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CARTOGRAPHY AND REMOTE SENSING

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Contents

FOREWORD

The Cartographic and Remote Sensing Bulletin of the Economic Commission for Africa is a recurrent 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 geoinformation, such as surveying, mapping, remote sensing, and geographic information systems. It is intended for scientists, scholars, government officials, decision makers, students, from Africa and abroad, and any one else who is concerned with how geo-sciences and technologies can support sustainable development in the continent.

This seventh issue focuses on technical and policy papers, benefiting from papers and studies presented at two main events organized by the Commission during the biennium. The first chapter includes a summary of the outcome of an ad-hoc expert group meeting on “cadastre and land information systems for African decision-makers” held in October 1998, and the individual country cases presented by the participants. The other chapters are a selection of papers --grouped by themes-- submitted to the Sub-committee on Geoinformation of the first meeting of the Committee on Development Information (CODI) in June 1999, one of the seven technical committees established during the recent restructuring of the Commission. It should be recalled that the Sub-committee on Geoinformation replaces the United Nations Regional Cartographic conferences for Africa.

The editors welcome comments on the content and presentation and suggestions for its improvement. They also 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:

The editors
Cartographic and Remote Sensing Bulletin
Economic Commission for Africa
P.O. Box 3001
Addis Ababa, Ethiopia

CHAPTER ONE

CADASTRE AND LAND INFORMATION SYSTEMS

CADASTRE AND LAND INFORMATION SYSTEMS (LIS) FOR DECISION-MAKERS IN AFRICA

Summary of working document for meeting of group of experts at United Nations Economic Commission for Africa, Addis Ababa, 23-26 November, 1998.

INTRODUCTION

The status of cadastral and land information systems in Africa is assessed, with specific reference to their capacity to assist decision-makers. Recommendations and guidelines are provided for the adaptation of existing systems and/or the development of new systems, so that they can be used for land reform, physical planning and integrated land administration. The guidelines take into account the need to create land information for decision-makers without creating unaffordable costs to the state, given that the average per capita income for Africa in 1995 was USD665.

BACKGROUND

- The United Nations has been involved in cadastral and land information issues since the early 1950s and the UNECA held its first seminar on the issue in 1970;
- A variety of conditions exist among African countries, and no attempt is made to develop a blue print. While most of the parameters discussed apply to many countries, some of the technical aspects might apply more in Member States that do not yet have a fully developed cadastre. The technical approaches could be utilized to improve the land information available to decision-makers, but this would vary across the Member States, as it would depend on the level of their existing cadastral development.

DECISION-MAKERS AND THE PRESENT CADASTRAL (INFORMATION) SYSTEMS

A review of the cadastral and LIM systems in Africa indicates that in general, decision-makers are not obtaining sufficient land information from these systems to make informed decisions. This is largely because:

- No documentary evidence exists for up to 90 percent of the parcels in developing countries, with about 1 per cent of sub-Saharan Africa being covered by any kind of cadastral survey;
- LIS/GIS systems do not exist, have lapsed, or are seen as too expensive;
- Manuel cadastral systems, with incomplete coverage, supply most of the land information.

INTEGRATING SURVEYING INTO A MULTI-DISCIPLINARY LIM SYSTEMS' APPROACH (SEE DIAGRAM 1 BELOW).

