

# TOWARDS BUILDING AND UTILIZATION OF CRITICAL MASS AFRICAN CAPACITY IN SPATIAL INFORMATION PRODUCTION AND MANAGEMENT

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## ABSTRACT

Capacity building and utilization in spatial information production and management in African countries are of paramount importance at the moment because more than 90% of all professionals, technologists and technicians in various organizations involved in spatial information activities were trained in the obsolete methods of map production whereas, the introduction of Geospatial Information Technology (GIT) demands a critical mass of well-trained staff at all levels within a reasonable time frame. It is therefore necessary to ensure that those undergoing new training are trained in modern technology. In this regard, this paper describes briefly the modern educational programmes of the Regional Centre for Training in Aerospace Surveys (RECTAS) and collaboration with other national and international institutions in the field of geoinformatics with the objectives of meeting the manpower needs and sustainability of African countries in Geoinformatics through:

- Provision of qualified graduates for immediate employment and productivity;
- Retraining of existing personnel for improved productivity and introduction of modern production techniques;
- Retraining of academic staff of other institutions so as to be able to modernize their curricula in line with modern trend;
- Significant savings in foreign exchange through efficient local training;
- Ability to assist production organizations through well-equipped consultancy services.

## 1. INTRODUCTION

As a result of advances in computer and space technologies, surveying and mapping have been totally revolutionized. Conventional methods and instruments in surveying and mapping have been digitally transformed. We now have at our disposal, the use of GIT tools to perform our professional duties in more efficient and effective ways.

Surveying and Mapping practitioners must therefore be necessarily well prepared and equipped to face the challenges of the new millennium as astute producers and managers of geo-spatial information. This requires thorough knowledge of Geospatial Information Systems (GIS), awareness of the many sources of data for input into a GIS, and an understanding of the way in which the data can be handled and analyzed to solve problems

associated with management of land and water resources. This calls for the combination of traditional skills with those of new technology and spatial data handling skills. These can be achieved only through a curriculum that is adaptive to changes. The curriculum must be modular and flexible in order to be able to quickly adapt to changing boundary conditions, set by technology advancement and development of the profession (Grun, 1998).

Moreover, as tertiary education worldwide comes under serious financial pressure, higher institutions have to make hard decisions about the viability of certain disciplines and their courses leading to merging of some while others may simply be stopped. To stay afloat therefore, every discipline must continue to move with the needs of the society and technological advancement.

Surveying departments all over the world have therefore been broadening their courses in order to remain solvent, as Brimicombe (1998) aptly puts it “expand the margin to strengthen the core”. Moreover, our education should increasingly focus on the global market place rather than on the national scene so that just like mapping systems the practitioners will also be on the move.

These considerations informed the decision to modernize the training programmes of the Regional Centre for Training in Aerospace Surveys (RECTAS) in order to serve Africa better in capacity building for geoinformation production and management in the 21st century.

## **2 THE CENTRE**

RECTAS was set up in October 1972 under the auspices of the United Nations Economic Commission for Africa (UNECA) to help develop the necessary critical capacity in geoinformatics in the member states of UNECA. At the moment, there are eight member states of RECTAS, namely Benin, Ghana, Nigeria, Senegal, Burkina Faso, Mali, Cameroon and Niger.

### **2.1 Objectives of the Centre**

The objectives of the Centre are to:

- (i) provide theoretical and practical training in the field of Geoinformatics including in particular photogrammetry, remote sensing, cartography and geographic information systems and their applications in geophysical surveys, environmental studies, etc;
- (ii) conduct seminars and courses with a view to providing an opportunity to government officials in the region to exchange information and experiences in the field of Geoinformatics;
- (iii) carry out studies and research in the field of Geoinformatics, and;
- (iv) provide advisory and consultancy services to member states of the Economic Commission for Africa (ECA) and other institutions concerned with geoinformation.

### **3. EDUCATION AND TRAINING PROGRAMMES AT RECTAS**

Being a regional Centre, RECTAS' courses are bilingual: English and French, and are conducted at three levels of Technician, Technologist and Post-graduate. Until the year 2000, two courses were run, namely Photogrammetry and Remote Sensing/GIS with about 1000 students trained at different levels from 27 African countries.

