UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA

CARTOGRAPHY AND REMOTE SENSING

BULLETIN

FOREWORD

The Cartographic and Remote Sensing Bulletin of the Economic Commission for Africa is an annual publication whose origins go back to the sixth United Nations Regional Cartographic Conference for Africa, when member States requested that an African analytical technical review be published under the auspices of ECA.

The objectives of the bulletin are to serve as a platform for the exchange of information, ideas, experiences and events in all disciplines of surveying, mapping and remote sensing, It is intended for scientists, scholars, government officials, decision makers, students, from Africa and abroad, and any one else who is concerned with how cartographic sciences can support sustainable development in the continent.

This sixth issue follows the format of previous issues, with the first section including technical articles, and the second one providing information on recent, on-going or future events and occurrences of interest to the African region. On this occasion, for our first section, we have focussed more on policy and regional issues than on purely technical aspects.

The editors would like to note the scarce submission of articles and material for inclusion in the bulletin, as well as the lack of comments and observations to previous issues. They, therefore, take the opportunity to reiterate the appeal to the African and international cartographic and remote sensing communities for contributions. The success of the publication depends on our readers and colleagues. Contributions should be sent to:

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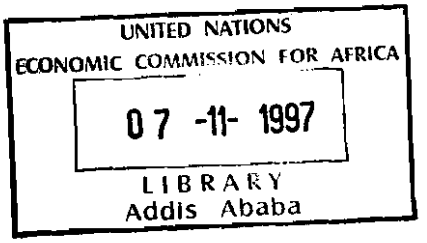

SECTION ONE: Policy and Regional issues

1 FRAMEWORK OF BASIC CONDITIONS AND GUIDELINES FOR THE ESTABLISHMENT OF A SPATIAL GEOREFENRECED GEOGRAPHIC INFORMATION SYSTEM

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1. SCOPE

The present document intends primarily to provide general guidelines - or better a framework - to those African countries/institutions wishing to establish a Geographic Information System at national or local level. However, it also targets those that have already embarked in their establishment.

Although the matter of implementing GIS entails, in practice, the incorporation of highly specialized computer hardware and software, expertise and procedures, this document avoids entering in technical particulars that are normally of exclusive interest to the specialist but not to the decision maker who has to decide on its establishment and on the strategies of implementation and management. In this context, the study aims at giving a complete yet simplified view on the subject, with a view of di-mystifying what neophytes and many professionals as well still consider as the realm of computer experts.

The document outlines a number of basic conditions at government and institutional levels that are thought critical for the success of the establishment of a national spatial information infrastructure, and attempts to list the major steps involved in the establishment of institutional GISes, within the scope of a nationwide information system. In doing so, the author has tried to compile, integrate and reconcile several schemes that have been proposed by renowned scientists and specialists, and published in different technical publications, but normally without reaching the decision-maker.

GIS has become the new creed for all those who deal, in one way or another, with land resource development, environment protection and all other activities related to land occurrences. This phenomenum comes, to a great extent, from the power of these systems to cope with increasing amounts of spatial information of different type and its ability and flexibility to process and display the data according to different uses and planning scenarios. And it creates dreams for those who believe that a GIS can do everything and can solve all their problems. In this highly technical and computerized world, where the current standard working tool is the personal computer with ever-growing graphic capabilities, the planners of today "feel" that GIS must be introduced at any cost and with no delay in their operations, without always understanding the implications of establishing a GIS, much less the kind of GIS that is suitable to them. Further, they are surrounded by an overwhelming amount of GIS-promoted software available in the market, ranging from complex and expensive packages to much simpler and cheaper ones. Many organizations are tempted to purchase one particular software and start collecting digital data, often on ad-hoc basis, in the belief that, by doing so, they are establishing the GIS they need. Within a region, a country, a municipality or even within an institution, a proliferation of ill-suited GISs may arise resulting, in the majority of the cases, in nothing else than a lamentable waste of resources.

On the other hand, there are many cases when there is reluctancy in going into GIS or the decision to establish such a system is taken grudgingly by unconscious fears of getting involved in something that is too technical, too costly, implies too much work and is not worth it.

When these two attitudes --the positive-but-naive and the negative-- persist, the high front-end costs coupled with confusion and frustration will by far outweigh any gains, and what initially were dreams and expectations turn into nightmares. The results rather than beneficial will prove damaging and may delay or destroy any further attempts to use this new technology.

In order to avert these situations, GIS developers, producers, scholars and users, usually from the private sector, have generated various models providing rules and guidelines on how to construct a GIS. However, they are part of the scientific literature and are "promulgated" in specialized publications, dispersed among or entwined with technical articles of all sort, and do not the reach the normal planner.

This document pretends to provide a set of general conditions and rules, exclusive of a particular sector or user's view, on how to proceed for the establishment of a national GIS composed by a network of databases and individual institutional GIS.

2. FRAMEWORK

There is no general model that suits every country for the establishment of a national geographic information system, as there is no general set of procedures or steps to implement such a system. These is a large range of conceptual models and implementing procedures among which to choose to better satisfy the needs and peculiarities of each individual country. However, a number of basic enabling conditions and guidelines are identifiable as being crucial to the success of building up a useful geographic information infrastructure in any country. These exist at both national level and institutional level. An attempt is made here to provide those that are thought of major relevance.

2.1 At national level.

Understanding of modern information technologies and their potentials by those who have the keys to development.

It is essential a full understanding of the potential of modern information technologies, in particular Geomatics, and of the ***need*** to use then in the inventorying, assessment and management of natural resources and the environment, and in setting up and steering sustainable development paths that will solve socio-economic problems of African countries, all urgent and overwhelming.

It must be realized that the possession of a reliable and efficient spatial information infrastructure is as important as other national infrastructures upon which the governments concentrate their efforts, such as health, education, transport, energy, etc. Making a parallel, what expectations could have an international airline without possessing a reservation database server or that is not linked to the global reservation network?. How could a modern bank presently operate without possessing a client/account information system networked with its branches and subsidiaries?.

Such an understanding must be done at the highest levels among planners, decision and policy makers, in the government (heads of state, ministers, etc.), in the political scenario (chiefs of political parties, senators, in some cases governors and majors, local community leaders, etc.), in the production and industry sectors, etc.

The appreciation for base-line spatial data and information.

Base-line data and information, in particular topographic and other land information maps, is normally the least appreciated tool. National mapping programmes, which in the past were at the forefront of development, are nowadays given little preeminence in national development programmes. As a consequence, the cartographic coverage of the majority of African countries, with some notable exceptions, is deficient and outmoded, in some areas nonexistent or the mapping is only planimetric, and in others little attention was given to geodetic control. Although valuable efforts have been made by some leading countries, the situation for many of them remains unchanged and may worsen as time elapses. The governments must grant to this activity a high priority, allocating the resources that it needs to complete, improve and maintain their national cartographic coverage. Otherwise, their efforts to build any national geoinformation infrastructure will be futile, and whatever is done will lead only to a lamentable waste of resources and an anthology of frustrations. Simply, a building without foundations cannot be erected.

The will and commitment to change.

Understanding potentials and realizing needs is not enough. It is necessary to have the commitment to change, by conviction. Only then we can expect to practically materialize this change.

This commitment has to be a long-term commitment. It has to last at least until the development of the system is well in place, and its benefits appear. Then the users (among which the government will be the major one) will be the driving force to maintain and continuously expand the system that may become self-sustainable.

The materialization of the will to change: A Plan of Action *(or the implementation of Agenda 21).*

A plan of action, issued at the highest level, that would lead to a national programme for the creation and management of a geographic information system, would be the first step to materialize the will to change. Such a Plan of Action would reflect nothing else than implementation of important components of chapter 40 of Agenda 21. A copy of this agenda appears as Appendix 2. This plan of action can (should) initially be simple. It would, at further stages and as results of its own implementation, be amended and improved, going in deeper detail, changing strategies and procedures, adding new components, fixing new responsibilities, etc.

This initial plan of action would:

(i) provide principles on flow, access and supply of geographic information.

(ii) define the goals at short, medium and long-term.

(iii) identify the sectors that would be addressed by the system: principal, secondary, tertiary.

(iv) identify the actors including those of the private sector: national and sub-national agencies, research and educational institutions, agricultural and livestock associations, scientific and professional associations, etc.

(v) create a national steering body, constituted by a core set of actors, including the private sector, with the task of defining the nature, characteristics of the system as the methodology, procedures and time-frames of implementation. When necessary, any other members can be coopted by the steering body. This body would be accountable to the highest levels of government, to which it would report regularly at specific intervals.

(vi) Define provisional budgets and budget lines.

A National steering body on geomatics:

It can be an ad-hoc Committee or a permanent Council. Sometimes, a leading Institution may be selected to coordinate the work of the Committee or Council. Its work would mainly be conducted by working groups, whose initial functions would be:

(i) Identify the spatial datasets that are required for each sector or aspect of development. This exercise will necessarily comprise the identification of data users, data needs and data sources, required data accuracy, as well as the selection and prioritization of scales.

In general, the following datasets have been accepted as an appropriate basic set for national planning.

core data sets

Fundamental data sets:	(a) Topographic map:	geodetic control elevation (DTM) water areas, drainage and shorelines terrestrial communication lines cultural elements general vegetation: forests, rangeland, cultivated areas and pastures. principal administrative boundaries
Other core data sets	(b) baseline satellite image	
	(c) cadastre, land tenure, detailed administrative boundaries.	
	(d) geology/mining	
	(e) land use/land cover	
	(f) soils and land vocation	
	(g) energy	
	(h) restrictive sites (public lands, special tenures)	
	(i) climate	
	(j) fauna species distribution	

It is very important to bear in mind that the topographic map is the basis upon which the other datasets are geometrically fit. *Hence, it must have the highest priority.*

(ii) Compile a classified catalogue of all existing data and information that is deemed relevant, assessing the attributes of each piece of information. The committee will also be responsible for assuring that such metadatabase is properly maintained.

(iii) Identify data gaps, and provide concrete recommendations for new data collection.

(iv) Select the model of the national geographic information system (central database, distributed database, combined central and distributed) and, accordingly, how the different datasets are organized.

(v) Compile an inventory of all existing hardware

datedness, flexibility, facility of maintenance, possibility to expand, etc.

(vi) Analyze the current mandates of the different participating institutions. The Committee would agree on new limits to the mandates for the purposes of the establishment of the national geographic information system, in order to avoid the normal conflicts due to overlapping and duplication, or to fill gaps, that inevitably will always be found. Precise responsibilities and roles of each institution would be clearly defined within the system, so that every actor knows what to do and what to expect without ambiguities.

(vii) In the light of the above, the Committee would propose or set up the rules, as applicable, concerning legal and technical aspects of mandates, proprietary rights, security and confidentiality, flow of information, access and supply, pricing of the information, data quality standards and standards for data collection, data up-dating, data conversion, integrity and integration of datasets (geometric, datatransfer, etc.)

(viii) At least a written master agreement is necessary to protect the interest of all parties to the extent possible, where the issues in (iv) and (v) above are clearly defined.

(ix) Provide advice on and revise the datamodels and datastructures proposed by each institution for the datasets of which it is responsible for producing and maintaining, verifying that they satisfy the needs of all the development sectors that will use those datasets.

(x) Revise the necessities and procurement of new equipment and software, assuring that there is full compatibility with the equipment and software of the other participants of the systems, and that appropriate existing equipment and software has maximum, but reasonable, possible utilization.

(xi) Design and coordinate the execution of pilot studies and pilot projects, where tests of small integrated systems would be carried out as a means of obtaining practical experience with the technology and its possibilities, and test system conditionalities such as networking and communication among GIS sub-systems, standards, database export-import, data integrity, data flow, etc.

(xii) Propose, set up and phase implementation plans.

2.2 At institutional level

Variety of databases and GIS within the system:

It is clear than the datamodels and GIS type and characteristics, as well as the strategies of implementation within the individual institutions will depend on each institution concerned, and will vary from one to the other. Among other factors, they will have to take into account and will be conditioned by: (a) whether it is a source producer, a user, or a combination of the two, (b) the type and nature of the data, (c) the volume and complexity of the data, (d) the analysis required on the data to satisfy the needs of the users, (d) the physical, financial and human resources available, (d) the institutional structures, (e) etc.

So far, it would be unrealistic to conceive uniform individual systems within the general national geographic information system network. Each institution will be responsible for selecting the GIS it will use, but the choice must not be isolated from the rest of the system. What is important is the conditionality that they communicate freely and that the databases are integrated together.

Building up and maintenance of the databases:

In a distributed system, with is being adopted

more and more widely, the producer (owner) of the data and information is also their custodian. In such context, he defines his own datatamodel and data structure, but will assure that they satisfy the needs of the users within the national information system, and in such a way as to facilitate the up-date and expansion of the content. Data conversion, data maintenance and data up-dating will be the responsibility of the producer. He will also be responsible of making his database fit to the geometry of the fundamental topographic database. In an ideal case, common elements from the two databases would be adjusted to share the same set of primitives, assuring full integrity.

Hence, the conversion of the fundamental database should be done with priority, as the other datasets are just layers to it.

At any rate, although it implies a greater rate of investment, the conversion of data should be done with great care and within the shortest possible period. The reason of preferring a short conversion period is that the effects and benefits will not be obtained until a complete database exists for at least one application theme covering a comprehensive geographic area.

***Organizational and cultural conditions**:*

The introduction of GIS technologies leads to changes not only in existing routines for information exchanges between and within national authorities and agencies, but also entails changes in old-time conceptions on the nature itself of spatial information, conceptions considered immutable in the minds of those who have been producing and managing that information. These changes imply organizational changes within the institutions and also challenges the cultural attitude of the staff, <u>at all levels</u>, as the new technology threatens their system of values. A certain amount of the personnel will oppose to them, either deliberately or not.

Institutions switching to GIS must be aware, from the very beginning, that these organizational and cultural problems are more intricate to solve than technical ones, and at the same time are crucial to the degree of success achieved. A great deal of time and attention has to be devoted these matters. Clear and open information on the new methods/goals of the organization to all concerned staff (operational, supervisory and managerial) should be a priority, where an internal convincing marketing of the new working procedures, new products and overall expectations would be earnestly conducted. Awareness and education through periodic seminars and workshops must be organized, encouraging and entertaining open discussions and creating a sense of solidarity and interdependence, whereby the units of the organization would feel genuinely responsible for developing and maintaining the new functions. If an important part of the organization does not accept them, then it should be removed from any role/activity related to the new system.

***Training**:*

Qualified staff is a sinequanom in geomatics. The success or failure of individual GISes will directly depend on the availability of competent staff, who can understand the processes behind the technology. Adequate and continuous training at all levels is required: (i) *Operators* for data conversion (digitizing, editing), up-dating and display. Sometimes experienced but enthusiastic cartographers and draughtmen can be successfully (and easily) trained, as they understand, better than others, the mechanics of cartographic data representation; (ii) *Supervisors*: They must be individuals with a full understanding of the mandates of the organization and of the processes utilized to carry out those mandates, in particular concerning the generation and the purpose of the institutional data that will be stored and used by the system. These individuals must also possess a thorough understanding of the system's datamodel and datastructure, with good expertise in the manipulation of the GIS dataconversion modules, and must understand how the database is to be

and datastructure, with good expertise in the manipulation of the GIS dataconversion modules, and must understand how the database is to be queried; (iii) *GIS applications staff*. These are professionals (engineers, surveyors, foresters, soil scientists, environmentalists, urban/rural planners, etc.) specialized in spatial data analysis with GIS, with an intense and dedicated training in the use and characteristics of the particular GIS package being implemented by the organization. Data analysis and manipulation, modelling, planning scenarios, etc., would be the responsibility of this group. It would also be responsible in assuring that the GIS meets the goals that have been set up and that the (growing) users' needs are met; (iv) *Institution managers*: A good understanding of the components and of hardware and software, database models and structure, functionalities of the GIS and how the system can be queried and analyzed, is essential, and can be attained through the organization of seminars and workshops; (v) *Decision-makers*: who are the real end-users of the system. Training would focus on knowing the content and structure of the database and in the use of the GIS modules to manipulate and analyze the database. As a rule, they are assisted in their task by the applications staff.

The training scheme will depend on the organization's structure and its resources, on the type and complexity of the data to be converted and used, as well as in the schedule and time-frame for the system's implementation. Some of the staff may be identified within the organization and some will have to be recruited. Some training can be done on-the-job (operators, supervisors) by the system's vendor during the initial installation phase and pilot projects, or, if available, by contracting with some experienced group in the country. If the data conversion phase is done by an external firm, provisions can be made whereby this process is utilized to provide the required on-the-job training to operators. A number of professionals will necessarily have to be sent for formal training and education to universities and specialized training centres, within or outside the country. The Regional Centre for Training in Aerospace Surveys (RECTAS) at Ile-Ife, Nigeria, established under the auspices of the Economic Commission for Africa, constitutes an excellent alternative for training and education in Spatial Information Systems in Africa at the three levels of technician, technologist and postgraduate. It has recently initiated the implementation of a new and full fledged course in Geomatics. The Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS), also under the aegide of the commission, although it does not offer regular courses as does RECTAS, organizes short and medium-term training courses in GIS to African nationals. Further, both centres have experience in organizing customized seminars and workshops, which are apt to provide the required know-how for those in (iv) and (v) above.

Whatever scheme is applied, any public organization will quickly realize that finding and retaining staff with adequate skills may be a serious problem, as it is the adoption of measures and strategies to solve this problem, such as the introduction of special salary scales and effective incentive strategies.

Database Administrator (DBA):

The person or a group of persons, normally constituted by computer scientist(s) and specialized in GIS design and management, responsible for the overall control of the database. Among other important tasks, he will decide how the data will be defined and stored (conceptual and internal data definition languages), and structured, he will liaise with partners and users ensuring that the data they require is available and accessed, will define authorization checks and validation procedures, will ensure that the data meets the established standards and that the data and information that is generated flow smoothly both internally and externally. Finally, he will organize the system so as to get the performance that is "best for the organization", and will make the

ordeal, has nowadays been eased as most of the major GIS packages of the market have incorporated the necessary utilities of the DBA within the system's DBMS, many of which are performed automatically and efficiently in a way that is invisible to the user.

A GIS has been rightfully compared to a car (Konecny, 1993), where the hardware and software supplied by vendors is the car itself, the data is the fuel and the administrator (manager) is the driver, without which the car could not go anywhere (and would serve no purpose).

If funds are available, the recruitment of a specialized consultancy firm to perform the duties of the Database/System Administrator, can be a simple yet satisfactory solution, at least during the entire period of implementation, until the whole system is working successfully and when experts within the organization are highly knowledgeable and familiar with the tasks of the Administrator.

Database design and conversion:

Database design: During this stage, the content of the database, which is conditioned by the requirements of the users' needs, is defined and documented. A datamodel, which is an abstraction of the "reality" of a particular application [1], is first developed, representing, in a simplified manner, the entities of interest, the attributes that have to be recorded about those entities, and their relationships. It is then followed by the development of a database dictionary, which classifies, lists and codifies every theme (and sub-themes), object and entity, down to the last identifiable and meaningful element. Examples of a typical datamodel and data dictionary for a multipurpose cadastre database system are given in annex 1. The database design should include as well descriptions of the specifications and standards, sources of data, and of the processes for data input and conversion, updates, maintenance and archival.

At the final stage of the database design, the actual structure of the database is developed and documented against the software platform that, by then, must have necessarily been already selected. However, the original concept of the database should not be confined or restrained to a particular hardware and software, as the lifetime and cost of the database surpasses by far the lifetime and cost of hardware and software. In this regard, data independence is a major objective of database systems.

Another important conditionality is that the database design takes into account interfaces and communication with existing and planned computerized datasets, as it is the case within a national geographic information system, more so when the datasets are spread across a network of distributed datasets.

Database conversion: Several options can be used to populate the database. The process can be done by an external contractor, it can be done internally, or part externally and part internally. Each one possesses advantages and disadvantages depending on the singularities of the organization and the database.

There are, however, good reasons that favour the first one, that is external conversion, at least for the bulk of the task:

(i) The database can be very large and therefore, it requires a large number of conversion units (digitizers, scanners, editing stations), all of which are costly and which the organization won't use after the database is completed. *It should be borne in mind that maintaining the database will only need a minimum of units, and that data*

[1] *Nevertheless, the database system should be independent from the application. In fact, different applications will need different views of the same data, in particular within the concept of a national distributed geographic information systems, where the different datasets will be use to satisfy the needs of different sectors.*

analysis within the organization can nowadays be performed with inexpensive but powerful desktop PC's and software. A large number of experienced operators is also required, who at a later stage may just sit idle, entailing all the problems related to staff redeployment, laying-off, etc. These operators can, of course, be recruited only to perform the task of data conversion, but again they have to be adequately trained, and once the process is over, the institution will lose the investment made. Finally, if the organization can not invest in an appropriate number of conversion units or cannot find and train sufficient operators, then the time to populate the database may increase substantially, postponing results (and benefits), and augmenting the risks of failure.

(ii) The process of data conversion is new to the organization. If not enough care is taken and quality control is deficient, too many errors are bound to be committed affecting the quality of the database, which sooner or later will be detected and will have to be corrected, either via re-digitizing and editing and re-editing, large portions of the database. In addition to unexpected delays, internal and external criticism and pressures, compounded with lack of confidence and frustration, may show very damaging to the implementation of the GIS.

(iii) Data conversion, as other routine tasks, are often carried out more efficiently by the private sector than by the public sector (see below the role of the private sector).

At any rate, a close monitoring of the data conversion process must be done, assessing the quality of the quality of results, whereby the data converted is accepted or rejected following a clear set of rules, standards and specifications. The responsibility for such control can be assigned to a unit of the organization, if the required know-how is available in house, or can be entrusted to a specialized external firm.

Pilot projects.

Pilot projects are essential elements of any GIS implementation plan. These pilot projects are necessary to test that all the components and functionalities of the system meet its objectives.

The realization of a pilot project consists of the data conversion of a small geographic area of the dataset, which is loaded into the hardware/software selected. Data content and structure, data storage and access, data analysis and queries are verified against the original specifications. The pilot project will also test data conversion and acceptance procedures.

Within the context of the national geographic information system, it is clear that an integrated pilot project, comprising data from distinct datasets from different sources, must be designed and conducted, to test, inter alia, data export/import and integration, compatibility among the individual systems of the network, and pilot applications.

Benchmarks should also be designed and carried out before the acquisition of the particular equipment that the system(s) will use is decided. The primary role of a benchmark is to provide an unbiased mechanism to measure the suitability and efficiency of a supplier's proposed GIS hardware-software solution within the context of the institutions' requirements and environment. The benchmark content should closely replicate the user's application and dataset characteristics, but should be concise and focussed on key aspects that can quickly exposed any potential inadequacies.

3.3 The role of the private sector vs. the public sector.

Many tasks are cheaper and more rapidly performed by the private sector than by the public sector. This fact, until recently considered an anathema by public officials at all levels, in both developed and developing countries, is now being slowly recognized and accepted. With notable exceptions, major public institutions have traditionally, by their nature, a strong inertia with stiff hierarchical structures, inflexible norms and rigid procedures, coupled with a "civil servant mentality", all of which make them difficult to perform fast and efficiently. "Social service", and not rentability, is the driving force. The sense of urgency is replaced by a sense of "gravity", where in order to do things properly, these must be done carefully at a determined pace that can not be accelerated. Taking risks is something that is totally out of question. When, in a given case, a decision is made to move faster, the organizational inertia will apply the brakes.

The private sector, on its side, is not limited by traditional cultures or procedures. It is therefore more flexible, and not only can adapt easily to changes, but these are welcome. The driving force is cost-effectiveness, and private firms will swiftly test and incorporate innovative technologies and methodologies to speed up production rates while at the same time lowering costs, taking any necessary risks. The staff, in expertise and number, is also elastic and is easily accommodated to fit the needs of the firm. The danger lies on the "responsibility" of the firm, as quality may be sacrificed on behalf of speed and cost.

To a greater or lesser extent, many States still consider that the private sector: (a) has no business in national mapping or in the collection and management of other types of spatial resource information, or: (b) are competitive bodies and that such competition should not be encouraged or allowed, or: (c) both of the above.

Such attitudes can not be any longer sustained in a modern market economy, where complementarity and partnership between the two sectors are main conditions for development. The private sector can lend/transfer to the national institutions the expertise and know how they may be lacking, and add to and complement their production capacities, enabling them to absorb new technologies as well as to cope with increasing demands for products and services. On its side, public entities, by contracting part of their activities with private firms, will encourage the development of this sector, not only creating new jobs and opportunities, but will also ensure the acquisition of appropriate endogenous technical capacities within the country.

Successful examples of such partnership are not difficult to find as it is the case in many countries with cadastre systems regulated and controlled by the State whereas the surveys are carried out by private surveyors.

Typical components and steps of an institutional GIS implementation process

* INITIATIVE TO INVEST IN A GIS

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* EDUCATION

Orientation to national planners, decision-makers and staff through seminars, workshops, formal and informal meetings.

- understanding GIS
- relational databases, topology, queries
- implications to the agency's role
- performance expectations
- demonstrations

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CONCEPTUAL DESIGN

Establishes the feasibility of GIS, establishes a concept for the system and provides an overall implementation strategy.

- organizational assessment: establishes a starting point: assets and facilities
  gaps and deficiencies
  staff knowledge and motivation

* • outline of responsibilities and relationships among all institutions involved

* • identification of users' needs and applications

* • identification and analysis of datasources

* • determining datasets, formats, scales and media

- determining training needs at all levels
- feasibility study: estimation of required resources: invest aggressively or within normal budget
  cost/benefit analysis

* • study and appraisal by national steering committee

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* APPROVAL

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* SYSTEM AND DATABASE DESIGN

- further development and streamlining of system concept
- datamodel
- database
- benchmark(s)

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* In cooperation and agreement with the national steering body on geomatics

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* IMPLEMENTATION PLAN

Provides a (normally multi-year) programme of tasks for establishing the GIS

- revision of resources
- strategies for: training
  selection and design of pilot project(s)
  procurement and installation of equipment and software
  data conversion:
  database and system administration
  data up-dating
  data analysis and manipulation
  overall system appraisal
  phasing
- schedule of tasks

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IMPLEMENTATION

It is the materialization of the implementation plan

* • training programme launched:
• procurement of equipment: bid/tender documents
* analysis of responses, benchmark carried out
* selection & award of contract
site preparation
installation
acceptance test
• specific operator's training completed
• data conversion process: external: conversion purchase process
pilot conversion: test data base
requirements met
full conversion
internal: recruitment of GIS data conversion consultant
pilot conversion
full conversion
• pilot project: test overall system performance
* test data transfer and communication within the network
* test existent/immediate applications
* develop and test new applications
test GIS management structure
Reassess budget requirements - cost/benefit analysis

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DATABASE ROUTINE MAINTENANCE AND MANAGEMENT

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SYSTEM REVIEW AND EXPANSION

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* In cooperation and agreement with the national steering body on geomatics

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2 THE CHANGING ROLES AND MANDATES OF AFRICAN NATIONAL MAPPING INSTITUTIONS VIS-A-VIS THE ADVENT OF NEW GEO-INFORMATION TECHNOLOGY [1]

Professor Olubodun Ayeni
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ABSTRACT

The world is going through a period of unprecedented "Digital Revolution" which has altered and restructured various aspects of society. Recent advancement in sensor, space and computer technologies has changed drastically many classical methods and conventional instruments in Surveying and Mapping. Digital Surveying, Digital Remote Sensing, Digital Photogrammetry, Digital Cartography which resulted from the new Geoinformation Technology have digital outputs into Geographical Information System (GIS). The paper reviews the mandates and Roles of National Mapping Institutions (NMI's) in Africa and the resultant changes, which will be necessitated by the new Geoinformation Technology in terms of Institutional Arrangement, Structural Adjustment, Survey Laws and Regulations, Commercialization of New Products, Personnel Structure, and Education and Research. The paper also reviews new mandates arising from the development of national Spatial Data Base for GIS and LIS. The role of the Private sector and sources of funding through technical cooperation, Government subsidy and internally generated funds are also discussed. The new Geoinformation Technology is viewed as a panacea for Africa's economic recovery and development. Recommendations are made as to how NMI's should implement the adoption of Digital Technology.

1. INTRODUCTION

The world has witnessed in the past four decades phenomenal development in science and technology which in turn has fundamentally altered and restructured various aspects of society. Recent advancements in sensor and computer technologies in particular have swept along many disciplines which are inevitably connected with the resulting wind of technological change. This phenomenon explains the change from print to electronic media, manual to automated operations, analogue to digital processes, divergent to convergent solution, single to multiple disciplines and local to global perspectives.

The "wind of change" has not spared the noble discipline of Surveying and Mapping. As a matter of fact there is a correlation or parallel between general development in science and technology and the changes in the techniques and equipment used for the past few decades in Geodesy, Surveying, Photogrammetry, Remote Sensing and Cartography. The digital revolution which has been the product of recent advances in sensor and computer technologies has also brought drastic changes and revolution to the theory and practice of Surveying and Mapping which is now digital oriented. The extensive technological advancement has given rise to the emergence of new capabilities such as Digital Surveying, Digital photogrammetry, Digital Remote Sensing and Digital Cartography, By virtue of this Surveying and Mapping operations have been extended from ground to satellite; air survey is hotly contesting aerospace survey; photographic imagery is yielding to digital imagery, and manual

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cartography in moving towards automated cartography.

One may be tempted to ask what impact these changes are making in the developing countries. Have the advancements in sensor and computer technologies made any appreciable impact on the roles and mandates of Natural Mapping Institutions (NMI's) in Africa? Does the need arise to change, amend or extend these mandates in the light of the new geo-information technology? What are the strategic challenges facing Africa's National Mapping Institutions vis-a-vis the advent of extensive technological innovations in recent times? The main objective of this paper is to provide answers to these and other related questions.

A survey of current roles and mandates of Africa National Mapping Institutions will be made before taking a look at the challenges and mandates necessitated by the new geo-informatics. Financial and budget implications, technical cooperations, challenges in the educational and research sector and the role of the private sector will also be discussed before making recommendations for future direction.

2. REVIEW OF CURRENT ROLES AND MANDATES OF NATIONAL MAPPING INSTITUTIONS

The task of reviewing the current roles and mandates of National Mapping Institutions (NMI's) in Africa appears, at first, to be a difficult one. NMI's differ widely in African countries with respect to their names, organizational structure, age and history, tradition, culture, staff strength, budget and income sources, facilities, methods of operation and responsibilities. For example "Ethiopian Mapping Authority (EMA)" is the name given to the NMI in Ethiopia whereas in Nigeria, and indeed in many former British Colonies such as Ghana, Kenya, Uganda and Zimbabwe it is simply called "Survey Department." In most former French Colonies in Africa NMI's are referred to as "Institut Geographique National" (IGN). The Survey Department in Zimbabwe is 104 years old whereas its counterpart in Ghana is about 88 years old. In some countries the NMI's are lodged in the Presidency while in others it is a regular department under the Ministry of works, natural resources, environment or a separate Agency like EMA. The head of NMI is called Director or Surveyor General while in others it is referred to as General Manager. Some NMI's have huge budgets and are self accounting and self sustaining while others live on small budgets as subsidy. In some countries the Survey Department is not officially responsible for Remote Sensing whereas in others it is solely responsible. In the midst of these diversities it is possible to establish some core mandates and responsibilities assigned to NMI's in Africa. The core responsibilities so identified are a result of a recent survey of NMI's in Africa as well as literature search (Ayeni (1996); Kure and Amen (1992).

