offered earlier and created greater uniformity. Furthermore, a modular approach has been introduced and a system in which a student's progress can be measured in credit points: 48 for PM and 69 for MSc. This was a first essential step towards gaining more efficiency and flexibility in our educational system. But more is required to fully answer the changing demands of our clients. The decentralisation of our educational activities will also be an important instrument for implementing this second strategy.

In this respect we will make use of the opportunities offered by the fast development of information and communication technology. This provides powerful tools for distance education. We have adopted Blackboard as a tool and over the last two years we have been developing modules to be offered by these tools and we have been experimenting on the use of this technology in the context of decentralised education. The two core modules of our educational programs are good candidates for a distance-learning project at ITC. The aim of such a project should be to provide the means for students to prepare for a common entrance level before they come to ITC.

The previous observations do not imply that all educational activities should be decentralised. There are several reasons for maintaining educational activities at our home base:

- Decentralised activities cannot serve all regions in which ITC is active; there will always be countries or organisations that prefer to send their staff to ITC rather than to another institute in our network. Furthermore, international exposure, and certainly exposure to the Western professional and scientific environment, will remain an important aspect of the education of high-level staff in many organisations.
- Educational programmes at ITC provide the experience we need for our central role in an educational network, including aspects of quality assurance.
- The programmes run at ITC should serve as a vehicle for permanent educational innovation. This innovation relates to content, educational methods and tools.

Furthermore, the newly introduced modular structure of our programmes provides the building blocks for short training programmes for which we think there is a good market and for the quick and flexible reaction to the increasing variability of the requests that we receive.

8. ITC's AFRICA NETWORK

Although ITC has been transferring educational and training programmes to the developing world for many decades within the framework of institutional development, this transfer has invariably been project-based. In other words, the building of local capacity to conduct education and training was based on temporary project funding. On completion of such projects, relations with ITC declined and became mainly of a personal nature. We see, however, that the attitude with respect to international cooperation is changing, this has also been expressed recently very clearly by the Netherlands Minister for International Cooperation, Mrs. Herfkens (Herfkens, 2001):

“.... Starting from existing capacity calls for a new way of doing business, from both donors and recipients. It is no longer

a matter of improving the knowledge base, producing institutional development guidelines, introducing new techniques for field operations, setting up a specialized unit or providing training for staff. The process needs to be turned upside down. From donor-driven to client-driven. Putting institutional development at the centre of our aid efforts implies a radical paradigm shift. It means:

- Accepting the fact that development does not take place by throwing money, projects and expatriate technical assistance at problems;
- Recognizing the need to start from local conditions and capacities, to look at what can realistically be achieved in a given institutional setting and to adapt donor ambitions accordingly;
- Redefining the development process as the stimulation of local performance in the public sector, the private sector and civil society.
- Shifting the focus of donor concerns away from policy objectives, or what should be done, to implementation, or how to achieve sustainable results.
- Changing the nature of donor involvement, moving away from writing policy prescriptions, setting conditions and making decisions and moving towards explanation, demonstration, facilitation and recommendations...."

ITC's current decentralisation strategy will be based on that concept. Joint educational programmes in a decentralisation venture should be accredited by both partners – both attaching their logos, both responsible for implementation and quality control – both partners are also committed to continuing the collaboration, using their own core funding sources and scholarships/fellowships funded from external sources. Hence the relationship is not based on temporary project funding and hence is more likely to be sustained.

To avoid becoming over-committed and unable to maintain quality control, ITC intends to develop regional networks, composed of a limited number of pre-identified partners that meet the above conditions. A regional network for Asia was drafted during the course of 2001. It is expected that similar networks will be identified for Africa and Latin America during the course of 2002, and for Central and Eastern Europe during 2003.

Partners for decentralisation of our African activities will be identified from among organisations with which experience has been gained during institutional development projects over the past 25 years, Table 1 (Beerens, 2001).

Ongoing and future institutional development projects will be geared towards supporting our decentralisation activities. Additional partners for strengthening the network will preferably be well-established organisations that meet the above conditions without requiring much additional investment from the ITC side. Wherever possible, organisations with a regional exposure and service experience will be preferred.

<i>The provisional decentralisation network in Africa comprises:</i>	
<i>Country</i>	<i>Partners</i>
Nigeria	<i>ECA Regional Centre for Training in Aerospace Survey (RECTAS)</i>
Kenya	<i>ECA Regional Centre for Mapping of Resources for Development (RCMRD)</i> <i>Moi University</i>
Tanzania	<i>ECA Southern and Eastern Mineral Information Centre (SEAMIC)</i> <i>University of Dar es Salaam – University College for Land and Architectural Studies (UCLAS)</i>
South Africa	<i>University of Natal – Centre for Environment Development (CED)</i>
Namibia	<i>Polytechnic of Namibia</i>
Zimbabwe	<i>University of Zimbabwe – Department of Geography and Environmental Sciences</i>
Ghana	<i>To be identified</i>
Egypt	<i>Egypt Survey Authority</i>

*Table 1. Major decentralised activities of ITC in Africa
(Beerens, 2001)*

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