These programmes have now been reviewed and modernized. In carrying out the curriculum review, consideration was given to the fact that geoinformatics education should be strong at conceptual level so that the graduates of the course can be versed not only in the use of GIS packages but also in GIS development. The well-recognised four broad specialized areas of geoinformatics (Spatial data acquisition, Spatial data management, Cartography and Geoinformation Visualization, and Geospatial information infrastructure and management) were also taken into consideration. Relevant to each of the four broad areas are fundamental subjects such as mathematics (including set theory, graph theory and topology), computer science, artificial intelligence and expert system (Kufoniyi, 1999c; Molenaar, 1998).

The new curricula in Geoinformation Production and Management at Technician, Technologist and Postgraduate Diploma levels are summarized in the following subsections.

#### **3.1. Technician Diploma Course (GPM.5)**

##### **(a) Objectives**

After the training, depending on the area of specialisation, the graduate should be capable of performing very competently the routine tasks associated with the following: digitization/scanning of maps, Spatial data acquisition from Photogrammetry and remote sensing, database creation, attribute data entry into geo-database and Cartographic processes.

##### **(b) Course Structure**

The Technician Diploma course is designed for duration of eighteen months, and is organized in four blocks. The first block, which is common to all course participants, is structured in three basic modules of learning activities in Geoinformation technology in the context of the applications in which it is used; it is therefore very much problem oriented. The second block of introduction to spatial data acquisition systems is also common to all trainees. The third block, the specialization block, is in turn structured with four modules based on the applicant's proposed area of specialization. The last block is the execution of the final project. More details are indicated below.

<b>GPM.5 Technician Diploma Course in Geoinformation Production and Management</b>		
<b>Block 1 - Common Modules 1 to 3: Introduction to Computing (16 weeks)</b>		
<b>Module 1:</b> Introductory mathematics (6 weeks) <b>Module 2:</b> Basics of computer systems (6 weeks) <b>Module 3:</b> Introduction to databases (4 weeks)		
<b>Block 2 – Common Modules 4-8: Introduction to Spatial Data Acquisition Systems (23 weeks)</b>		
<b>Module 4:</b> Introduction to Digital Photogrammetry and Remote Sensing (6 weeks) <b>Module 5:</b> Analogue to Digital Data Conversion (Scanning and Digitizing) (8 weeks) <b>Module 6:</b> Introduction to point determination systems (2 weeks) <b>Module 7:</b> Introduction to GIS (4 weeks) <b>Module 8:</b> Introduction to Cartographic visualization (3 weeks)		
<b>Block 3: Modules 5 to 8 - Specialization (15 weeks)</b>		
<b>Photogrammetry and Remote Sensing</b> <b>Module 9:</b> Photogrammetric methods of data Acquisition (4 weeks) <b>Module 10:</b> Remote Sensing data acquisition (4 weeks) <b>Module 11:</b> Topographic information extraction (2 weeks) <b>Module 12:</b> Thematic information extraction (2 weeks) <b>Module 13:</b> Individual Project (3 weeks)	<b>Geographic Information Systems</b> <b>Module 9:</b> Introduction to GIS functionalities (3 weeks) <b>Module 10:</b> Introduction to GIS Software Packages (3 weeks) <b>Module 11:</b> Spatial/non-spatial databases (3 weeks) <b>Module 12:</b> Elementary spatial analysis (3 weeks) <b>Module 13:</b> Individual Project (3 Weeks)	<b>Cartography</b> <b>Module 9:</b> Cartographic symbolization (3 weeks) <b>Module 10:</b> Map composition (3 weeks) <b>Module 11:</b> Introduction to Topographic Cartography (3 weeks) <b>Module 12:</b> Introduction to Thematic Cartography (3 weeks) <b>Module 13:</b> Individual project (3 weeks)
<b>Block 4: Module 14-15: Study Visit and Final Project (11 weeks)</b>		
<b>Module 14:</b> Study visit (1 week) <b>Module 15:</b> Final Project (10 weeks)		

### 3.2. Technologist Diploma Course in Geoinformation Production and Management (GPM.4)

#### (a) Objectives

The main objective is to provide a comprehensive training in theory and practice in the field of Geoinformatics at the level of supervisors. After the training, the graduate should be capable of performing very competently the routine tasks performed by the technician and in addition should be able to carry out laboratory maintenance and supervision, and spatial analysis of georeferenced data.