General Advisory and supervisory functions on Survey Matters . This mandate is common to all NMI's world-wide and by and large this mandate has been carried out fairly well except that the expression "Survey Matters" is restrictive in the light of today's Geo-information technology. NMI's also have responsibility for supervision of all type of survey works.

Establishment and Maintenance of National Geodetic Network. This network usually includes the National triangulation network (first, second and third order) Geodetic Level network, Primary Traverse network and in some cases Gravity network. By and large most NMI's in Africa have established these networks partially or completely. In some cases some modern techniques were employed for example Doppler Campaign was popular in the eighties for strengthening some primary triangulations networks. The maintenance is of course a problem, in that classical methods

which were used for the establishment of these networks, cannot be used for their maintenance.

Provision of all types of Maps and map substitutes. This mandate includes provision of topo maps series thematic maps, cadastral maps, etc. for the exploration, exploitation and management of natural resources, and for urban and country and regional planning, recreation and tourism. This mandate includes the provision of National Atlas in some cases.

Establishment of a National Cadastral System and it Maintenance. This is usually a mandate of NMI's to be executed in collaboration with Land Surveyors in the private sector of the economy. In most African countries the image of the Surveyor is best created by the Land Surveyors who carry out property cadastral surveys. This mandate ensures a basic requirement for a successful Land Title Registration System which can guarantee security of titles, regulation of the optimal use of land, minimize Land disputes and make for equitable distribution of land. Also relevant here is boundary surveys which can be local government, state on international boundaries. This mandate is equally important, although not operated by NMI along modern lines using computerized Land Information System. It should be noted that the cadastral branch is not always hosted by NMI's.

Data Acquisition and Storage in form of Maps and Map Substitutes for the use of the General Public. This mandate covers all types of maps, airphotos and photo mosaics as defined in many Survey Departments.

Provision aeronautical Chart and Hydrographic Charts and Survey. This responsibility is calling for specialized survey products for safety of air and water (sea river and ocean) navigation and for management of Aquatic resources of the ocean, sea, lagoons rivers and lakes.

Research and Development. This task usually involves the conduct of research into technical aspect of Surveying and Mapping. It also puts the responsibility of training of necessary personnel on NMI's. In some cases it requires the establishment of a survey school and sending of staff for training locally and abroad.

Licensing of Surveyors for Private Practice and the regulation of Surveying Practice. Only very few NMI's do not perform the role of licensing surveyors. But all NMI's are responsible to establish or advise its government to establish laws and regulation instructions and specifications for governing survey operations and practice in their countries.

Association and Cooperation The role require the NMI's to associate and cooperate with other local or international organizations in carrying out their roles, mandates and objectives. The main objective of these mandates is to ensure on orderly and peaceful society and to maintain security internally and externally of life and property by provision of map and survey information. These mandates are also meant to promote economic growth . The questions which must be answered in the light of modern Geoinformation Technology discussed in the previous section of this paper are as follows: Do these roles and mandates go far enough? Do they need expansion or modification? Do the NMI's need a new organizational structures? What changes are required in Personnel, Survey laws and Regulations and policies concerning commercialization and marketing of new products? What are the strategic challenges in the educational and research sectors as well as in the private sector? The next section is devoted to providing answers for these and other related questions.

3. NEW ROLES AND MANDATES OF NATIONAL MAPPING INSTITUTIONS VIS-A-VIS THE NEW GEO-INFORMATION TECHNOLOGY

Introduction of Digital Technology.

In the light of the new Geo-information technology discussed in chapter two of this paper which has revolutionized Surveying and Mapping processes and products, it is obvious that the roles and mandates so far discussed do not reflect the importance of Digital Technology. It therefore seems that National Mapping Institutions in Africa has to modify these mandate to pave way for introducing modern techniques based on computer, space and sensor technologies in their technical operations. This is the first challenge facing NMI's. In seeking to introduce Digital Technology into survey and map production care must be taken to carry along the user community which they serve. Digital Technology which has pervading influence on society through banking, transportation, telecommunication, publishing, television etc is therefore a must in Surveying and Mapping and not optional. Equipment based on old techniques are being phased out by manufacturers and NMI's are supposed to set the pace for the state of the Art of Surveying and Mapping in the country. NMI's should indeed be a pace setter.

Care must be taken to plan properly the introduction of GPS, Inertial Surveying, Analytical photogrammetry, digital photogrammetry, Digital Remote sensing, Digital Cartography, Spatial Data Base System and GIS. A systematic and gradual approach is preferable to a drastic change. Long term and short-term planning must be gradually worked out. It is good to start from the known to the unknown, from the simple to complex aspects of Digital Technology. Certain requirements must be carefully planned and worked out viz, training of personnel, provision of adequate infrastructural facilities, adequate budget provision, purchase of right equipment, etc. There is also the aspect of where to start: that is setting up priorities. For example if the Geodetic Networks (triangulation, leveling and traversing) have not been completely established, that is a priority because every other aspect of Survey and Mapping depends on a strong Geodetic network. If 1:50,000 topo and lower scales have not been completed this should be the next priority. Other changes involving new mandates institutional and organizational arrangements will be discussed later.

One big advantage in introducing Digital Technology is the resulting high speed and accuracy of Surveying and Mapping Operation. Consider the case of producing topo map series in Africa even by conventional photogrammetric methods. This has taken several decades and yet many African countries are yet to complete even the small scale topo series in 1/100,000. Only very few countries such as Ghana and Nigeria have completed 1/50,000. (see table below extracted from Hassan and Hutchinson (1992) P. 44).The introduction of analytical photogrametric methods and instruments such as APC in Europe accounts for the high rate of completing of topo map series, compared to Africa where modern techniques are not applied. When a topo map series take 30 - 40 years to complete, the map becomes obsolete and outdated before its completion. Let us consider also the primary, secondary and tertiary geodetic network both in plan and height, GPS is the fastest and most accurate means of establishing a geodetic network. Unfortunately, most African countries are yet to establish a complete and unified geodetic network, whereas in Europe most or the countries have completed and adjusted a unified and consistent geodetic network using GPS.

	Percentage topo map coverage				
	Map Scale	1/25,000	1/50,000	1/100,000	1/250,000
Africa		2.50	34.50	19.50	86.60
W. Europe		83.40	96.20	28.5	90.90
World (1987)		17.30	56.40	58.90	90.20

Table 1: Topography map coverage.

New Mandate: National Environmental Information System (Neis)

One of the new mandates which should be conferred on Africa's National Mapping Institutions (NMI'S) is the establishment and maintenance of a National Digital Mapping Data Base System (NDMDBS) necessary for the creation of a National Environmental Information System. The NDMDBS will consist of a National Topographic Data Base System (NTDBS) and National Land Data base system (NLDBS). The NTDBS will be derived from topo map series at various scales (medium and small) scales using 1/50,000 as the principal mapping scales. NTDBS is considered the future source of topographic mapping and map revision for the country. NLDBS will be extracted from cadastral survey plans and maps (mainly large scales) and it is considered as the basis for creating a National Cadastral Information System (NCIS) and Land Use (Land cover) Information System (LUIS). As conceived the National Environmental Information system (NEIS) will be derived from NDMDBS, whereas National Geographic Information System (NGIS) will be generated from NTDBS. Other specialized GIS will be derived as shown in fig 1, such as Highway GIS, Population Census GIS and Transportation GIS etc if National GIS has linkage with other relevant data bases.

While it may be debatable to house the National Environment Information System (NEIS) in a country's NMI because of its multidisciplinary nature, it seems most appropriate that NMI in best suited to play host to the National Digital Mapping Data Base System (NDMDBS). The following requirements for NEIS make it mandatory for NMI to be its custodian:

(i) The existence of a consistent unified and accurate national geodetic controls both in plan and in height with enough density.
(ii) The existence of accurate topo and cadastral maps and surveys at various scales. Alternatively current photography at various scales can be used for topo mapping.
(iii) Availability of necessary manpower for converting existing maps to digital form.
(iv) Availability of specialized data on natural resources actual and potential; population census data, tourism etc.
(v) Good and positive response from sensitized actual and potential user of the NEIS.

As suggested by Kure and Amer (1992) an alternative arrangement would be to entrust the coordinating role of NEIS to a national committee with a permanent secretariat and strong participation of NMI. The committee should formulate national policies regarding resource information data bank, sale of maps (soft and hard copies), copyright law and national security, vis-a-vis the national data base. The NMI's of some countries such as Israel as Canada, UK, U.S.A., Ghana, Nigeria, and Ethiopia have been playing a

leading role in this respect.

The advantages of setting up the data bases illustrated in fig 1 may be summarized as follows:

(i) Fast reproduction of maps at various desired scales
(ii) Faster, cheaper and more accurate revision of maps using the most current data e.g via satellite.
(iii) Easy linkage of a data base with other data bases.
(iv) Easy and more efficient storage and retrieval of map information.
(v) Provision of up-to-date maps.

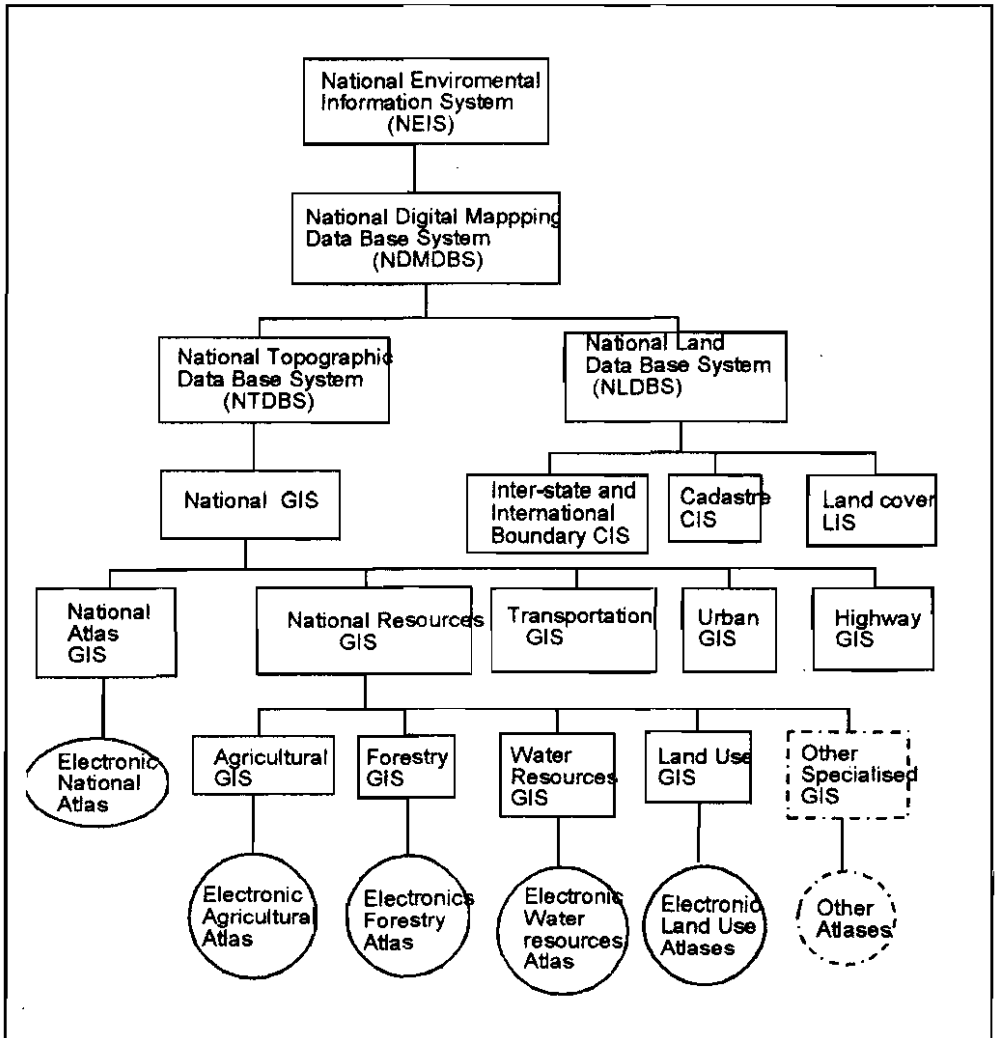

Fig. 1 National Enviromental Information System

The advantages of GIS can be illustrated by the problem of producing a National Atlas. (Ayeni - 1987). It normally takes more than two decades to complete through manual cartography, a new or revised National Atlas. That has been the experience of most African countries.

By the time the Atlas is completed and published it is usually outdated, and grossly inaccurate. With the use of GIS technology and the concept of Electronic Atlas the National atlas can incorporate the latest data derived from the most current photography and Remotely sensed data. A pioneering publication can be completed in five years and its revision within two to three years although some countries have a policy of revising its National Atlas every ten years. This achievement can only be possible in a GIS environment. Digital technology will encourage African countries which have hither to not embarked on National Atlas Project, to establish an Atlas GIS project. National Atlas of Canada is in electronic form and can be accessed globally through World Wide Web (WWW).

The solution to some problems which are likely to face NMI's on the implementation of GIS have been discussed in Ayeni (1979),(1995); they include the choice of suitable map projection, transformation of one projection to the other, storage and handling of large Data Base system particularly for a large nation such as Nigeria. Other problems encountered in establishing a topographic Digital Data Base in Israel, Italy, Canada, UK and Germany are recorded in Reled et.al. (1991) Maraffi et. al. (1988) Allam (1996) Rind et. at. (1983) and Wiggenhagen (1996). Such problems include lack of densified Geodetic control, use of cadastre for LIS, access to confederated set of dispersed spatial data bases and accuracy standard for a topographic data base and data fusion and data integration of vector and raster data. In conclusion we assert that the new mandate of providing current spatial geo referenced data about a nation is the purview of NMIs.

Natural Resources Survey

While it is true to say that all the current mandates of NMI's are still relevant today, the new Geo information technology has indirectly imposed another mandate on NMI; that is of providing accurate and current information about the natural resources of the nation in a spatial reference digital frame. Such information should include forestry, water, agriculture, mineral, petroleum, tourism, marine, population and atmospheric and subterranean resources. Each one of these resources should be established as a sub-set of the GIS data base. As shown in Fig. 1 GIS products cover natural resources. Fig. 1 also depicts functional GIS to solve certain problems such as highway planning, and urban GIS, whereas natural resources GIS should produce specialized Atlases of natural resources. The natural resources GIS can be used for monitoring and management of natural resources. This new mandate which is a corollary of GIS mandate, implies that all references to provision of map in the current mandates of NMIs should include spatial data base systems. All maps, map substitutes and charts must be in digital form. It is good to remind NMI's that the capability to explore exploit and manage Africa's natural resources was recognized and emphasized in the Lagos plan of Action and the Final Act of Lagos as one of the panaceas for Africa's economic malaise.

Advisory and Supervisory Role

It is obvious from the introduction of the new Geo-information technology and the provision of accurate and current spatially georeferenced data that NMI's advisory and supervisory role on survey matters will be expanded to include Digital Data Base System, CIS, GIS and digital mapping techniques for managing and monitoring natural resources and natural disasters.

Survey Laws, Regulation and Licensing for Professional Practice.

NMI's are currently charged with the responsibility of implementing the Survey Laws and Regulations concerning the Practice of Survey and Mapping Profession. One of the first casualties of change due to the introduction of new digital technology should be the Survey Laws, Regulation and instructions established by the country's constitution, Decrees, ordinances, Acts and Instructions related to Survey Matters. New technology should bring about new Laws and Regulations. For example there are technical instructions and Regulations which make reference to Surveys by the type of instruments e.g "Theodolite Surveys", "Compass Traverses", "Chain Surveys". These names have to change to reflect new digital survey methods. There are definitions such as "Cadastral plan", "Traverse" Pickets, " Record sheets" etc which were made according to the state of the art of surveying in the 1930's. Computational devices were prescribed by using logarithm and hand computation; all these have to change to reflect the new Geo-information technology and computer processing of data.

Another aspect of change of Survey Laws and Regulations is the survey aspects of Land Title Registration Law which according to the new Geo-information Technology should be based on the Cadastral Information System (CIS). Reference should be made to computer verification of claims of ownership in cases of dispute within the context of CIS. Also because survey work and verification can be done faster, the periods specified for verification and resurvey in the Regulation may have to be shortened. Besides the specifications for maps, parcels and boundary surveys may be more stringent in the light of higher accuracies attainable by Digital Technology. For example a cadastral survey of individual plots may attain an accuracy of second order primary traverse with GPS without any extra cost.

Some sections of the Regulations refer to types of surveys such as trigonometric, topographic and geodetic survey; these types have to include GPS surveys, Inertial survey, photogrammetric (Digital or analytical) and Remote Sensing Survey or simply aerospace surveys Regulations concerning testing of instruments also have to change to reflect modern instruments such as Total Stations, GPS, Gyroscopes, accelerometers (Inertial Survey Instruments), Digital Levels, Electronic Field Books, Analytical Plotters, Digital Plotters, and computer processing. Besides the Regulations should make reference to GIS and Digital Mapping. Reference to aerial photography and films should recognize digital photography, digital images, and digitized images.

Survey Laws concerning Licensing of a Surveyor has to change in the light of the new Geo-information Technology which has a tendency towards integrated surveys and a convergence of Surveying, Photogrammetry, Remote Sensing, and Cartography. For now a combination of any of these four branches with technical expertise in GIS and data base management may be required to grant license for Professional Practice. In the future technical expertise in all four branches and in GIS and data base management may be required. Other changes envisaged because of the introduction of GIS is the definition of organizational structure, standard role and responsibilities of agencies creating GIS. There is need for legislatory accuracy standards for Topographic Data Base and Cadastral Data Base Systems. Laws regarding design of GPS controls new classification of Geodetic standards are a most because of the increase accuracy of GPS over existing Geodetic standards.

There will be a new definition for a Surveyor. Already FIG - The International Federation of Surveyors has redefined a Surveyor in 1991 to include land management, LIS, GIS:- "A surveyor is a Professional person with academic qualifications and technical expertise to Practice the science of measurement; to assemble and assess land and geographic related information; to use that information for the purpose of planning, and

implementing the efficient administration of land, the sea and structure thereof: and to instigate the advancement and development of such Practices" FIG (1991) Publications No. 2. FIG Commission 3 takes change of LIS; Commission 4 is for Hydrographic Surveying, commission 7 is concerned with Cadastre and Rural Management, while Commission 8 has to do with Urban Land Systems: Planning and Development and Commission 9 deals with valuation and management. One should then ask should we retain the name surveyor in the light of these developments vis-a-vis the new Geo-information Technology? Is he not a land and resource Surveyor or just Geo-resource Surveyor? The California Land Surveyors Act 1991 defines Land Surveyor as a professional who "creates, prepares or modifies electronic or computerized data in the performance of the activities described in subdivisions of all other definitions and descriptions of the practice". The question of name for the profession will be discussed further in this paper.

Commercialization and Marketing of existing and new Products.

This is a mandate that most NMI's have adopted by default due to lack of fund to finance the implementation of commissioned tasks. The huge cost of introduction of Digital Technology will however make commercialization of Digital Surveying and Mapping products, mandatory. The new Geo-information Technology will give rise to new products such as Digital Data base, soft copy, Electronic map and Electronic Atlas. Bahr (1996) has suggested that a new product in 4-Dimension (including a 3-D plus time dimension) will emerge as a result of the new technology. It is good to note that instead of selling maps, satellite imagery, photographs and orthophotos as hard copies, these products will be sold in digital forms and on diskettes, magnetic tapes and on CD ROM. The crucial question is how do we determine the price of goods and services offered by the new Digital Technology in relation to existing products?

The first step towards getting an answer to this question is a well defined policy of commercialization of existing and new products. Hitherto many government departments have a "laissez faire" attitude about pricing of their products at commercial rate since their annual budgets are from government subsidy. Some government departments are even declared as non-profit and others as parastatals which are expected to generate some income. In view of the fact that the new Geo-information Technology is capital intensive for most developing countries and it is an emerging technology within the context of adverse economic climate featuring huge debts and external loan financing, a strict policy on commercialization of digital technology product is a must and not optional. A sales and consultancy services Division should be established in MNI's to tackle this problem.

The second step towards the realization of Commercialization of Digital Mapping /GIS products is to develop a cost model. Finegan et. al (1992) and Finegan and Ellis (1992) have proposed a model based on the principle of Project Management for Remote Sensing in Australia. There is a need for more study in assessing the cost-effectiveness and cost-benefit of the products of the Digital Technology which will be a guide in accurate pricing of these products. A model can be established based on the following factors.

- Define the main objective of the project
- Identify the key tasks of the project
- Define the immediate objectives
- State the expected outputs
- State the activities leading to the realization of each output
- Cost the input element of each activity including duration (man hours), equipment, material and the level of personnel needed.
- Establish a budget for the project.

The correct pricing can be established from the budget and the relative values of the outputs. The cost of existing products should be revised based on

the factors listed above.

Apart from the initial cost there is the elements of cost of maintenance and updating spatial date base or GIS map or data base which should be built into the cost model. There is also need for a policy of copyright to protect some of the new products and value added cost any time the buyer makes use of such products. There are other questions to be resolved e.g. Does a client (buyer) pay more for a map which he intends to digitize? Is the buyer free to digitize a purchased map and add more information to produce another map? Can the buyer purchase a soft copy or digital data? NMI's have to find answers to these questions.

Personnel Structural Changes

The introduction of new technology is bound to produce structural changes in the personnel needed to practice the new technology. At the moment the personal structure of Surveying and Mapping Profession in Africa is at three levels - **technician, technologist** (higher technician) and **Professional.** The new technology is high technology, base on sensors, space technology and computer science. How much of this can a technician understand to operate the high technology equipment very well? Is it likely that the technician level will disappear from the scene? Do they need to know the theory behind the high technology.

Another dimension to personnel structural change is the various nomenclatures for practitioners engaged in the branches of the profession, e.g Geodesist, Land Surveyor, Photogrammetrist, Remote Sensing expert, Cartographer and now we should add experts in Digital Mapping and experts in CIS or GIS. Now that the trend is gravitating towards integrated mapping some of these nomenclatures may be phased out and we may have to settle with experts in integrated mapping, expert in Digital mapping or expert in GIS/LIS. Some are of the opinion that GIS is not a profession according to ISPRS. The NMI's will have to grapple with these changes and also retrain existing staff with a resultant change in titles and nomenclatures. For example maintenance of repair Engineers and technicians will be required.

Another significant change is the total number of workers required by the new technology and the proportion of professionals to other categories of workers. Digital Technology being an advanced technology will require less number of employees in total and probably fewer professionals than presently employed because of the trend towards automation in Digital photogrammetry, Digital Remote Sensing, Digital Surveying and Digital Cartography

Education and Research

From the discussion on modern trends in the various branches of Surveying and Mapping sciences the following facts have emerged:

(i) Digital revolution has affected all the various branches of Surveying and Mapping - Digital Surveying, Digital Photogrammetry, Digital Remote Sensing and Digital Cartography are dependent on sensor, computer and space technologies with a tendency towards automation and turnkey systems.

(ii) Each branch of Surveying and Mapping has developed a subject of Spatial Information System (SIS) called GIS and LIS (cadastral based).

(iii) There is a trend towards integration of one, or two of the branches with GIS/LIS. For example there are combinations such as GPS/Photogrammetry/GIS, Remote Sensing/GIS, Photogrammetry /Remote Sensing/GIS, GPS/Photogrammetry/Remote Sensing/GIS, Cartography/ GIS, ISS/GPS /Photogrammetry/Remote Sensing/GIS, Remote Sensing/Cartography.GIS. etc., in various teaching, research or production environments.

In addition to the above there are changes in nomenclatures of educational institutions, around the world as a reflection of these changes in the

various branches. The Institute for Aerospace Survey and Earth Sciences (ITC) formed in 1991 a new Department of Geoinformatics (ITC 1991), which integrates surveying and mapping disciplines plus GIS. Laval University has also formed the Department of Geomatics (Groot 1991) to imply a combination of Surveying, Mapping, Remote sensing, and GIS. (Woolnough et. at. 1992). The term "Image Information Engineering" is used to describe a specialization of the Department of Photogrammetry and Remote Sensing, to embrace the two disciplines and GIS. Finally in 1995 Department of Surveying Engineering, University of New Brunswick changed its name to Geodesy and Geomatics Engineering Department to affirm a new direction in education programme orientation. Finally the term, Iconic Informatics has been used many times to connote a combination of photogrammetry, Remote Sensing and Cartography, (Deren, 1992).

Since some NMI's have a mandate for education and training, these changes have serious implications for them. Some African NMI's have established Survey Schools with formal and informal education primarily to met the need for in-service-training of their staff. Usually the training is at two levels- technician and technologist (upper technician) levels. High level training is normally done in the Universities and colleges within and outside the Country. The education and training programmes of NMI's should respond to two factors - "top-down technological pressure" and "bottom-up pressure" coming from the multitude of users or employers of labour (Krakiswshy and Mueller 1992). NMI's fortunately constitute the second pressure. What we have discussed so far are the technology - driven changes. Since Survey School establish by NMI's train staff from other establishments, the curriculum change must reflect the users' needs outside NMI's.

Two approaches which should be adopted simultaneously by NMI's are proposed for Curriculum change. First we consider technological - driven change to the Curriculum modules for Higher National Diploma (HND) Digital mapping and GIS. Based on the concept of Depth, Breadth and Spread enunciated in Ayeni (1992) the Curriculum will consist of (i) Digital Mapping/GIS (Depth), (ii) Digital Cartography, Digital Remote Sensing, Automated Photogrammetry and Digital Surveying (Breath) and (iii) Physics/Celestial Mechanics, Mathematics, Computer Science and use of English (spread) see Fig 2, which represents a radical departure from traditional curriculum modules.

A technological and user driven Curriculum change for HND Remote Sensing maintenance a balance between the two approaches as illustrated in Fig 3 which represents a middle of the road approach to curriculum change. Similarly a middle of the road Curriculum Module for HND Cartography, HND Photogrammetry and HND Surveying can be constructed using these principles. The idea is to allow the "ancient" and the "modern" to co-exist for a while. The two approaches to be operated simultaneously are however recommended for NMI's sponsored Survey Schools as exemplified per excellence by the new Curriculum recently developed for Ghana Survey School (GSS) Accra under a World Bank Project. GSS curriculum package in the author's opinion is a master Piece and model for African NMI's supported Survey Schools.

Curriculum change also leads to changes in teaching aids and teaching methods e.g, new or modified Hardware, Software, textbooks, slides, transparencies, videos films, etc. will be used. The new development in the area of teaching aid is the use of computers and T.V. programmes as teaching aids. For example Hypermedia or multimedia consists of a combination of text, graphics, full motion video, still images, sound (audio) and animation into a single computer - controlled product. This method improves the students' ability to learn and assimilate knowledge through text, sound and pictures. This method has been used for teaching GIS (Zhuang et. al 1992), Photointerpre-tation, Remote Sensing (Argialas, et. al. 1992), and Photogrammetry, (Newlson, J. (1996).

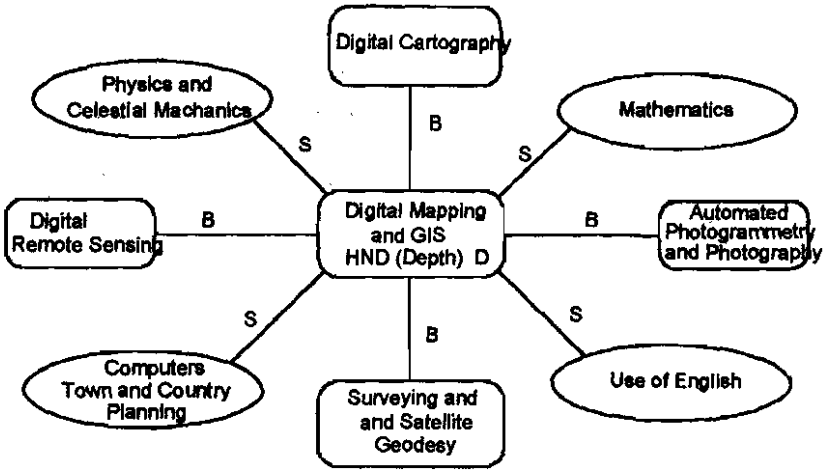

Fig. 2: Conceptual Model for the Cirriculum Contents of Higher National Diploma (HND) in Digital Mapping showing Depth (D), Breadth (B), and Spread (S) and Integrated Mapping.

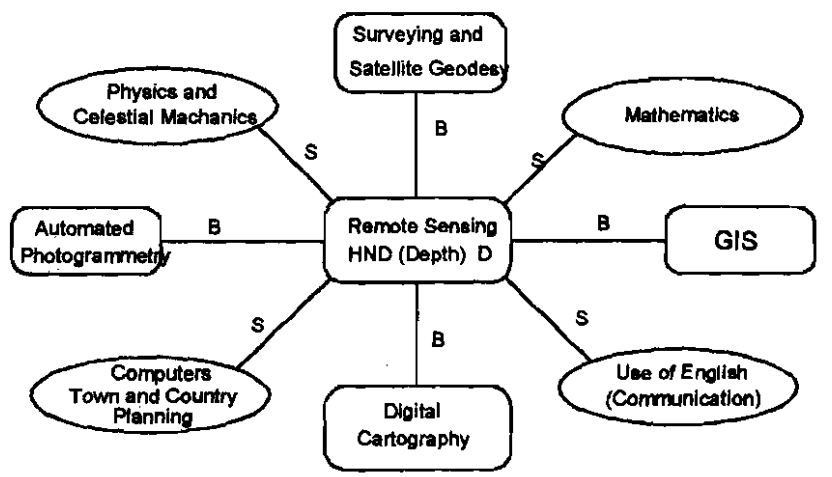

Fig. 3: Conceptual Model for the Curriculum Contents of Higher National Diploma (HND) in Remote Sensing showing Depth (D), Breadth (B), and Spread (S)

During the 18th Congress of the ISPRS a competition was organized by a working Group of Commission VI on computer - teaching aid for photogrammetry Remote Sensing and GIS. University of Leeds Media Services has instructional teaching Videos on Electronic Theodolites, Distance measurement , and Leveling . University of Nottingham has computer teaching packages for GPS. ASPRS also has Video tapes for teaching GIS.

On challenges on research, NMI's should take up the challenges of research into efficient Data Base system best suited to their needs. There is need also to research into the best design for GPS network. The research efforts in Survey schools can be complemented by expertise in industry and Universities. NMI's will also ensure that their staff who are sent to Universities for higher degree are distributed to various modern techniques in Geodesy, Photogrammetry, Remote Sensing, Cartography and GIS and that their research works for these degrees are relevant to the problems of their respective organizations in the area of Digital Technology. Besides NMI should sponsor staff to workshops, conference and seminars on modern techniques in Survey and Mapping.

Institutional Arrangements and Organizational Structural Adjustment.

