BUILDING CAPACITY TO USE GEOSPATIAL TECHNOLOGY FOR DEVELOPMENT IN AFRICA: LESSONS FROM THE UGANDA GIS PROJECT

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INTRODUCTION

Over the past several decades geospatial technologies, as a set of tools and methods used in acquiring, managing, interpreting, integrating, displaying, analyzing, data in the geographic, temporal, and spatial contexts, have gained increasing importance in both the public and private sectors. They include geographic information systems (GIS), remote sensing of the environment, surveying techniques, and global positioning systems (GPS) These technologies have been used to help store and manage land records, locate public and private facilities, plan and manage transportation systems, manage environmental problems, and promote and protect human health (Malone, Palmer and Voigt, 2002). The potential of these technologies for the future is so great that the US Government identified geospatial industry as one of the 14 growth industries of the future. However, geospatial technologies are more than computer hardware, software, and data. The effectiveness of geospatial technologies as data and information management, and decision-making tool depends on people who know the theory and applications of those technologies and can be resourceful in identifying and collecting spatial data, determining the quality of the data, processing it, and asking the right kind of questions to get right answers to aid decision-making.

In spite of these, Africa's capacity to use geospatial technologies is very weak. On the one hand, much of the efforts at building capacity in this area have been single-layered and single-targeted projects. Once the project is over so is the capacity building effort. On the other hand one is bound to find trained expertise in universities with no adequate teaching and research laboratories. Not surprisingly, recent evaluative reports on the state of geospatial technologies in Africa noted that in spite of the growing number of institutions that were using geospatial technologies on the continent the human and organizational capacity needed to support the effective use of these technologies in many African countries is still very weak (National Research Council, 2002, Taylor, 2004). In particular, the National Research Council (2002) report concluded

> "it is unlikely that long-term capacity building in technical skills such as geographic information science can be sustained in the absence of strong foundations in higher education with emphasis on science and technology. … There is an urgent need to coordinate and strengthen the capacity of African university departments providing both research and training in geographic information science. African universities should become a focus for capacity including training and research in geographic information science, and development organizations should coordinate their efforts to achieve this goal" (National Research Council, 2002 p. 117).

This paper is about one such capacity building effort in geospatial technology in Uganda that sought to strengthen the capacity of university departments to provide training in geographic information science (GIS), while training district planners to use GIS in local government planning. The main thrust of the paper is that capacity building effort in geospatial technology needs to go beyond the single-layered, single-targeted project approach and emphasize building infrastructure that will enhance the capacity to train a larger amount of people in the technology. However, this calls for a long-range commitment on the part of both the universities as well as other interested parties. Implicitly, the paper calls for full incorporation of geospatial technology as part of the university curriculum and placing it at the same level as other subjects in the science curriculum. Anything short of this will make it harder to achieve the desired goal. The paper is divided into three sections. First, I make a case for the need for capacity building in geospatial technology in Africa. Second, I describe the Uganda GIS project as a case study. Third, I discuss the lessons from the project.

THE NEED FOR CAPACITY BUILDING IN GEOSPATIAL TECHNOLOGIES IN AFRICA

The need for capacity building in geospatial technology in Africa has been well articulated by many researchers (e.g. NRC 2002, Taylor 2004). From this paper's perspectives, this need stems from two main reasons. The first is the role of geospatial technology in economic development of Africa and the second is the weaknesses of past capacity building efforts in geospatial technology in Africa. However, what do I exactly mean by capacity building? Definitions of capacity building abound, but for the purpose of this paper I will follow Eade (1997 p.24)'s definition – "capacity building …involves identifying the constraints women and men experience in realizing their *needs*, and finding appropriate vehicles through which to strengthen their ability to overcome *those constraints*"

The Role of Geospatial Technology in Economic Development

Economic development is a problem-solving process that results in improvements in living conditions of people. Like all problem-solving processes, economic development involves making decisions, but unlike most other problem-solving processes, these decisions are about allocating and utilizing limited resources to meet greater needs that tend to be geographically distributed and uneven. Consequently, most of these decisions are about who gets what at where and it is in this regard that geospatial technology becomes crucial. Geospatial technologies provide not only the data and the tools, but also an entire framework within which efficient and effective spatial decisions can be made.

The role of geospatial technologies in economic development also lies in the fact that improvements that result from the economic development process must not only be structural but also spatial. Thus, transformations in income, unemployment, and social structures of the country must be accompanied by spatial changes including location of economic activities, distribution of population, and decentralization of government and private services (Gilbert 1974). This transformation requires making appropriate spatial decisions, which cannot be made without spatial data and spatial tools.

In Africa, development efforts to date have created spatial changes that need modification. From late colonial period through early post-independence era, rapid economic development policies were encouraged without much regard to its spatial consequences. Efforts to resolve this through the rural development movement of the 1970s in some countries did not succeed due to either political instability, economic and financial crisis. The result is that today, the urban system of majority of African countries is dominated by primate cities that keep siphoning investment projects, population from the periphery, and substantial amounts of national budgets on infrastructure and services to the detriment of all the other areas of the country (Mabogunje, 1981). The powerful tools of geospatial technologies can help in reorganization these spatial structures. They can aid in collecting relevant data, mapping of such data, and studying and analyzing them to identify the major areas of need and developing solution for those areas.

The Weaknesses in the Current Geospatial Technology Capacity Building Efforts in Africa

In spite of the role geospatial technologies play in economic development, capacity building in these technologies in Africa is weak. Two recent reports on the capacity building in geospatial technologies in Africa are NRC (2002) and Taylor (2004). The NRC (2002) report entitled *Down to Earth: Geographic Information for Sustainable Development in Africa* examined Africa's capacity building in geospatial technology in three main areas, namely human capacity, organizational capacity, and societal capacity, and found all them wanting.

With respect to human capacity the report found that although capacity-building begins with primary education, all the training in the use of geospatial technologies has occurred at the tertiary level of the education system. Here too, the report noted at in West Africa for example, about 55% of the training in the use of geospatial technology occurs within the context of projects. The use of continuing education is in its infancy-the report identified only two networks about to start. In summary, the report noted:

> "A cadre of well-trained individuals will need to be formed in each country to apply geographic data and information in support of sustainable development in Africa. Continuing and on-the-job training should be an integral part of the process of enhancing geospatial capacity" (NRC, 2002 p. 116).