Furthermore, the Technologist should have the capacity to supervise Technicians in the routine tasks and relate to professionals in the planning and execution of Geoinformatics projects, and write draft project reports.

## (b) Course Structure

The Technologist Diploma course is designed for duration of eighteen months, and is organized in four blocks. The first two blocks, which are common to all course participants, are structured in three modules each, of learning activities in Geoinformation technology. The third block, the specialization block, is in turn structured with five modules based on the applicant's proposed area of specialization. The last block is the execution of the final project. Details are indicated below:

<b>GPM.4 Technologist Diploma Course in Geoinformation Production and Management</b>		
<b>Block 1 - Common Modules 1 to 3: Basic Computing (16 weeks)</b>		
<b>Module 1:</b> Basic mathematics (6 weeks) <b>Module 2:</b> Fundamentals of computer Systems (6 weeks) <b>Module 3:</b> Fundamentals of databases (4 weeks)		
<b>Block 2 – Common Modules 4 to 6: Principles of Geoinformatics (21 weeks)</b>		
<b>Module 4 – <i>Spatial Data Acquisition Techniques</i> (12 weeks)</b> <ul style="list-style-type: none"> <li>• Primary Data Acquisition Methods (2 weeks)</li> <li>• Georeferencing (2 weeks)</li> <li>• Image Products and Interpretation (4 weeks)</li> <li>• Introduction to DTM (4 weeks)</li> </ul> <b>Module 5:</b> Digital mapping and cartographic visualisation (6 weeks) <b>Module 6:</b> Fundamentals of GIS (3 weeks)		
<b>Block 3: Modules 7 to 10 - Specialization (20 weeks)</b>		
<b>Photogrammetry and Remote Sensing</b> <b>Module 7:</b> Photogrammetric Techniques (4 weeks) <b>Module 8:</b> Remote Sensing Techniques (5 weeks) <b>Module 9:</b> Topographic Databases (4 weeks) <b>Module 10:</b> Thematic databases (3 weeks) <b>Module 11:</b> Individual Project (3 weeks)	<b>Geographic Information Systems</b> <b>Module 7:</b> Hardware and Software Components of GIS (5 weeks) <b>Module 8:</b> Introduction to spatial data modeling (3 weeks) <b>Module 9:</b> Spatial/non-spatial database creation (5 weeks) <b>Module 10:</b> Spatial analysis (4 weeks) <b>Module 11:</b> Individual Project (3 Weeks)	<b>Cartography</b> <b>Module 7:</b> Cartographic Design and Presentation (5 weeks) <b>Module 8:</b> Topographic Information Visualization (4 weeks) <b>Module 9:</b> Thematic Information Visualization (4 weeks) <b>Module 10:</b> Introduction to Web-Cartography (4 weeks) <b>Module 11:</b> Individual Project (3 weeks).
<b>Block 4: Module 12 – 14: Project Planning (11 weeks)</b>		
<b>Module 12:</b> Planning (1 week) <b>Module 13:</b> Study visit (1 week) <b>Module 14:</b> Final Project (9 weeks)		

### 3.3 Post-Graduate Diploma Course

#### a. Objectives

This is designed for management level training for duration of 12 months. Upon completion of the course, participants should be able to contribute to the design, implementation and management of geoinformation production systems and quality control systems

## b. Course Structure

The Post Graduate Diploma course is organised in five blocks. The first block is common to all course participants and is structured in three modules of learning activities in GIT. The second block of one module, which is also common to all course participants, deals with the various methods of spatial data acquisition and information extraction. The third block, the specialization block, is in turn structured in 4 modules based on the applicant's proposed area of specialization. Block 4 deals with modern techniques of information technology management. The last block is the execution of the final project.