The new mandates and roles of National Mapping Institutions arising from the introduction of Digital Technology in all its ramifications calls for institutional changes and organizational adjustment necessary to implement changes and innovations involved in acquisition of new equipment, software, new technical operations, staff training and staff development commercialization and marketing of old and new products, staff recruitment, personnel structural changes, training, education and research and in developing new laws and regulations. As suggested in relation to the introduction of Digital Technology, the institutional and Organizational structural adjustment should be gradual. All temptations to adopt sudden and drastic changes should be resisted. The organizational structural changes should be consistent with gradual technological changes.

One of the first institutional changes to be considered in view of the new roles and mandates is the Official name of the NM's. Is it ideal to retain the name "Survey Department"? Is it wise to separate cadastral survey from Survey Department (Institut Géographique National) as is the case in some African countries. The new mandates should be reflected in the new name of NMI's. In 1987, the Survey and Mapping Department of Canada changed its name to Geomatics Canada to reflect its new additional role in providing accurate and current spatially georeferenced information about Canada landmass, Allam (1996). In 1987 the Department set up the GIS's and Services Division and in 1988 the new Division established the National GIS technology centre and acquired several GIS hardware (PCS) and Software. Other names earlier suggested are Geoinformatics and Iconic Informatics. It must be admitted that new mandates do not necessitate change in name. Change in name may bring a new beginning, better recognition and better future; If not it is better to stick to the old name. What is in a name?

Another inevitable change is the organizational structure. Fig. 4 incorporates a possible structural change in the administrative set up of an NMI which has introduced Digital Technology. The following descriptions and functions of the various Divisions will explain their justification.

(i) **Cadastral and Boundary Survey** which is not new will take charge of Cadastral Surveys of individual plots, and estates, as well as interstate and international boundaries. This division will also establish and maintain an efficient CIS or LIS as explained in the initial paragraphs of title "New Mandate: National Environemental Infroamtion Systems".

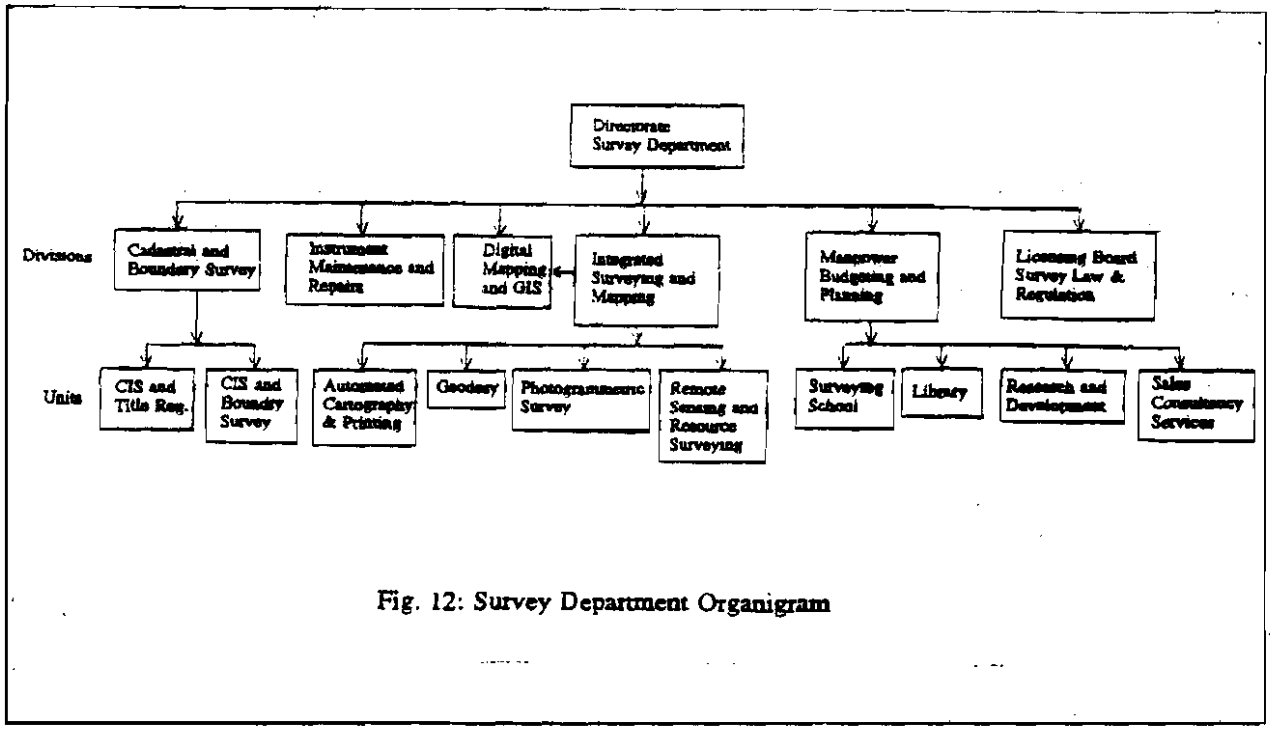

Fig. 12: Survey Department Organigram

(ii) **Instrument Maintenance and Repairs** a new division will be responsible for the repairs and maintenance of new digital and analytical Surveying, photogrammetic, Remote Sensing, Cartographic equipment as well as the Computers and other support electronics such as stabilizer, Uninterrupted Power Supply (UPS) etc. The amount of money invested in Digital Technology equipment will justify the establishment of this new division. This division will establish a maintenance culture in the whole organization by conducting workshops on routine instrument maintenance for staff members who are regular operators of the instruments. Engineers and technicians who are well trained abroad and locally should be recruited to man this division. The staff is this division will also conduct periodic routine inspection of instruments installed in the whole organization.

(iii) **Digital Mapping and GIS** is also a new division for establishing EIS which as already discussed will give rise to GIS . It will derive its spatial Data Base from Integrated Surveying Division.

(iv) **Integrated Surveying and Mapping** is a new Division which should merge Cartography, Geodesy, Remote Sensing and Photogrammetric Survey. Their outputs will be plowed into GIS.

(v) **Manpower, Budgeting and Planning** is not new, but new functions will be performed with the Sales and Consultancy Services Division (CSD) and the library. CDS should develop aggressive and pragmatic policies for income generation. Activities and opportunities for extra budgetary resources should be diversified by making and selling natural resources maps, tourist maps, road maps, town guide maps, topo maps, digital data bases to other government departments, and also private companies and develop GIS for various applications, see Amer, et. al. (1992) for other suggestions. The library should in addition to its regular function provide facilities for storing digital

data on tapes, diskettes, CD ROM containing digital data or imagery as well provide Image and GIS spatial browser for clients.

(vi) **Licensing Board and Survey Laws and Regulations** which is not new should be in charge of taking care of administrative duties in connection with the Registration and Licensing of private practitioners. It will also be responsible for drafting new Survey Laws and Regulations and draft amendments of the same as the need arises. The problem of who is a surveyor will be in responsibility of this division in the light of Digital Technology, It is however noted that licensing and registration of Surveyor for private practice is not a mandate for all NMI's.

4. FINANCIAL IMPLICATIONS OF INTRODUCING DIGITAL TECHNOLOGY AND THE NEED FOR TECHNICAL COOPERATION.

Budget Constrains

There is no doubt that the introduction of Digital Technology in capital intensive in terms of Institutional building e.g acquisition of sophisticated hardware, software and imagery, development of spatial data base, physical development (putting up new buildings and other social infrastructures) or modifying existing ones to suit human and machine requirements) and also human resource development (education, training). NMI's in Africa are already experiencing serious budget constraints in completing and maintaining their core task e.g geodetic networks, topographic map series, township mapping etc NMI's budget restrictions derive from the economic crises facing African countries in general. The crucial question is where will the funding for introducing Digital Technology be obtained? The answer to this question can be found from three sources.

Sales and Consultancy Services

The importance of realistic assessment of sales and goods and services provided by NMI's cannot be over emphasized. Individuals, Companies, Corporate bodies (public or private) should pay realistic prices for such goods and services at commercial rates in particular for the goods and services which will be utilized by them to make profit. Before introducing the new Geoinformation Technology NMI's should develop and implement pragmatic policy in sales and consultancy services as previously noted. The organigram shown in Fig. 5 is not necessarily ideal for every NMI's but it contains some elements which might be good to incorporate into a new NMI administrative set up.

Government Funding

The second identifiable source of funding for the implementation of Geoinformation Technology Programme at NMI's is from the Government budget. As noted before, African countries are going through economic crises hence the NMI's have budget constraints. However it is the author's view that NMI's can get substantial increase in their budgets if only we can get the powers that -be-to recognize the importance of National Surveying and Mapping Institutions and in the words of Lagos Plan of Action (LPA) "to rate them high among their national Priorities and to provide sufficient budget for them and also take steps to establish them when non-exist". NMI's can also formulate and executive a systematic and effective Programme of Public awareness on the role of Surveying, Photogrammetry, Remote Sensing, Cartography and GIS to the economic and social life of the Nation. The Public Campaign in collaboration with the Private sector, should be mounted at national and local government level through the mass media (print and electronic media). We must not keep the General Public in the "dark" about our real worth to the Nation. Digital Technology with all its economic benefit to the nation has become a good instrument for popularizing the worth of Surveying

and Mapping. In using this tool NMI's should refer to relevant documents which represent a blue print for Africa's economic recovery such as LPA and the final Act of Lagos, the UN Programme of Action on African Economic Recovery and Recovery and Development (UN-PAARED), as well as the Alternative Frame Work to Structural Adjustment Programmes for Socio-Economic, Recovery and Transformation (AAF-SAP). Reference can also be made to Agenda 21 of the Earth summit in Brazil in 1992 on the Environment to convince decision makers to increase the budget for implementing the Digital Technology Programme of NMI.

Technical Cooperations

The third source of funding for introducing Digital Technology is through technical cooperation and assistance. With all the good intention of Government funding of NMI's, it will still be difficult to introduce Digital Technology. The final recourse is to Donor Agencies. Professor Konecny through a Private discussion recently in Vienna noted that the world has gone through a period of **Colonization**, and is now going through a dying period of economic **Control**, but it is on the threshold of an era of technical **Cooperation** to complete the three Cs. The few African NMI's who have begun to introduce Digital Mapping such as Ghana, have been able to do so through technical assistance. Ghana will probably report the tremendous success of its World Bank supported digitization of 1/50,000 topo map and other digital data Base Programme apart from the modernization of the curriculum of its' Survey School, Accra. Without technical cooperation I doubt whether any African Government can successfully introduce Digital Technology to Surveying and Mapping.

In order to tap financial resources through technical cooperation each NMI must plug themselves into its country programmes dealing with the Environment, in consonance with Agenda 21 of the Earth's summit. Each country has an Environmental Protection Agency (EPA) which is strongly supported by World Bank. Besides UNDP, UNESCO and EU National Programme has Surveying and Mapping inputs. NMI's should take advantage of these fundings to implement Digital Technology innovations for their countries. I should mention here, World Bank initiative to assist Sub-Saharan African countries to develop their Environmental Information database. Under the "Program on Environmental Information System (EIS) for Sub-Saharan African "which has been the Bank's high priority Programme since 1990. An Action Plans - "National Environmental Action Plans (NEAPs)" has been developed and a number of African Countries whose priority needs are in environmental and land information are currently participating in NEAPs Besides NMI's can also take advantage of bilateral cooperation with countries like France, Japan, Britain, U.S.A., Germany, and the Netherlands. Possibility of cooperation can also be extended to NMI's Survey School under inter-university or tertiary education linkage with institutions in these developed countries.

6. THE ROLE OF THE PRIVATE SECTOR

The Professional Surveyor in private practice is an inevitable partner of progress in the introduction of Digital Technology into professional practice. He has the responsibility of introducing the new technology into his practice in collaboration with the NMI. His personal ambition is to build up gradually modern capabilities with the profit he makes annually. Since NMI is a major source of fund for surveying and mapping contracts and in most cases is responsible for the licensing and registration for private practice the private professioner should work hand-in-hand with NMI. Apart from introducing electrical total station instruments, digital levels and EDM's the private practitioner can also purchase GPS for both Property Surveys as well as Geodetic Surveys which are contracted out by NMI. In order words he should conform to NMI contract specification

concerning the use of Digital Technology. The private practitioner should also be ready to execute contracts award for the formation of Digital Date Base for GIS or LIS. The Private Surveyor should be interested in setting up an integrated Surveying System which incorporates GPS, ISS, Photogrammetry or Remote Sensing into GIS.

The Private Surveyors could also form a GPS Users Group as part of the National Society of Surveyors with the following objectives:

(i) to provide a forum for discussion and distribution of information for those using or interested in using GPS;

(ii) to share experiences and difficulties encountered and solutions

(iii) to maintain a high standard for GPS control survey works.

(iv) to educate the public as to the capabilities and limitations of GPS for a wide range of applications. Surveyors in public and the education sector could also join the users Group.

The private Surveyors can also form a GIS forum as part of the National Professional Body with similar objectives as the GPS Users Group: The exchange of experiences will promote rapid development of GIS and create more public awareness for the profession and its contributions to society and the economy.

The Private Practitioners of Surveying, Photogrammetry, Remote Sensing, Cartography and GIS have been known in some African Countries to form separate organization. Nigeria is a typical example where five separate organizations exist for the five disciplines. The trend towards integration implies that one single Body should represent all five disciplines "United we stand; Divided we fall" This institutional arrangement does not preclude the formation of specialized committees or commissions, groups or forums or even semi-independent associations under one umbrella. The question arises again as to what name should be given to this body taking note of the diversity of specialized capabilities under the same body. Suggested names include Association of Geomatics (AOG), Association of Geoinformatics (AOG), Association Iconic Informatics (AII), Institute of Geomatics" (IOG) etc. See Bahr (1996) for other suggestions.

Whatever the name of the Body of practitioners, other roles of the private sector and private practitioners remain the same which may be summarized:

(i) to collaborate with NMI to promote the development of Digital Technology

(ii) to join hands with NMI in creating public awareness for the new Geoinformation Technology

(iii) to organize conferences, training seminars, or workshops on new techniques such as GPS, ISS, Digital Photogrammetry, Digital Remote Sensing, Digital Cartography and GIS.

(iv) to promote and fund research into the problems facing practitioners in the application of these modern techniques.

(v) to develop man power for Digital Technology in their own organizations.

(vi) to form Non-Governmental Organizations (NGO) to promote public awareness for Decision Makers who are likely to influence increased funding for Surveying and Mapping. In Nigeria an NGO for GPS and GIS was formed by individuals who do not know anything about Surveying and Mapping.

(vii) to sponsor Surveying Practitioners for elected or appointed positions of authority in

Government where crucial decisions can be influenced in favour of Surveying and Mapping.

6. IMPORTANCE OF GEOINFORMATION TECHNOLOGY TO DEVELOPMENT IN AFRICA

Africa is potentially a rich continent with a population of over half a billion people, and accounts for 28 percent of the earth's surface. There is abundant Solar, Thermal and Hydroelectric power, vast areas of virgin forests and rich grasslands full of animals, fruits and crops in addition to abundant evidence of other untapped natural resources such as 170 rivers, 52 lakes, 54 international rivers lake basins, 200 million hectares of arable land and plenty of valuable mineral deposits including petroleum, copper, gold, bauxite diamond, manganese etc. Africa is said to be naturally endowed and potentially bequeathed with abundant natural and human resources and yet Africa is suffering as it were in the midst of "Plenty". The explanation for this paradoxical situation in which Africa finds itself is because of her technological backwardness which gives rise to economic and social underdevelopment. This prevents her from translating her rich natural and human resources potentials into reality of economic development and economic wealth. That is why Africa plays host to a high percentage of the World's Least Developed Countries (LDCs) which lack the technology to harness their natural resources. In World Bank terminologies Africa is "data-rich" but "information poor", it has "oceans of data" by only "drops of information". Hassan et. al. (1992). This problem was identified in the Lagos plan of Action which states, "The major problems confronting Africa in the field of natural resources development include: lack of information on natural resource endowment of large and unexplored areas and lack of capacity (capital, skill and technology) for the development of there resources." Africa has become highly vulnerable to natural disasters and hazards and their devastating effects on agricultural products and human lives because of the lack of appropriate technology to combat them.

Natural Resources

In this paper GPS, ISS Photogrammetry, Remote Sensing Cartography and GIS have been presented as a powerful tool for exploration, exploitation and management of natural resources of Africa. The new Geoinformation Technology has been applied in various countries of the world to harness natural resources through the use of Earth Resources Satellite imagery. There are some application studies financed by the World Bank on forestry, resources, water resources, energy resources, and mineral resources in some African countries.

Agriculture and Food Security

Africa in the past two decades has been subjected to frequent food crises and low agricultural productivity. All the branches of the new Geo-information Technology can be used to boost improved agricultural production and food security. Remote Sensing is applied to soil studies. Meteorological satellite information is used to forecast weather and climate condition for the benefit of agriculture. Crop yield can also be estimated with remotely sensed imagery, photogrammetry GPS and Remote Sensing and Cartography has been used in some developing Countries like Nigeria, Lesotho, Chad, India, Brazil, Bolivia to take inventory of soils, fisheries and agricultural resources, wild lives and live stocks, irrigation and land use, through World Bank Projects.

Disaster and Environmental Monitoring

It has been well established that Geoinformation Technology provides the powerful tool for environmental monitoring of atmospheric and

industrial pollution, weather, storms, cyclones hurricanes, forest fires, earthquakes, flooding, landslides, volcanic eruptions, tidal waves, soil erosion, drought and desertification, traffic accidents, industrial accidents, oil spillage hazards, and locust invasion. It is unfortunate to find that in some cases the information needed for monitoring the environment are located outside the countries of Africa and can only be obtained through bilateral assistance. There is a joint project between UNEP and FAO for monitoring the Sahelian Pastoral Ecosystem. There are satellites which are designed mainly for disaster monitoring.

Other Applications for Development

There are other applications of Geoinfomation Technology for economic and social development which time and space does not permit us to discuss fully. These include, inter alia, Environmental Impact Assessment (EIA), transportation planning, measurement of engineering structure, urban and regional planning, high way construction, population studies, biodiversity studies health care, tourism, space science, archeology, anthropology, and museum, police and military applications.

7. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

From the foregoing presentation concerning African National Mapping Institutions and the new Geoinformation Technology the following conclusions can be made:

(1) A majority of African NMI's have not incorporated Digital Technology into their organization. Only a few NMI's have started to convert their topo maps into digital form.

(2) The introduction of Geoinformation Technology into the Surveying and Mapping operations of NMI's is not optional but compulsory because manufacturers are phasing out old instruments and spare parts are becoming difficult to get. Furthermore Geoinformation Technology has far greater advantages over conventional technology in mapping.

(3) The Introduction of Digital Technology implies the use of modern techniques based on GPS, ISS, Analytical and Digital Photogrammetry, Remote Sensing, Digital Image Processing (DIP), Digital Cartography and GIS. The application of these modern techniques were noted. GPS and GIS are the most popular techniques today.

(4) There is a current trend towards integration of two or three or all of these new techniques each one leading to GIS since each method has a digital output as input into GIS.

(5) Although many of the current mandates of NMI's will still be valid even with the introduction of Digital Technology, many of them need to be modified and extended. However some new mandates have to emerge, such as establishing and maintaining Digital Data Base and GIS.

(6) New Survey Laws and Regulation have to change in the light of new modern methods of Surveying and Mapping.

(7) Other changes envisaged in NMI's include institutional arrangements, Personnel Structure, and policy concerning commercialization and marketing of new products.

(8) From the educational point of view the curricula of Survey Schools will have to be modernized to reflect acquisition of modern digital instruments. Research orientation will

also be affected with digital approach becoming more prominent.

(9) The financial implications of introduction of Digital Technology was found to be too great a burden to be borne by NMI's regular budget. Extra budgetary sources will have to be explored by NMI's to supplement annual Government subvention. A pragmatic policy on sales and consultancy services will have to be pursued by NMI's and the final recourse will be, to source funds through technical assistance.

(10) In the light of new roles and mandates a new NMI's organizational structure will emerge with great prominence for digital data base system, GIS and LIS.

(11) The role of the private sector will be crucial in the course of change to Digital Technology and in terms of developing its own capabilities, hardwares, softwares and human resources. Its cooperation with NMI's in creating public awareness will also be crucial. The private sector could also organize conferences, seminars and workshops on Geoinformation technology to update its members in the professional association. The private sector will be a contractor for some of NMI's contracts in Digital Technology.

(12) It is obvious that Geoinformation Technology is a powerful tool and a sine qua non for socio-economic development of Africa. It is therefore going to play a big role in Africa's economic recovery and development programmes.

RECOMMENDATIONS

In view of the foregoing considerations the following recommendations are made:

(1) NMI's should introduce Digital Technology as a matter of urgency. The introduction should be systematic and gradual, starting from known to the unknown, from simple to the complex. For example professionals and other relevant staff should be introduced to computer technology in general, analogue Photogrammetric equipment should be converted to semi-analytical and fully analytical. Analytical plotters could be purchased also simultaneously or subsequently. The advantages of introducing Digital Technology were already discussed.

(2) Where the National Geodetic Networks in plan and height are not fully adjusted and established, NMI's should take this as top priority. The urgent purchase of GPS equipment is recommended to complete this. Analytical photogrammetry could be used for the densification of the national networks.

(3) Priority should also be given to completion of small scale topo map series up to 1/50,000. Since these maps will form the base line information for the National Digital Data Base. Remote Sensing imagery should be used for the revision and completion of these map series at smaller scales.

(4) It is recommended that NMI's should be given a new mandate to establish and maintain an accurate and consistent Spatial Data Base from Topographic maps, Cadastral Maps and Surveys, and from other surveys. This Spatial Data Base should serve as the basis for establishing a national Environment Information System (EIS) from where a national GIS and LIS could be created.

(5) It is also recommended that EIS, GIS and LIS should be housed in the country's NMI

although the management of EIS could be done by a joint national inter-ministerial committee because of the contributions from other governmental institutions.

(6) Another new mandate recommended for NMI's is the establishment of a national resource surveys data base because of the need for Africa to harness her natural resources for promoting economic recovery according to Lagos Plan of Action and the Final Act of Lagos.

(7) A comprehensive review of Survey Laws and Regulations is recommended in the light of new Geoinformation Technology, such as GPS, ISS, GIS, Analytical and Digital Photogrammetry, Digital Cartography and Remote Sensing. Areas where Survey Laws should be amended have been highlighted. There is need for a new definition of a Surveyor and a new name for the profession and NMI's may be desirable if found to be advantageous.

(8) A new policy on commercialization and marketing of new products should be in place with the advent of Digital Technology. The steps towards correct pricing of the products of the new Technology are contained under the subtitle "Commercialization and Marketing of existing and new Products".

(9) A Personnel structural change is a direct result of adopting Digital Technology. Existing staff should therefore be trained locally and abroad. Suitable and competent Personnel can also be recruited from outside.

(10) NMI's should establish their own Survey Schools (with syllabi along modern lines) where non exist. Existing Survey Schools should endeavour to modernize their curricula to reflect Digital Technology. In revising curricula NMI's should resist the temptation for a radical change. A gradual transformation or "middle of the road" approach is recommended in which the "ancient" and "Modern" co-exist for a while. NMI's should promote research in the tertiary Institutions to solve problems peculiar to their locality in the implementation of Digital Technology Programme.

(11) Introduction of Digital Technology should give rise to a new organizational structure in which Digital Data Base is the focus. Fig. 4 exemplifies this type of structure. One of the recommendations for NMI's is to consider the possibility of a new name if this will give them an advantage. New divisions proposed in the new structure are sales and consultancy services, Instrument Maintenance and Repairs, Integrated Mapping, and Digital Mapping and GIS. The structure in Fig. 4 is not necessarily ideal but it contains some good elements which NMI's may wish to adopt.

(12) The financial burden arising from the adoption of Digital Technology is heavy. Internal revenue generation through consultancy services and commercialization of new products is highly recommended to supplement Government annual subsidy. Funds should also be sourced through technical cooperation without which NMI's may find it difficult to introduce Digital Technology. World Bank, UNDP, EU UNESCO and bilateral sources such as U.S.A, France, Germany, the UK, Sweden, Canada, the Netherlands and Japan are suggested. Tertiary education linkage with institutions abroad is also recommended.

(13) The private sector contribution as a partner in progress to NMI's is strongly recommended in terms of execution of contracts for government agencies, creating public awareness, supporting surveyors seeking election or appointment to position of high authority which can influence policies and

allocation of funds in favour of Surveying and Mapping and also sponsoring research in Digital Technology. A new name is also recommended for the new umbrella professional organization which will embrace all branches of Digital Technology.

(14) The establishment of more satellite receiving and processing stations in Africa is high recommended.

(15) Geoinformation Technology is recommended as a powerful tool.

(a) for exploration and management of Africa's natural resources,
(b) for boosting agriculture and food production
(c) for monitoring the environment and potential and actual disasters and finally
(d) as a sine qua non for promoting Africa's economic recovery and development.

(16) At national level, it is recommended that African countries should take advantage of the World Bank sponsored National Environmental Action Plans (NEAPs) to launch their own micro satellite programmes for earth observation and for communications in order to realize the full potential of the New Information Technology discussed in this paper. the micro satellites can be used for other specific aspects of national development, e.g. weather forecasting telemedicine, teleeducation, and disater monitoring. The alternative is to establish low cost micro receiving stations for earth observation, etc. This recommendation also calls for the establishment of National Space Agencies by African governments.

(17) At the regional level the establishment of Africa Space Agency by Africa governments similar to the European Space Agency (ESA) is highly recommended. This will enhance the possibility of launching a big space programme for the continent as a collaborative effort, e.g. the erection of more receiving and processing stations in Africa apart from the one in South Africa and the launching of big satellites for the use of African countries. Almost all the institutions which responded to a recent survey agreed with this recommendation.

(18) It is finally recommended that African governments should make substantial investment in space technology applications as a panacea for harnessing the full potentials of Africa's abundant natural resources.

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3 THE CONTRIBUTING ROLE OF THE PRIVATE SECTOR IN MAPPING AND OTHER GEO-INFORMATION SYSTEMS IN AFRICA [1]

Ambrose B. Made, Cosultant

ANALYSIS OF THE TRADITIONAL MAPPING AND OTHER GEO-INFORMATION SYSTEMS

1. INTRODUCTION

The need for accurate and timely delivery of maps at different scales in Africa has never been so apparent as it is now because of a number of pressures. These pressures have resulted from the fact that in order for the African continent to compete more meaningful with the rest of the world it needs to know the spatial distribution, quantity and quality of its resources. At a local level there is the ever increasing demand for more land due to population pressure/explosion. Further Africa needs to consciously look after its environment in order to preserve it for the future generations. More recently African governments have accessed international funding sources who in turn would only give out money if the governments knew what resources are there, how much there are and where they are located. The onus then is on the various national mapping agencies (NMA) to provide these maps which can accurately describe the resources of the countries. Further the maps need to be updated periodically.

Generally, surveying and base-line mapping are the responsibility of the NMA and these are funded from the national budget.

Among the activities of the NMA are;

* production and revision of national topographic and other specialized map products
* survey and recording of legal property ownership boundaries
* provision of ground survey control

1.1 Production and revision of national topographic maps and other specialized map products.

The topographic maps in most African countries are outdated as there has been no attempt to update them since the early 60s. Very few countries have any coverage at scales of 1: 50 000. Most countries at best have maps at 1: 250 000 scale, which can provide the user with a general view of the terrain, but can hardly be used for any meaningful planning.

In most countries the mapping capacity is very low, needing expertise, trained staff, equipment and adequate funding to maintain and regularly update the maps. Even a country like Zimbabwe which ten years or so ago boasted of a very elaborate aerial photography coverage every five years for update of topographic maps has failed to maintain that standard.

On the other hand the developments in satellite remote sensing and global positioning systems offer a great opportunity for these countries to update the maps. On these technologies how many NMA have used them on a routine basis. The flexibility of these datasets, their timely availability and multi-disciplinarity have not been exploited at all. However lack of adequate funding, lack of understanding of the new technologies and

[1] *Paper commissioned by the secretariat for submission to the Ninth United Nations Regional Cartographic Conference for Africa*

unavailability of sophisticated equipment have been cited as some of the reasons that stand in the way of the countries that desperately need to get to grasp with base mapping of the countries.

Figure 1 briefly graphically shows at a very high level the processes that are still applied in the production of maps in Africa. Quite clearly there are steps that are constrained from the sheer lack of technology application let alone from availability of materials etc.

Figure 1 The mapping process in a typical NMA

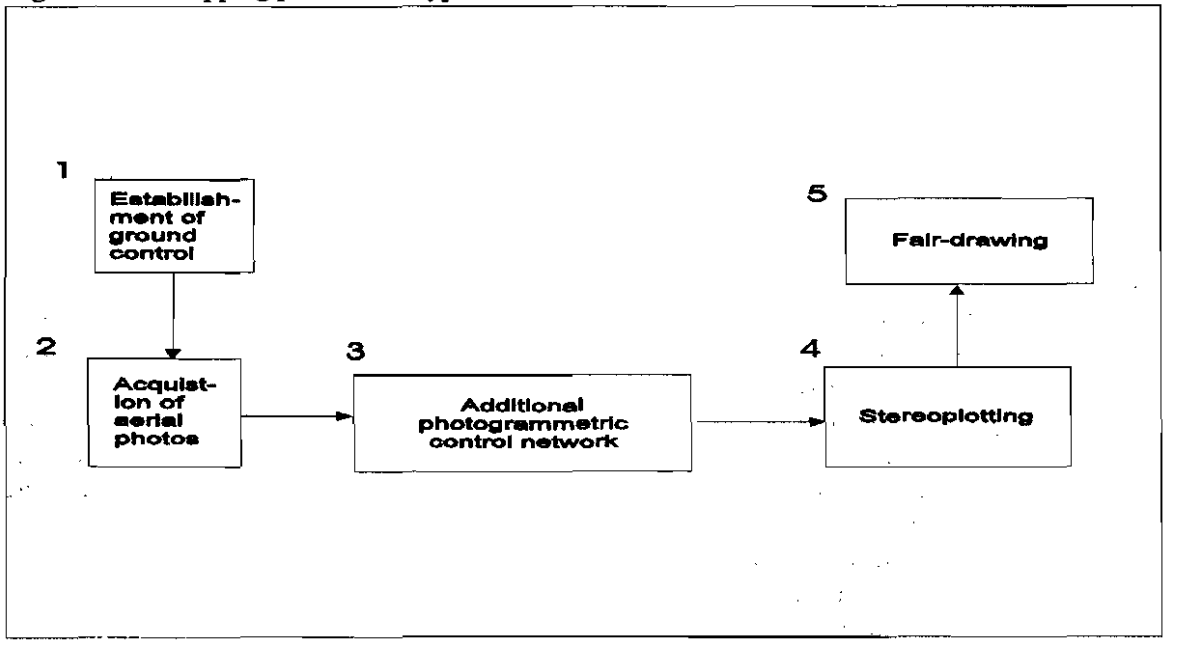
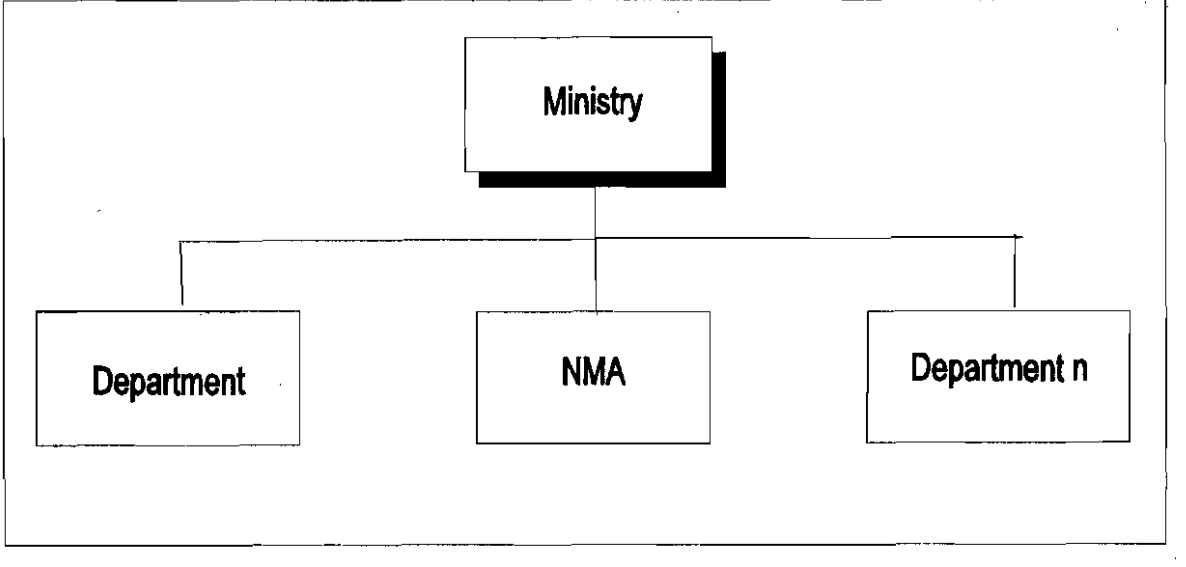


Figure 2 NMA in relation to the line ministry.