With respect to organizational capacity, the report noted that higher education institutions in Africa should be at the center of the capacity building effort. However, they have unfortunately failed to do so because of institutional policies and massive budget cuts due to hardships in their respective national economies. The report concluded

> "There is an urgent need to coordinate and strengthen the capacity of university departments providing both research and training in geographic information science. African universities should become a focus for capacity-building including training and research in geographic information science, and development organizations should co-ordinate their efforts to achieve this goal" (NRC 2002 p. 117)

On social capacity, the report emphasized the role of the government in generating demand for people trained in geospatial technologists as well partnerships between the public, private and international organizations.

Taylor (2004) echoed most of the findings of NRC (2002). Basing himself on Beerens (2002), Taylor (2004) identified geospatial capacity building as having three components. These are human resources development, organizational strengthening, and institutional strengthening. From these Taylor (2004) provides an excellent discussion of the roles of Africa's formal education sector, interregional and intergovernmental organizations, as well as international players and agencies in building capacity in geospatial technologies in Africa.

The role of Africa's formal education sector in building capacity in geospatial technology, from Taylor's (2004) account was at best very minimal at this time. First, a large portion of the capacity building in geospatial technology in African universities is project-based. The incorporation of geospatial technology into the curriculum is yet to be achieved. Second, most of the universities lack the resources and infrastructure to make capacity building in geospatial technology a priority. The few courses that exist in the curriculum may be taught without any laboratories to give students hands-on experience. Third, very little of the research on human resource development in geospatial technology demonstrates an understanding of the cultural and economic contexts of the technology's application.

The regional and interregional organizations involved in capacity building of geospatial technologies in Africa are UN Economic Commission for Africa (ECA) institutions and networks. Among the institutions are the Regional Center for Mapping Resources for Development (RCMRD), the Regional Center for Training in Aerospace Surveys (RECTAS), the Southern and Eastern Africa Mineral Centre (SEAMIC), and the African Centre for Meteorological Applications and Development (ACMAD) (Taylor 2004). Of these, Taylor (2004) focuses on RECTAS, whose activities include training and researching in geoinformatics, conducting seminars and short courses to introduce government officials to geoinformatics, and consulting and advising member states of ECA. RECTAS is also involved in a new initiative called Capacity Building for Geoinformation Production and Management for Sustainable Local Environment and Natural Resources Management (CABGLEN). According to Taylor (2004) this initiative is in conjunction with the Federal School of Surveying (FSS) in Ojo, Nigeria, the International Institute for Aerospace Survey and Earth Sciences (ITC), the Netherlands, and the Groupement pour le Développement de la Teledection Aerospatiale (GDTA) France. The initiative has four programs including an M.Sc. in Geoinformation Production and Management, a Professional Masters (PM) in Geographic Production and Management, a three-month certificate course in a specialized area of the PM program, and one-week or one-month refresher courses and workshops. However, Taylor (2004) notes that the resources needed to establish and develop these were yet to found.

By far the bulk of the capacity building in geospatial technologies in Africa is being done by international agencies. In addition to the sponsorship of GIS-based projects, these agencies are heavily involved in the training of African professionals. In this connection, Taylor (2004) gave special recognition to GDTA of France and ITC of the Netherlands for the training of geospatial professionals in Francophone Africa and Anglophone Africa, respectively. According to Taylor (2004) the mission of GDTA is to

promote the development of remote sensing, space imaging, and GIS worldwide through courses and workshop, and does not confine itself strictly to developing nations. In contrast, ITC was established to train mid-career professionals from developing countries, initially in photogrammetry and cartography. However, it expanded later on to embrace analysis of satellite imagery and geographic information systems. Program areas include geoinformatics, geoinformation management, urban planning and land admnisntration, and natural resources management (Taylor, 2004) Each of these programs offer four different training possibilities: a PhD, an M,Sc, a Professional masters, and short-term courses responding to client needs.

The ITC has been extremely successful in training mid-career African professionals in geospatial technology, having trained 4,433 people from 45 African countries from 1950 – 2002 (Bereens 2002, Taylor 2004). However, even the ITC acknowledges that that the critical mass of geospatial expertise needed in a single African organization is yet to be achieved (Bereens 2002, Taylor 2004). As a result, ITC plans to change its capacity building efforts from training mid-career professionals to building social capital based on networks and partnerships within both the Netherlands and Africa (Taylor 2004). Examining this new direction, Taylor (2004) applauded the ITC but also raised a number of challenges in the way including how to provide adequate funding and resources to African institutions, how African institutions can create the necessary and workable networks among themselves, and the problem of unequal strength of ITC and its African institution partners.

Other players in the capacity building of geospatial technology in Africa includes professional associations, foreign universities, and private companies. Professional associations such as FIGS, ISPRS, ICA, IAG, hold meetings and workshops for young professionals. US universities provide training in geospatial technology through such programs as Fulbright programs. In Canada, both the Canadian International Development Agency (CIDA) and International Development Research Center (IDRC) offer similar support (Taylor 2004). Finally, private sector firms including consultancies, hardware and software vendors also continue to play a role in the capacity building process.

With respect to the future, Taylor (2004) discusses several strategies and directions for capacity building in geospatial technology. These include the ECA Committee on Development Information's plan, ICT strategies articulated by the African Development Forum in 1999, a new role for African universities, particularly in the area of research applications, private sector partnerships, and the creation of "Technology Corps" along the lines of the "Peace Corps."

Clearly, a lot of strides have been made in capacity building in geospatial technology, but a lot more need to be done in order to really make geospatial technologies part of the decision-making tools in Africa. In connection with this, there are a number of pertinent questions that need to be addressed.

(1) Geospatial technologists are fully aware of the role geospatial technology plays in the sustainable development of Africa, but all that is academic. Have there been any market analyses of the supply and demand for geospatial technologists in African countries that inform all these capacity building efforts?

(2). So far the emphasis of all the capacity building efforts appears to be on postgraduate training. If these efforts have created a cadre of expertise in African

higher education institutions, will it not be more appropriate to shift emphasize to undergraduate level? Is post-graduate level training the appropriate level of training needed?