<b>GPM.3 Postgraduate Diploma Course in Geoinformation Production and Management</b>		
<b>Block 1 - Common Modules 1 to 3: Advanced Mathematics and Computing (6 weeks)</b>		
<b>Module 1: Advanced Mathematics (3 weeks)</b>		
<ul style="list-style-type: none"> <li>• Logic and set theory (3 days)</li> <li>• Linear algebra (3 days)</li> <li>• Graph theory, Co-ordinate systems, geo-referencing, datums and transformations (5 days)</li> <li>• Statistics and theory of observations (4 days)</li> </ul>		
<b>Module 2: Computer Applications (2 weeks)</b>		
<ul style="list-style-type: none"> <li>• Operating Systems (2 days)</li> <li>• Computer Programming (5 days)</li> <li>• Introduction to Information and Communication Technology (3 days)</li> </ul>		
<b>Module 3: Database Systems (1 week)</b>		
<ul style="list-style-type: none"> <li>• Review of Database Structures (2 days)</li> <li>• Database design and creation (3 days)</li> </ul>		
<b>Block 2 - Common Module 4 : Spatial Data Acquisition and Information Extraction (14 weeks)</b>		
<b>Module 4 – Spatial Data Acquisition and Information Extraction</b>		
<ul style="list-style-type: none"> <li>• Primary Data Acquisition (1 week)</li> <li>• Image Products (2 weeks)</li> <li>• Geo-referencing and DTM generation (2 weeks)</li> <li>• Information extraction (2 weeks)</li> <li>• Scanning and Digitizing (2 weeks)</li> <li>• Principles of GIS (2 weeks)</li> <li>• Computer Assisted Cartography (3 weeks)</li> </ul>		
<b>Block 3 - Modules 5 to 8: Specialization (12 weeks)</b>		
<b>Photogrammetry and Remote Sensing</b>	<b>Geospatial Information Systems</b>	<b>Cartography</b>
<b>Module 5:</b> Analytical and Digital Photogrammetry (3 weeks)	<b>Module 5:</b> Spatial data structures and Algorithm (2 weeks)	<b>Module 5:</b> Cartographic Principles (3 weeks)
<b>Module 6:</b> Remote Sensing Applications (3 weeks)	<b>Module 6:</b> Spatial database design (3 weeks)	<b>Module 6:</b> Topographic and Thematic Cartography (3 weeks)
<b>Module 7:</b> Topographic and Thematic Information extraction (3 weeks)	<b>Module 7:</b> GIS Applications (4 weeks)	<b>Module 7:</b> Desktop and Web-Cartography (3 weeks)
<b>Module 8:</b> Individual Project (3 weeks)	<b>Module 8:</b> Individual Project (3 weeks)	<b>Module 8:</b> Individual Project (3 weeks)
<b>Block 4 - Common Modules 9 - 11: Production System Management (3 weeks)</b>		
<b>Module 9:</b> Project Management (1 week)		
<b>Module 10:</b> System Development Methodologies (1 week)		
<b>Module 11:</b> Study Visit (1 week)		
<b>Block 5 - Module 12: Final Project and Presentation (10 weeks)</b>		

### 3.4 Short Courses

The modular design of the regular programmes provides opportunity for interested candidates to attend short-term training and retraining in any module or combination of modules of their choice. Thus organizations that are unable to release their staff for a long duration programme now have the opportunity to send candidates for short-term courses consisting of one or more modules in core areas of their activities. Apart from the modules, user-defined training courses either at RECTAS or in-house within the user's organization can also be mounted.

### 3.5 Fee Schedule

Regular Programmes:

	Technician	Technologist	Postgraduate
Student on Fellowship	\$7640	\$7815	\$6265
Private Student	\$6085	\$6185	\$4490

The cost includes accommodation and lecture materials.

#### Short Courses:

For modules of less than 4 weeks duration: \$100.00 per week

For modules of 4 weeks duration or longer: \$400.00 per module.

The cost includes accommodation in students' hostel and lecture materials.