Clearly, there are steps in the above diagram that can be improved in order to bring efficiency in delivery of the required map products. Briefly Step I is laborious requiring manpower and financial resources. Step 2 is highly dependent on the season for a large part of the African continent as well as high costs in the use of aircraft. Step 5 is very mechanical, time consuming etc. On the whole it takes about five years to produce a 1: *50* 000 topo sheet following the above steps. Can this process not be improved?

.2 The bureaucratic structure in a NMA.

Surveying and mapping are usually under government control through a line ministry. **Figure 2** below shows a typical NMA in relation to the line ministry.

The NMA is considered like any department in government. Yet, in terms of its functions it is a productive as well as a service organizations. The map products produced are sold at a nominal fee which does not cover the production costs. Even if it did the revenue generated by the NMA is for central treasury.

Whatever the NMA does it is on behalf of the government and reported through the ministry. Given such a set up the NMA as a department cannot promote and implement a management system that is responsive to the needs of the client and partners, because whatever it does should be standard to the rest of the public service system.

The NMA cannot introduce a business culture quite successfully without the necessary approvals. It cannot re-organize itself without going through agonizing stages to get the approvals. Yet there could be opportunities to commercialize, subcontract or even private some of the operations of the NMA.

2. PERSONNEL

2.1 Employment criteria

The personnel of the NMA are government employees. As such they are governed by the same public service conditions of service without exception. At the same time the personnel required by the NMA is a highly qualified calibre. The duties of the staff are as defined by the ministry's and department's mandate and responsibilities. These establishments were put in place during the colonial era. Little change has taken place in spite of changes in technologies, methods and ways of doing business. The needs of the organizations and of the client may have changed dramatically.

Thus recruitment into the NMA is more on the basis of the available posts. If needs change and the NMA requires such personnel with relevant qualifications it is tortuous and a cumbersome process for changes to be made in the existing organizational structure. Voluminous submissions have to be made to the **public service commission** (PSC)/ or its equivalent in other countries to justify new structure that will bring in people that can answer to the needs of the clients. In the event the potential candidates to such positions would have been snapped up by the private sector.

The steps outlined above are complex in that the processes that go into each of the boxes are many. Quite commonly there is shuffling of paper between the departments, ministry head office and the PSC. This is usually due to inadequate information being provided or the human resources staff not understanding the needs of the NMA, which in most cases is very technical. The lack of understanding of the needs is very common to technical departments in government. Unlike in the private sector where if the need arises the responsibilities of recruitment may be given to an employment agency.

walks into the NMA may take a minimum of six months and can be anything at the outside. The negative impact on the operations of the organization's operations are quite high. This in turn means some of the duties of the required staff are not done or are transferred to someone else who may already be overloaded and not quite competent in that particular discipline. This results in late delivery of the products for the customer.

2.2 Promotion in employment.

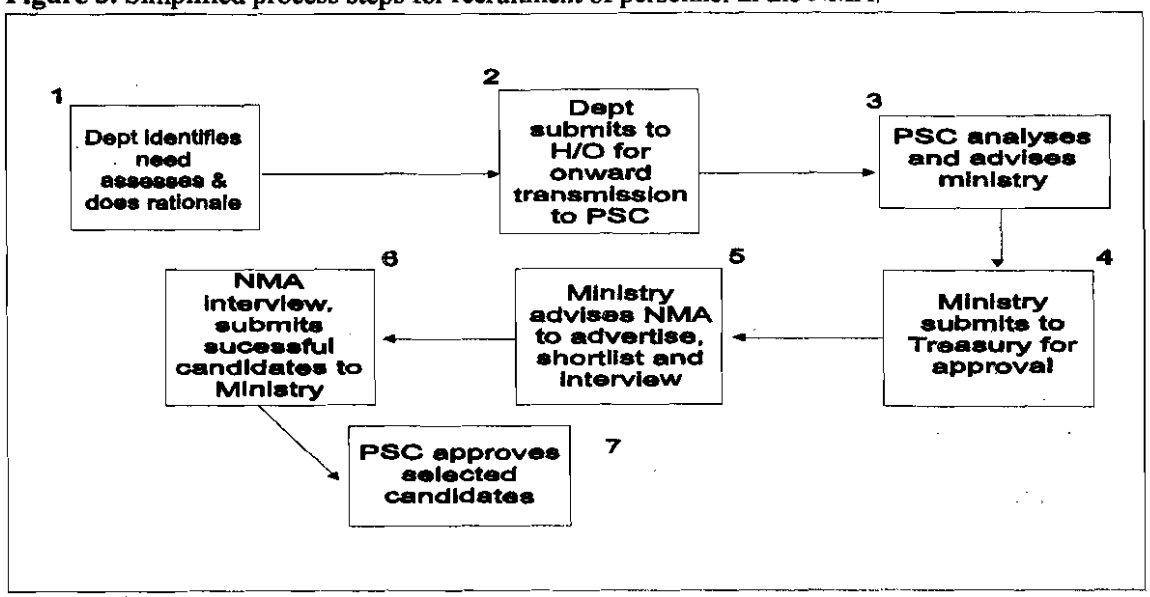
Promotions are not necessarily determined by the competence of the incumbent only.
They are effected upon the retirement, death, resignation or dismissal of the immediate senior.

lacks the required managerial and technical skills. Thus the young and usually more educated who are therefore familiar with new technologies find themselves unable to remain in the NMA for too long if they are frustrated. This results in the NMA loosing on introducing new ideas as rapidly as it may be opportune.

2.3 Staff motivation and incentives.

The civil service falls far behind the private sector in the areas of motivation and providing incentives to its employees. The human resources divisions of the public sector are unable to motivate staff in the NMA by improving the conditions of service, offering benefits or bonuses outside those stipulated by the public service authority. As productive

Figure 3. Simplified process steps for recruitment of personnel in the NMA.



Thus the career path of the incumbent is compromised. This frustrates the employees.

Further following the PSC or similar regulations and procedures no immediate junior can supersede a senior. Protocol demands that the next in line should be promoted regardless of competence. Thus one may be promoted even though he/she

organizations staff rewards should be judged on the basis of production. The implementation of a performance reward system is non-existent. Even the payment of the so called bonuses in the civil services in some countries has been removed because of economic hardships and budgetary constraints.

Managers while they may attempt to give accolades to their juniors they cannot offer anything material to them. The young technicians who are normally the first victims of these circumstances have no choice but to leave the employment of the public sector for the private sector or universities.

The establishment of a conducive working environment does not exist in the NMA, because of lack of up-to-date equipment as well as opportunities for the staff to improve themselves by training courses, refreshers courses, attachments, rotational and exchange programmes both within the government and outside government. Even if it did happen usually there is no equipment and technology on which the staff would come and work on.

This brain drain again results in 'dead wood' being sustained in the NMA. But these are already unmotivated and unproductive to the organization.

3. HIGH OPERATING COSTS

NMA agencies require sophisticated and expensive equipment for surveys, photogrammetry, cartography and aerial photography acquisition and processing, and vehicles/aircraft for field work. The NMA are funded from a central government budget and this is usually not more than 1% of the total budget.

The equipment require maintenance, service and replacement. Most NMA are not able to do so. As a result the majority of NMA on the African continent are still using analogue equipment for photogrammetry, manual methods for cartography etc.

The high costs associated with field work cannot be adequately met by the budget allocation. Staff require allowances for field surveys, transportation , accommodation in the field. Quite often even for those NMA considered to be better off do not have enough to last a financial year. This results in unnecessary unproductive time as staff spend time in the offices instead of the field.

The NMA staff are normally specially qualified personnel along the lines of engineers and technicians, generally commanding high salaries on the market place. NMA find it difficulty to meet the adequate salaries and wages of this type of personnel.

The material inputs for the operations of the NMA are specialized and sophisticated. Most of it has to be imported especially for cartography, aerial photography, processing materials and chemicals. A lot of African countries are unable to raise sufficient convertible currency to acquire these materials.

The lack of appreciation of the need of maps for development purposes result in the government not providing adequate funding for projects. Quite often money is diverted from the NMA to meet a catastrophe such as drought because this is what will earn the local member of parliament the votes in the next general elections. Thus projects are abandoned mid way. Ironically these catastrophes could be managed if there were up-to-date, accurate and timely maps.

3.1 Pricing structure

The pricing structure in NMA agencies is determined by the central treasury. In most cases, the tariffs set out have no bearing on the market value of the products. The following are some of the reasons:

- no cost/benefit analysis is ever carried out
- no market surveys are carried out
- no accounting for inflation is made.

The setting up of price structures for map products and services from NMA have no relation to the inputs into the product. This is mostly because the NMA, like most government agencies, is considered as a service organization. Thus whatever is eventually sold has no bearing on the recovery of

the costs, let alone on even making profit. The situation is worsened by the fact that the revenue accrued is forwarded to the central treasury. The allocations of budgets have no bearing whatsoever on the productive capacity of the concerned organization. These prices/tariffs are set up in the Act, and any change has to be approved through the normal channels. This is not conducive to a business-like atmosphere that should otherwise prevail in an organization such as a NMA.

3.2 Increasing demand for surveys and maps.

The implementation of developmental plans has placed a high demand on the need for surveys and maps. NMA are experiencing backlogs in cadastral surveys. These backlogs translate into increase of costs on the part of the developer.

Many governments have given priority to land resettlement programmes. Those resettled need titles to the land they get so that they can pursue their normal businesses and forward these title deeds as their collateral. However this measure to relief pressure on overpopulated lands results in more work for the NMA. Can the NMA cope up with that. This is clearly shown in the case of Zimbabwe, whose resettlement programme is well behind schedule due to lack of surveyed farms.

At the same time there is mounting pressure from the donor community and financing institu-tions to complete this before aid can be made available for development.

Thus there appears a demand for maps and indeed the NMA will sell what they have, in most cases, outdated though they may be. This gives the false impression of the fact that there is an increase in demand on maps. But are the maps of the right quality, up to date etc.

3.3 Inflation

The fall in the international value of local currencies for most African countries has fuelled the costs of imported goods. These prices have increased by over 20 times in the post-independence era. Goods required for NMA include vehicles, photographic films and processing chemicals, survey and photogrammetric equipment, etc. Almost all imported requirements are financed by donors for most countries. The recipient governments have not been able to meet the cost of maintenance of these imported equipment posing a big question concerning the sustainability of the whole system. Indeed most of the NMA have almost collapsed due to lack of adequate funding from their own governments.

3.4 Foreign Aid

Foreign donors, in a bid to alleviate the chronic problems facing NMA, provide the essential equipment to carry out mapping and surveys. However, these donations do not cater for the servicing of the same. Scarcity and high costs of spare parts (often imported from the developed world) have left a museum of defunct equipment in the developing countries. The prohibitive cost of hiring engineers from the developed countries has also worsened the situation. In some cases, the supply of obsolete equipment at high cost has been a stumbling block, leading to either expensive major maintenance or a complete repetition of projects. In some instances, donor funding may be channeled to other deve-lopmental projects rather than those intended. Projects with a training component in overseas countries, notably UK, Canada, USA, Norway, Denmark, Germany etc., also represent a provision of expenses in foreign currency. Sometimes foreign donors who want to assist the NMA to improve or undertake institutional strengthening projects are faced with bureaucratic red-tape which frustrates their effort to help.

3.5 Value of Survey and Mapping Services

Survey and Mapping Services are heavily subsidized by the central governments. No cost recovery programmes are instituted in NMA.

Increase in costs of such services are often met with resistance by the public. It is not easy to justify increases in prices of services that are carried out by the very tax payers' money. On one hand, the prices for surveys and mapping services do not reflect their true value in terms of costs in labour, salaries equipment etc. On the other hand, if these prices were to be taken into account in the pricing structure, most of the products and services offered by NMA would pay for themselves providing much needed revenue for NMA, but would be unaffordable to the poor majority of the population.

4.0 PRODUCTION DRIVEN POLICIES

4.1 Law of supply and demand

Maps in NMA are produced as a national service. A countryside coverage of a particular map series must remain in supply whether in demand or not. (For example, 1:50 000 series for the whole of Zimbabwe). However if innovative and diverse products are offered there would be a demand for them.

4.2 Lack of market research

Generally, for any business planning market analysis must take place with a broader perspective, incorporating products and services, consumers and competitors, but also marketing channels, order processing, distribution, financial transactions and corporate organizations. In most NMA's business acumen lacks because they are protected by the statutes.

In the case of planning and control, a number of different marketing opportunities can be recognized which relate to target marketing, resource allocation, sales force, automation, performance evaluation, distribution channels, stock levels, promotional activities, sales forecasting and pricing. The onus is not on the managers to make such decisions but the parliament.

In so far as operational control is concerned, for example, detailed data are required on stock levels for inventory control, to enable replenishment via warehousing/distribution system to satisfy customers' needs.

Strategic-planning decisions about marketing are non-existent, and if at all these have to be made they are made from top-to-bottom. The managers in NMA cannot implement any solutions even if it is for the public good.

Innovations by creative individuals in NMA are thwarted due to the bureaucratic red tape, rigid procedures have to followed. This bottleneck in civil service contributes to the low morale in the employees. The end result is that:

- Customers make do with the old products and shoddy services because they can not get alternative practitioners.
- Requirements by users are not met.
- No new products to meet changing needs.
- No value-added products.

5. CONCEPTUALIZATION OF MAPPING ACTIVITIES.

5.1 Government Responsibility in Surveying and Mapping

Private practitioners in the relevant surveying and mapping activities are restricted in rendering such products and services despite NMA failing to meet the demands of the users.

The NMA enjoys a monopoly which is protected by statute. Even if the NMA takes a supervisory role in surveying and mapping activities there will never be any progress due to the sluggishness and rigidity of bureaucratic structure of NMA as a civil service organization. The needs and benefits of the NMA have to be communicated effectively to the political decision makers and foreign aid donors. The only way to improve the situation is to involve the private sector. The latter will do the work and the NMA will provide the necessary control mechanism.

6.0 SUSTAINABILITY OF SURVEYING AND MAPPING ACTIVITIES.

6.1 Budgetary Constraints

The budgetary provision of NMA is generally inadequate to meet the basic needs of the office. In a typical distribution of funding to the various sectors of the Government, the NMAs are well off if they get away with more than 1% of the national budget. Usually, unproductive and administrative ministries are accorded larger provision in the national budget. The introduction of the Economic Structural Adjustment Programme (ESAP) in many developing countries has also brought in conflicting priorities, hence governments cannot adequately meet the needs of NMA or fund large-scale modernization to improve such services.

6.2 Cost Recovery

The funds released from the sale of maps and cartographic services are not retained by the mapping authorities. They are channeled through the central treasury who has the responsibility of distributing it in the national recurrent budget. This causes financial problems in the budgetary allocation as the most unproductive sectors of the government tend to get the largest part of the national cake.

ANALYSIS OF CONSTRAINTS OF TRADITIONAL SYSTEMS

1. How well are these traditional systems fitted to operate in a competitive commercial world, within a market economy?

Most national mapping agencies are funded by the central government to produce maps and a national positioning system for all potential users. Full cost recovery is rarely aimed at, all users benefit and are only charged for the cost of reproduction and subsequent distribution of the copies. The mapping effort is seen as an investment in the national economy and returns are obtained through development investments.

Government funding of the National Mapping Agencies is continuously decreasing and it is getting increasingly difficult to meet the required operational costs. The traditional structure of these NMAs will only continue to function if funding is assured by the central government. With the current harsh economic conditions funding is getting scarce and the only way these NMAs can survive is to adopt some strategies for revenue generation.

NMAs traditionally have little experience in marketing their products, simply because there is no incentive, any generated revenue goes to some central treasury and does not come back to serve the department where it was generated and that kills any incentive to generate more revenue. To be able to operate in a competitive commercial world, the NMAs must change their strategy and consider adopting some of the following points:

1. Reduce costs of core tasks such as the maintenance of the geodetic network without any corresponding reduction in the quality of the work.
2. Improve the quality of service by stream lining some of the working procedures
3. Expand their traditional working procedures by adopting the computerized geo-information methods being developed.
4. Generate extra revenue from product diversification to at least maintain selffunding, and this requires a market analysis.

The diagram in **Figure 1** above traced the high level processes that the NMA goes through in order to produce a product that it eventually supplies to the customers. Certainly some of the stages in the processes are bedeviled with bottlenecks. An analysis of these to determine areas of improvement requires an answer to the basic question of 'Should

the NMA continue to carry out these tasks ?'. In the process of reengineering it is necessary to understand the following;

- define the customer needs
- describe the existing process (and its shortcomings)
- re-engineer the process (to satisfy the customer) and including use of technology
- validate the new process.

The main problems observed in NMAs are;

- under funding from central government
- high staff turnover due to poor conditions of services
- inability to deliver services and products promptly.

It appears therefore that the NMA has to determine which route to go.

Several options are considered;

- maintain the status quo and try and improve on the services offered
- commercialize some of the sections of the NMA
- sub-contract some of the operations to the private sector.

2. Maintain the status quo and improve on the services offered.

The NMA are part of a larger ministry controlled by several other ministries (finance, PSC, treasury, labour etc.). Thus any proposed change has not only to be approved by these other partners but it has to apply to all the PSC. These changes include improvement of the conditions of service, higher budget allocations, etc. Most African governments are undergoing structural adjustments and the way is pointing out to redefinition of core businesses,

reduction in staff etc. Thus this option would not be possible.

3. Commercialize some of the sections of the NMA.

This option certainly is attractive to some degree if only it can be seen as a step towards total privatization of the NMAs. It allows the agencies to set fees and charge for services according to the market value. However it also entails some major investment up-front in order for the NMAs to operate effectively. The investments would mean that the central government has to subsidize these operations for sometime. But more critically is that it is too much of a traumatic change for the organizations such that there are bound to be more mistakes than doing the business properly. Therefore is it really worthy it or not? Under the circumstances it is perhaps not quite feasible. The issue of subsidy is against the grain of most structural programmes that are being implemented by various governments.

4. Sub-contract some of the operations to the private sector.

The mandates and nature of operations of NMA are such that there is need for overseeing the work done in mapping and other geo-information systems.

Sub-contracting certain operations to the private sector allows for the work to be done outside the NMA but the agency still maintains control of the operations. More critically it allows for close co-operation between the private sector and the NMA, if not the whole public service systems in the areas of mapping and geo-information systems. Of course, notwithstanding the above, it will mean that the cost of the products then supplied by the NMA will increase dramatically. On the other hand the customer should be able to pay for prompt and efficient service.

5. How well will they continue to respond to current and new needs and clients?

The current data requirements far exceed the available NMA production capacity and this situation will probably only worsen. Traditional data handling does not offer the flexibility required by today's clients. Apart from standard map products, tailor made products should also be provided in a reasonably short time.

NMAs should therefore consider production co-operation agreements with other agencies, both government and private in order to be able to respond promptly and effectively to requests.

6. How do they see the private sector as clients?

Traditionally the government assumes financial responsibility for the basic map products. All other users, public and private, are only charged the cost of reproduction. The private sector has, on one hand, been just another client who requires the NMA's products and, on the other hand, a contractor who would provide some occasional services to the NMA. An attractive option considering today's demands would be to consider the private sector a partner in the map production process. The private sector has the potential to provide quality work in a reasonably short time and the NMA would have overall charge of quality control.

THE CURRENT STATUS OF THE PRIVATE SECTOR

1. General

The private sector has in the main dealt with the supply and support of hardware and software to the NMA. In the majority of cases there has been little investment on the part of the private sector into those areas that would offer direct services in the production of maps and other geo-information related products. This is because of a variety of reasons;

- lack of understanding of the potential of the market in mapping and geoinformation systems
- high risk involved in start-up if definite partnerships were not the norm with the NMA
- lack of continuous contact with the NMA to understand the opportunities that may be available
- most projects have been undertaken with the assistance from the donor countries who bring their own expertise

Yet it would be the private sector that has the resources to invest in the required technologies, offer attractive conditions of services to employees etc.

Thus the private sector can offer the following;

- supply of hardware and operating systems as well as applications systems
- supply of networks
- maintenance and servicing of equipment
- supply of both non-CAD and CAD materials and equipment
- training of staff on supplied hardware and systems
- data acquisition and data capture
- quality control of products supplied

1.1 Supply of hardware, operating systems and applications systems.

Trends all over the world are that the NMA are gradually automating their operations. The hardware and software is supplied by the private sector. It is important that even those technologies provided for by the donor community aren supplied through the local private sector. This guarantees after-sales-support and sustainability of the technologies. At the same time, in doing so, the

donor community suppliers will be transferring technology to the local private sector.

As technology matures and the African countries are able to implement LAN and WAN the services of the private sector will be indispensable. These technologies are relatively new to the NMA yet by and large there will be demands to transmit and transfer data from one point to the other.

Traditionally NMAs have always been the largest users of non-CAD materials and equipment. This trend will continue for some time. The private sector will supply these requirements.

The applications software acquired by the NMA will include such packages as for database development, GIS, remote sensing, GPS, and other traditional technologies used by the NMA. There is great need to undertake research and development to ensure that these packages are suitable for the local conditions and applications. Considerable time and money will be spent in unpackaging and adapting the packages for local applications. In most cases the most successful route is through partnership between the public and private sector.

As organizations automate they will demand more and more of digital data from the NMA to use as base maps. There is no way the NMAs can on their own capture and quality control all the records and maps in their organizations without the assistance of the private sector. The NMA will probably provide the guidelines and policies on these issues but sub-contract for services from the private sector.

If the NMAs are to supervise the work done by the private sector it is clear they have to be trained in the technologies that are current. This again will be done by the private sector.

2. Specific

2.1 What aspects should be maintained.

The following are some of the aspects that would be ideal to maintain as is in the current NMA set-up:

a. The core tasks of the NMA, such as the maintenance of the national geodetic framework and the topographic mapping process, would not have no immediate interest to individuals but a very basic need for national development. Part of the work could be contracted out but the overall quality control is the responsibility of the NMA.

b. National guidance with respect to developing data standards.

c. National guidance on policies related to geo-information.

d. Co-ordination of mapping activities.

2.2 What others should change, why and how?

The following are among the leading ones:

a. Redefinition of NMA missions to reflect the changing demands on geo information. The traditional mandate was geared towards the production of standard map products. The demands on geo-information are now more and a lot of flexibility is now required.

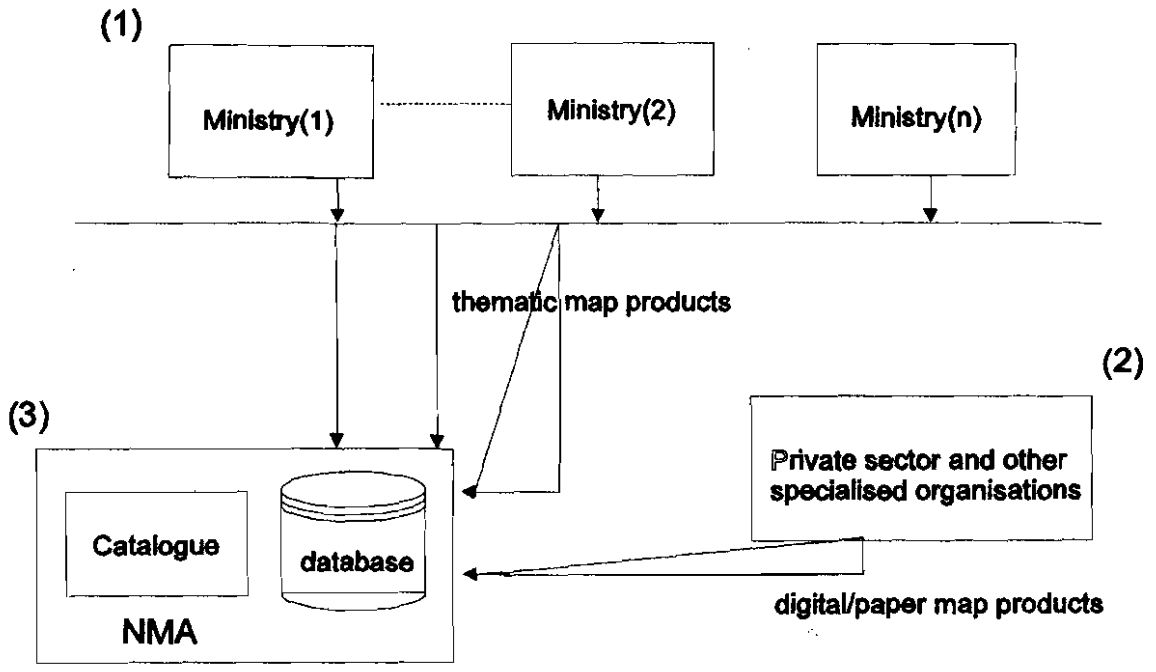
b. The trends in technology have provided great opportunities in the handling of geo information. This has resulted in a change in the working procedures and an opportunity to produce diverse products from the same old traditional data. The decision to go digital is a decision which every NMA should seriously consider because it offers vast amounts of opportunities.

c. Users have not been accustomed to getting prompt responses to their requests. It has also been impractical to get tailor-made products. As a result clients only get standard products. The introduction of digital techniques will remove these barriers.

d. Explore all avenues of increasing financial resources through active marketing, research and revenue generating activities.

e. Negotiate with treasury to use some of the generated revenue for NMA activities, this will encourage the NMA to generate more revenue.

Figure 4 Conceptual relationship of the NMA, other organizations and private sector.



Block 1: Ministries.

The ministries are sources of data/information to the NMA. This information is incorporated in the map products produced by the NMA.

Block 2: Private sector and the specialized organizations.

This block is made up of the private sector, specialized organizations(universities, research institutes etc.) that will deal in maps and geo-information systems.

The members of this block have access to technologies and advanced sources of data/ information from satellites and spacecrafts (LANDSAT, SPOT, ERS, RADARSAT, MOMS etc.). The products they deliver to the NMA are as per specification and guidelines laid down by the NMA.

Block 3: NMA.

The NMA agency itself retains its authority to catalogue, archive and disseminate/sell map products to the customers. It will provide these in the required format and media as specified by the client.

Some of the steps outlined above need to be implemented in order to relieve the government of these sectors that can generate revenue to do so.

However, to ensure that the proper protection and the integrity of the products are of expected standards the NMA will set up the standards in surveying, topographic mapping, cartography, and together with other users will determine the standards for thematic mapping that will be included onto the topo-base of the NMA. Further, as more responsibilities are given to the private sector and better quality products are expected, the increase in data/information exchange will undoubtedly grow. The NMA, together with relevant interest groups, will need to address data/information exchange standards. This actually is fundamental otherwise the products from various sectors will be rendered useless.

2.3 Is legislation encouraging the monopoly of national geo-information systems?

The NMA was traditionally "in charge" of national topographic mapping and surveying activities. This has led to a monopoly and bureaucratic NMA activities at the expense of the rest of the users. In a way it can be concluded that, yes, the current legislation on NMAs encourages a monopoly in the national mapping activities.

However current developments around Africa are showing signs that governments are willing to commercialize or even privatize those sections of the operations that can generate revenue. As such, it is anticipated that legislation will be amended to provide an enabling environment for the private sector to participate in mapping and development of geo-information systems.

2.4 Is a monopoly necessary or convenient?

Increasingly the role of governments is being scrutinized and a new alliance of governments, academia and the private sector is being explored. The academia more for research, development and educated advice, NMA for overall charge and the private sector for efficient contract work as well as research and development.

This may result in a more effective distribution of the workload as long as the NMA can be in control of specifications, priorities, cost and quality control. The NMA has the experience to be a leader in setting up a national geo-information system. The current monopoly could be justified but with the changes in the information technology their capacity is getting less and less adequate.

The diagram 4 brings together three different blocks that to a large extent operate almost independently in most African countries.

2.5 Can it ensure prompt and adequate services?

If the NMA maintains monopoly of the overall charge only, but involves all the players in the map production process, the system could be capable of producing prompt and adequate services. The production work can be carried out by the public and private sectors together, though it may be more effective if the private sector was contracted to do the work and NMA checks the quality of the work.

2.6 Does it affect the sustainability of these institutions and their services?

The monopoly enjoyed by the NMAs ensures a stable and long term surveying and mapping system. This monopoly goes along with a lot of bureaucracy and inefficiency but with the proper management of the system a relatively stable system can be created. The private sector provides very effective short term solutions, but in the long run a lot of piecemeal unrelated surveys will be the result.

The monopoly is therefore required on some aspects of the surveying and mapping process such as the quality control, but the overall workload should be distributed among all the interested players whether public or private.

2. 7 What sort of challenge are national institutions bound to face from private firms competing (if allowed) in the production of maps and geographic information? In type, quality, promptness, cost of standard products and provision of innovative products better suited to the needs of the client or reaching new methods.

Private sector funding surveying and mapping is not a viable option as the services are basically social services which can hardly generate any appreciable profit for would-be investors. There are however some surveying activities such as property surveys which are mostly carried out by the private sector under the quality control of the NMA. In as a far as these services are concerned there is no real threat from the private sector.