(3) This is not the first time Africa is building capacity in a field of study. The history of early post independence period is replete with how African countries build capacity in teachers, lawyers, doctors, nurses, etc, Are there no successful templates in Africa's past efforts to build capacity in a technical field? What is so different about geospatial technologies that capacity building efforts in them seem to be scattered all over board?

Efforts to build capacity in any skills must be tied to the demand for that skill. With limited resources it will be difficult for African universities to make geospatial technologies a priority in their curriculum. The creation of this demand lies with both the public and private sectors. In particular, African governments need to put their money where their mouths are to create demand for these specialists, and provide resources to support the training of geospatial personnel. Also capacity building in a field such as geospatial technology should be all encompassing, going beyond the human capital training to physical, social, and institutional capital. From the point of view of many African universities, the most crucial needs lie in infrastructural support for teaching and research. Training people in a fast growing field such as geospatial technologies without the infrastructural support for the trainees to apply the skills in their profession be it teaching, research, or service is a half-way measure. Yet for the most part aid agencies will not fund such needs as physical infrastructure. It is these ideas that guided the design and implementation of the Uganda GIS project

THE UGANDA GIS PROJECT

Background

The Uganda GIS originated from the decentralization policy that was introduced by the Uganda Local Government Act of 1997. The Act charged local governments in Uganda with the responsibilities of preparing and implementing district plans at the local level to improve people's livelihoods. In recognition of the pivotal role of information communication among various stakeholders in this effort, and given the fact the various governmental units were not talking to each other, the Uganda Ministry of Local Government (MoLG) in collaboration with the Economic Policy Research Center (EPRC) at Makerere University developed an information-sharing infrastructure referred to as Local Government Information Communication System (LoGICS) in 2002. LOGICS was set up as a one-stop information gathering and sharing center for all the various government units that shared in local government, with funding support from the Rockefeller Foundation.

To pilot test the system, MoLG rolled out LoGICS in the eight districts of Jinja, Rakai, Soroti, Tororo, Kigoba, Mpigi, Mukuno, and Wakiso, and in the municipality of Kabale. In December 2003, EPRC at Makerere University in collaboration with the MoLG organized a round table workshop, sponsored by the Rockefeller Foundation, to review and assess the progress and lessons learned from the performance of LoGICS in

the districts that had tried it. The workshop identified four main areas of constraints – design process/technical, environmental, implementation, and sponsorship/funding constraints. One of the design process/technical constraints was that the original LoGICS had no geographic information system (GIS) facility. It was recommended that a GIS module should be developed to interface with LoGICS. EPRC and MoLG submitted a grant to Rockefeller Foundation to enable them integrate GIS into LoGICS, but the grant had one major flaw. There was no training component. Given its experience in supporting GIS projects before, the Foundation questioned how the project would be accomplished without the appropriate resources, especially trained GIS personnel, in place. To address this question, the Foundation wanted a needs assessment of the possibilities of developing and implementing a training program that will build capacity for integrating GIS into LoGICS project and beyond.

About this time, I had been in communication with the Rockefeller Foundation for almost a year about a GIS capacity-building project I wanted to start at the University of Ghana at Legon, Ghana. However, because the Foundation was not funding any projects in West Africa, it was not able to respond favorably to my proposition. So, when the Foundation wanted a needs assessment on GIS capacity in Uganda, I was called upon to help.

Needs Assessment

Objectives and Methods

The main objectives were as follows:

- Meet the major stakeholders of the project
- Visit existing GIS training facilities and ascertain the type of training being offered
- Discuss and ascertain the type of training that will be appropriate
- Establish and agree on a detail plans of what the training should cover
- Identify who will receive the training
- Establish where, how, and when such training can be offered

I met with representatives of the following stakeholders

- Ministry of Local Government (MoLG)
- Ministry of Education (MoE)
- Office of the Prime Minister (The Karamoja Data Center Project)
- Uganda Bureau of Statistics (UBOS)
- National Planning Authority (NPA)
- Economic Policy Research Center, Makerere University (EPRC)
- Makerere University Institute of Environment and Natural Resources (MUIENR)
- Makerere University Department of Geography
- Makerere University Department of Soil Science.
- Tororo District
- Jinja District

Where appropriate, these meetings focused on existing GIS capacity in within the unit, existing resources and facilities for GIS training, as well as examples of previous GIS training efforts and lessons learned.

GIS Capacity in the Local Government Sector

There was a great deal of awareness of the supposed role GIS could play in the Local Government sector, but there was very little capacity at the time within the sector at the ministry headquarters, the district and municipal levels. There was only one staff member who has had a post graduate training in GIS. This person is at Jinja District but since returning from his training abroad, he had not been able to apply GIS because of lack of GIS hardware and software resources. Two efforts at GIS capacity building at the district level were reported. One of these was by the Karamoja Data Center of the Office of the Prime Minister and the other was by GDED, the German Development Agency, in Tororo District.

The Karamoja Data Center

The Karamoja Data Center Project began in 2001 with support from the Italian Government. The objective of the project was to collect, process, and analyze data for the development of the Karamoja Region. Activities started with the environment, and then extended to mapping of schools, bore holes, health units, ethnic groupings, and settlements. To build capacity in the use of GIS, the district planner and the district environmental officers from 8 pilot districts were trained to use GIS for purposes of environmental management over a four-week period- a two-week introductory GIS and a two-week Intermediate GIS courses. According to the Director of the Center, the trainees received data, equipment, and real world exercises, before they left for their respective places. However, within the space of about a month or so, they had all forgotten what they learned. The result was that at this study, the Data Center was producing all the planning maps as well as doing all the GIS analysis for the districts in the region, instead of the districts doing it themselves, which is contrary to the decentralization process.

Responding to why the training program failed, the Center reported that the people that were trained lacked self-drive and were not motivated enough to take initiative of the training. A further probe, however, revealed that the “wrong staff” was trained since these district planners and district environmental officers were actually not the ones who analyze the data for planning at the district level. Within the typical "African culture of office organization,” these officers were “bosses” who gave directives and made requests of their subordinate staff. Apart from that the officers had other responsibilities that made it difficult for them to become GIS Analysts at the same time. Finally, there was no plan for a follow-up to sustain the training. The result was that the Prime Minister’s Office was still doing the GIS work for which they had trained people.