## 4. PROGRAMMES UNDER CONSIDERATION

### 4.1 Masters Programme

Recently, member States of RECTAS indicated a strong desire to have the opportunity of Professional Masters (PM) and MSc. training in Geoinformatics at RECTAS. This is indeed true when one considers the fact that trainers in our various countries also require further training while production organizations need to have a strong research and development units in their organizations. An earlier initiative on M.Sc. collaboration between the Federal School of Surveying (FSS), Oyo, Nigeria, and the International Institute for Aerospace Surveys and Earth Sciences (ITC) was therefore expanded to include the Regional Centre for Training in Aerospace Surveys (RECTAS), Ile-Ife, Nigeria, and the Groupement pour le Développement de la Télédéttection Aérospatiale (GDTA), Toulouse, France to take advantage of the existing partnership among RECTAS, ITC and GDTA.

The initiative has been packaged as a four-year project under the name: Capacity Building for Geoinformation Production and Management for Sustainable Land, Environment and Natural Resources Management (CABGLEN) and submitted to donor agencies for funding support.

The following four programmes have been identified for implementation under the proposed project:

- (1) ITC or GDTA MSc in Geoinformatics as sandwich programme.
- (2) Professional Masters (PM) in Geoinformatics, with specialization in:
  - (a) Photogrammetry and Remote Sensing
  - (b) Cartography and Geoinformation Visualization
  - (c) Spatial Information Systems
  - (d) Optimization of Geoinformation Processes.
- (3) Three months certificate course in any of the above four specialization modules.
- (4) Refresher courses and workshops of duration of one to four weeks.

The four programmes would be integral components of the RECTAS and FSS academic programmes, and will continue beyond the period of the project. We are however still sourcing for funding support from international donor agencies to enable the project to take off.

## **4.2 Web-based Distance Learning**

The rate of development in GIT is so rapid that it is often difficult for staff to be constantly retrained to keep pace with technological development. The solution to this problem is to provide web-based distance learning programmes in UNECA's specialized regional training centres.

RECTAS is therefore making effort to have full internet connectivity at the Centre with a web-site in order to start the *e*-learning programme. This facility will enable RECTAS' alumni and other personnel in Geoinformation production organizations in member states of ECA to keep abreast with the developments in GIT. We are therefore soliciting for the assistance of donor agencies to realize this important objective.

## **5. TRAINING FACILITIES AVAILABLE AT RECTAS**

In addition to the skilled manpower available at RECTAS, the Centre has modern Digital Photogrammetry and Remote Sensing, Geographic Information System and Cartography Laboratories, which are well-equipped with modern hardware and software including state-of-the-art GIS software packages.

## **6. CONSULTANCY SERVICES**

The Centre is well set-up for consultancy services in the areas of short-term/customized training and production-related jobs. Customized training can be arranged for organizations either at RECTAS or in their organization in all aspects of geoinformatics and its applications according to the user-defined needs.



RECTAS also has capabilities for advisory, consultancy or direct execution of jobs in the above-mentioned areas. Some of the jobs executed recently by RECTAS either singly or under joint venture include:

- a) Environmental sensitivity index mapping of some Shell Development Company's Oil Fields in Nigeria. In collaboration with Mail Oil Field services Ltd., July 1997
- b) National Workshop on Agricultural and Environmental Applications of Remote Sensing and GIS. Jointly organized by FAO/RECTAS/NASENI (National Agency for Science and Engineering Infrastructure) in Nov/Dec 1994.
- c) Digital Base Map Production of Ibadan, Nigeria at 1/25,000 and 1/50,000 scales for the Sustainable Ibadan Project (SIP), United Nation's Centre for Human Settlements (UNCHS). Completed in 1995.
- d) A GIS Database for the secretariat of Economic Community Of West African States (ECOWAS) showing natural resources, roads, main towns, hydrography, socio-economic and military/political aspects of the community including areas of military intervention by ECOMOG and refugee data. Started in March 2001 and nearing completion.
- e) Training workshop on the development of Hadejia River Basin Information System, Nigeria; including database design and actual implementation with real datasets. May and June 2001. Funded by Embassy of France in Nigeria.
- f) Production of 1/25,000 scale digital base maps of three towns in Ebonyi state in Nigeria, in collaboration with Helzek Systems Nigeria. Started in September 2000 and nearing completion.

## **7. CONCLUSION**

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. Example of modern training programmes that can assist African countries in capacity building and utilization has therefore been given above. Further information on these programmes and the Centre are obtainable from the Director at the main author's address and at [www.uneca.org/rectas](http://www.uneca.org/rectas).

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