- An LIM system is **more than a GIS** as, besides the technology, it also involves organizing procedures, a corporate structure and a policy towards users;
- A **new spatially referenced framework** should be developed for a wider range of users and stakeholders, with visualization being its core component;
- Usually an LIM system is a sub system of a cadastral system and is limited by the cadastre's requirements (high accuracy, legal evidence etc.). As the cadastre covers less than one percent of sub-Saharan Africa, the **cadastral layer should be left out of the LIM system's initial design**, making it easier to develop an LIM system. The cadastre can be a linked sub-system of the LIM system;
- The primary purpose of an LIM system should be to supply information for sustainable development, **not for conveyancing and mortgages**;
- **Varying accuracies should be accommodated**, because of cost and lack of capacity in regard to the generation of accurate, comprehensive, standardized information. Information produced for other purposes, by non-surveyors, could be used to populate the LIS/GIS, by using new cheap technologies;
- **Sustainable development** meets the needs of present generations without compromising the ability of future generations to meet their own needs. LIM system' processes should integrate the principles of economic, social and ecological sustainability;
- **Participatory land use planning** has replaced the 'Package of Plans' top down approach, because of a lack of government capacity, and because the identification of user needs involves a conflict resolution process among stakeholders. Instead the social, institutional and technical dimensions of land use planning/management are being integrated at the lowest level. This approach is more cost effective and is based on the understanding that the *de facto* users are critical to land use allocation processes, rather than this being only a professional exercise. The LIM system should manage the information flows to facilitate such an environment. Also, participatory land use planning decisions generated locally have implications for cadastral surveys in regard to:- timing, coordination, institutional linkages and legal evidence;
- LIM systems should serve decision- makers at all levels, especially for **decentralized decision making**. Land registration, allocation of public land, permits for land development, conflict resolution, land use planning and management and land taxation should all be decentralized. Decentralized land information collection should be interconnected with vertical, horizontal and local network(s). Technical and institutional interconnectedness is integral to an LIM system. Also, national legal frameworks are required for local land management. Local institutions, acting alone, cannot legally define the rules by which they interact with outsiders. The decentralization of land information and/or land registration should be assessed in regard to the existing legal frameworks, and legal regimes adapted to facilitate local land management;
- Large scale government programs of compulsory systematic titling is not a viable strategy. Instead, **titling should be application driven, sporadic** and funded by the developer/investor. It should be done only after negotiation with local communities, to ensure that the resource base of the poor is not

forfeited during titling. Government should quality assure this process;

- An LIM system should supply information to the users of **due process mechanisms**. Such mechanisms include, local land management forums, planning appeal boards, adjudication/negotiation procedures for changes in land use/land rights;
- Land registration/recordal systems should be more accessible, in terms of location and cost. **The land office should be at the local level** and be user-friendly to poor, often uneducated people. This challenges existing land registration systems that are centralized, expensive and designed for the middle class, leading to an abuse of third party rights and lengthy approval processes. Local registration offices make land use planning more sustainable, protect the land rights of the poor and shorten procedures;
- **Informal and formal tenure systems should be combined**, otherwise the informal systems will continue to defeat the goals of governments and others, trying to supply security of tenure, poverty alleviation, food security and sound land management. The LIM system should include formal, informal and customary tenures;
- The LIM system should **remove all barriers to women's access to resources** including land and information, and ensure their full participation in all the decision making associated with the system, whether as users, decision- makers, generators of information or property owners;
- Most land information in rural and urban Africa is not parcel based. Databases should accommodate **a range of identifiers**, including, un-referenced parcels, lines and points;
- **Cost effectiveness and cost avoidance** approaches should be integral to system design;
- The **vision for an LIM** system should be a focus on the user (decision-maker). Prior to the acquisition of technology, a User's Requirement Analysis should be undertaken, institutional co-ordination done by a Stakeholders' Forum, and a Technology Business plan created.

WHAT TYPE OF DECISION- MAKERS NEED SPATIAL INFORMATION

The public and private sectors, local and traditional authorities, informal settlements, utility companies, NGOs , including women's groups, among others.

WHAT TYPE OF DECISIONS NEED TO BE MADE

Often, because of a lack of available information, there is a divide between the reality of the situation and the ability of decision- makers to always comprehend that reality. Information is needed for a range of decisions such as, the resolution of land conflicts, natural resource management, the management of cities, land administration, and prior to investment.

CREATE A STAKEHOLDERS' FORUM AND UNDERTAKE A USER'S REQUIREMENT ANALYSIS

A Stakeholders' Forum should be created to build capacity among the country's decision-makers, to make more sustainable decisions. At national level there should be a Steering Committee heading the Stakeholders' Forum, assisted by a technical secretariat.