The Tororo District GIS Project

Tororo district was one of the two districts that were using GIS at the district level. The other district was Busia. The Tororo project began in 2000 with funding from

UNICEF and technical staff from GDED, the German Development Agency. At the time of the assessment study, there were two German technical personnel in the district planning office involved in two main training activities. The first was training of extension workers to go into the field to collect point location data of facilities with Global Positioning System (GPS). The data were then downloaded into a GIS and used to produce maps. The second training was given in GIS to some district officers and staff over a 6-day period. Two of such training had been held by the time of the study and eight people had been trained to use GIS. However, only one could actually use GIS as a planning tool. Consequently, the German technical experts were producing all the maps. Even so, the main activity so far has been creating the databases. At the time of the visit two main layers had been completed for the district, using ArcView 3.2. One layer was for facilities (primary schools, trading centers, markets, churches, water points, petrol stations, agricultural stations) and the other layer was road network. The likelihood that this effort can be sustained after the departure of the expatriate technical staff appears doubtful.

In addition to there were other problems. First, it took too long to for the trainees to put the knowledge and skills they had gain to use, and this made them forget. The district also needed assistance with base maps from the UBOS, which also took a long time to obtain. There was also a high turnover rate among trainees, which made it difficult since every time new people had to be trained. Some of the officers also lacked basic computer knowledge so it was difficult for them to get used to GIS. Some of the units at the district level also did not have computers and there was also a problem with data compatibility makes data harmonization.

GIS Capacity outside MoLG

GIS Capacity at Uganda Bureau of Statistics (UBOS)

Uganda Bureau of Statistics (UBOS) is the premier government agency for census data collection in Uganda. Its main function is to conduct the decennial census. The bureau has a Cartographic Section, which was set up with a very narrow mandate of producing maps for the census. Later on this mandate was broadened to include updating of the maps.

Over the past few years, the section has ventured into GIS and started to do school mapping and developing administrative boundaries for Local Governments. The mapping of administrative boundaries began in 2001 and it was still not complete during the study. The main problem is that the number of districts has been changing every few years. When the exercise began in 2001, there were 30 districts. In 2004, there were 56. In 2006, the number increased to 79.

GIS capacity at UBOS was very limited and further development was in its infancy. The Cartographic Section had 10 computers, and the ArcView, and ArcGIS software. They had two plotters but none of them was working. It employed 5 people in addition to the Director. The five had received some in-house training in GIS that had allowed them to create and update district boundaries as well as embarking on school mapping. These resources were clearly inadequate for the pivotal role UBOS has to play in promoting the use of GIS as a planning tool in Uganda. Fortunately, in a 2004 report

titled “GIS Capacity Development for National Statistical System” a number of important recommendations were made regarding capacity building in GIS at UBOS. Specifically, it proposed a two tiered-level training for UBOS staff at all levels by local lecturers with a few selected staff members going overseas for more technical training. It was reported that UBOS was going to implement the recommendations, with an outside vendor conducting the training

To a question of whether such training could not be provided by MUEINR, the director reported that the main problem with training at MUEINR was with the admission into Makerere University. The existing GIS courses offered by MUEINR were all at the graduate level. This made it difficult in the first place for people to get training in GIS. In addition it took too long. What was needed is a certificate program.

GIS Capacity in the Education Sector

The Ministry of Education (MoE) was just in the middle of a school mapping exercise, which is being conducted with the help of UBOS. There was therefore very little GIS capacity at the moment, but the Assistant Commissioner for Education Planning Unit gave an account of the Ministry’s experience in capacity building in the use of computer technology that had important lessons for GIS training. He reported that in 1999, the Ministry began working on its Education Management Information System (EMIS). Each district received two computers and each municipality received one computer. The ministry organized a two–day workshop in basic computer automation. This workshop was targeted at two people at the District Level – the District Education Officer and the District Statistician. A second training in computer applications – Microsoft Excel and Microsoft Access was held. There were plans to continue this in 2000-2001. However, when the trainees were called back they had forgotten all that they had learnt.

A number of factors were identified as the reasons for this failure. One was lack of funding to follow up with the program. Another reason was the high turnover rate among some of the trained people to other government units. A third factor was that the people who were trained would not do data entry, since they were the heads of departments, so there was the need to hire and train data entry people. This implied the need for more money and finding the people with such skills, none of which was easy to come by. A fourth factor was also the need for new computers and more equipment. The final factor was network problems.. The department began a pilot project of a wide area network (WAN) in which 10 districts would be linked. However, there were no telephones in the districts so only two of the districts ended up having a WAN

GIS Capacity of Other Key Stakeholders

The Ministry of Health (MoH), the Ministry of Water, Lands, and Environment, the Ministry of Finance, Planning and Economic Development, and the Ministry of Works, Housing and Communication are the other stakeholders in LoGICS. These were not visited, but from previous reports on GIS in Uganda, it was evident that the MoH was using GIS very extensively in various forms of mapping. It was reported that the ministry was mapping all the health facilities in the country. The Ministry of Water, Lands, and

Environment was also using GIS to map water points, water resources assessment, modeling and reporting. The Department of Lands and Survey of the same ministry was planning to provide support to GIS and mapping related activities in the land sector.

Teaching Resources and Facilities

The Ministry of Local Government One-Stop Information Resource Center

In terms of other computer hardware facilities that could be used for training, the Ministry of Local Government had a computer facility that had 15 computer workstations, fitted with up-to-date operating systems that could GIS software. In addition, it had 4 server computers, one printer/scanner/photocopier server, and two screens and a mobile LCD Projector that can be used for instruction. However, a much larger facility would facilitate the training of more people at a time.

Makarere University

Makerere University is the single most important source of resources and facilities for teaching GIS in Uganda. A number of academic units in the university offer GIS courses as part of their curriculum. These include the Institute of Environment and Natural Resources, the Department of Geography, Department of Soil Science, Department of Survey, and Department of Agricultural Engineering.

