Improving Capacity Building in Earth Observation and Geo-information Science in Africa through Educational Networking

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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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