The Stakeholders' Forum should:-

- Bring **stakeholders together**, including technical people, so that land information acquisition and dissemination is not solely a technical process but is interactive;
- Assess the **existing cadastre** and LIM system, including a gender sensitive analysis;
- Identify **over-lapping responsibilities** in government. This will reduce public expenditure and increase the LIM system's capacity. A common base map should be promoted;
- Promote **public-private partnerships** where applicable, to increase capacity;
- Address both **centralization and institutional fragmentation** problems. Partnerships should be created between different institutions to set up the LIM systems' linkages, first institutional then technical links. This will improve the effectiveness of computerization;
- Include **all stakeholders**, even those who have been previously excluded from such forums;
- Create a **decentralized** LIM system which is **transparent** and serves all stakeholders;
- Develop an **integrated land information** and mapping system;
- Advise on an **appropriate regulatory environment** for the LIM system;
- Undertake a **User's Requirement Analysis**.

The Stakeholders' Forum approach accords with **Habitat and FAO proposals**. Habitat's recommendations, outlined in its Global Urban Observatory, relate to information at local authority level. The FAO suggests the establishment of a National Task Force to facilitate information exchange for integrated land management.

The steering committee attached to the Stakeholders' forum should catalogue information, analyze institutional mandates, undertake awareness campaigns and produce a handbook to inform users about existing information. The **technical secretariat** should produce and disseminate technical information and assess to what extent visualization should be used.

SOME TECHNICAL IMPLICATIONS: SUPPLYING DECISION-MAKERS WITH THE 'BIG PICTURE'

The **major design criteria** is to create an LIM system with a national reference framework which can be used by a range of decision-makers, both non expert and (measurement) expert. A shared framework, or 'big picture,' needs to be developed (see Diagram 1.), which accommodates: -high/low value land, urban/rural, professionals and technicians with basic training, raster/vector, high/low accuracy data, from a range of techniques and technologies. It should also accommodate graphical (pictorial), geometric (measurement based) and topological (connectivity not absolute position) data. The LIM system's reference framework should: -Link paper maps and cadastral and/or GIS data sets of varying accuracies, service all levels of decision-makers cross sectorially, and enable decision- makers to visualize spatial information, both the framework and the information outputs, instead of geometric data being the core component.

Decision-makers should be able to visualize (see) what exists on the ground, so they can make better decisions. The graphical (pictorial) framework, of small scale base maps created through cartographic generalization, should include:-

- Information, about **major features** in the country, such as coastlines, roads etc., **geographic names**, and **major administrative boundaries**;
- **Human settlement patterns** generalized as classes, mapped thematically and graphically. Data acquisition is cheaper if individual houses/fields are not mapped;
- **Land use/tenure patterns**, but not using the conventional land use classifications. Patterns should depict existing *de facto* land use, irrespective of its legal status, not the *de jure* land use zoning. Land tenure should not be based on cadastral parcels but should include all forms of land tenure –legal, illegal, social and informal.

This largely follows the AFRICOVER approach, however to aid visualisation, land tenure patterns should also be included in AFRICOVER's classification system. Satellite imagery should be used to create the **graphical base maps** and populate the GIS. The maps should give small scale, topologically correct land use linked to human settlement patterns, and supply a generalised 'big picture' of a region cost effectively. A series of base maps of different scales should be created, with urban base maps at the largest scale. The result should be a series of layers, all linked graphically and/or geodetically. Research and development should be undertaken in the establishment of a visualisation based LIM system, as well as the appropriate standards and specifications.

The **graphical and geodetic frameworks should be linked** (see diagram 1.) with the base maps being the common frame of reference for both decision-makers and/or experts. The base maps make it possible: -to use information of varying scales (by referring either to the major features depicted or to the measurements), to link spatial information of varying accuracies (either by cleaning up the data or through eye-ball generalizations related to graphical information), and to link graphical information to any existing cadastral surveys. Also, the maps should be created for a manual (paper) system, but be capable of being transformed into a GIS/LIS. The cadastral link should be a separate exercise to avoid the demanding characteristics of the cadastre at the outset. If finance is limited, the graphical reference framework should be produced first as the primary data set.