Makerere University Institute of Environment and Natural Resources (MUIENR):

The Makerere University Institute of Environment and Natural Resources (MUIENR) offered three academic programs in which GIS and remote sensing courses were taught. The first was a BSc degree program in which one course in GIS/Remote Sensing is taught. This course had just been introduced and the department was thinking of adding more GIS courses. The second program was a 12-month Post Graduate Diploma in Environmental Information Management. This had one course in intro GIS and another in GIS for Environmental Management. The third program was an MSc degree in Environmental Management and Natural Resources. This program offered one course in Remote Sensing and Geographic Information Systems and one course in Advanced Remote Sensing and GIS (if the student specialized in the Rural Area Management). Essentially, GIS was an option so it was the students who are taking that option that have the GIS courses. They had two GIS specialists on the faculty, both of which were ITC-trained.

The average enrollment in the M.Sc. program specializing in the option with GIS courses was 8 students a year, and 4 to 10 students for the Post Graduate Diploma, depending upon resource availability. The BSc degree was new so enrolment figures were available. The Institute had a GIS computer laboratory with 8 workstations, a digitizer, and two HP printers. The main software: TNT MIPS; ArcView 3.1, 3.2; IDRISI and ILWYS.

In addition to its regular program, the institute reported that it conducts tailor-made GIS courses, which run usually for a two-week period. The courses were offered to officials at the district level, environmental officers, and water officers as needed. They covered such topics as basics of GIS, how to operate GIS, GIS applications, and Issues in Setting up and Management of a GIS. The main problem with this training, according to the Institute, was that the trainees were not able to use GIS when they went back to their respective places, because of lack of facilities and data, and they soon forgot what they had learned. An examination of a copy of the Practical Training Manual, did not give any clear indication of the practical exercises that the trainees do in the course. As a result, one could also speculate that lack of training manual with examples for trainees to use for future reference, as well as lack of follow-up also be part of the failure

Makerere University Department of Geography

The Department of Geography offered three undergraduate (BA) degree programs in Urban Planning, Tourism, and Environmental Management. It also offered an MA in Geography and MA in Land Use and Regional Development. The department had 16 faculty members of which two were GIS experts. It was also reported that in 2003, all the 16 members of the faculty went to the ITC, The Netherlands, to get some crash GIS training. Yet, GIS course was only at the graduate level. At the undergraduate level, there was only an introductory course. It was reported that the department was planning to introduce a BA Geography program. This would have two GIS courses, one covering introductory elements and the other advanced.

The main problem according to the Head of Department was lack of laboratory space. He said ITC donated six computers to start the laboratory with two more to be added, but the computers were still in their boxes in his office. As a result, students had to use the faculty computer lab to do their practical exercises. However, the department had obtained a new space in the new Institute of Computer Science building so there were plans to transfer the faculty computer facility into that space at the end of school year. The new computers would then be installed in the current faculty computer lab to constitute a laboratory for teaching GIS. Once this was in place the head said the department would target the Ministry of Local Government and other end users for GIS training.

Other Makerere University Departments

The Department of Soil Science in the Faculty of Agriculture, Makerere University offers three degree programs: B.Sc (Land Use and Management), M.Sc, and PhD in Soil Science. They have one GIS course in the BSc program while at the MSc and PhD levels they did GIS applications. The department has been involved in training for local government in a very limited way – so far for only two districts. The Department's GIS facilities included a lab with 10 computers; soil maps of 1:10,000; and Digital Elevation Models (DEMs). It also has Quickbird, which allowed it to capture satellite imagery. The Department of Survey, the Department of Agricultural Engineering, and Faculty of Forestry are other departments that also offered GIS courses as part of their degree programs.

Data Resources

A GIS is as good as its data. There can be no GIS analysis without data. More important however is not only the existence of data, but the accuracy and precision of such data. The following data layers were reported to be available for use.

- District Administrative Boundaries
- Roads
- Water Resources
- Vegetation/Land Cover/Land Use
- Soils
- Topography
- Wildlife
- Parks and Reserves

However the data layers had a number of problems. The first was the level of accuracy and precision. It was reported that the data were created as ArcInfo coverages for the Uganda Biomas Project, which actually started in 1989 as a survey of 9 peri-urban areas with particular reference to fuelwood availability and deficiency. In 1992, a GIS facility was established by the project and from then on the data layers became a base reference site for GIS in Uganda. Since then not much has been done in updating the database. As a result, some of the data, especially land cover and administrative boundaries, were dated. A much more serious data problem reported, however, related to inconsistencies and harmonization. For example, data layers prepared by different government departments such as lands, water, health, over the same area could not be matched, due to the use of different resolutions, coordinates and projection systems. Another problem was the high number of duplication among the different government departments that operate at the district levels. This problem was mainly due to the absence of GIS metadata and the fact that these departments were not talking to each other.

The development of LoGICS would go a long way to remove the duplication, but with respect to GIS, there would also be the need to develop metadata, to inform all stakeholders of what data are in existence, who has them, where, and how to get them. In relation to this, it is important to note that a report titled “Design and Development of Geographic Information System” by the Swedish Consortium in 2001, made comprehensive recommendations regarding establishment of a national GIS standards and development of metadata. The report recommended UBOS to be in charge of the standardization exercise, and coordinate it. When asked about this, an official from UBOS reported that this standardization was already working, but what was lacking was documentation.

Summary Findings and Recommendations

At the end of the needs assessment process, two sets of constraints were found in relation to integration of GIS into LoGICS. The first related to the immediate needs of the Local Government sector, while the second related to long-term needs of not only the local government sector, but beyond.

Constraints Related to Immediate Needs of the Local Government Sector

1. There was no GIS training program in the local government sector
2. Existing GIS training resources at Makerere were not geared to meet the immediate GIS needs that would arise from integration of GIS into LoGICS.
3. Undergraduate courses did not cover enough depth in terms GIS applications that would be required by the local government sector in the effort to integrated GIS into LoGICS
4. Graduate courses did provide enough GIS skills, but they were also difficult to get into since prospective students had to meet the postgraduate admission requirements of the university.
5. The few customized training sessions that had been offered had not been successful due to some of the problems already identified above with the Karamoja Data Center and the Tororo District GIS projects.