For strictly national mapping services the private sector has been very passive. Their participation would be encouraged through government patronage and their efforts will supplement the direct labour operations of the NMA to improve the response to user-needs. This will not offer a challenge to the NMA because the latter is the one which has ultimate control of the mapping process at the end of the day. However, when the private sector and the NMA start collaborating, the private sector will put pressure on the NMA to process their work in a shorter time, and hence force the NMA to increase its efficiency. The private sector is generally more efficient than the public sector. The private sector operates commercially and at competitive market prices, their products will therefore be more costly than those produced solely by the NMA.

If the private sector was to completely take control of the surveying activities the products would definitely become more expensive but the clients would be assured of diverse, up-to-date and high quality products. The expected high costs probably explain why there are very few private mapping companies.

As was discussed earlier, a partnership between the private and public sector would be the way forward. The private sector provides timely data and the NMA provides quality control.

SOME CONCLUDING REMARKS

The above discussion indicates that the private sector can indeed play a meaningful role in the mapping and geo-information systems in Africa, if not more crucial now than ever before. At the same time there is likely reduction of staff in the various NMA as the workloads are transferred to the private sector..

Firstly the reduction of staff is a necessary consequence with any re-organization/ reengineering process. However this results in the staff being able to concentrate in their areas of competence to ensure that quality products are delivered to the client.

Secondly those that may find themselves in what may be considered unfortunate positions are in fact not unfortunate. It is these individuals that can actually be subcontracted by the NMA to provide the services that are required. This then requires that governments provide them with start-up capital. Further the donor agencies who intend to support the NMA should be encouraged to support these individuals and consortia who may wish to offer their services to the NMA'S. Such an affirmative action would see the sustenance of the industry and the profession because not only is technology transferred to the public sector but to the private sector as well.

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4 IN SEARCH OF A COMMON GEOMETRIC REFERENCE FOR AFRICA.

Brief report on Africover Working Group on 'Geometry and Geodesy".
O. Nino, DISD/ECA
& Paper presented by Mike Chodota, Senior Surveyor, RCSSMRS

BACKGROUND: An old outstanding issue

The economic development of Africa depends largely on comprehensive and accurate survey networks, as they provide the framework for the reliable mapping of natural resources and the environment. However, in many areas of Africa, as it occurs frequently in other developing countries of the world, the basic geodetic networks are endowed with numerous deficiencies and shortcomings, which are reflected, inter alia, in variable accuracy, sometimes unknown, or in being quantitatively poor, all of which causes serious problems in the execution of projects based on such cartography and surveys. In particular, multinational projects, covering several countries, can not be economically planned and implemented, and will resort to cumbrous and laborious co-ordinate transformation and eventually embarking in new mapping.

The establishment and use of regional and sub-regional databases, as well as the integration of distinct referenced datasets within a Geographic Information System (GIS), will face serious problems not always possible to overcome. This is specially preoccupant when the use of GIS technology is becoming an essential tool for resource planning and management.

This issue of standardization of the cartographic geometric reference is not new for Africa. As far back as 1949, the African scientific conference of Johannersburg was anxious to study the possibility of harmonizing and standardizing some cartographic data such as ellipsoid, projection system, sheet formats, scales, conventional signs and toponymy transcription. The Johannesburg conference was followed by a meeting of specialists in surveying and mapping held at Bukavu (Zaire) in September 1953. The recommendations made at these meetings narrowed down some of these differences but the objectives have remained far from being attained.

This matter was subsequently raised practically at every United Nations Regional Cartographic Conference for Africa, which resulted in a number of initiatives and studies realized by many relevant organizations, such as the then African Association of Cartography, now subsumed by the African Organization for Cartography and Remote Sensing, and in particular by the African Association of Geodesy, which carried out the gigantic task well known as the ADOS project under the umbrella of the International Association of Geodesy. (see Bulletin No.

It is then not surprising that the AFRICOVER technical consultation meeting (Addis Ababa, 1994) identified with priority the necessity to establish one Working Group that would look into this issue of cartographic standardization and would provide concrete and practical recommendations.

At this point, it is worth recalling briefly that the preparation of the AFRICOVER products relies essentially on remote sensing data and geographic information systems (GIS) techniques but will make use as much as possible from the existing data available in the countries. The land cover data base will be mainly derived from visual interpretation of recent high resolution satellite images digitally enhanced. It will be done according to a homogenized and hierarchical classification system whose conception is under finalization by an international working group which met in Senegal

last July. Results obtained by this working group were very successful and may become the norm for a global land cover classification system!.

As far as the geographic referential or cartographic data base is concerned, the International Working Group of Experts on "Geometry and Geodesy" met in Addis Ababa in September 1996 at the headquarters of ECA and derived detailed specifications and techniques that should be applied taking into account the geometric disparities of Africa's cartography, the combination of existing topographic maps, remote sensing documents and ground surveys georeferenced with GPS.

This article presents a summary of the outcome of the above AFRICOVER Working Group, and a related paper prepared by the Regional Centre for Services in Surveying, Mapping and Remote Sensing.

1. The AFRICOVER Working Group on "Geometry and Geodesy"

The expert consultation took place from 23 to 25 September 1996. A total number of 25 experts representing 23 countries, among which 16 African countires, participated in the consultation.All objectives of the meeting were acheived with a high level scientific consensus.

Two Subworking Groups (SW) were established.

SW 1 on "Geodesy and Geometric Corrections" had the following terms of reference: (i) Review of the status of the existing geodetic networks and of the cartographic coverage; (ii) Streamline the geometric and cartographic specifications of AFRICOVER Project; (iii) Define and study main scenarios for the preparation of the cartographic base; (iv) Review operational considerations: work plan, budget, external assistance.

SW 2 on "Simplified Topographic Data Layer" was mandated to: (i) specify and define the content of the simplified topographic layer for the AFRICOVER database, and (ii) define the terms of reference of the pilot projects to test the adequacy of this content and the methodology to be used.

Results:

Sub-working Group No1 reviewed and confirmed previous findings and emphasized that the main parameters to be considered to analyse methods to be implemented, are:

(i) Geodetic status, with two situations: (a) good geodetic network covering 20% of the continent, and (b) low quality networks comprising astronomic and astro-geodetic networks, for the rest of the region.

(ii) Quality of existing maps. It was noted that in most cases good geodetic networks corresponds to good quality maps. For astro and astro-geodetic networks, mapping varies from good to bad.

(iii) Relief was categorized into three main classes as follows:

- flat: height differences less than 200m
- medium: between 200m and 500m
- high:in excess of 500m

Specifications on Geometry

Project scales:	1:250,000; 1:200,000 and 1:100,000 for small countries or specific areas.
Reference system :	WGS84
Spheroid:	IAG-GRS80
Projection:	UTM
Mapping Grid:	1° X 1° (1:200,000), 1½° X 1° 1:250,000) and 30' X 30' (1/00,000)
Planimetric accuracy:	within 50m - 100m. These values are to be confirmed by the pilot project.
Altimetric accuracy: of DEM:	for geometric corrections, between 100 to 150m, for flat and medium relief areas and 50 to 100 m for high relief areas. for thematic applications (optional DEM), between 50 and 100m. coresponding to countour lines from 100m to 200m.

General Recommendation to member countries

From the beginning of the project all work will be undertaken in the WGS84 system by all countries. At the end of the project, the data can be converted to the local geodetic system for those countries requesting this conversion.

The use of the new WGS84 Geoid model with GPS technology is recommended in order to improve height determinations.

Scenario 1: Availability of High Quality Geodetic Network and Topomaps (20% of African countries)

Datum and geodetic network will be transformed into WGS84, using available transformation parameters (ADOS, etc). If not available, they must be processed with GPS determination on existing points. New points may be necessary to establish in order to ensure a good distribution.

Satellite data: appropriate season for optimum discrimination of land cover. Nadir viewing in medium and high relief areas. Gemetric correction using parametric model and a set of GCP's extracted from topomaps if accuracy is of 10 m rms in X,Y and ≤ 50m rms in Z. If not, the a ground GPS campain is necessary.
The use of GCPs from the Russion GPS controlled satellite data may prove useful.

Scenario Two: Astronomic networks or Astro/ Geodetic Networks combined with substandard mapping. (80% of African countries)

In this case, the accuracy of both vertical and horizontal datum would be evaluated by comparing the coordinates of selected points (5-20, depending on the country) of the old datum tranformed into WGS84, with the one calculated with GPS. If the difference exceeds 10 m, the old datum wulf be recalculated. Complementary geodetic points may be necessary to recalculate to densify the network, using GPS with 5-10 m accuracy.

Specifications for satellite data are the same as for Scenario one.

Subworking Group 2 divided its work in two tasks:

Task 1: To define the minimum set of features that will conform the topographic dataset of the Africover digital database The objective is to have a simplified topographic layer upon which the thematic layers will be referenced. The data will be obtained from existing topographic maps. This satellite imagery will be the main source for up-dating the dataset. When the topographic maps are not available, or their quality is poor, the data will be obtained from satellite imagery, to the extent possible.

The considered features are are: (i) Administrative boundaries, (ii) Hydrography, (iii) Transportation network, (iv) Urban areas, (iv) Toponymy.

Task 2: : To define the terms of reference of the pilot project for testing the applicability of specifications and methodology formulated by the Working Group 2.

Specifications of the simplified topolayer

Element	Description
Hydrography	Primary and secondary river network, major canals and water bodies.
Transportation network	International and national primary road network. All railways, including non-operational ones.
Utilities	Major utilities such as high tension power lines and gas/oil pipe lines.
Urban areas	All capitals, other cities and major human settlements.
Administrative boundaries	International boundaries, and first order national administrative limits.
Toponymy	Names of primary rivers All cities shown in the data base International Airports, Ports/Harbours Administrative regions shown in the data base..

Clasification of the elements of the dataset will be provided by the countries according to their national specifications The classification of the elements of the dataset will be provided by the countries, according to their national specifications. The level of simplification of the topolayer will be decided with the national authorities of each country.In all cases the names shall be provided by each country in the Roman alphabet. Africover will respect the spelling provided.

Recommendations on the pilot projects

Objectives:

Test 1 : The preparation of the simplified topographic features according to various environmental situations and various level of quality of existing topo maps. In particular will be assessed:

(a) To test whether the set of topographic features for the simplified topographic layer are adequate for the purposes of Africover.

(b) To ascertain the adequacy of existing topo-maps to provide the required data.

(c) To establish to what extent satellite imagery is adequate to extract the required elements of the simplified topographic dataset, either for up-dating or for new mapping where maps do not exist, or these are of low quality.

Test 2: The ability of space technology to provide ground control points (GCP) by: (i) using high resolution space photographic images positioned by spaceborn Doppler positioning systems (Russian spinnoff systems); (ii) spatial triangulation.

Test 3: The generation of DEM from stereo optical and radar satellite images vis-a-vis topographic maps

Test Sites: Test 1

The following criteria for selection of sites for the pilot project is proposed:

Quality of existing cartographic coverage with respect to accuracy, completeness and degree of up-to-datedness all considered at three levels, of assessment, good, medium and poor.

Land cover and environmental conditions will be studied:

- desert or semi-arid area
- tropical low populated area
- tropical densely populated area
- equatorial area
- high relief areas.

Number and size of the Sites:

It is recommended to adopt the same sites formulated by the WG1 on land cover classification and legend).

2. The FAO AFRICOVER Project and a Possibility of a Unified Geodetic Datum for Africa (UGDA) . *M. Chodota, Senior Surveyor, RCSSMRS*

Abstract

The FAO executed AFRICOVER Project aims at the Production of a homogeneous land cover mapping at scales of 1/250,000 to 1/100,000 covering the whole of the Continent of Africa. To carry out this momentous objective, it has been planned to start with the harmonization of the geodetic datum, mapping spheroids and projections. The WG84 has been selected as the geodetic datum to be used together with IAG-GRS80 reference spheroid.

This is indeed an ambitious decision and very important for Africa. For if it is successfully implemented, at the end of the project, Africa will have a unified datum and spheroid. This is the goal the geodetic community have been straining to achieve for nearly a century since the 30th Arc Meridian network was conceived by the South African astronomer, Sir David Gill at the end of the 19th Century.

In this paper, the author proposes that the geodetic community should cooperate with FAO and all concerned with the AFRICOVER project to ensure that the resulting unified Datum meets geodetic standards. Following this project, the remaining geodetic networks of Africa could then be transformed into the World Geodetic System, so linking Africa to the rest of the world.

Introduction

Efforts to establish a Unified Datum for Africa started after the 1963 1st United Nations Regional Cartographic Conference in Africa. To this end, the African Doppler Survey (ADOS) project was conceived and implemented between 1981 and 1986 in which more than 300 points were established using the Doppler positioning technique and which covered more than 45 countries of Africa. Although the main aim of this project was to compute a Unified Datum for the continent, for various constraints, this goal was not achieved.

At the end of the project, it was left to each member state to use the data (and up to now only a few countries have used the ADOS results) to compute transformation parameters for their networks.

The IAG has tried to supplement the efforts made by AOCRS and ECA to develop another project through which a Unified Datum for Africa can be achieved. In this paper, the author proposes the use of the FAO executed AFRICOVER project to achieve this goal. The main output of the AFRICOVER project is a homogeneous landcover mapping for Africa at scales ranging between 1/250000 to 1/100000.

To achieve this momentous objective, the project implementation will start by the harmonisation of the geodetic datum, reference spheroids and map projections. Although it has been decided that all geodetic datums of Africa will be transformed into WGS 84, a Unified Geodetic Datum for Africa is not even noted as a major output of this project. This means that the effort put into the transformation exercise will be so as to achieve mapping accuracies at the 1/250000 scales. These need not be geodetic accuracy specifications.

In this presentation, we propose that the African geodetic community, the IAG, AOCRS, ECA and International Geodetic Organisations such as DMA, IFAG, IGN, etc should cooperate with FAO so that in establishing the mapping datum for AFRICOVER, geodetic standards are achieved. This will enable the geodetic community to compute a Unified Geodetic Datum for Africa (UGDA) which would be linked to the WGS 84, using GPS data collected during the AFRICOVER project campaign.

Role of the International Association of Geodesy (IAG)

The IAG Commission for Geodesy in Africa, was abolished by the Executive during the 21st IUGG General Assembly meeting held in Boulder, Colorado in July, 1995.

The main reason for this was that this Commission had become almost inoperative mainly for lack of funding and plausible programmes. The geodetic activities for Africa were however not abandoned. Instead, these would come under Commission X - Continental Networks, and the African geodetic datum project comes under this Commission.

Further work would also be coordinated by the IAG - Committee for Developing Countries (IAG-CDC) formed in 1992. The purpose of this committee is to coordinate geodetic activities as they affect development in all developing countries.

At present this committee is chaired by Prof. Sanso of Italy, the 1st Vice President of IAG. Its membership is drawn from each of the continents of Africa, South America and Asia.

During the IAG meetings at Boulder in July 1995, it was further endorsed that the establishment of an African Geodetic datum should be given a higher priority. A preliminary Working Group was formed with the IAG and Nairobi Regional Centre as the convenors.

No meeting has been called up to now. The reason is lack of funds necessary to convene such a meeting. Lack of funds will continue to hinder the implementation of this important project. This is why we now propose that IAG should seize this opportunity and participate in the planning and collection of GPS data to be used for the AFRICOVER project. In doing this, IAG will ensure that the data meets geodetic standards and can later be used to compute a unified geodetic datum for Africa.

Use of the ADOS Data

In the computation of the North America Datum of 1983 (NAD 83), the United States used data collected from as far back as 1800s. This data included observations for astrofixes, triangulations, traverses, baselines, longitudes, and azimuths. The data also incorporated the current data obtained from Doppler Satellites and Very Long Baseline Interferometry (VLBI) observations.

We learn from here that Doppler data is acceptable for establishing and strengthening datums. The difference with the African situation is that whereas NAD83 was an improvement of only one Datum, that is NAD 27, in Africa there are more than 20 Datums of all sorts of uncertainties and these have to be unified to get one datum.

The North American experience has shown that we can use good Doppler data (ADOS) to compute a new datum provided all the inputs are in place. On analysing the ADOS results, it was found that of the 310 points established during ADOS, more than 165 points were located on existing control points whose local data is known.

Others were located on existing trigonometric points but no local geodetic coordinates were provided.

If the concerned member states provided the required data, then more than 200 of the 310 points could be available for analysis to compute the local transformation parameters from the ADOS data. Looking at Table 1, it is difficult to see how the transformation parameters obtained from this data could be used to compute a unified datum for Africa. From this data only, there are more than 20 datums used by about as many countries. After computing the transformation parameters for each country, the problem will be the combination of all these to get one set of parameters for the more than 50 countries of Africa.

IAG could commission a working group to carry out this computation. Alternatively, the computation could stop at the transforming all the national geodetic networks into the Doppler datum. This could now be followed by a GPS survey in which a number of the ADOS or transformed points would be occupied. The relationship between Doppler Transit system and WGS 84 is well known.

Discrepancies from these transformation values and those obtained through observations would then be treated as errors to be used in adjustment process to get the final datum in WGS 84.

The AFRICOVER Project Strategy

The strategy for the implementation of the AFRICOVER project is that it will be divided in phases.

The first phase is to start with 12 countries of North-Eastern Africa, starting from Egypt in the North to Tanzania in the South, bounded by Zaire in the West.

After this phase, the other zones will be implemented at sub-regional or national levels. However, the agreed strategy is that the first step will be to unify and harmonise the mapping datum together with the reference spheroid and map projection for the whole continent. The selected mapping datum is WG 84 and all the existing datums in Africa have to be transformed and unified into WGS 84. The vehicle to this goal is the Global Positioning System (GPS). Six years were required to carry out the ADOS project. The total budget for this project is not known because observations were carried out through bilateral agreements.

The only task which was carried out centrally was the processing and publication of results.

This experience could be used for the implementation of a GPS project to establish a datum for Africa. Bilateral agreements would be used for the densification stage in each country. However, there will be need to have a main project to establish about 30 GPS points uniformly distributed across Africa.

These points must be coincidental with ADOS stations and must all be on known existing national geodetic points.

This network of 30 points will enable the computation of transformation parameters between ADOS and GPS which is on WGS 84 datum.

The next step is for each bilateral team to compute the transformation parameters between the national points (as transformed into ADOS) and the WGS84 points. This will be followed by densification in each country and the transformation of all mapping control into WGS 84 for the AFRICOVER project.

Recommendation

In the endeavour to achieve a unified and homogeneous datum for Africa through the FAO AFRICOVER project, it is recommended that the following steps should be implemented.

- The African Doppler Survey (ADOS) data should be analysed and its relationship to WGS 84 established.
- For each country with the ADOS points on existing national geodetic control compute the (NATIONAL-ADOS) transformation parameters.
- Analyse the above (NATIONAL-ADOS) shifts for the whole continent and find out if there is any useful pattern to enable them to be combined.
- If no pattern, analyse the values obtained under 5.1, compute (WGS 84-NATIONAL) shifts and see if there is any pattern for points scattered across Africa. If pattern found, select 30 uniformly distributed points and recommend them for an African GPS (AGPS) Campaign.
- Compute this network and new shift parameters for use in datum densification for each subregion or country. This is the new African Datum.

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5 MAPPING (GEOMATICS) RELATED EDUCATION TRENDS AND NEEDS IN AFRICA

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1. Introduction

It was the original intention of this paper to report on the state of mapping related education in Africa. However, during its preparation it became obvious that communication and co-operation between educational institutions in Afiica is, in spite of many encouraging improvements, still so limited that it is virtually impossible to produce a comprehensive and accurate state-of-education document with the presently available information. Existing documents on this topic are incomplete, statistics are skewed and often outright incorrect and subsequently misleading in their conclusions. Instead of adding further confusion by another set of questionable statistics, the author decided to make some general points on mapping related education and try to identify some of the opportunities and threats facing the profession from an educators point of view. The paper will attempt to define the principal needs of education and suggest scenarios for self-help development of mapping related education in Affica.

It is the nature of such a paper that the obvious will have to be stated, thoughts which have surfaced in many discussions and which are in many minds will have to be repeated and old discussions will be reopened, but there are also some new developments and these require exposure in addition to a reminder of the long existing difficulties. Problems in education tend to be seen by practitioners and non-academics as either so obvious that they need no special mention or action, or as so academic and irrelevant in the "real world" that they are of no interest outside the educational sphere. Neither is true.

Very little is done from inside universities and technikons for the mapping discipline. Mapping related departments are typically very small in student numbers and relatively insignificant in the overall picture of their respective institutions. Thus educators in the disciplines have little access to the resources required for a modernisation of the department and often cannot respond to the needs as they would wish to. In some cases more effort is spent on arguing for the relevance of mapping related departments and their survival within educational institutions than on educational issues.

On the other hand, educators have to deal with pressure from practitioners who, not infrequently, hold the view that an entirely needs-driven approach is appropriate in education and that the profession should guide the educator. The author believes that educators need to be more proactive than reactive. They must accept the responsibility and be given the freedom to provide vision and guidance. Their ability to extrapolate into the future, understand trends and look for new ground beyond the present boundaries of the profession will provide new members with skills and knowledge for the future. If educators fail to interpret trends correctly or to explore new avenues, then there is real danger for the survey discipline to become an insignificant service provider with a low profile. Little development will take place in the discipline and many of its traditional areas of expertise may be taken over by others. This potential downgrading of surveying is especially threatening in the Afiican context, where the constraints of limited educational budgets often make it difficult to address questions of education which go beyond mere survival.

In the third section of this paper the author will discuss the need for a suitable new name for the mapping profession; he will make the point that the term 'mapping' is too restrictive and that education should aim to produce a new individual with a broader knowledge base. The name geomatics and geomatics Engineer are suggested to reflect the new profile of the profession and shall be used in the following text without claiming that this is the only or even the best possible designation. It is simply considered more encompassing than the conventional terms of "mapping", "remote sensing" or "surveying".

2. Redefining the Profession

Like many others the geomatics profession (in this paper profession is used in its general sense and not restricted to articled professionals) has, for some considerable time, enjoyed the privileges of a stable and complex knowledge base with a clear structure and definable functions for its members at all levels. Boundaries with other professions were well defined and seldom under dispute. This structure is now changing as a result of technological advances and the competitive interests of other professions in geomatics activities. The profession has now reached a stage where a redefinition of the discipline is essential to its survival.

A great mistake would be made in restricting the geomatics engineer's activities to those of surveying and mapping of land. The ability to collect and manage spatial data equips uniquely for a range of activities well beyond conventional mapping. The geomatics engineer of the future must be a spatial data and general measurement expert with the capability to specialise on measuring objects ranging from the topography of the earth surface to parcels of land, any man made structures, mechanical components, models for manufacturing processes, human or animal bodies and objects of art or archaeological artefacts. She/he must be able to record dynamic processes such as the movement sequence of an athlete, particle flows in a chemical process, a person operating a machine for an ergonomics study or movement for a virtual reality visualisation. This implies that existing measurement skills must be retained while new technology and new areas of expertise such as visualisation and advanced GIS must be added.

More important than expanding the application range, the future geomatics engineer must grow beyond the level of data acquisition and become a spatial data analyst. S/he must be equipped to be equally capable of designing and interpreting a spatial data base for an insurance company, a marketing campaigns, risk assessment or urban management as providing and processing remote sensing data for an environmental assessment study.

Because of their multi-disciplinary nature the above mentioned activities must be carried out in co-operation with other disciplines and not in competition with them. The geomatics engineer of the future must become a spatial data expert with team thinking and management capabilities, if geomatics is to survive as an independent identifiable profession.

To achieve these aims, education must change at all levels, existing functions of educational institutions must be redesigned and new ones added, and above all, a preparedness to continuously re-assess and evolve the profession must be developed.

3. The Need For a New Name.

Accepting that the profession requires redefinition, then a clear message must also be sent to the user, the general public and to other professions, informing about the surveyor's new revised profile and her/his capabilities and areas of expertise.

A number of Universities in Canada, China, the UK and Australia have responded to this challenge to redefine the profession by restructuring the degree and introducing the term 'Geomatics'. The Department of Surveying and Geodetic Engineering at the University of Cape Town has decided to follow this route and the equivalent department at

the University of Natal is considering a similar move. The survey profession is by no means united behind the new name as evident from recent discussions in the Australian Survey Journal. Such discussions, while helping to bring the problem of the profession's self-image to the fore, also damage the profession's image. In the final analysis the name is not the issue. What is essential, is the need to convey the new profile of the spatial data expert in order to market the profession in areas beyond its traditional fields of activity and to attract more and better students at all levels.

Without wanting to add to the debate on Geomatics here, I would like to quote the International Standards Organization (ISO) definition of Geomatics which very appropriately describes the role of the redefined profession, may it be referred to as surveying/ geodesy/ geomatics/ geomatics engineering/ geomatics science, spatial data science or any other new term. ISO states:

Geomatics is the new scientific term referring to the integrated approach of measurement, analysis and display of spatial data.

This clearly does not restrict the discipline to mapping and cartography and opens up the world for the new profession.

The discussion on Geomatics should primarily be seen as an indicator of the internationally perceived need to break out of the old mould, and not as an argument about a name. It is important that this trend is recognised in African geomatics education and that a wider view of the discipline is taken in order to develop in spite of dwindling student numbers and support.

4. The Profession and Cartographic Education in Africa

One can argue that cartographic needs in Africa are largely unchanged, that conventional survey skills are still required and that thus education can follow its conventional form for some time and that the concerns voiced above are not yet relevant for Africa.

While this argument may have some merit, it could also lead to the demise of the discipline in Africa. First world expertise and black-box mapping systems could dominate the region and African geomatics engineers could be reduced to purely operational functions. This must be avoided under all circumstances, African institutes of education must educate internationally accepted and marketable geomatics experts, world class geomatics scientists must come out of the research units of African Universities, appropriate technologies for Africa must be developed in Africa and African geomatics experts must manage activities with African technicians responsible for the execution of such activities. All this must be done based on first world knowledge and in close contact with international educational institutions, but nevertheless with a high degree of independence and self-reliance.

African countries can be grouped in a variety of configurations according to geography, language, history and colonial past, religion, political learning and other criteria. One of these historical groupings separates Francophone, Anglophone and Portuguese speaking countries, Africa north of the Sahara and, as a result of its political past, South Africa.

These divisions are not merely nominal and have inhibited the flow of information and movement of individuals between regions, a phenomenon also reflected in cartographic and other geomatics activities, especially in the area of education. Language is the principal medium of education and thus plays a more significant role in this than in most other spheres of professional activities. It is here where the division is most obvious. There is little or no mutual knowledge of educational institutions in Africa , standards differ, staff exchange is very limited and students seldom transfer between institution within Africa and typically prefer to advance their studies elsewhere. There still appears to be a perception that quality in

education can best be provided outside Africa. Although it must be accepted that - largely for historical and financial reasons educational standards in geomatics outside Africa are on average higher than in Africa. It is also true that centres of geomatics excellence do exist in Africa and that there are no reasons why other African institutions could not reach international standards.

Recent developments and the activities of international and regional organisations such as the UN, the OAU and SADC have reduced the level of separation substantially and co-operation is growing. However, professional links of individuals, organisations and countries with the "first world" appear to be stronger than those within Africa.

5. Levels of Education

A brief analysis of the various educational levels within the profession might help to define some objectives towards improved professional education in Africa. One can classify education into the following levels:

* post-graduate education and research at universities and research organisations
* under-graduate education
* technikon and engineering school education and training
* basic skills training

In addition to these there is also a requirement to educate the user of geomatics products.

5.1 Post-graduate research

Research in an educational institution has three essential objectives, these are the development of

1. the student
2. new methods, algorithms, instruments or systems and
3. the supervisor

This three-pronged relevance of research is often overlooked and research is evaluated solely on the basis of the second criterion, the tangible research output. The author is of the opinion that the first objective, the personal development of the student, is of much higher relevance in post-graduate research than the research product. One can even go so far to premise that gaining knowledge in the particular research area is of less relevance for the developing the students than the ability to abstract from the literature, analyse critically, structure thoughts in a logical fashion, formulate a readable document and learn self management.

Post-graduate research is also essential for the supervisor, who is forced to continually improve own knowledge and critically assess own understanding of the discipline and the research area. The author firmly believes that excellence in teaching at university and technikon level is primarily based on the teacher's research activities.

The improvement in professional maturity observed by the author in post graduate students under his supervision has convinced him of the invaluable contribution made to the profession through post graduate programs, a benefit often overlooked by the profession. It is therefore most important to establish post-graduate programmes at African Universities and other institutions of learning.

5.2 University Education

Geomatics related departments at Universities will produce a 'new' student with different levels of understanding, a versatile problem solver with a sound knowledge of principles and methods in mathematics, physics and computer science. Universities world-wide are critically reviewing their teaching methods, new educational models are suggested and tested and different 'quality control' criteria are discussed. Geomatics related education in Africa now faces the dual challenge of teaching new concepts in a new format.

Employers tend to judge a newly employed student by her/his immediate ability to operate an instrument or run a software package. This is merely a by-product and should not be the principal objective of a University degree... The body of our knowledge increases at such a rate that our knowledge has a half-life of between four and six years, i.e. half our knowledge is obsolete after that period, computers and software have an even shorter life expectancy with near complete obsolescence after some two years. From this it should be obvious that Universities have to educate with a view of producing a highly adaptable graduate who can survive in this rapidly changing environment and syllabi must be designed with this in view (a proposal for UCT's newly designed Geomatics curriculum is attached, it must be seen as a first attempt towards the new geomatics degree, it makes no claim to offer a final solution).

5.3 Technikon and Engineering School Education

Many of the traditional skills related to geomatics have turned into black-box operations. Total stations with field to map capabilities, GPS and digital ortho-photo stations need little knowledge and do not require in-depth understanding of the underlying processes for their operation. Much of the originally required mathematical and technical knowledge has been incorporated into the software and an expert user, although still desirable, is no longer essential. Also, the technical and non-legal aspects of cadastral surveying can easily be mastered without the basis of a full university education and previously complicated photogrammetric or remote sensing processes are executed by powerful bundle-adjustment and image processing software. It need not be emphasised here that such black-box capability has its inherent dangers and that severe errors can occur if the operation is not supervised by an expert.

Nevertheless there can be no doubt that education requirements in many areas have been reduced and that many aspects of traditional survey education can be moved from university to technikon level.

Black-box-technology has thus a notable impact on technikons and universities, moving some material from universities to technikons, while requiring from technikon graduates a substantially deeper understanding of topics, which were previously only mentioned in passing; two examples for this are the need to understand the relationship between ellipsoid and geoid when determining heights by means of GPS or the relevance of geometry for control point geometry and error theory in modern aero-triangulation surveys.

In rethinking their curricula Technikons need to work in close co-operation with Universities. There must also be a mutual understanding between the two levels of education towards facilitating transfer in both directions.

5. 4 Basic skills training

A number of low level survey activities are of a nature which is technically so undemanding that they can easily be executed by lay persons after some rudimentary training and under the supervision of an expert. This option should be given serious consideration in view of, for example, the need for low level infrastructure development in remote areas or the allocation and documentation of occupation sites in informal-settlements to name only two of the many areas. Here the development of methods of grass-roots training for lay-personal deserves the attention of educators.