Linking the graphical and **geodetic** frameworks is crucial to the comprehensive economic development of Africa. There are presently a number of problems in regard to Africa's geodetic framework. The AFRICOVER project will not produce the geodetic accuracy specifications to address all these problems. It will start by harmonizing the geodetic datum, reference spheroids and map projections. All geodetic datums will be transformed into WGS 84. However, a Unified Datum for Africa is not planned as an outcome. Rather, the project will attempt to achieve mapping accuracies at a scale of 1:250,000. ECA, AOCRS and the International Geodetic Organizations should cooperate with the FAO so that in establishing the mapping datum for AFRICOVER, geodetic standards are also achieved.

Present approaches emphasize the need **to link the central and local levels and decentralize decision making** and information. This has implications for an LIM system: -

- A graphical base map should enable central level decision-makers to make holistic broad brush initial planning decisions. If final decisions are only made after local consultations are held, such exercises can be used to generate the large scale information required to change the land use and/or land rights. The symmetry and richness of local information makes up for its lower accuracy. This approach makes it unnecessary for the central level to hold high accuracy and/or large scale information giving complete coverage. Large scale, comprehensive information, is only required once an initial decision had been made about an area. This approach is application driven and facilitates cost avoidance and cost recovery;
- Land tenure/land use could be mapped at any central point using remotely sensed images, for economies of scale, with the information being made available locally. As users drive cadastral systems, the land office should be local and not centralized. If cadastral information is kept locally, it will be unnecessary to transfer information from the local to central level, as long as the administrative processes ensure that the final decision is made locally, utilizing both central and local sources of information. Records of low value land surveyed to lower accuracies should be kept in the local land office. To avoid costs, no record of the low value land should be maintained at national level. Lengthy technical processes will be short circuited for low value land leading to cost savings;

By decentralising the LIM node, information could be provided by people with fewer skills, using lower grade, cheaper technology. This is possible because: - the graphical base map allows local surveyors to produce a textual, data rich, topologically correct, description of features in the field, to accompany their lower accuracy surveys, supported by a public witness system. This should increase the amount of data and coverage in the LIM system and reduce costs. The survey data could be transformed by professional surveyors into stronger legal evidence when required, after an investigation of the local land office records and on site inspections, accompanied by adjudication/negotiation, to be able to create a clear title, defensible in the highest courts. Information about rights to high value land should be held both by the wider society and by the affected local group. The responsibility for, and funding of, the information flow, including updates, should rest with the investor/developer and the professionals.