Constraints Related to Long-term Needs of the Local Government and other Sectors

1. There was no comprehensive undergraduate GIS program that qualifies undergraduate students to work as GIS analysts in any governmental sector after graduation. Given the need for GIS expertise in the public sector this was a major constraint that needed to be addressed.
2. Existing GIS programs lacked adequate and up-to-date laboratory facilities for both teaching and research.
3. Existing GIS data infrastructure, including such important features as accurate databases, national data standards, and metadata, were either nonexistence or inadequate.

Recommendations

On the basis of the above, two GIS capacity building programs were recommended for the successful integration of GIS into LoGICS and other areas of planning and development (Ofori-Amoah, 2004).

1. The first was a GIS training tailored to the immediate needs of local government sector. It was determined that this training should be in two parts. The first part should be on overview of GIS functionality and capability and should be offered to staff at the Ministry of Local Government Policy and Planning Division (PPD), and the senior administrative staff and personnel as well as section/division heads and designated GIS analysts at the district level. The second part of the training should focus on the technical and application details of GIS and should be offered to the designated district GIS analysts and staff from PPD.

2. The second was GIS training targeted at the long term needs of not only the local government sector but of Uganda as a whole. This should involve strengthening existing GIS programs at Makerere University especially at the undergraduate level through the establishment of more GIS courses and dedicated GIS programs.

This type of training was needed to make the use of GIS in governmental planning sustainable.

The Rockefeller Foundation accepted the recommendations and requested proposal to implement the two recommendations. In December 2004, the Foundation the proposal was funded.

Project Design

The project to build capacity to use geographic information system (GIS) in local government planning in Uganda followed a two-pronged approach – (1) training of district planners in the Uganda Ministry of Local Government (MoLG) to use GIS and (2) enhancing the ability of Makerere University (MU) to offer GIS training at both undergraduate and graduate levels. To this end the objectives of the project were identified as follows:

1. To increase the awareness and knowledge base of the functionality and capability of GIS within the local government sector.
2. To develop competency among local government staff in the collection, processing, and management of GIS data.
3. To develop competency among local government staff in the use of GIS as an analytical and problem-solving tool to support local government planning.
4. To build long-term capacity in GIS through design and implementation of more undergraduate GIS courses and programs at Makerere University.
5. To build long-term capacity in GIS research through the strengthening of existing graduate programs that offer GIS and related courses at Makerere University.
6. To establish collaboration between the University of Wisconsin-Stevens Point and Makerere University in curriculum development, and faculty, staff, and student exchange.

To achieve these objectives, the project activities called for collaboration among the University of Wisconsin-Stevens Point (UWSP), MU, MoLG, and the Regional Universities Forum of Capacity Building in Agriculture (RUFORUM). UWSP was represented by its Department of Geography & Geology, and MU by the Makerere University of Institute of Environment and Natural Resources (MUIENR) and the Department of Geography. The role of each these stakeholders in the project was spelled out in a memorandum of understanding (MOU), which was signed by the heads of all those units. The program was designed for 4 years from 2004 to 2008. UWSP was to lead the first two years working with collaborators in Makerere and turn the program over to the MU for the last two years. The two main projects activities were

<u>Short-term Needs of MoLG</u>

- Development of training manuals for MoLG — Year 1
- GIS training for personnel from pilot districts — Year 1
- Evaluation workshop of pilot training — Year 1
- GIS training for remaining districts and follow-ups — Year 2-4
- Evaluation workshop of the training program and final report — Year 4

Long-Term Needs of MoLG

- Upgrading of GIS labs at MU for teaching and research Year 1
- Funding of two graduate research Year 1-2
- Implementation of new undergraduate and graduate GIS programs Year 1-2
- Submission of Final Report Year 4

With respect to the short-term needs of the MoLG, it was decided, after consultations with the Policy and Planning Division (PPD) of MoLG, that ten districts and two municipalities would be used in the pilot run. Two prospective trainees will be selected from each jurisdiction for the training. In addition, all the Chief Administrative Officers (CAOs) or their representatives would be required to attend the first day of the training. This was so that the politicians at the district level would be at least aware of what the basics of the functionality and capability of GIS and would be willing to provide budgetary support. It was decided that the training should focus.

In terms of the long-term needs, the initial plan was to upgrade one central laboratory facility for both MUIENR and Geography Department at Makerere. However, it soon became clear that due to lack of central time tabling and other institutional cultural practices that will not work so a decision was made to develop two separate labs. In addition, two graduate fellowships were to be offered through RUFORUM to graduate students to enable them do applied GIS research

Project Implementation

Project activities began soon after the funding was announced. A project team consisting of three faculty members and a student from the University of Wisconsin-Stevens Point, two faculty members from the Department of Geography at Makerere University, two faculty members from MUIENR, the head of RUFORUM, and two staff members from the Policy and Planning Division of the Uganda MoLG was established, coordinated by the project leader.

The first task was to upgrade the GIS laboratories at Makerere University for the short-term training of the district planners and also for long-term use in offering GIS courses. The initial idea was for MU to purchase all the hardware and software. However, due to a change in the fund allocations, UWSP ended up purchasing all the hardware and software for the laboratories.

The second task was to ensure that the trainees would get the software that would be used for the training at their various places of work so that they could keep up after the training. To do this, there would be the need for licenses for ArcView software licenses. I negotiated a good package deal with ESRI, but when I contacted the PPD, the initial response was they did not have the budget. However, after further consultations, the PPD was able to purchase 25 ArcView licenses for its staff. In addition, 25 copies of “Getting to Know ArcView GIS” were purchased for the MoLG as reference books.

While negotiations and purchasing of equipment were going on a training manual for the project was being developed by the US team in Wisconsin. Initially, the idea was to use Uganda data for all the exercises so as to make the training more relevant. However, this became more of a challenge since most of the data layers received from Uganda were inaccurate and could not be used. The result was that it became necessary to supplement with US data. At the same time, PPD was asked to select the ten districts and two municipalities they would like to use as pilots. The selected districts were Arua, Bushenyi, Kayunga, Lira, Masindi, Mbale, Mbarara, Rakai, Tororo, and Wakiso, and the municipalities were Jinja and Kabale (Figure 1).