6. GIS in education

The role of GIS in modern geomatics is so prominent and so well established that there is no need to discuss its relevance for the discipline here. In spite of its importance, though, GIS is not yet part of the syllabi of all African educational institutions and urgent attention must be given to its incorporation into modern curricula.

In this context GIS is to be seen in the right perspective. GIS is highly interdisciplinary, it has, without doubt, a prominent place in a modern geomatics degree, but it is neither exclusive to geomatics nor should it be allowed to dominate the discipline. GIS is merely a component, albeit a very important one, in the spatial data toolbox.

7. Proposals for self-help in African Geomatics Education

From the above observations flow a number of possible suggestions towards improved geomatics education in Africa through the activities of African institutions. Among these are:

1. establishment of a geomatics-education data base for Africa.
2. design of a sample curriculum for geomatics education in Africa.
3. establishment of a network between educational institutions.
4. joint research projects by African educational institutes.
5. establishment of regional centres of expertise in geomatics

7.1 Geomaties related educational data base and curriculum design

A number of attempts have been made to contribute to a data base of educational institutions in Africa, these have either been very limited in the number of institutions involved or based on incomplete or incorrect information.

The establishment of a more comprehensive educational data base would serve to provide

* for potential students: a choice of institutions available for education

* for graduates: opportunities for post graduate research

* for educators: exchange of individuals, joined courses, distribution of teaching over regions

* for researchers: a possibility for joined research projects and communication on research issues

The data base would also aid the assessment of students and graduates for

* transfer between institutions

* a transfer into postgraduate programs

* recruitment for professional positions

Collection of the data for the data base cannot rely on questionnaires as is clearly obvious from, for example, a recently published statistics on digital mapping education in developing countries. One can safely assume that utmost care was taken in designing and analysing the results of the questionnaire as well as in answering the questions, In spite of this, severe flaws exist in the data related to, for example, South Africa. Among other errors, only one of the two South African Survey Departments is listed and well established postgraduate degrees in digital photogrammetry, GIS, Land management and Geodesy remain unmentioned. This is not meant as a criticism of the publication but as an indicator of the shortcomings of surveys relying exclusively on mailed questionnaire. Questionnaires typically suffer from the inability of the two sides involved in the question and answer process to communicate in an iteractive way. Terms are used in different contexts, questions are misinterpreted and answers misunderstood.

In the same paper an assessment of the national knowledge base of the countries involved in the survey is made in which the technical know-how in the listed countries is assessed as 'very well', 'fairly well' and 'not so well'. Such an assessment should

not be based on the answers to a questionnaire and, if done at all, could only be established by a comprehemsive research initiative.

As a step towards geomatics development, the author suggests that a working group consisting of staff members of a representative range of educational institutions in Africa is formed to establish a reliable data base containing information such as

* curriculum structures
* educational standards
* details on staff members
* ongoing research
* post graduate programs etc

The same group could design guidelines for appropriate syllabi for African institutions at various levels. It is not suggested to provide a set of standard curricula for Universities and technikons, but rather offer a guideline to assist with the design of new courses and with the assessment of existing programs. Such a group could not function without financial backing and continuity and attempts will have to be made to find resources for such an undertaking,

7. 2 Networking Educational Institutions and Joint Research projects

Mutual visits between educational institutions and joined research projects are common place in Europe and other parts of the world, while they remain the exception in Africa, African educators and experts can more often be found at international conferences and research- or educational institutions, than in corresponding institutions in other African countries. Attempts should be made to establish contacts and arrange visits in preparation of joined projects with the objective to create, within Africa, the fertile atmosphere of close co-operation and friendly competition as it exists in other parts of the world.

The formation of the African Association of Remote Sensing of the Environment, AARSE, represents an important step in this regard, but is restricted in its interests to remote sensing. With the formation of ASESA, the Association of Survey Educators in Southern Africa, the author has taken first steps to establish a regional group in Southern Africa and other regional associations are in place. However, more far-reaching steps are required to create meaningful co-operation among educators and in fact the entire geomatics community in Africa.

The final objective of a united African geomatics community should be the research and development of appropriate technologies for Africa in Africa and by African technicians, researchers and academics.

7.3 Regional centres of Geomatics expertise

Regional centres of expertise exist in Africa and it would appear that little would be gained by adding a further institution of this nature. However, the existing centres are geographically oriented towards Central-, East-, West- and North Africa and their academic focus is primarily in the remote sensing area. A centre with a broad interest in geomatics associated with a University or a Technikon in the Southern African region appears to be lacking. Such a centre could contribute substantially to co-operaton between geomatics professionals, not only in the region, but also throughout the continent. It would be responsible, among other activities, for the co-ordination of education, provide short courses in continued education programs, consult in geomatics issues, carry out pilot projects and joined research in conjunction with existing technikons and universities and develop appropriate technologies for the African environment.

It is interesting to note in this context that the esablishment of regional centres of expertise was suggested in the Bogor Declaration by the United Nations Interregional Meeting of Experts on Cadastre in Bogor, Indonesia in March 1996.

8. Conclusions

The paper has highlighted some of the threats and opportunities for the geomatics profession in general and specifically in Africa from the point of view of an educator. It premises that survey education is required in Africa and sustainable at all levels of educational institutions, provided a broader view of the profession's areas of activity and responsibility is adopted. An exclusive limitation to mapping is not in the profession's interest and the international development towards an 'information society' must be recognised when designing a new profile for the profession.

The profession in Africa must be strengthened against isolation and downgrading to purely operational level and self-help must be added to assistance from. First steps proposed are a working group to establish a data base of available educational capabilities in Africa and a network of African geomatics educators with a view to staff exchange, joined courses and joined research projects. The design of a guideline for geomatics educators with a view to staff exchange, joined courses and joined research projects. The design of a guideline for geomatics curricula for Africa is suggested, such a process would naturally force educators to critically inspect needs and possibilities for the discipline. The chance of success for these proposals will depend on the enthusiasm of the participants and on funding. As a long term objective the establishment of a centre of geomatics expertise attached to a university in the Southern African region is desirable. The final objective of any educational effort in Africa must be the development towards a largely independent geomatics capability throughout the continent.

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6

GENDER AND CARTOGRAPHY

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1. Introduction

In 1989, the President of the International Cartographic Association, Dr. Fraser Taylor, voiced his concern about "the disproportionately low participation of women in the ICA", and later said that "if ICA is to prosper and grow, then the Association must attract and involve cartographers who are currently under-represented in its ranks. These include the younger generation of cartographers, cartographers from developing nations, and women cartographers...".

Out of this concern came the establishment of the ICA Task Force on Women in Cartography, which subsequently became the ICA Working Group on Gender and Cartography and last year the Commission on Gender and Cartography. These were the ICA's first major attempts to address how women's participation in the organization could be increased.

This paper on gender and cartography attempts to accomplish a number of goals - it explores the UN's role in promoting gender equality; touches on social cartography; attempts to explain what gender issues are and why they should be of interest to cartographers; outlines some gender based research in the field of human resources that should help men and women work together more fruitfully; and describes gender-related research and activities of the ICA, including a summary of the 1991 study on women's participation in the ICA.

2. The United Nations and Gender Equality

It is fitting at this UN conference to recognize the pivotal role played by the United Nations in promoting the equality of the sexes, raising the status of women worldwide, identifying barriers to women's progress, and proposing and encouraging strategies to overcome them.

The United Nations Decade on Women, 1975-1985, with its theme, "equality, development and peace," highlighted by international conferences in Merida, Copenhagen and Nairobi, did much to focus the world's attention on the reality of women's lives in a global context. With large-scale involvement of governments and non-government organizations (NGOs), these conferences led to an encouraging international exchange of information and a challenging intercultural dialogue that has resulted in progress for women in almost every sphere of life.

Further development needs: Unfortunately, such developments have not been systematic, nor have they benefitted women in all countries equally. One innovative atlas, Women in the World, reminds us that: "The official invisibility of women perpetuates the myth that what women do is less important, less noteworthy, less significant. Women are made invisible by policies and priorities that discount the importance of collecting information about them... We do not presume a global community of women. What we do see, however, is that everywhere women are worse off than men; women have less power, less autonomy, more work, less money, and more responsiblities though equality of the sexes is now established as a principle and policy matter in many countries, a 1993 NGO submission to a UN Commission acknowledged: "Despite rational arguments for including women in decision-making, there is an almost involuntary resistance. The exclusion of women from important consultations is so deeply ingrained in most cultures that change is unlikely without a conscious, deliberate effort to

involve them. Change, even when undertaken voluntarily, is rarely perceived as positive at first; rather it is often profoundly disturbing... fundamental changes in the way human being relate to one another are both necessary and inevitable, but will not occur overnight. The transition to full equality between women and men is an evolutionary process requiring education and patience with oneself and others, as well as unswerving determination (BIC, 1993). And more recently : "The creation of a peaceful and sustainable world civilization will be impossible without the full participation of women in every arena of human activity. While this proposition is increasingly supported, there is a marked difference between intellectual acceptance and its implementation. It is time for the institutions of the world, composed mainly of men, to use their influence to promote the systematic inclusion of women, not out of condescension or presumed self-sacrifice but as an act motivated by the belief tnat the contributions of women are required for society to progress. Only as the contributions of women are valued will they be sought out and woven into the fabric of society. The result will be a more peaceful, balanced, just and prosperous civilization" (BIC. 1995).

A Partnership of Women and Men: The task of achieving gender equality on a societal level is gradually becoming understood as one that demands a full partnership of men and women: without the qualities, talents and skills of both women and men full economic and social development of the planet becomes impossible: "Partnership calls for changes by both women and men. Women need to develop their own capacities and step forward to play an active role in solving the world's problems. Men, for their part, must learn to cooperate with women and encourage their efforts. When men actively promote the principle of equality, women will no longer have to struggle for their rights" (ibid.).

The holding of a fourth UN-sponsored International Women's Conference in Beijing in September 1995 is sure to provide a stimulating and realistic accounting of the progress and barriers experienced by the world's women ten years after International Women's Decade.

3. Research trends In Cartography

In 1991, an ICA working group was established to identify major theoretical issues facing cartography. Of these, social cartography has rapidly become a main focus of theoretical research at the present time. As Torok has pointed out: "Cartography is more than maps. Map makers and users are human and members of societies. This ontological fact again puts cartography into a much broader context than its immediate professional environment. The social context of cartography, its institutions, professional organizations, the commercial side and the political-ideological effects on map making and other activities - these are a prospective field of present and future investigations...". "Cartography is a part of the cultural context, and digital technology makes possible temporary, dynamic, cartographic representations that become parts of our everyday life, that organize, transport and influence our world views. Maps as social images are very effective and the deeper understanding of the interrelations and co-existence of the different social contexts is the way how we develop cartography. Creation is a divine act, so modern cartographers should not fear of giving up the myth of the objective and value-free cartography. Instead of this ideology we must accept, understand, and popularize the idea, that cartography was, is and hopefully will be modelling the social-natural reality and exercising [its] power to protect and enrich humen lives (Torok, 25-8, 27). Concepts such as cultural context and inter-relationships, which guide the social cartographer, are also crucial to gender studies.

4. Gender Studies and Cartography

While this short paper cannot hope to deal in any substantial way with this emerging inter-disciplinary field, a few key concepts will be introduced that should be of value to the cartographic community.

Gender issues: Although they are typically perceived as women's issues, gender issues are in fact sex neutral, since they are based on the relationship between the sexes. A gendered perspective acknowledges that so-called "gender neutrality" probably does not exist and recognises that what had been thought to be a "neutral" work place is probably dominated by a variety of gender-associated values and assumptions. Many researchers now feel that denying any differences between the sexes is probably as imbalanced as upholding a rigid division of labour or roles based entirely on sex.

Gender studies and human resources research now acknowledge that men and women demonstrate at least some distinct values and approaches in the work place and have begun to speak of "male-associated" or "female-associated" styles. The following constitute a few examples only and should not be considered definitive pronouncements about how all men and women operate.

The old social order is increasingly being characterized as essentially the (unexamined or not-yet-deconstructed) traditional white male hierarchical power structure. Here, tasks are fragmented, specified, prescribed, predictable, non-random, fully scheduled and carried out without reference to context (Franklin, 84). This structure has produced what has been described as a male-associated "command-and-control" management style that uses power from one's organizational position and from formal authority. This is a style most men, and many women, have learned and continue to use in the workplace.

Recently, various "female associated" principles, values and skills have been identified as practiced (though not exclusively) by female leaders (Kundsin, Wilwin, Rosener). These include, among others:

- a greater sense of the inter-relatedness of actions and events and more attention to context
- a less hieriarchical or formal leadership style; encouragement of participation; sharing of power, information, recognition and rewards; greater collaboration
- an attempt to reconcile being efficient and being humane
- a focus on communications, including "highly developed listening skills"
- an emphasis on building relationships, long term interactions and the use of negotiation skills
- seeing work as being part of one's life rather than as separate from it or the only focus of it.

Women in Non-traditional Fields: Numerous studies have, also examined the experiences of women who have entered non-traditional fields or who work in male-dominated environments. In one study, the two greatest obstacles to thriving on the job were reported as being accepted by male co-workers ("making it in a man's world") and being isolated (from other women) in the workplace. Many women have reported not being taken seriously by men, having their achievements overlooked, having to prove their competence to a greater degree than male colleagues to be accepted, being excluded from after hours activities and informal circles, "hitting the cement ceiling"; and being excluded from the most senior ranks. Women often report dismay at the violation of ethical principles in the workplace. And, because it is usually them who feel primary concern in families for the preservation of marriages and the quality of parenting, and them who still take on the largest share of child care and housework, many women find it challenging to strike a balance between personal and professional life (Carroll & Cherry, Milwid).

Possibilities for Change: In some countries female-associated values and styles are beginning to infuse the work place and become valued by men, though change is gradual. Organizations are being re-designed; "the validity of the corporate pyramid, a structure than dictates top-down decision-making, individual competition, and centralized control"

(Milwid, 269) is being examined. In some instances, a new corporate culture in which men share is gradually developing, one in which some men worry about how to be good parents and still get ahead, and speak more openly about the private costs of their careers.

Should cartographers and their professional organizations be concerned about gender? Gender Issues should matter to cartographers because the dynamic between male and female colleagues affects both individuals and the places they work. If, as our own and others' research tells us, women have less visibility and power in the workplace than their male colleagues, if their voices are mostly absent from policy and decision-making, if they have less access to learning new technology, if they have more difficulty finding mentors, if their experiences and perceptions are undervalued, this represents a loss not only to women themselves, but also to men and to the workplace in general.

5. Promoting Gender Equality/Women's Participation within the ICA

Only recently have the ICA and other international organizations begun to question whether gender might play a significant role in their activities or orientation. As in most male-dominated fields, the ICA has always had much lower female than male participation. This was seriously addressed in 1989, when the ICA Task Force on Women in Cartography was appointed, with a mandate to measure and encourage the participation of women cartographers or professionals in related fields in the activities of the ICA.

Women in Cartography: Report and Recommendations

In 1990, the Task Force undertook an international survey to learn more about the women currently working in Cartography and related professions, and the barriers and incentives that contribute to their participation or non-participation in the ICA. Many of its findings, support some of those cited in the gender studies section. About 1,300 questionnaires were sent out, and 600 returned, 412 being used in the tabulations. Questionnaires were received from women in 34 countries, with the largest number coming from the United States, Canada, Norway and Sweden. The respondents were generally well educated (most with a completed post-secondary qualification or higher); mainly worked in cartography/GIS but come from a variety of experience categories; work primarily in the public sector and to a lesser degree in the educational field and private sector; and are in the middle-to-higher job ranks. Most had little involvement with the ICA and more involvement at the national level.

The primary barriers to women's participation were identified as:

- Lack of knowledge about what the ICA is, how it operates and what it has to offer. This was identified as a major barrier to women's involvement in the organization.

No existance of ICA awareness in my country (Sudan)

- Participants' perceptions or assumptions about the ICAs style of operation: many respondents indicated their perception that women's contributions are underrated, female-associated management and work styles are not valued, and appointments are made through long-standing, exclusive male networks.

I think there is low participation [of women] because Surveying and Cartography have traditonally been male dominated (South Africa).

Accroitre la participation des femmes ne devrait pas prendre l'allure d'une marginalisation par rapport à la participation des hommes (Tunisia)

- Professional barriers: travel funds are not available at the participants' level; they are not

encouraged by their employers to be involved in the ICA; most are not in a decision-making position and few have publications.

I am not in a position to attend international meetings because there are few chances offered (Sudan).

- Personal barriers: lack of time was frequently cited as a reason for not participating. It is still difficult for many women to balance family responsibilities and their professional life.

I would like to participate more fully in the ICA in order to have a full idea about ICA activities, hoping to increase my knowledge and to follow professional progress of my field (Sudan).

My department is so small thus I find myself involved in cartography, remote sensing, photogrammetry and GIS...Further, GIS in Botswana is still in embryonic stage and I find myself doing management, teaching, research and development (Botswana).

The primary incentives/encouragements to the participation of women were identified as:

- More information about the ICA.
- The possibility of receiving travel grants that would match those of the employer.
- Greater participation of women in the ICA Executive Committee, Commissions and structure generally.
- The holding of regular women-in-cartography sessions at conferences.

Recommendations and Results from the Task Force Report

The Task Force Report and Recommendations were presented to the ICA Executive Committee at the Bournemouth Conference in 1991. The following recommendations were made, followed by the results achieved:

A broader range of participation by women and other under-represented groups generally should be encouraged within the ICA.

Recommendation: in order to create a more balanced and broader base for participation for the entire organization, amend the ICA Statutes to include the addition of the following clause: "The promotion of equality of opportunity in all organizational units and at all levels of responsibility within the ICA and its member national organization".
Result: This amendment was passed unanimously by the Canadian Cartographic Committee and has been adopted at the 10th ICA Congress and General Assembly in Barcelona in 1995.

Lack of knowledge about what the ICA is, how it operates and what it has to offer is a frequently quoted barrier to women's involvement in the organization.
Recommendation: Prepare and distribute general information brochures, posters or a videotape of the ICA, through the appropriate national organizations.
Result: A brochure on the ICA including information on its commissions and Working Groups has been produced and is being widely distributed.

Recommendation: Request wider distribution of the Newsletter within member countries
Result: This recommendation has been implemented on the recommendation of the Executive Committee of the ICA.

More participation by women and other under-represented groups in the ICA Executive Committee, Commissions andWorking Groups, and at conferences should be encouraged.

Recommendation: Consider actively encouraging Commission Chairs, Country Representatives and national organizations to involve more women in their activities.
Result: The president of the ICA wrote to all chairs

of Commissions and Working Groups to strongly encourage implementation of this recommendation.

Recommendation: Consider whether quotas for Board seats or Commissions or Working Groups would be appropriate for the ICA, perhaps on a temporary basis,
Result: The ICA Executive Committee feels that this recommendation should not be considered at the present time.

Recommendation: Permit, not as a general rule, but selectively, in order to encourage the participation of women, minorities, and younger participants, representation by more than one per country on Commission and Working Groups.
Result: Implementation of this recommendation would require changes to the ICA Statutes.

The primary professional barriers to ICA participation cited by respondents are that travel funds are not available at their level, and they are not encouraged by their employers to be involved in the ICA.

Recommenclation: Establish a fund to provide matching travel funds to selected participants at ICA conferences, particularly to younger, first-time and developing country participant, ensuring that 50% of such funds be made available to women for any one occasion.
Result: It was decided by the Executive Committee to fund some activities undertaken by the commissions and the working groups on a project basis. Within this framework, some assistance was made available to members of the Working Group on Gender in Cartography to assist members from developing countries to participate in seminars in Mexico. During the 10th General Assembly in 1995, a promotion and solidarity fund has been created: travel awards to ICA international conferences will be given from this fund.

Recommendation: Request that conference organizers provide an inexpensive accommodation option, and encourage informal home-sharing and hotel-sharing for those who request it.
Result: This type of accommodation has been available at all major ICA events since the recommendation was made.

Recommendation: When possible and in particular, when requested, address (or request national organizations to address) invitations to would be participants in ICA conferences or through their employers.
Result: The Working Group has received a number of requests for its Women in Cartography data base so that members can receive individual mailings.

The primary personal barrier to ICA participation cited by respondents with dependents, after lack of time, was child care requirements.

Recommendation: Ask conference organisers to investigate the possibility of offering childcare arrangements during conferences, whatever age range is feasible, and announce a contact name for further information in conference brochures.
Result: While this can be encouraged informally, a response to this recommendation is within the jurisdiction of individual conference organizers.

Further study of the issues raised in the survey is required.

Recommendation: establish an ICA Working Group on Gender in Cartogrphy.
Result: The ICA Working Group on Women in Cartography was named in 1991, with a mandate to promote equality of opportunity in all organizational units and at all levels of responsibility within the ICA and its memember national organizations. Its initial terms of reference for 1991-1995 were:

1. To document the present status and trends in participation of various groups in carto-graphic activities.

2. To document the role of female associated

values in changes in the cartographic profession.

3. To propose mechanisms which will ensure that equal opportunities do exist within ICA for all component groups.

4. To identify and analyze the perceptual differences according to gender in the creation and use of maps and other cartographic products.

These terms of reference have been changed for the period 1995-1999 into:

1. To serve as a resource on issues related to gender and Cartography by preparing papers for presentation at conferences or for publication in cartographic journals by preparing and disseminating a basic bibliography on topics related to gender and development within the context of cartography and related fields.

2. To facilitate professional contacts between cartographers in the international community by updating the Directory of Women in Cartography, Surveying and GIS by organizing joint projects with other ICA commissions and Working Groups by maintaining contact with commissions in the "sister organizations" such as the International Geographical Union, la fédération Internationale des Géomètres, and with UNESCO, which focus on gender and development related issues.

3. To enhance professional development opportunities for the ICA target groups (women, younger cartographers and cartographers from developing nations) by organizing special sessions at ICA conferences; by holding seminars and workshops, featuring women and other target group members as presenters, to provide a forum for the development of professional skills by target group members and others.

4. To propose mechanisms which will ensure that equal opportunities exist within the ICA for all component groups, by approaching the Executive Committee to consider special programs for target groups and by promoting equal participation in the ICA, through the study of participation trends.

ICA Working group on Gender in Cartography: Activities

The Working Group first met in Mexico City in November 1991. Believing their work will strengthen the ICA country member organizations as well as the ICA itself, members decided on the following objectives, in addition to their Terms of Reference: to strengthen the network of women in cartography, to provide a support group for women cartographers, to provide information about women in cartography and about the ICA and to act as a catalyst.

Members plan to reach out to women's groups or commissions in other organizations, such as the Gender and Geography Commission within the International Geographical Union, with which a working relationship has already been established. The group has produced an international directory of women in cartography in electronic format (Dbase, IBM/PC), including about 380 names to date.

While in Mexico, working group members presented two seminars: "GIS - - an Introduction to Basic Concepts and Terminology" which included an overview of GIS activities in China, the United States, Mexico, Norway and Canada; the second was entitled "Application of Expert Systems to Cartography and Geographic Information Systems". A high degree of interest was shown, both in terms of content and in terms of the impact of seeing all-women panels of cartographers in the Americas. The Working Group is indebted to the ongoing interest and support of ICA President Fraser Taylor.

Other working group activities have included presentations at the IGU Symposium on Women

and Work at Rutgers University in August 1992, and a workshop on gender held in Cologne in 1993. "Multi Media/Hyper Media" and "Introduction to GIS" sessions were also presented at a conference held jointly with the ICA Commission on Education and the Commission of Map Production Technology in Istanbul, Turkey in April 1994.

Conclusions: This paper has explored the recent history of gender equality and has touched on social cartography. It has examined some gender issues and some gender-based research in the field of human resources. It has reviewed the research and activities of the ICA related to women participation.

While Conditions, opportunities, economies and social values vary tremendously throughout this region, some gender issues are almost universal in character. It is hoped that the general principles introduced here will stimulate further discussion and be given attention in national Working Groups. Consideration should be given to the following proposals for concrete actions:

- The under-representation of women and other minority groups should be recognized wherever it may exist in the cartographic community and addressed at the local, national and international levels.

- Increased opportunities should be created for women and other minority groups in the cartographic community to participate in professional and educational conferences at regional level and networking activities. The importance of creating more role models for women in cartography cannot be over-emphasized.

- Discussion of gender issues in the cartographic community from a cross-cultural perspective should be promoted.

This conference should consider the recommendation: **Acknowledging the unequal participation of African women in the cartographic both at the national and international levels, the conference recommends to systematically encourage the appointment of an increased number of women to the national delegations. Further, it recommends to establish a monitoring mechanism to ensure that the general targets for the increased participation of women are met.**

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7 REMOTE SENSING: A TOOL FOR SUSTAINABLE DEVELOPMENT

An assessment of the remote sensing activities in Africa

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1. INTRODUCTION

Since the United Nations Conference on Environment and Development, commonly known as the Earth Summit, held in 1992 in Rio de Janeiro, Brazil, the global awareness of the interrelationship between earth resources, environment and development has greatly increased. The recommendations of the Conference became an action plan or an agenda for the 21st Century with a view to advocating the establishment of cooperative, collective and global environmental conservation and management strategies. Agenda 21 identifies information as an essential means of achieving sustainable development and calls on countries to: "Strengthen information, systematic observation and assessment systems for environmental, economic and social data related to land resources at the global, regional, national and local levels and for land capability and land-use and management patterns".

Although Africa is endowed with rich natural resources, there are numerous development problems yet to be solved before the benefits of those resources could fully be utilized. Agricultural development, for example, has to meet the challenge of providing enough food sufficiency for the increasing population. This means that agricultural land use should be monitored carefully and managed properly so as to increase the productivity and avoid over-exploitation of marginal land. Equally important is the monitoring and management of forests, rangeland and water resources. Further, the exploration and development of mineral and energy resources for national development need proper planning and management. Therefore, systematic and reliable information is an essential element for obtaining an adequate knowledge about the extent and location of the national natural resources and the status of the environment.

Considering the magnitude of the task of assessing the earth's resources, it is essential that modern technologies and tools such as remote sensing and geographic information systems (GIS) be employed to their maximum advantage. Satellite remote sensing data provide reliable information concerning earth surface, allow us to integrate with other ancillary data thus enabling us to use the information to develop strategies for sustainable development. Successful applications of satellite remote sensing technology have been demonstrated at national, subregional and regional levels in physical planning, water, mineral and energy resources development, environment impact assessment, as well as food security planning.

Seminars and workshops were held in the continent at the beginning of the early 1970s as part of the global awareness raising on the peaceful uses of space science applications and in order to assess the interest in and acceptability of the technology. The African countries with encouragement of the United Nations Economic Commission for Africa (ECA) recognized the importance of the technology for identifying and monitoring resources and supported the establishment of regional centres in Kenya, Nigeria, Burkina Faso, whose main objectives are to provide training and technical assistance for resource managers. Also, the use of the technology

was expanded within the framework of technical assistance through the international agencies and the donor countries. Though with varying degree, remote sensing and related technologies are accessible to potential user institutions in most of the African countries.

This paper reviews the status of remote sensing technology in Africa giving a historical background, analyse the current activities by identifying problems encountered and achievements made, and make recommendations for future orientations.

2. REMOTE SENSING TECHNOLOGIES

Advances in space technology during the last 20 years have opened up many new opportunities for the spatial processing of data useful for the development and management of natural resources. The most important of these technologies relates to rapid development in powerful computers with reasonable prices, communications, and thematic application softwares.

Remote sensing is broadly defined as obtaining information about objects by measurements made at a distance, without coming into physical contact with the body by means of electromagnetic waves. The main elements of remote sensing techniques comprise recording, measuring, analyzing and interpreting the properties of an object such as the earth or phenomena under study. Remote sensing systems can be classified according to the inherent characteristics of their operation such as active and passive systems, photographic or scanning systems, or according to their platform on which the sensors are mounted into airborne or space-borne systems.

Satellite remote sensing as applied space science and technology has become operational, and is being widely used in many countries for resource management and environmental applications. As Africa's economy is based largely on natural resources such as agriculture, forestry, mining and energy, there is a continuing need for technologies that offer an efficient means of collecting and analyzing resource and environmental data for effective development and management of these resources. Remote sensing and its associated image processing technology provide access to spatial information on scales ranging from global to local. Current and future remote sensing programmes are based on a variety of sensors that will provide timely and repetitive multisensor earth observation. These technologies are also increasing the capability to acquire digital spatial information at very high resolution.

As the practical use of the technology for resource management and monitoring natural disasters, particularly drought and desertification, improved, drought monitoring programmes were initiated. Moreover, some countries began establishing national centres to ensure that government departments have access to the technology.

3. COMPONENTS OF THE REMOTE SENSING ACTIVITIES IN AFRICA

The United Nations Economic Commission for Africa held an intergovernmental meeting in Addis Ababa, Ethiopia in 1976, which founded the African Remote Sensing Council. Further, several regional centres for training and applications services, data receiving and processing ground stations were recommended as a continental network. Of these, only two remain functional: RCSSMRS in Nairobi, Kenya and RECTAS in Ile-Ife, Nigeria.

The remote sensing programme in Africa became an informal network of interrelated activities carried out by different organizations having different roles, different functions and objectives. These are international, regional, subregional and national organizations, whose roles include financing and execution of development projects, institutional capacity building in mapping, resource management, environment monitoring and physical infrastructural development.

(a) National Institutions

Remote sensing and geographic information systems technologies as tools for resource information have been introduced in the member countries in one way or the other. The national institutions that are involved in remote sensing activities can be grouped into the following departments or agencies: (a) mapping and survey; (b) natural resources and environment; (c) physical infrastructure planning and development; and (d) education and training.

(i) Survey and Mapping Departments

Through the experience with aerial photography and photogrammetry, the mapping and survey departments and agencies were among the first institutions to have access to satellite based remotely sensed data in Africa. As a result of human activities and the rapid land use changes taking place there is an urgent need to update and extend map coverage, especially at the scale 1:50,000. Because of the need for improved map coverage, most survey departments have taken a keen interest in the utilization of remote sensing for mapping and map updating. However, as this type of data did not have the stereoscopic coverage needed for precise mapping, it is only after SPOT data, and photographic images from space were available that this kind of data could be used for topographic mapping.

While it is generally agreed that presently available satellite imagery is not quite adequate for topographic mapping at the scale 1:50,000 and larger, the urgent need for new map coverage seems to overweigh the considerations of map quality and map accuracy standards. Further, the data proved to be useful for map revision and for providing services to other agencies whose demand for qualitative image photo-interpretation are relatively high.

(ii) Ministries of Natural Resources and Environment

Besides the survey and mapping institutions, the other major group of users of remote sensing technologies are those departments and agencies that are involved mostly in natural resources development and the management of the environment. The use of aerial photography and satellite imagery to agriculture, forestry, water, mineral and energy resources development, environmental monitoring has improved the methodology of data collection, processing and analysis in cost effectiveness and timeliness. Through the needs of such departments many of the several types of national centres or institutes for remote sensing and environmental information systems (EIS) came into existence.

The Environment and Remote Sensing Institute (ERSI) in Zimbabwe, the Centre for Ecology and Resources (CSE) in Senegal, The Comite National de Teledetection et d'Information Geographique (CNTIG) in Côte d'Ivoire and the Department of Remote Sensing and Resource Surveys (DRSRS) in Kenya are examples of such national institutions. National centres should therefore be encouraged and strengthened as they serve the country as focal points and accelerate the transfer of these technologies and simultaneously help avoid costly duplication.