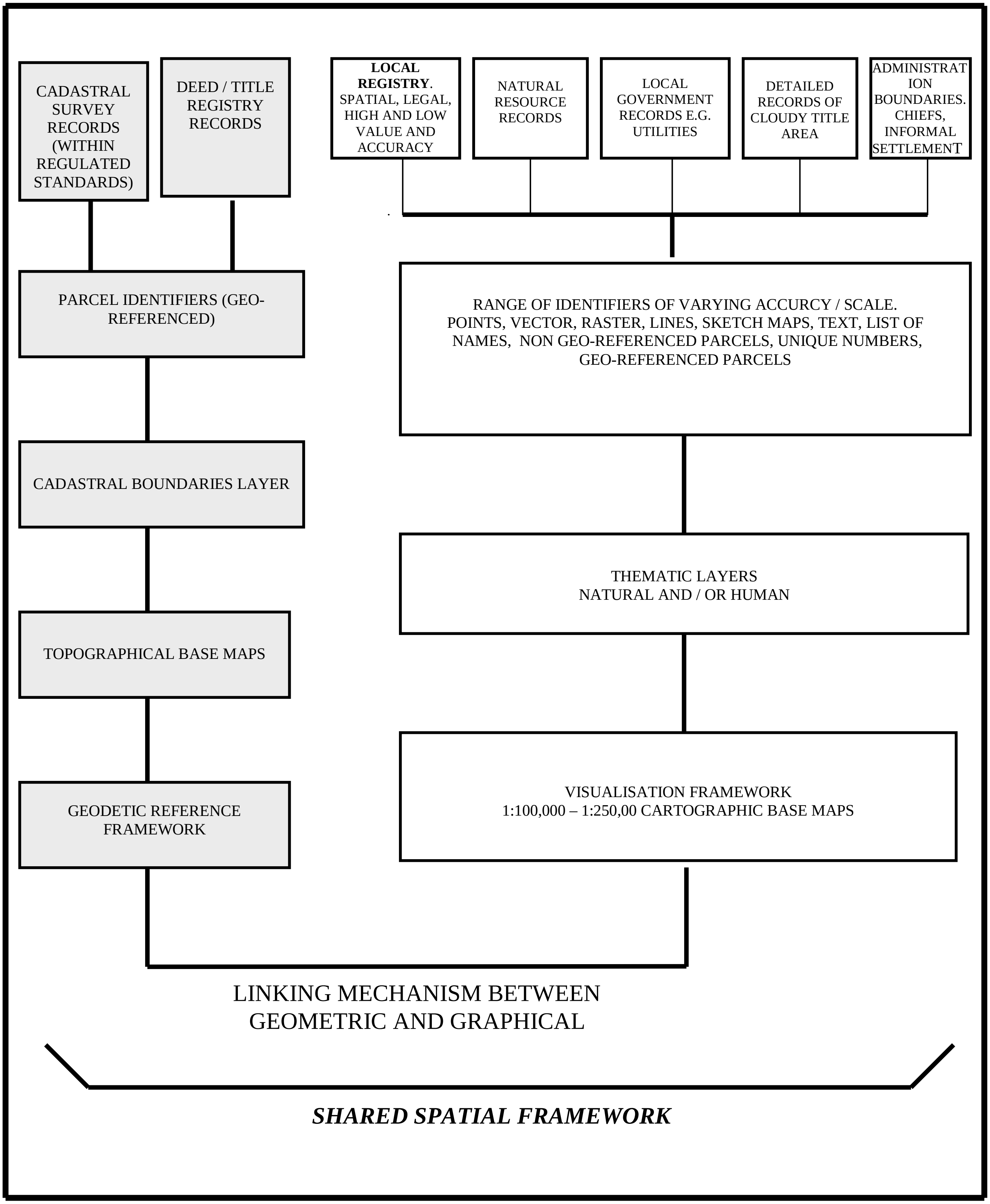

Diagram 1. Shared Spatial Framework

A range of identifiers is needed to address the problem of the integration of spatial information within an LIM system. The integration of different data from different sources, which was captured using different methods, at varying accuracies and resolutions, and stored in different formats, using diverse referencing mechanisms, is a critical issue. To solve the problem, a referencing mechanism common to every system is required, together with a range of identifiers (not just accurately surveyed parcels).

Conventionally LIS systems have used parcels as the basic unit of data collection and the linking mechanism to other information in the database. Most information about the land in developing countries could not be utilized in an LIM system, as the information is not often parcel/polygon based, let alone cadastral parcel based. A graphical reference framework makes it possible to use information from a range of sources which could not otherwise be used, through the use of non parcel based identifiers, both when acquiring the information, and as the linking mechanism. The type of identifiers, of varying accuracies and scales, which an LIM system should be able to accommodate are: - points, geo-codes, lines and polygons (with/without fuzzy boundaries), text (including lists of names), unique numbers, parcels (poorly surveyed/geo-referenced), sketch maps and photographs.

Urban and rural examples demonstrate that a range of identifiers is required for decision making. `
Information is required to regularize **urban** informal settlement. The underlying properties are often not parceled (state and/or customary) and low accuracy thematic polygons should be used for the boundaries of the state, informal settlement and customary areas. Lists of leaders should be attached to the thematic polygons, to identify stakeholders for negotiation. A geo-code (and text) against a location, such as an informal site, or house, should also be used.

Most **rural** family holdings have not been mapped (un-parceled). A commonly used spatial reference is a country's administrative units. However, socio-territorial units, such as chiefships and/or extended families, take most decisions about land management. A range of identifiers, besides a polygon for the administrative units, should be used. Again, a geo-code is appropriate, consisting of selected points representing an area or feature of interest. Lists of names of leaders should be attached to the socio-territorial areas to facilitate negotiation, for sustainable land use. Also, fuzzy boundaries might be more useful than definite boundaries.