Finally, the two graduate scholarships were awarded to two students in the Department of Soil Science to conduct GIS-related research. One of the students was working on the "Evaluation of the Spatial Prevalence and Contribution of Malaria to Paddy Rice Labor loss in Bugiri District" and the other was on the "Evaluation of the Relative Contributions of Rice Production Constraints to the Yield Gap." Both are currently conducting their fieldwork.

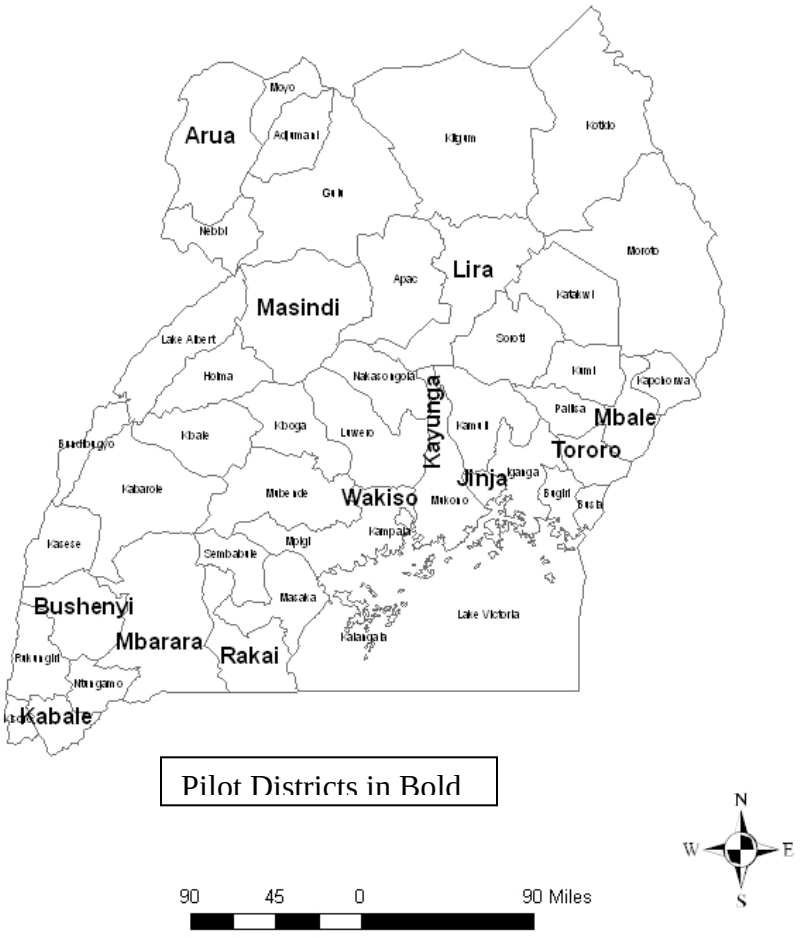
By mid-June, 2005, the laboratory at MUIENR was up and ready to host the training workshop. The training manual had been completed, a tentative training program had been drawn and the US team had finalized its traveling arrangements. The team was scheduled to arrive in Kampala, on July 6, 2005 start the training on July 11, and end it on July 22, 2005.

However, there was one more problem to deal with. Following the terms of the MoU that had been signed, I wanted to know from PPD if everything was in place for the logistical support of the trainees in terms of where they will stay, and whether arrangements had been made for tea/coffee and lunch breaks. However, the PPD told me that it had no budget to support the trainees for the two-week training as had been required by the MoU. When I pointed to the MoU, the staff at PPD said they had not seen any MoU, although someone, high up in the Ministry, had signed it on January 28, 2005. PPD thought my grant was going to pay for the logistical support of their staff, while I thought their grant was going to do that. At that time, it was too late to change any travel plans so the training team arrived in Kampala on July 6, as scheduled. After the team arrived in Kampala, the misunderstanding continued until the third day when it became possible to hold the training workshop.

In spite of this, a very successful one-day introductory workshop was held for Chief Administrative Officers and/or their representatives from 10 districts and two municipalities on definition, functionality, applications, and requirements GIS, and its implications for district authorities. The day also ended with a discussion of the data layers needed at the district level. The group identified about 25 data layers of which five were ranked as the most important. These were health and medical facilities, administrative boundaries, road networks, population distribution, and water points. There were 29 people there.

The one-day workshop was followed a seven-day intensive training covering the GIS fundamentals, GIS database creation, GPS applications, and GIS analytical tools, which was given to the planners from 8 districts and two municipalities as well as 4 staff members from the PPD of MoLG. In all a total of 21 MoLG personnel received the training.

Figure 1: Uganda Local Government Districts



The training was highly successful as evidenced in the evaluation of the trainees. For example, when asked to rate the relevance of the workshop to their job responsibilities, 14 out of the 21 trainees who completed the evaluation forms or 66% gave the relevance of the workshop to their job responsibilities the highest rating. Another 5 or (24%) gave it the next highest training. Trainees overall impression of the training was also positive. Twelve trainees gave the workshop the highest rating, while another 8 gave it the next highest rating. Only one person rated it the lowest. Finally, seventeen out the 22 or 77% of the trainees gave the likelihood that they would use GIS in the future the highest rating. Only one trainee gave the lowest rating.

In addition to the training, the project team discussed curriculum matters and encouraged their Ugandan counterparts to develop and introduce more GIS-related courses. By the end of the first training workshop, it was clear that some changes would be needed to continue the project. Perhaps the most important was that it was not going to be possible to extend the training to the rest of the districts as initially planned, because those districts did not have the hardware and ArcView software to work with. In addition, the MoLG did not have the funds to support the training of all the districts. As a result, it was proposed that in order build on the gains made in the first training workshop, it would be necessary to do a follow-up training for the same districts that had received the first training. Consequently, a second training workshop was held in June 2006. This training focused more on such advanced topics as GIS statistical mapping, spatial relationships, buffering, and cartographic and spatial modeling.