(iii) Education and Training

The pace of introducing courses in remote sensing technologies to the education programmes in African universities has been limited despite the fact that many academic staff members benefited from training courses or academic studies given at universities outside Africa. However, through the recent rapid development in GIS technology the involvement of universities has increased and courses are now being offered in a number of universities in the various applications.

(b) Subregional Institutions

There are two types of subregional intergovernmental institutions that are involved in remote sensing and related activities. The first group are those that have the technology and the expertise to carry out training and provide user assistance in these fields. Centres such as RCSSMRS, RECTAS, AGRYHMET, ACMAD, etc. belong to this group. The second group of institutions are those that are development policy-oriented and which because of their mandates as subregional decision-making bodies became involved in these technologies as important users. Organizations of this type are the Comite Permanent Inter-Etats de Lutte contre la Secheresse dans le Sahel (CILSS) in Western Africa, the Intergovernmental Authority on Development (IGAD) in Eastern Africa and the Southern African Development Community (SADC).

The first initiative to establish intergovernmental institutions in geo-information for Africa goes back to the first United Nations Regional Cartographic Conference for Africa, held in 1963 in Nairobi, Kenya in which the conference passed a resolution calling for the establishment of such service rendering centres in the continent. This resolution was submitted to the ECA Council of Ministers and endorsed as resolutions 280 (XII) and 313 (XII). Subsequently, on the initiative of the member States and the support of the United Nations Economic Commission for Africa (UNECA) several subregional centres were established in different locations of the continent.

One of the main objectives for the establishment of subregional and regional resource information centres is the training of personnel from member States. The duration of training period offered by the different centres varies from one week to two years. RECTAS offers regular courses in several areas while RCSSMRS training courses are on adhoc basis.

(a) RCSSMRS

The Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS)in Nairobi, Kenya was established in 1975 initially as a regional centre for services in surveying and mapping with the principal role of providing services in these areas. In 1977 USAID concluded a hosting agreement with the Centre for a semi-autonomous Regional Remote Sensing Facility which eventually became a department of remote sensing. The Facility obtained equipment for a modern photo laboratory and photo-interpretation, and established a browse file of imagery of the Eastern and Southern African region which was later augmented by a complete set of 70 mm negatives of all Landsat imagery from 1972 through 1977 as donation from NASA.

The Facility began by offering fully funded short-term courses to resource managers in the region. Later project oriented training and longer term courses were added to its activities to meet the needs of member States. Meanwhile, USAID phased out its direct support and the facility had been transformed into a department within the Centre.

However, other donors such as France, European Space Agency and several International Organizations provided technical and financial assistance. The French Government for example has been providing technical experts to RCSSMRS who conduct user assistance and training on specified projects in the participating countries which improves the Centre's image and capability to provide training and technical assistance.

The Centre attained an active role in the utilization of a remote sensing applications and developed itself to accommodate geographic information applications. It collaborates with FAO and the Kenya Meteorological Department in processing weather satellite data for early warning system. Further, the Centre had been selected to host the

FAO-Executed AFRICOVER project for the Eastern Africa Subregion.

UNEP, besides contracting the Centre for certain assignments, will also contribute to the activity at the Center by establishing a node for its global resource integrated database (GRID) programme. Under this project, the Center's staff will help to analyse and distribute natural resources and environmental data that has been collected by GRID for the Africa region.

(b) RECTAS

The Regional Centre for Training in Aerospace Surveys (RECTAS) in Ile Ife, Nigeria was established in 1972 primarily as a centre for training in aerial surveys, photogrammetry and photo-interpretation. Its role was broadened a few years later to include the new aspects remote sensing technology. Though the Centre's mandate covers the whole continent, however, as it is now it draws students mainly from the West Africa subregion. The Centre offers courses both in English and French.

RECTAS receives its funding from member States with a notable share from the host country. During the period of development of the centre, there were donor funds available for the purchase of equipment and for trainee fellowships. The Swiss, the Dutch and French Governments and the UNDP were the principal donors. RECTAS has relatively large technical staff whose members are available to undertake, besides the regular training courses, consultancy contracts for development projects. A related source of funding is from the sale of data products such as maps and photographic reproduction. These kinds of activities are viewed by the staff as the best way to keep the centre operational.

(c) CRTO

CRTO was established in 1977 as a regional remote sensing centre to provide training and user services in the applications of remote sensing technologies to resources management. CRTO offered long and short-term training courses and has thus trained over 600 trainees from its member States. During its development period, plans were drawn up to establish a West African satellite receiving station at CRTO. However, funds for this project never materialized and with the phasing out of donor funding and the reduction in member States' contributions , CRTO has been facing more financial difficulties than other centres.

To enable CRTO to survive as well as carry out its training and technical services, substantial investments in computer hardware and software will need to be made available to the Centre. Further, some refurbishment of the buildings and laboratory facilities will be required and additional staff would need to be recruited and funded to enable it carry out a training programme.

Because of these financial difficulties, the duplication of activities and the inability of the member States support two or more regional institutions aggravated its financial problems. In order to improve the operationality of the ECA sponsored institutions, ECA carried out a study which recommended to merge RECTAS, CRTO and AOCRS. While a merger of RECTAS and CRTO appears to be favourable, there is a question to whether AOCRS should be included as it is a different kind of organization and would not necessarily be harmonized with the other organizations in the merger process.

(d) AGRHYMET

The AGRHYMET Regional Centre in Niamey, Niger was established in 1974 through the cooperation of the nine CILSS (Intergovernmental Committee for Combating Drought in the Sahel) member States. AGRHYMET is a specialized subregional centre for training and services in the areas of agrometeorology, hydrology and plant

protection. It is also an environmental information centre which is well equipped for receiving meteorological satellite images that are used for agroclimatic information for early warning purposes.

(e) ACMAD

The Regional Centre for Meteorological Applications for Development (ACMAD) in Niamey, Niger was founded in 1987 by ECA member States with the following objectives: (a) to provide an advanced weather and climate monitoring system over Africa; (b) to develop and adapt practical methods for the application of meteorology to sustainable socio-economic development in Africa; and (c) to develop progressively into a centre of excellence for designing and developing of new capacities in meteorological and climatological research for Africa.

The main customers of ACMAD are the national meteorological services, the regional and national drought monitoring centres and the regional institutions in charge of environmental issues. ACMAD has established strong working relationship with subregional organizations such as AGRYHMET. Further, the Centre receives a good technical assistance from the World Meteorological Organization (WMO) and some donor countries.

(c) International Institutions

International cooperation and support in remote sensing is considered vital for the promotion of this technology in Africa. Through financial and technical assistance it has been made possible to establish institutions and train skilled manpower in this field. The regional centres and most of the national centres would not have come into light without the generous donations of the developed and the international organizations and agencies. Food security and early warning programmes in Africa could be realized only through the international collaboration.

The number of international initiatives to support and strengthen resource information for sustainable development in Africa has increased over the last decade. For example, FAO with financial support of the Government of the Netherlands, developed the Africa Real Time Environmental Monitoring using Imaging Satellites (ARTEMIS), an advanced remote sensing data receiving and processing system for regional monitoring of precipitation and vegetation. This initiative proved to be very useful for food security programmes in the IGAD and SADC countries. Another important project is the AFRICOVER project whose overall objective is the production of a land cover map and digital database and a topographic reference at 1:250 000/1:200 000 and 1:1000 000 scale for the whole of the African continent, with some specific areas and few small countries (below 30 000 sq km) for the land cover at 1:100 000, based mainly on satellite remote sensing and GIS.

The United Nations Institute for Training and Research (UNITAR) have been providing GIS training to personnel from African countries. UNITAR in collaboration with the Sahara and Sahel Observatory (OSS) and other United Nations and donor agencies have initiated the AFRICAGIS that has been held every two years since 1993. The participation from Africa and abroad has been very high owing to generous sponsorship by the organizers. The AFRICAGIS, besides the United Nations Regional Cartographic Conference for Africa, serves as a forum for exchange of experience and information on geo-information technologies applications in Africa. The AFRICAGIS had a wide media coverage which drew the attention of policy and decision makers to this field.

Financial institutions such as the World Bank support country programmes on natural resources and environment management, many of which depend on remotely sensed data in their planning and execution. Several African countries benefited from the environment information systems (EIS) programme.

4. APPLICATION SECTORS OF REMOTE SENSING TECHNOLOGY

Natural resources management and environmental monitoring are dynamic areas that are require a huge amount of data collection, processing and analysis. This can only be effectively carried out by the use of modern technologies such as remote sensing, geographic information systems and improved communications systems. Remotely sensed data from satellite have become an indispensable tool for users involved in various fields. Many projects undertaken in Africa during the last decade would have been virtually impossible or too expensive without the availability of this type of technology. As a result of the commercialization of remotely sensed data, various types of data are available for the users that are offered by the different owners of the existing satellite systems.

The systems which image in the visible and near infrared range of the electromagnetic spectrum are those which are most commonly used for resource analysis and environmental monitoring. Satellite based remote sensing systems have several advantages over aircraft based systems. The high altitude of the satellites makes coverage of large areas on a single frame feasible whose geometric conditions could be compared to that of an orthophoto. This kind of imagery is good for mapping resources and monitoring environmental conditions over large areas. Exposure conditions over the entire frame are constant leading to more precise interpretation of regional vegetation distribution. Repetitive coverage is economical and enables many aspects of resources management and monitoring which include crop monitoring during growing season, rangeland assessments, weather forecasting, as well as flood and fire monitoring.

(a) Food Security and Environment

One of the challenges facing the African countries is to achieve food self-sufficiency with a rapidly growing population in a sustainable manner. This involves managing the productive land and simultaneously minimizing land degradation. Remote sensing technology can help to monitor crop health, predict harvests, etc. In agriculture, the use of high resolution satellite imagery to the classification of traditional farmland in Africa has been limited due to the size of plots and the mixture of crops. However, in large farming areas, this type of data have been useful for the estimation of areas under cultivation and in distinguishing the types of crops.

During the last decade a number of drought monitoring centres have been established or the existing regional resource information centres such as RCSSMRS expanded their activities to these areas as a response to the various needs of their constituent members. These centres monitor the vegetation growth in order to provide an early warning for those responsible for food security. With the combination of weather and earth observation satellite data along with modern hardware and software used for processing these data, we are approaching the possibility of monitoring the carrying capacity for particular provinces or the whole country on a year to year basis.

Land use management is the key to understanding and addressing the problems of land degradation such as deforestation, soil erosion, declining soil fertility and over-grazing. Land use management is influenced by a number of factors such as land use practices, land distribution, resource and land tenure, technology, investments, local knowledge, policies, legislation, access to resources, local participation, indigenous knowledge systems and governance issues and population.

(b) Vegetation/Land Cover

Natural vegetation is an important resource for the African population as it is the main source for fuelwood, shelter materials and other uses for daily life. The rate of removal of trees for these purposes exceeds much that of regeneration and the

competition between the various interest groups to the same resource is immense. Though, most African countries are aware of the importance of reforestation and afforestation programmes and mostly developed strategies for national forest action plans, nevertheless their practical implementation has been limited. A major constraint is the lack of a systematic, accurate and timely information about the type, distribution and condition, especially over large areas.

The use of remote sensing and GIS technologies in the management of vegetation landcover have been demonstrated and found helpful for execution of integrated resource development and management projects in many African countries. These techniques provide valuable information at a variety of spatial, temporal and spectral resolutions which can help map and monitor the extent, type and condition of natural vegetation over large and diverse areas.

Another type of projects that has been carried out at national level are the woody biomass projects. Though the main objective of these projects has been to assess the potential availability of fuelwood and ultimately come up with strategic plan on how to develop and manage these resources, nevertheless the amount of geographic information compiled for the overall strategic development planning process for the provinces concerned and the country as a whole is amazing.

(c) Environment

The management of natural resources and the environment is a development issue which involves socio-economic, administrative, legal and political decisions. The purpose of environmental monitoring is to provide information that could affect its management. Environmental information means better knowledge and fuller understanding of the interactions between nature and human activities on which decisions and measures are to be taken. Remote sensing and related technologies have been useful in providing valuable inputs into such environmental information systems. Experiences at the subregional level in the CILSS, IGAD and SADC programmes indicate the potentiality of these technologies.

The Meteosat series of the geostationary meteorological satellite has now been in operation for almost two decades and has been providing data that proved to be useful for weather forecasting, agrometeorological research and many other environment monitoring applications. In relatively less populated regions, where recording stations are limited, remotely sensed data play a much more central role in forecasting the weather conditions. Access to data from operational meteorological satellites had been free until September 1995. Because of the fact that many countries have become dependent upon these systems and as the information derived from this data has been crucial for food security and emergency preparedness programmes, it is necessary to ensure the continuation of its data at reasonable user charges.

Multitemporal data sets acquired by NOAA satellite are used to produce maps showing the vegetation index at country and subregional scales. These proved to be very useful for drought monitoring.

(d) Physical Infrastructure Planning and Development

As a result of the rapidly growing population in Africa urban areas are expanding at an uncontrollable pace so that existing utilities such as water, electricity, sewage, etc. are becoming overstretched. Furthermore, lack of up-to-date information contributes to the problem of poor urban development programmes including telecommunications, and transportation systems. The need for integrated information systems is increasingly being recognized by many town and regional planning authorities and some countries such as in Botswana have adopted the use of geographical information systems for planning resource management and infrastructure development.

Aerial photography has been the one of the main sources of data for the production of town plans, however satellite images such as those from SPOT and Thematic Mapper are complimenting this type of data, especially for the compilation of strategic urban and regional development plans.

(e) Mineral and Energy Resources

Airborne remotely sensed data has traditionally been used in the exploration of mineral and energy resources in Africa as this was the only source of information because maps were hardly available for most of the regions. Multispectral satellite remote sensing technology improved the detection of different rock types which is an important aspect for mineral analysis. The synoptic view of satellite images is an asset for regional geology in observing large scale plate tectonics, faults and foldings.

Oil exploration companies use remotely sensed data for planning and implementing their activities and the monitoring of oil spills resulting from their production operations.

5. ASSESSMENT OF THE REMOTE SENSING ACTIVITIES

A total of eighty organizations in 13 countries were visited during a study in which all but a few use the technology to collect, process, store and analyse geographic information for projects they are implementing. These organizations utilize remotely sensed data for mapping, agriculture, forestry, water and hydrologic studies, land use, geology, rangeland carrying capacity, environmental monitoring, etc.

In the 1970s attention was focused on the application of satellite remote sensing for developing countries as a new technology for the management of natural resources and the environment. In the 1980s similar attention was put on GIS. Currently, we are experiencing an era in which remote sensing and GIS are being integrated and applied to priority areas such as food security and environment. A multisensor, multispectral, multiresolution and multitemporal imagery data will eventually be available in most parts of the continent. Therefore, the processing, analysis and management, and the proper utilization of such information will be the major challenges of the coming decades.

In making an assessment of the contribution of remote sensing technology applications to sustainable development in Africa, it was necessary to select appropriate indicators that could show whether remote sensing technology is being adapted and utilized properly in the resource and environmental fields for which the technology was developed.

(a) Institutional Infrastructure

During the various missions ECA undertook it was observed that the organizational pattern of remote sensing technology applications in the countries visited were quite similar. All the countries have trained personnel and some equipment and experience with both remote sensing and GIS. The variation occurs in the extent to which the technology is utilized and which agencies have taken the decision to use the technology.

In each country there are agencies and government departments which are using or planning to use remote sensing and GIS technology. These are typically departments of environment, forestry, water, geology, natural resources, agriculture etc. In general, coordination between the various departments is rather weak. There is no particular pattern or reason why one agency adopts the technology and another does not. In many cases it is probably due to one or more senior persons in the department having or being exposed to the technology in courses at the regional centres in Africa or in conjunction with higher education overseas.

Further, it had been noticed that wherever an agency is developing a GIS, there is also donor support that is related to the project on which the GIS is being

used. In these cases, introduction to the technology probably came with a donor funded project that required the use of remote sensing data or the development of a GIS. The project package probably would have included training at home or abroad for project personnel and equipment which would remain with the department at the completion of the project when the external support ends.

The extent to which ECA member States have invested in the remote sensing technology is one of the most important indicators as this shows the financial commitment and the level of understanding that the decision makers have with these tools and techniques. In discussions with the concerned managements and the technical staff, the responses clearly indicate that owing to the priority of the country to other pressing issues hardly any funds have been allocated by the governments for the acquisition of hardware and software. However, funds are usually allocated for the national staff.

Now with almost every country having centres or agencies using remote sensing and geographic information system (GIS) technology, there is a need to examine the role of regional centres to ascertain whether they are continuing to meet the needs of member States. There is also a need to maintain coordination and linkages among these various organizations that have begun utilizing these technologies since the establishment of the centres.

The subregional environmental and development oriented organizations such as CILSS, IGAD AND SADC appear to be emerging as major players in food security, drought monitoring and other development issues. All the three organizations recognize remote sensing technology as a vital tool for the execution of their programmes and projects in resource management and environmental monitoring. CILSS and SADC are mobilizing resources and channelling them to their subregional or national centres respectively. IGAD had already an important early warning project in RCSSMRS and in principle is willing to integrate the Centre and other relevant institutions into its subregional activities. Because of the importance of resource information technologies for the subregion, the link between the subregional development organizations and the ECA-sponsored centres should be strengthened

(b) Availability and Cost of Data

In general we are experiencing an era in which more satellites are in space and others are planned to be in orbit for earth resources observations. Consequently, more data is, and will be, available from a new generation of satellite remote sensing systems.

Satellite data ground receiving stations are an integral and indispensable part of the satellite remote sensing system. Until such a time as the technology evolves to the point where earth resources observation satellite signals can be received and processed in each user's facility like those of meteorological satellites, users will remain dependent upon a few ground receiving stations. At present ground receiving stations are very complex installations with sophisticated receiving and processing facilities and a relatively high operational costs, a major factor for inhibiting the acquisition of such a system in the region.

However, the coverage is limited to the Southern African region with the northern arc of coverage extending as far north as central Tanzania. Recently a number of smaller portable mobile stations have been developed to cover the few areas which are not covered by permanent ground stations. These mobile stations only collect data which they send to the permanent stations for processing. Mobile stations have an advantage that they can be moved and installed at different sites to collect data on seasonal opportunities and unusual events such as natural disasters.

It has been observed that African organizations purchase less satellite imagery than similar organizations in other regions. The suppliers of

satellite imagery apparently have some flexibility in establishing costs and terms for the use of the imagery. They appear to be interested in working with an organization such as the subregional centres in the sale of imagery and in the deployment of mobile receiving stations for Africa. There appear to be some opportunities for collaboration with the major imagery suppliers such as EOSAT and SPOT that would expand the utilization of satellite data. ECA should therefore explore opportunities for working with these and other organizations to help improve the availability of satellite imagery in Africa at reasonable prices and deploying mobile stations that would serve the entire continent.

(c) Quality and Compatibility of Databases

National map archives contain maps made over a substantial space of time by different agencies and with different equipment and techniques. Therefore, sources and reliability of information should be included with any geographic information that is entered into a national database. While the staff members of the regional centres and the survey departments generally have the mathematical skills and awareness of map accuracy standards to produce reliable products, there are many resource and environmental specialists who do not have this training and awareness.

With the rapid development of national geographic databases that is taking place in most countries, there is concern about the accuracy and consistency of the information that is being entered into these databases. There is evidence of duplication mainly owing to lack of communication and coordination between the various users. Simultaneously, there are substantial opportunities that need to be properly exploited.

(d) Training

A closely related issue is the need for training in the use and maintenance of equipment. Remote sensing and all of the technologies related to the development and use of resource and environmental information are rapidly changing and it is extremely difficult for individuals to keep up with changes. ECA and other regional and subregional centres should take the lead in acquiring and disseminating information about technological advances that impact on resource managers in the continent. Technology transfer can significantly be strengthened through a network of cooperation between the subregional and national institutions.

Long-term commitments to, and investments in, the capacity building with a view to developing a critical mass of technicians, professionals who understand the technology and who are able to adapt, further develop and maintain the technology as well as develop applications suitable to their local environment.

Training should not only focus on the use of a particular software, but should go further to upgrade the skills of data organization and management and the dissemination of data to other users within and outside the ministry or agency.

In Africa the role of national universities as a stable source of ongoing training has been overlooked. Therefore, donor support to the countries should include the institutions of higher learning dealing with space science technology and related areas. This would in the long-term contribute to building capacities within the countries and alleviate the bottlenecks in obtaining skilled manpower.

(e) Organizational and Management Aspects

During the past few decades, when most of major technological breakthroughs have occurred, we have been experiencing that the keys to utilizing and reaping the benefits of new technologies are not always technical in nature. The limiting factors in implementing a new technology is often organizational and financial. And so it is with the remote sensing activities in Africa. Computer hardware especially microcomputers and software are now available and accessible to most Africa managers.

Table showing countries and type of organizations visited

Country	Organization (No)	Mapping/ Survey	Agriculture / Forestry	Meteorol.	Education/ Training/ Research.	Phys. Infrastruct.	Environment.	Mineral/ Energy/ Water
Botswana	4	1	1				1	1
Burkina Faso	6	2	1		1		2	
Cote D'Ivoire	6	2			1	1	1	
Ethiopia	7	1	3	1			1	1
Kenya	11	1	2	1	4		2	1
Niger	4	1	2				1	
Nigeria	9	1	2		3	1	1	1
Senegal	6	1			3		2	
South Africa	7	1	3		1		1	1
Swaziland	2	1	1					
Tanzania	4	1	1		1		1	
Zambia	5	1	1	1	1			1
Zimbabwe	6	1	2		1		2	

(Technical skills for resource data processing and analysis are available in all organizations dealing with resource data processing and analysis for resources management and environmental monitoring. Through the many training programmes that have been developed in Africa as well as the generous support of donors to provide funds for training in and outside Africa, there has emerged within the past two decades a large pool of persons skilled in all aspects of digital processing technology. In many countries information that exists is not accessible owing to various factors, including organizational and management problems.

6. CONCLUSIONS AND RECOMMENDATIONS

In Conclusion, the status of remote sensing technology applications activities in Africa looks positive. Despite the problems identified at regional centres it must be recognized that the majority of those interviewed feel that the centres are needed and means must be found to keep them operational. With some adjustment of their programmes and the creation of stronger ties with their member States and the donor countries and agencies, there is no reason why the centres should not be able to continue as viable institutions for many years to come. At the country level the interest and awareness in the use of GIS is rapidly increasing and therefore improves the utilization of remotely sensed data.

Remote sensing and the related technologies are powerful monitoring and management tools. These technologies provide the planners and resource managers a means for managing resources and the environment that will accelerate the sustainable socio-economic development of the member States. Remote sensing systems are currently the most effective methods of generating environmental and resource information at different spatial and temporal resolutions.

A dozen of recommendations have been adopted in every workshop, expert meeting and conference that took place in the last successive years. The question to ask is how is the status of the practical implementation of these recommendations? Knowing the existence of such recommendations that have been drafted by experts, the Secretariat would confine itself on a few which are based on our observations and discussions with professional colleagues, recommendations from ECA consultant reports and other studies:

(a) Resource information at varying spatial and temporal resolutions is required for planning, management and sustainable development of the critical sectors of the African economies such as agriculture, mineral and energy resources development etc. Therefore, African governments, the subregional and regional organizations, the international organizations and developed countries should pursue the implementation of the recommendations made in the various conferences such as the AFRICAGIS, MARISY, etc.

(b) ECA in close collaboration with the national, intergovernmental and international organizations should undertake a review of selected elements in the remote sensing network to identify problems confronting Africa.

(c) The international agencies should be encouraged to strengthen national and regional expertise by using the services of country or regional experts in the fields of geo-information technologies.

(d) The African governments and the donor countries (agencies) should promote the private sector involved in natural resources development and the management of the environment similar to the promotion of any other sector.

(e) More support should be provided to the African universities in establishing or strengthening their teaching and research capabilities in space science technologies and its applications to the various fields for sustainable development.

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SECTION TWO: Information Review

The Ninth United Nations Regional Cartographic Conference for Africa

AFRCAGIS'97 Conference

COPINE Project

Announcement of the of the African Association of Remote Sensing of the Environment (AARSE)

Projected Remote Sensing and GIS activities in Africa by the organizations of the United Nations System for 1997, 1998 and future years.

A WORD ABOUT CHANGES: New strategic directions of ECA

The Ninth United Nations Regional Cartographic Conference for Africa.

Scope

The United Nations Regional Cartographic Conference for Africa was established in May 1961 by Resolution 816 adopted by Economic and Social Council. The first Conference took place two years later, in 1983 in Nairobi, Kenya.

It is one of the three series of regional cartographic conferences convened by the United Nations secretariat:

UN Regional Cartographic Conference for the Americas
UN Regional Cartographic Conference for Asia and the Pacific
UN Regional Cartographic Conference for Africa.

It was retained by the ECA Conference of Ministers at its nineteenth meeting in May 1993, as one of the subsidiary organs of the Commission, to be held every three years.

Its objectives are, in general terms, to provide a regional forum were government officials, planners, scientists and experts from both the public and private sector, from Africa and abroad, meet to address common needs and problems and to exchange experiences in the field of geoinformation. It offers the best opportunity for African participants to interact with their counterparts from the developing and the developed world, and constitutes an excellent platform to lay down contacts for negotiations of bilateral and multilateral technical assistance.

Proceedings

The Ninth United Nations Regional Cartographic Conference for Africa, with the theme "Providing the foundations for accelerated growth and sustainable development through cartography and other forms of land resource and environmental information technologies," was held at the new UN Conference Centre at the headquarters of the United Nations Economic Commission for Africa (ECA) in Addis Ababa, Ethiopia, from 11 to 15 November 1996.

Representatives of the following African countries attended the conference: Algeria, Botswana, Chad, Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Lesotho, Libya, Madagascar, Malawi, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Seychelles, South Africa, United Republic of Tanzania, Tunisia, Uganda, Zambia, and Zimbabwe.

The meeting was attended by United Nations Member States: Canada, France, Germany, the Netherlands, Poland, Sweden, United Kingdom, United States of America.

Observers from the following subregional and regional institutions were represented: Organization of African Unity (OAU), African Organization for Cartography and Remote Sensing (AOCRS), Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS), Regional Centre for Training in Aerospace Surveys (RECTAS), Centre Régionale de Télédétection Ouagadougou (CRTO), Centre Régionale de Télédétection pour les Etats de l'Afrique du Nord (CRTEAN) and African Association of Remote Sensing for the Environment (AARSE).

Also present were observers from national and international organizations from Economic and Social Commission for Western Asia (ESCWA), Food and Agriculture Organization (FAO), United Nations Educational, Scientific and Cultural Organization (UNESCO), Office for Outer Space Affairs, Vienna (OOSA), United Nations Fund for Population Activities (UNFPA), Conseil National de l'Information Géographique (CNIG, France), ITC - The Netherlands, Industrial and Commercial Projects (Leica), International Development Research Centre (IDRC), International Hydrographic Organization (IHO), University of Lagos (Nigeria), University of Glasgow (United Kingdom), Institute of Geography (Bern University, Switzerland), International Cartographic Association (ACI), GDTA (France), International Society for Photogrammetry and Remote Sensing (ISPRS), AMTECH Services (Ethiopia) and MEMONAS P.L.C. (Eritrea).

During the five days of the Conference, reports on national, subregional, regional and international activities were presented. The reports highlighted the progress made by the respective countries and organizations in the fields of cartography, remote sensing and geographic information systems.

The technical papers covered data acquisition, data manipulation and utilization, regional mapping issues, and policies and management of geoinformation. The following issues were addressed in detail:

Land tenure and land registration
Managing resource information
Capacity building
Partnership between the public and private sectors
Gender and Geoinformation
Future directions of institutions responsible for the provision of base-line geographic information.

During the final deliberations, the Conference discussed and adopted its report (ECA/NRD/ CART.9/9), including one resolution recommending actions to be implemented by member States, the ECA and other organizations to improve the spatial information base of Africa.

Resolution of the Ninth United Nations Regional Cartographic Conference

The Conference,

Acknowledging the measures taken by African countries and the efforts being made in capacity building in the fields of cartography, remote sensing and Geographic Information Systems as well as the acquisition of new technologies in these fields,

Convinced that these developments are the logical results of multiple appeals made by previous conferences,

Realizing the need for continued efforts by all African countries and for further capacity building,

Recognizing the importance of reliable spatially related information for sustainable development,

Taking note of the advances in technology to acquire, process, analyze and disseminate spatially related information,

Resolutions of the Ninth United Nations Regional Cartographic Conference for Africa (cont)

1. Encourages member States to:

(a) establish spatially related information systems consisting primarily of cadastral, topographic, demographic, land cover and land use information as a matter of urgency and to make this information available for development projects;

(b) support through their national mapping agencies the Africover project;

(c) use the regional centres to facilitate capacity building;

(d) allocate adequate funds for capacity building and the transfer of technology in the planning of development projects;

(e) take cognizance of the need for the participation of women in cartographic activities in countries where this is not being done;

(f) establish a national committee on Geographic Information to coordinate activities and advise governments on the use of technology and spatially related information;

(g) establish a national committee for the standardisation of geographic names where these do not exist or reactivate existing committees;

(h) provide an enabling environment for the stimulation of the private sector; and

(i) facilitate the creation of professional associations in the fields of surveying, cartography, remote sensing and geographic information systems.

2. Urges maritime African States and those with navigable waters to express support for the establishment of regional hydrographic and nautical charting facilities;

3. Further urges member States to:

(a) cooperate in the establishment of regional data standards and a unified geodetic datum; and

(b) make concerted efforts to pay their arrear contributions to the regional organisations in the fields of cartography and remote sensing to which they belong and those who have not acceded to the agreement establishing these centres to do so urgently.

4. Requests member States to provide information required by ECA and AOCRS to complete and maintain their cartographic and related inventories;

Resolutions of the Ninth United Nations Regional Cartographic Conference for Africa (cont)

5. Requests the Economic Commission for Africa to:

(a) establish and maintain a database on the status of mapping and baseline information coverage in Africa, including the extent and age of coverage, output formats, technologies in use, cadastral survey and mapping programmes, physical and human resources and gender participation;

(b) accelerate the completion of the digital cartographic Atlas and update it;

(c) establish and maintain a database of educational and training facilities and programmes in Africa and disseminate this information;

(d) coordinate, together with AOCRS and the regional centres, the establishment of a working group to investigate and recommend regional data standards for spatially related information;

(e) compile and publish the proceedings of the Ninth Regional Cartographic Conference for Africa;

(f) coordinate the setting up of a regional remote sensing programme for Africa based on the concept of technical cooperation between countries; and

(g) convene the tenth Regional Cartographic Conference for Africa in 1999;

(h) submit the resolutions of the ninth conference to the Council of Ministers and to monitor and report the progress made by member States in implementing them;

(i) consider establishing working groups at the next conference to enable delegates to discuss technical papers prior to reporting to the plenary session;

6. Requests ECA and AOCRS to cooperate in harmonising and integrating their cartographic and related inventories;

7. Appeals to donors and other funding agencies to give support to:

(a) the national mapping agencies in capacity building and their activities.