REGULATORY FRAMEWORKS AND QUALITY ASSURANCE

The frameworks that should be put in place by governments include a:-

- Spatial framework **shared by all stakeholders** –i.e. a graphical framework in the form of base maps, based where possible on the geodetic framework;
- Regulatory framework that also **caters for the poor** and protects their land rights;
- **Institutional and policy** framework for the LIM system.

NEW TOOLS AND APPROACHES

LIS/GIS systems should be adapted specifically for the African environment using the new tools available. Full use can be made of the new technologies only if:-

- The **cadastre is a sub system** of the LIM system allowing varying accuracies/scales;
- **Non parcel identifiers** are used in the database;
- **Graphical references are generated routinely** when mapping, designing databases, choosing scales, technology etc. A LIS should display and output the results of data analysis in a format that is understood by all stakeholders, including local communities;
- Surveyors develop procedures for incorporating the data from non-surveyors into databases, and for **assisting non-surveyors** to use and acquire better spatial information.

RECOMMENDATIONS

- LIM systems should be designed to **assist decision-makers** and increase a country's capacity to acquire information. The primary focus should not be on technical issues;
- A **Stakeholders' Forum** should be set up in conjunction with the **Habitat GUO Program** and the **National Task Force under consideration by the FAO;**
- A **User's Requirement Analysis** should be undertaken;
- **Policy development** should take place within the Stakeholders' Forum;
- **Graphical base maps** should be considered by using the **AFRICOVER** project. AFRICOVER should also include a land tenure classification and be used to create a Unified African Datum;
- **Pilot project**(s) should be used to demonstrate the feasibility of a GIS/LIS system based on visualization, and include a cost benefit analysis. Regional organizations and/or countries should be invited to formulate such pilots;
- **Regional Forums**, which include existing regional LIS organizations, should work out a spatial data framework for cadastral and LIM systems at regional level, in liaison with similar LIS organizational structures at international level (Habitat's GUO and FAO's proposed Task Forces);
- The Regional and National Forums of Stakeholders should **identify sources of funding.**

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SPECIAL REVIEW OF CADASTRAL SYSTEMS IN KENYA

A. K. Njuki – Director of Surveys, Nairobi, Kenya

ABSTRACT

Two different systems of Cadastre are operating in Kenya. One system is the "Torrens System" while the other system is based on the English principle of "General Boundaries." This paper reviews the different types of cadastral systems that have existed in Kenya for the lst ninety years, the programmes that have been implemented and the strengths and weaknesses that have been identified during the implementation processes; and recommendations of the reforms that are to be under taken for the cadastral system in Kenya to operate effectively and efficiently.

INTRODUCTION

To study the cadastral system in Kenya and to determine whether the system is managed properly, this paper attempts to define the cadastre, describe how the different concepts of cadastre in Kenya were formulated and implemented in the last ninety year and evaluate their operations since their inception. The study will concentrate on the techniques used in the preparation of maps that support the cadastral process of adjudication of land rights, land transfers and mutation. An evaluation of the successes and weaknesses of the different types of the cadastral systems will be made and recommendations on the cadastral reforms that need to be undertaken to meet the needs and development priorities of Kenya.

DEFINITION OF CADASTRE

The International Federation of Surveyors (FIG) published a "Statement on the Cadastre" in 1994 and defined cadastre as follows:

"A cadastre is normally a parcel based and up-to-date land information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements. It may be established for fiscal purposes (e.g. valuation and equitable taxation), legal purposes (conveyancing), to assist in the management of land and land use (e.g. for planning and other administrative purposes), and enables sustainable development and environmental protection"

This definition of Cadastre has been accepted universally and shall be used as a benchmark in my presentation.

ESTABLISHMENT OF CADASTRAL SYSTEMS

HISTORICAL BACKGROUND

The British Government took over the direct administration of Kenya from the Imperial British Africa Company in 1895. The absence of certainty and uniformity in the land law on the Coast, caused the enactment of the Kenya Land Regulations 1897, which provided for recognition of title to land held by persons of any race – but mainly the Arabs or Indians – who could produce documentary proof of ownership. It was recommended that Indian Transfer of Property Ordinance should be applied as being "Plain simple and devoid of refinements."