As it was in the case of the first training, the second training was very successful as evidenced in the evaluation of the trainees. For example, when asked to rate the relevance of the workshop to their job responsibilities, 14 out of the 21 trainees who completed the evaluation forms or 66% gave the relevance of the workshop to their job responsibilities the highest rating. Another 5 or (24%) gave it the next highest rating Trainees overall impression of the training was also positive. Twelve trainees gave the workshop the highest rating, while another 8 gave it the next highest rating. Only one person rated it the lowest. Finally, 17 out the 22 or 77% of the trainees gave the likelihood that they would use GIS in the future the highest rating. Another 2 gave it the next highest rating while 2 others rated it 3. Only one trainee gave the lowest rating. Table 1 summarizes the final comments of trainees of the both training sessions.

Table 1 Trainees' Comments After GIS Training

- Need for an extensive training in how to use GIS
- There is the need for another round of training. Otherwise the training was good and timely
- The GIS software should be interfaced with other software
- Support the districts with hardware and software to put GIS at local level
- GIS is a good planning tool which should be taken seriously. Support for implementation of the GIS is very vital
- More training is needed
- Constant communication and interaction. More training. Excellent Instruction. More frequent visit to Uganda
- There is need for continuation or review of what has been passed to us
- Sustain knowledge of through sharing of information with the team at Policy level with MoLG
- Satisfied with the workshop
- Please respond to our questions in future. Send us more exercises, monitor our performance. Advise where necessary
- More needed to be said in relation to attaching photo clips to maps
- Time for going through the previous days work on individual basis would help to grasp the material
- The fear of not utilizing the knowledge I have gained in the workshop

- Commendments. It was a job well done. I wish training was 14 and not 7 days for slower pace
- I enjoyed and followed the training from experienced facilitators. The manual was easy to follow. Please, could you follow up?
- Thanks for the good work and patience.
- Instruction manual was very useful. Any possibility of developing further material to enable us progress in GIS?
- Needed more time and more exercises to help internalize the program.
- The team should facilitate the districts with aerial photographs.
- Sustainability of the program in LGs

The initial plan to hand over the leadership of the project to the Ugandan stakeholders was accelerated because of the change of institution of the project leader, and the fact that no one at his former institution was ready to take over the leadership. So, in July 2006, the project's administration was transferred from University of Wisconsin-Stevens Point to Makerere University. The heads of the three units – MUIENR, Geography and RUFORUM became the new management team with the Director of MUIENR assuming the leadership role. Based on recommendations for further funding the Rockefeller Foundation provided a follow-up grant to Makerere University to continue the training in 2006. To all intents and purposes, this might be the last support from the Foundation for the project because after the grant was awarded, the Foundation decided to shift its focus to agricultural development.

CONCLUSIONS AND LESSONS LEARNED

The Uganda GIS project was born out of the need to integrate GIS into local government planning. This need was predicated on the potential role GIS can play in planning in Uganda and the need to build capacity in GIS in order to reap that potential. Based on previous experience of capacity building efforts in Uganda and elsewhere the project was designed with the philosophy that capacity-building effort in GIS should go beyond short-term training provided by expatriates to equip local educational institutions so that they can build sustain that process. Thus, as this philosophy came to be translated into reality, the project adopted a two-pronged approach – (1) training of district planners in the Uganda Ministry of Local Government (MoLG) to use GIS, and (2) enhancing the ability of Makerere University (MU) to offer GIS training at both undergraduate and graduate levels. In addition, the project also must be eventually owned by the local people, and that there should be a change of leadership after two of the project's four-year lifespan.

Against a number of formidable odds, by the end of the first year, major strides had been made in two academic departments at Makerere University. First, two state-of-the-arts GIS teaching and research laboratories were established at the Department of Geography and MUIENR, Makerere University. The Geography Department had successfully restructured its undergraduate and graduate programs to include the integration of GIS and Remote Sensing in all programs offered by the department. All the undergraduate programs of Geography, Urban Planning, and Environmental Management had basic and applied courses in GIS and Remote Sensing. An introductory course of

Principles of Geographic Information Systems for second year followed by Applied GIS in third year had been implemented. MUIENR also had began planning substantive changes to its undergraduate and graduate programs to include the addition of new GIS courses at the undergraduate level and strengthening remote sensing and advanced GIS courses at graduate levels. The increased availability of computer facilities resulting from the collaboration in this project greatly enhanced teaching of existing GIS and Remote Sensing courses at MUIENR and the Geography Department at Makerere University. On the research front, the project had allowed the funding of two graduate students conducting GIS-related research into diseases and agricultural production.

GIS capacity at the MoLG also increased. Beginning with nothing, the ministry had 25 GIS software licenses. Chief Administrative Officers or their representatives from 10 districts and two municipalities were exposed to GIS, while planners from the same areas were given more intensive training in the basics and uses of GIS in local government planning.

However, the project had several shortcomings too. The miscommunication and misunderstanding between the project leader and the MoLG during the project design phase almost torpedoed the training component of the project. The result was that there was not enough funds to extend the training to the rest of the country as had been originally planned. Also, a number of changes within the support apparatus of the project affected the sustainability of the project. For example, the main contact person at the MoLG during the needs assessment phase of the project departed from the ministry a few months before the project started. This affected the smooth implementation of the project. In addition, the inability of MoLG to provide more computer hardware and software and also support further training restricted the training program to only 10 districts and two municipalities. The departure of the project leader for another institution and the inability to transfer the project to the new institution made the faculty and student exchange component of the project unachievable. Finally, the policy changes at the funding agency and the made the future of the project uncertain. The final outcomes of the project, however, will become clearer in the coming years.

In the meantime, a number of important lessons can be learned from this project. First, geospatial technology capacity building efforts that provide short term training to participants are less expensive but they do not build capacity. Second, geospatial technology capacity building efforts that are embedded in specific research projects do not have far-reaching results since such efforts end with the projects. Third, for it to be effective, geospatial technology capacity building efforts must focus on long-term effects. In this regard, emphasis should shift to infrastructural support that will strengthen local institutions to take central role in the capacity building efforts. This should especially be the case where there is local expertise, but no facilities to make them effective. In places where there is no local expertise, the effort should be a two-pronged approach to tackle both the training and building the infrastructure that will make the training of lecturers last. Fourth, African governments must move beyond commitments to using geospatial technologies on paper to commitments in action. It is true that there are too many demands on their meager resources, but until they take the lead in creating a demand for geospatial technologists and really invest in the training of geospatial technologists it will be difficult to build capacity.

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