(b) the Africover project;

(c) improving the services that regional centres and organisations are mandated to provide;

(d) the working group on data standards; and

(e) the setting up of a regional remote sensing programme for Africa based on the concept of technical cooperation between countries.

AFRICAGIS'97 Conference and AFRICAGIS'97 expo.

Scope

Within the Framework of the programme AFRICAGIS, and with respect to Integrated Information Systems for the Environment in Africa, in partnership wide the Sahel and Sahara Observatory (OSS), the African Organization for Cartography and Remote Sensing (AOCRS/UNECA) and the Government of Botswana, UNITAR held its third Pan African Conference on Geographic Information Systems, AFRICAGIS'97 in Gaborone, Botswana, from 23 to 27 June 1997.

This Conference follows AFRICAGIS'93 held in June 133, in Tunisia and AFRICAGIS'95 held in March 1995, in Cote d'Ivoire. The objective of the series is to provide a platform where scientist and decision makers using GIS in Africa meet with each other to share their experiences. AFRICAGIS provides an important forum for learning about new trends and findings from leading scientists in the field, and discussing and debating specific problems in working groups and training sessions. In addition, at a concurrent exhibition, new products and technologies are displayed for the benefit of the participants.

The Conference

The 1997 Conference was attended by close to 250 participants from 26 African countries. 20 exhibits were displayed.

It was organized in six plenary sessions and eighteen technical sessions. It was noted that the focus of this Conference was on subject applications while the previous focus was more on technical issues such as data standardization, models and system design. This shows an increasing growth in the understanding of concepts and issues and a better articulation of how technology should be used in Africa.

Aspects of growth worth noting

- increase in trained personnel
- African doing the work
- mastering of the technology
- greater institutional awareness
- a higher number of applications

Major recommendations identified

- take advantage of existing opportunities
- ensure that applications support development at local level
- increase role of GIS in planning and decision-making
- apply principles and techniques for data standardization and harmonization
- main streaming GIS in Africa

Future evolution of AFRICAGIS

The Conference also debated on the future evolution of AFRICAGIS. It was proposed that AFRICAGIS be organized by a consortium of three key African constituent organizations: the African Organization for Cartography and Remote Sensing (AOCRS), the African Association of Remote Sensing of the Environment (AARSE) and the Programme on Environment Information System in sub-Saharan Africa (EIS Programme). They would collectively ensure the planning and implementation of the Conference. Partnerships with international, regional, sub-regional and private organizations would be maintained and developed to ensure the success of AFRICAGIS.

COPINE: A cooperative information network linking scientists, educators, professionals and decision makers in Africa

What is it?

A call for action by African professionals to improve the existing state of information exchange within Africa was articulated at the United Nations Regional Conference on Space Technology for Sustainable Development in Africa held in Senegal in October, 1993. The COPINE proposal was developed in response to this call.

When operational, COPINE would be a satellite information exchange network with interactive capability linking urban and rural centres in 12 African countries (Botswana, Ghana, Kenya, Malawi, Morocco, Mozambique, Namibia, Nigeria, South Africa, Tanzania, Tunisia, Uganda, and Zimbabwe) and selected hospitals, universities/institutions and documentation/information supply centres located initially in Europe and elsewhere. The COPINE network would not be a competitor to public switched networks but would be a network whose success could generate traffic for future public networks in Africa and corresponding revenue to their operators. COPINE offers possibilities for data-exchange that are superior to those presently available via the Internet and may serve to complement available Internet services.

The project is proposed to be implemented as a Partnership between the participating African countries and European countries.

COPINE operations will be overseen by a Governing Board which would be comprised of representatives from participating countries, entities and organizations which financially support the project. The responsibility for the day-to-day running of the project is proposed to be vested in a permanent COPINE secretariat.

COPINE would strengthen collaboration between and among selected universities and institutes within Africa, as well as with their counterparts in Europe and the international community and thus provide a vehicle for the transfer of know-how and technology in a number of priority application fields described below.

Health Care (Tele-Medicine)

Medical units in less developed and rural areas can, using COPINE, draw upon the expertise as well as the facilities of better equipped central hospital facilities in urban areas. COPINE would facilitate the transfer of high resolution images of, for example, Xrays, computer tomography and other visual information on a patient's condition. This would permit the solicitation of advice and the delivery of consultations by non-local experts in diagnosing difficult cases. COPINE would also facilitate the exchange of data files and texts through facsimile and E-mail.

The proposed Tele-Medicine application aims at improving health care within rural areas. It would also facilitate monitoring and coordination of health care activities at national and regional levels. In addition, the COPINE system can, in conjunction with other systems of information on health statistics, be used to assess, for example, the magnitude and geographical extent of disease outbreaks, such as the outbreak of tuberculosis

and other plagues. Furthermore, COPINE can be used to support the training of medical staff in remote rural areas, following the occurrence of such outbreaks or on a regular basis, using well established distance learning methods by specialists at either national, regional or international locations.

Tele-Education

Educational centres in Africa equipped to access COPINE can use the system to transmit educational information to educators in rural areas. In addition to digital data, graphics, and facsimile, distant learning sessions using COPINE can be supported by live video transmission with characteristics corresponding to that of modern video conference systems. Through its electronic-mail (E-mail) connection. COPINE would offer Africa's social and physical scientists as well as government entities, electronic access to data bases around the world.

The objective of the Tele-Education application of the COPINE system would be to improve the quality of education in remote rural areas by providing educators in these areas with a tool that gives them easy and efficient access to the education centres of their countries. The quality of education in rural areas could then be improved by broadening the basis upon which the educators work. Joint projects involving educators in several rural locations and at education centres could be undertaken using the COPINE communication system to monitor the progress of the projects and to coordinate the results achieved by the participants.

Exchange of Scientific and Technical Information

Scientists in universities and research institutes in different African countries would be able to use COPINE to exchange ideas, data and experiences which would improve the definition of regional interests and problems; COPINE would thus stimulate scientists in different countries to work together on projects of common interest. Collaborative projects would pool the know-how and the resources of several interested institutions to jointly tackle important problems regarding, in particular, health care, food security (land cover and land use, soil erosion, agricultural productivity, research on crop yield and seed resistance) and environmental conditions, all of which are of common concern to African countries.

Management of Natural Resources and the Environment

Satellite remote sensing and Geographical Information Systems (GIS) provide an appropriate and necessary information base for the management of natural resources and the environment. The coverage of large areas of the surface of the Earth offered by environmental satellites, makes it possible to observe, in near real-time, global change processes which influence and determine regional and national environmental conditions. Timely and efficient access to data acquired from environmental satellites would help developing countries to plan actions to avoid the adverse effects of forthcoming environmental catastrophes such as drought, flooding and large-scale infestations. The COPINE system would link remote sensing and environment centres in the participating African countries to acquisition stations, processing and archiving facilities located in Europe as well as in Africa.

User community

The users of the system would include non-profit entities supported and financed by the Governments in their countries (e.g. universities, institutions of technology, research and application centres and health-care

institutions which are engaged in programmes aimed at responding to the major development needs of the greater population in African countries. In both Africa and Europe, the COPINE system would be established at institutions of talent, including hospitals and leading universities with creditable science and technology programmes. The participating centres in Europe would support the participants in Africa in three major fields: (i) Collaboration in research (ii) The provision of background information on medicine, science, technical programmes and applications; (iii) The supply of satellite remote sensing data products and technical support in remote sensing data analysis and applications.

In order to ensure that participants in Africa are able to take full advantage of the COPINE system and to ensure that they gain the necessary know-how from participating in the project which they can use to further the activities started under this project, training of the participants in the use and application of the system is an important element of the preparations for its operational phase. Training sessions would be organized by industry responsible for developing and manufacturing the system, as well as by other specialists recruited for the project.

Types of information-exchange supported

Computer File Transfer: Computer files to be transmitted through the COPINE system would be those that are commercially available within the file size 1 Megabyte to 105 Megabytes. For example, large files containing 45 Mb to 105 Mb of data, could contain raw, pre-processed or processed image data acquired from environmental satellites. Similarly, smaller files of about 2 MB files could contain information related to medical or scientific processes, high resolution document images or environmental situation maps.

Interactive Data Transfer: The COPINE system would offer its users the possibility of interactively searching and retrieving information from distant archives.

Document Transmission: The capacity in the COPINE system would make it possible for its users to transmit "documents" in the form of images, hard copy (e.g. facsimile, scanner, high-resolution-slow scan-video, etc.) as well as character coded text and messages compatible with E-mail services. The broadcast feature of the satellite downlink may be drawn upon to transmit simultaneously the same document to several destinations. All Earth stations in the network would be able to transmit and receive electronic records of documents.

Image and Video Transmissions: When the capacity in the satellite is not occupied by other data transmissions, the Type I earth stations can use the available capacity to transmit and receive video or imagery signals at 384 kbit/s (or 2048 kbit/s) with a quality corresponding to at least that of modern video conferencing systems.

Voice Communication: For cases when fast coordination is necessary and in order to facilitate efficient working-level communications, it is proposed to offer the users of COPINE the possibility of selective voice communication. In line with the conditions under which the COPINE system would operate, the use of the system for voice communication must be agreed to by the telecommunication authorities (e.g. the PTTs) in the country/countries concerned.

Earth Stations

Two types of Earth stations which would be served by the same INTELSAT satellite are currently envisaged.

The larger of the stations (Type I) would be sited on the premises of each designated host university/ institution, while the smaller station (Type II) could be used, as may be appropriate, in rural areas and other locations in each participating country. Participating centres in Europe would be connected to Type I stations in Africa. The Type I station in Africa would serve as a national hub which communicates with smaller Type II stations in the rural areas and other areas of each participating country. Type I stations in different countries in Africa would communicate with each other as well as with the Type I stations in Europe.

The type I Earth station is capable of handling all types of traffic transmitted in the network at a digital rate ranging from 32 kbit/s to 2048 kbit/s. In addition to supporting all kinds of data traffic, it is capable of transmitting and receiving imagery and video signals at 384 kbit/s (and 2048 kbit/s).

The type II Earth station is modest in its size and capabilities. It is capable of transmitting and receiving data (and where appropriate voice) at 32 kbit/s and 64 kbit/s. In general, the Type II stations would be transportable, so that they can easily be relocated to serve different projects in rural areas or to the sites of important scientific or environment events in Africa.

Present Status

A detailed project document was finalized during a special workshop held in Namibia on 19-23 May 1997. The Provisional COPINE Governing Board will this final project document at its next meeting on 7 and 8 July 1997, in Helsinki, Finland. At that time, the Board will map out the implementation steps for the project including its preparation for submission to the European Governments and their respective AID agencies., for their endorsement. We hope that by the time this Bulletin comes out from press, COPINE project has been given green light.

2nd Regional Conference of the African Association of Remote Sensing of the Environment (AARSE)

on

"lessons of experience and the way forward for integrated development and application of remote sensing and geographic information systems (GIS) for sustainable development in Africa"

Context: The focus of the Second Regional Conference of AARSE organised by the National Committee of Remote Sensing and Geographic Information (CNTIG) from October 4 to 10, 1998 in Abidjan, Côte D'Ivoire, is to address how developing countries, especially Africa, could increase their capability to share in the benefits of developing and utilising geoinformation technologies for their socio-economic growth and sustainable development, and design the way forward for Africa to establish an enabling and conducive environment that will lead to the prospective development and beneficial application of these revolutionary technologies for the systematic growth and sustainable development of the content of Africa.

Call for papers : Prospective authors who are wishing to make oral and poster presentations at the conference on the objectives and the conference sub-themes are invited to submit an extended abstract which should not normally be more than 500 words. The deadline for the abstract is October 1, 1997. Authors of accepted papers will be informed by November 30, 1997 while the deadline for the full text of the paper should be submitted not later than March 31, 1998.

Exhibition: A large exhibition space for manufacturers and commercial companies as well as for research institutes wishing to exhibit their hardware and software and their achievements in the fields of remote sensing, GIS and related technologies will be provided. Boots in units of 4 x 3 metres are available for US$2500. Interested companies and institutes are requested to contact the conference secretariat.

Workshops : A number of pre-conference workshops will be organised. A one-day workshop for decision-makers, Director Generals and Chief executives of resource and environmentally based organisations on Geoinformation technology and its impact on socio-economic and sustainable development will be organised. Arrangement is also being made by ISPRS, Unilag Consult and CNTIG to organise a workshop on Geoinformation Technology with focus on GIS. Further details on this will be contained in the second circular on December 31, 1997.

Other organisations wishing to organise workshops related to the theme and sub-themes of the conference are requested to do so. Such requests should be addressed to the conference secretariat.

Information: For further information, please contact:

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Planned Remote Sensing and GIS activities by United Nations Organizations and Associated Centres in Africa for 1996, 1997 and future years

A. EDUCATION AND TRAINING PROGRAMMES TRAINING COURSES, WORKSHOPS AND SEMINARS

ECA	ECA, through its education and training programme in 1997 and 1998, will continue to focus on developing and strengthening institutional, technical and human capabilities in the application of cartography and remote sensing techniques in data collection for the natural resources and environmental management, while organizing expert meetings to enhance policies and design legislative guidelines for the use of cartography and remote sensing in social and economic planning.
UNOOSA	The United Nations Programme on Space Applications is planning the following training courses in the period 1997-1998: Seventh United Nations International Training Course on Remote Sensing Education for Educators, being organized in cooperation with the Government of Sweden, to be held at Stockholm and Kiruna, Sweden, from 5 May to 13 June 1997; Fourth United Nations/European Space Agency (ESA) Training Course on Applications of the European Remote Sensing Satellite (ERS) Data to Natural Resources, Renewable Energy and Environment for English-speaking African countries, to be held at Frascati, Italy, in October 1997; United Nations Regional Conferences on Space Technology and Applications for Development in 1998.
FAO FAO (cont)	FAO plans to organize, jointly or on its own, the following remote sensing training courses, workshops and seminars in 1997 and in future years: FAO/German Foundation for International Development (DSE) workshop for decision-makers on remote sensing and GIS applications, to be held in eastern Africa in 1997; FAO technical workshops on land cover mapping, to be held within the framework of the AFRICOVER project in 1997 and 1998. FAO will continue providing fellowships and organizing study tours within the framework of remote sensing technology transfer activities of field projects in the period 1997-1998.

A. EDUCATION AND TRAINING PROGRAMMES TRAINING COURSES, WORKSHOPS AND SEMINARS (cont)

UNESCO	UNESCO will continue to support the following postgraduate training courses in 1997, 1998 and future years: Post graduate course on integrated study and rational use of natural resources at the Université de Paris, de Montpellier and de Toulouse, France; International postgraduate training course on applications of remote sensing, digital image processing and aerospace surveys for applied geomorphology and engineering geology at the International Institute for Aerospace Survey and Earth Sciences, Enschede, Netherlands;

B. EXPERTS SERVICES , PILOT AND OPERATIONAL PRODUCTS AND SURVEY MISSIONS

UNOOSA	In 1997 and beyond, the Office for Outer Space Affairs, under the United Nations Programme on Space Applications, will continue to collaborate with ESA and the Department for Development Support and Management Services (DDSMS) of the Secretariat in follow-up activities related to the recommendations of the training courses on applications of the ERS data to natural resources, renewable energy and the environment, held at Frascati, Italy, in 1993, 1994 and 195. Efforts will continue to be made to identify and implement support mechanisms to enable scientists from Africa, Asia and the Pacific, and Latin America and the Caribbean to receive and utilize ERS data in resource management.
ECA	ECA will continue to provide, upon request, its advisory services to member States to assist them in developing tools and methods for spatial integrated analysis. Particular attention will be given to ECA-sponsored training and service centres, responsible for mapping, remote sensing and GIS applications, when new medium-term programmes are implemented by the Regional Centre for Training in Aerospace Surveys (RECTAS) and the Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS). Requests were made by the ECA Conference of Ministers to evaluate those ECA-sponsored regional training and service centres and to make proposals concerning their continued usefulness and the ways to better rationalize, coordinate and harmonize their activities. In response to that request, ECA will pursue its actions towards the rationalization and harmonization of those centres. Within the framework of UNDP-funded project RAF/94/008, assistance has been provided for the rationalization process,

B. EXPERTS SERVICES , PILOT AND OPERATIONAL PRODUCTS AND SURVEY MISSIONS (cont)

ECA (cont)

which started in June 1996 and will continue until June 1998. This project will review the recommendations of the ECA studies in consultation with the respective Governing Councils of the institutions.
In 1997 and 1998, ECA will undertake a series of technical studies and projects as well as compile technical reports which will deal with, as essential components, mapping, remote sensing and geographic information systems, including the following:

Preparation of a report on guidelines for the effective management of the inter-relationships among food security, population and environmental sustainability (nexus issues);

Study on appropriate institutional and organizational framework to ensure an integrated and coordinated analysis of the nexus;

Preparation of a publication entitled "Mapping and land information systems: proceedings of the Eighth United Nations Regional Cartographic Conference for Africa";

Completion of the "Digital Cartographic Inventory Atlas" Project.

In the biennium 1997-1998, ECA will establish a database on mapping and baseline spatial information on Africa, including [coverage, age, formats; CHECK W/ECA: "existing images and their dates and formats"?], technologies in use, cadastral surveys and systems, physical and human resources, production capacities and other relevant factors, such as gender participation and the role of the private sector. This database will also include information on educational and training facilities in the area of geoinformation.

ECA will cooperate with FAO in planning, coordinating and implementing activities of the "Land Cover Map and Geodatabase for Africa (AFRICOVER) [CHECK DEF.BY FAO]" project, in particular those related to the establishment of an African uniform [geometric; CHECK W/FAO: "geodetic"?] reference.

During the biennium 1997-1998, ECA will coordinate with member States, relevant inter-governmental and non-governmental organizations the establishment of a Working Group on Regional Data Standards for Spatially-Related Information.

B. EXPERTS SERVICES , PILOT AND OPERATIONAL PRODUCTS AND SURVEY MISSIONS (cont)

FAO	FAO will continue to cooperate with the regional commissions and regional remote sensing centres in the efficient use of remote sensing technology for the mapping, assessment and monitoring of renewable natural resources and natural disasters. The priorities of this assistance will follow the Agenda 21 recommendations of the United Nations Conference on Environment (UNCED) and the recommendations of the World Food Summit as well as the related International Conventions (Desertification, Biodiversity and Climate Change). Following the successful completion of phases I and II of the FAO/United States Agency for International Development (USAID) project on monitoring, forecasting and simulation of the Nile River, FAO will implement a phase III follow-on project during 1997 and 1998 to assist the Government of Egypt in the consolidation of the results achieved in the earlier phases. FAO will complete phase II of its regional remote sensing and food security early warning project for the member States of the Southern African Development Community (SADC) with funding by the Government of the Netherlands. FAO will also continue its sister project for the countries in the region of the Intergovernmental Authority on Development (IGAD) in cooperation with the RCSSMRS with funding by the Government of France. A similar project for West and Central Africa has also been formulated. FAO continues to contribute, with the use of remote sensing technology, to the development of schemes to control animal pest diseases. Earlier studies relating normalized difference vegetation index data sets from ARTEMIS to tsetse fly distribution and land utilization types in Nigeria and Togo led to the establishment of an operational information system to define policies for African animal trypanosomiasis control. Remote sensing is used to define technical concepts for tsetse control in countries where high resolution satellite images are available to discern land utilization types. A project is currently being prepared to design maps and GIS to assist 11 western African countries affected by onchocerciasis. FAO is preparing a complete coverage of Sierra Leone with satellite image maps at 1:100.000 scale to support the preparation of land cover maps by national experts.
UNESCO	Within the framework of the Geological Applications Remote Sensing (GARS) programme, organized jointly with the International Union of Geological Sciences, UNESCO will continue to implement the Third phase of the GARS-Africa project concerning the creation of a regional remote sensing user network, in cooperation with the Royal Museum of Central Africa (Belgium).

B. EXPERTS SERVICES , PILOT AND OPERATIONAL PRODUCTS AND SURVEY MISSIONS (cont)

UNESCO (cont)	The network now includes Botswana, Burundi, Ethiopia, Rwanda, Swaziland, Uganda, United Republic of Tanzania and Zambia. Moreover, remote sensing data interpretation capabilities will be added to UNESCO's Africa project, Pan-African Network for a Geological Information System, which is implemented also in cooperation with the Royal Museum of Central Africa and the Centre international pour la formation et les echanges géologiques of France;
	UNEP, through the Global Resource Information Database (GRID) network, maintains its linkage with providers and users of major remote sensing and information technology and applications to support a global cooperative assessment framework to address environmental issues of international significance. The results of its activities are circulated and/or transferred to the other regional GRID centres in Bangkok, Geneva and Nairobi, and form the basis of initiatives to be taken in 1997 and beyond for capacity development in data and database management in developing countries and countries with economies in transition. UNEP, through GRID-Sioux Falls, will continue the development of an environmental database of the Great Lakes Basin of Africa consisting of satellite-derived and other spatial data-sets. UNEP is working with UNDP to assess the value of these data-sets in addressing the environmental information and management needs of the Basin. UNEP, through GRID-Sioux Falls, collaborates with the Environment Canada, World Resources Institute and other organizations in the development of a global population database, and medium-resolution population database of Africa in a GIS format. Following the completion of a national land degradation assessment and mapping exercise for Kenya in 1996 (see A/ZC.105/631, paragraph 67), UNEP, through the Desertification Control Programme (DC/PAC), will continue discussions to formulate a similar assessment programme for Mali using the results of a base survey conducted by the "Institut Géographique National - France International (IGN-FI)". The work is being carried out in cooperation with UNEP Division of Environmental Information and Assessment (DEIA) and GRID Nairobi.
UNEP	UNEP, through DC/PAC and GRID Nairobi, has reviewed the World Desertification Atlas and is preparing a revised edition for publication in 1997.

UNEP (cont)	UNEP, through GRID Nairobi, works with the Michigan State University to explore approaches to the development of national GIS which integrates both environmental and socio-economic layers. A trial system developed for Rwanda has proved successful and could be extended to cover the countries of the Africa Great Lakes Basin.

C . DISSEMINATION OR EXCHANGE OF INFORMATION ON THE STATUS OF TECHNOLOGY OR OPERATIONAL SYSTEMS

ECA	In 1997 and 1998, ECA will continue to publish its cartographic and remote sensing bulletin, of which five issues have been published, either as a separate publication or as a part of a more general publication comprising articles related to natural resources, food security and the environment. ECA plans to organize in 1998 an ad-hoc expert group meeting on guidelines for defining, structuring and developing integrated data-sets, required for policy analysis and the decision-making process concerning food security, population and environmental sustainability and their inter-relationships, commonly referred as the "nexus". The meeting will be followed by a workshop for decision-makers on integrated geo-information systems needed for the management of the nexus issues. In 1999, ECA will organize and service the Tenth United Nations Regional Cartographic Conference for Africa.
UNEP	UNEP, through GRID-Sioux Falls, conducts the biennial comprehensive survey of GIS and image processing software systems to provide member countries with up-to-date information about their status and trends. A report entitled, "Access to environmental data and information using Internet tools", which was prepared by GRID-Sioux Falls in 1996, is available for distribution to developing countries. UNEP, through GRID-Sioux Falls, provides tens of thousands of users with access to environmental data and information through its World Wide Web (WWW) site. Similarly, data and information resources of GRID-Arendal and GRID-Geneva are accessible through the Internet and WWW. UNEP will continue to enhance the dissemination of data and information of new GRID sites through the Internet and WWW, as resources permit.
FAO	FAO disseminates information on its activities in the field of remote sensing and GIS in support of FAO programmes in agriculture, forestry, fisheries, sustainable development and food security through WWW FAO homepage (http://www.FAO.org).

D. ESTABLISHEMENT OF CENTRES FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION

OSAD	In response to General Assembly resolutions 45/72 of 11 December 1990 and 50/27 of 6 December 1995, the United Nations Programme on Space Applications continues to make progress in establishing United Nations affiliated regional centres for space science and technology education in developing countries, which are expected to enhance the academic and professional capabilities and technical infrastructure in space science and technology in each region. The following activities will be conducted in 1997 and future years: The Programme is providing assistance to the Governments of Morocco and Nigeria for the establishment of centres for French-speaking and English-speaking countries in Africa, respectively; these centres are expected to become operational in the second half of 1997; ECA will continue to support the initiative of the Office for Outer Space Affairs of the United Nations to establish regional centres for space science and technology education in Africa as a necessary step for the creation of endogenous technical capacity and as a complement to the training normally offered by regional centres.

E. CAPACITY BUILDING

ECA	In 1997 and 1998, ECA will focus its main activities in the field of remote sensing and geographic information systems, in particular, and geomatics in general on improving the capacity of member States to analyse and manage the inter-relationship among food security, population and environmental sustainability, commonly referred as the "nexus".
UNEP	UNEP continues to provide technical backstopping assistance, through the GRID-Nairobi facility, to Botswana, Burkina Faso, Côte d'Ivoire, Ghana, Kenya, Lesotho, Mozambique, Niger, Uganda, Tanzania and Zambia. Significant networking activities are underway in Ghana and Eritrea in 1997 in cooperation with the UNDP Office to Combat Desertification and Drought. A major coordination effort is made by members of the World Bank-sponsored Advisory Committee on Environment Information Systems in Sub-Saharan Africa. UNEP, UNDP Office to Combat Desertification and Drought, World Bank, French Ministry of Cooperation, Gesellshaft fur Technisccbe Zusammenarbeit (GTZ), USAID and North American Air Defence [CHECK WITH UNEP] (NORAD) support the Committee, which provides a forum for coordination and exchange of ideas.

E. CAPACITY BUILDING (cont)

UNEP (cont)	UNEP continues its capacity building and networking activities in Africa under ENRIN by holding workshops for the East African sub-region in cooperation with IGAD. An information networking strategy has been developed with IGAD, and resource mobilization action is underway. UNEP also cooperates with SADC in the development of institutional capability in environment and land management in the region and in the establishment of environmental and natural resource information networks. A number of networks have been established, notably in Zambia. (See A/AC.105/631, paragraph 141 (a) and (e).) UNEP provided support to develop and strengthen national database capability of Kenya, Uganda and Tanzania under the UNDP/Global Environment Facility (GEF) regional biodiversity project, implemented by FAO. The project was completed and a second phase is now under review.
FAO	FAO, through its AFRICOVER project, contributes to strengthening African capacities in advance geographic information technologies on environment and natural resources. The value of the AFRICOVER project is not merely in the usefulness of the maps and databases to be produced; the elaboration of such maps will initiate efforts towards capacity building in the region of Africa through the development of national information systems on environment and natural resources, crop assessment and food security, land management and large watershed management, preparation of investment field projects and locust and desertification control. The project proposal for a Land Cover Map and Digital Database of Africa, which was formulated by FAO and endorsed by the United Nations Inter-Agency Meeting on Outer Space Activities, is now being submitted by African countries to potential donors.

A WORD ABOUT CHANGES

ECA'S NEW STRATEGIC DIRECTIONS

The Commission launched two years ago a process of change and reform, based on the three principles of excellence, greater cost-effectiveness and effective partnership. This renewal process has been marked by a series of broad consultations, within the secretariat, with experts drawn from governments, the private sector, African regional and sub-regional IGOs, academia, the civil society, the Bureau of the commission and ECA's principal partners. This programme of reforms and renewal, embodied in document E/ECA/CM.22/2 entitled "Strategic Directions for the Economic Commission for Africa', was examined in deep by the thirty-first session of the Commission and the twenty-second meeting of the Conference of Ministers, which endorsed it.

In a nutshell, ECA used to have 21 programmes, which have been sharpened in focus to five programmes areas, namely:

- Facilitating economic and social policy analysis and implementation
- Ensuring food security and sustainable development
- Strengthening development management
- Harnessing information for Development
- Promoting regional cooperation

Cross cutting these five areas are two important issues: gender and capacity building, which will influence all ECA's programme activities.

In addition, major reviews of ECA's programming and budgeting systems, human resources management, skills mix of the professional staff and communications strategy were undertaken.

The effective implementation of the structure of ECA required to accommodate the new programmes started on 1st January 1997. In this new structure, the Natural Resources Division, quite familiar to our readers, doesn't exist anymore. Its different activities have been subsumed within several new Divisions. As such, the activities related to surveying, mapping, remote sensing and geographic information systems, nowadays referred to as geo-informatics, are now incorporated within the Development Information Services Division (DISD), as a recognition that Geo-informatics is definitely an important subset of Information Technology at large. The new Division is headed by Ms. **Karima Bounemra Ben Soltane**, a national of Tunisia, former Director of the Regional Institut of Information and Telecommunication Sciences (IRSIT) based in Tunisia.

The intergovernmental machinery of the Commission was also reformed by the African Ministers for Planning and Socio-Economic Reform in May 1997. The subsidiary bodies of ECA are now seven Committees addressing different sectors of development. Matters on geoinformation are dealt by the Committee on Development Information. The functions of the United Nations Regional Cartographic Conference for Africa, as a legislative body of the Commission, have been subsumed by this Committee on Development Information. However, the UN Regional Cartographic Conferences for Africa will continue to be convened as a special & technical Conference.

Dr. **Peter N. Mwanza**, who as Chief of the former Natural Resources Division was the focal point at ECA for the activities concerning Geoinformation, went on early retirement on 1 January 1996.

Evaluation Questionnaire

Readers' evaluation of this publication along with comments and suggestions will be highly appreciated.

Title of publication: Cartography and Remote Sensing Bulletin

No. of issue and date of publication: _____

Name of respondent: _____

Employer of respondent: _____

Country: _____

1. **How did the publication reach you? Through:**

   [ ] UN Secretariat (mail dispatch, distribution at meetings, conferences, etc)
   [ ] UN Development Programme office in respondent's country
   [ ] Government office
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   [ ] Others (please specify) _____

2. **Please indicate your assessment of quality of the publication by inserting the rating number in the appropriate box, using the following scale:**

   5 = excellent, 4 = very good, 3 = good, 2 = poor, 1 = very poor, na = not applicable

   [ ] Presentation/format [ ] reliability of data [ ] coverage of subject
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3. **How useful was the publication to your work? Use this scale:**

   3 = very useful, 2 = useful, 1 = not useful, na = not applicable

   [ ] information [ ] analysis
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4. **Compared to your usual resource publications, do you find this U.N. document to be:**

   A - above average, B - average, or C - below average [ ]

5. **Kindly feel free to give any suggestions for improvement of the publication. Better yet, send a written contribution on any water related matter for a future issue of this publication.**

Questionnaire d'Evaluation

L'Evaluation des lecteurs de cette publication ainsi que les commentaires et suggestions seront hautement appréciés.

Titre de publication : Cartography and Remote Sensing Bulletin

Numéro et date de publication: _____

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Pays : _____

1. **Comment avez vous reçu la publication? Par le canal :**

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   A - plus que moyen B- Moyen ou C- en dessous de la moyenne [ ]

5. **Soyez libre de donner toute proposition d'amélioration de cette publication. Mieux encore, envoyez-nous une contribution écrite sur toute question relative à l'eau pour le prochain numéro de cette publication.**