Accordingly the Indian Transfer of property Ordinance, 1882 was applied by an East African Order-in-Council. It was an Act which fitted in well enough with the simple system of registration of deeds such as existed in India. It was recommended that a system of registration of documents be introduced in Kenya and this proposal was implemented by the enactment of Registration of Documents Ordinance in 1901. The purposes of the Ordinance was to give publicity to transactions in land to prevent concealed dealings. No provision was made for plans or any proper means of indexing or even identifying parcels in the Ordiance.

In 1902, the Crown Lands Ordinance was enacted and defined Crown Land, "as all public land subject to the control of His Majesty." Under the Ordinance, land was made available for disposal, almost exclusively to non-indigenous persons, for housing, commercial and industrial development in towns and for farms in rural areas.

There was at the Coast a large area of land which was privately owned and there was an even greater area which was unoccupied and which was claimed by the Government as Crown Land and so available for disposition under the Crown Lands Ordinance. Without some specific legal processes it was impossible to separate the wasted or unused land from the land which was claimed by private owners. There was danger particularly in the neighbourhood of towns, of squatters acquiring good holding rights unless the Government took steps to safeguard its interest. The Government introduced the Land Titles Ordinance in 1908 which required all persons who claimed land or interest in land to come forward and prove their title within a specified time. A certificate of Title was to be granted by the Land Court to those who proved their claims and unclaimed land or land in respect of which the claims were rejected was deemed to be Crown land and so available for alienation.

A substantive parts of lands rested in the Crown were already settled by indigenous people. The Crown Lands Ordinance of 1902 provided that "**in all dealings with Crown Land regard shall be heard for the rights requirements of natives, and in particular the Commissioner shall not sell or lease any land in actual occupation of the natives."**

Crown Land was alienated to European settlers on payment of minimum compensation by the settler to Africans who were in occupation and although those compensated were in many cases allowed to remain on the land, they did so as "squatters" without legal rights. Suspicion and fear were aroused that further alienation will be done on land occupied by natives. To counter those fears, the policy of creating "**Native reserves**" was adopted. The first native reserves were enacted in 1906, but their inviolation was not protected by law.

In 1915, the Crown Lands Ordinance was enacted to "**make further and better provisions for regulating the leasing and other disposal of Government Lands and for other purposes."** It was through this Ordinance that the British Government implemented its policy of European settlement in the Kenyan Highlands and racial segregation in and around the towns of Kenya. The Ordinance also provided for the establishment of reserves, "**for the use and support of the members of the native tribes of the protectorate**." Those reserves were defined and proclaimed in 1926. The land in the reserves remained vested in the crown, although administered separately under the Native Land Trust Ordinance. The establishment of the reserves were never successful in countering the suspicions and fears of the African population. In an attempt to allay the fears the concept of "**Trust Lands**" was evolved to give more meaningful expression to the intention of the British Government, which had been investingating the problems of land tenure within the native areas. As a result of the recommendations of the Kenya Lands Commission of 1933, a new category of "**Native Land**" quite separate from the "**Crown Land**" was established. The ownership of these lands, known as "**Trust Lands**" was deemed to lie with the indigenous population, although vested in the Native Lands Trust Board.

The Crown Lands Ordinance, 1915 introduced in Kenya an advanced system of registration of deeds which provided for accurate survey and the use of certified deed plans, but which nevertheless still necessitated investigations of title whenever there was a transaction and there was no state guarantee or indemnity

There is not much information as to how the Registration of Titles Ordinance of 1919 come about, but its framers were Australian and its purpose was "**to introduce a form of title by registration commonly known as the Torrens system**." Its objective was to provide security, simplicity, reduced cost, government guarantee, certainty and finality when dealing in transactions inland. Although the Ordinance was very severely criticized from the outset, the question of African title to land and the land policy generally with respect to land in African occupation had come very much to the fore, and criticism of the registration of Titles Ordinance and its operation seems to have been overshadowed.

By 1939, there was a move in the direction of the recognition of individual private titles in the African areas. The outbreak of the Second World War slowed this down but after it ended in 1945, great progress was made. In 1953, Her Majesty appointed East African Royal Commission to examine the measures to be taken to achieve an improved standard of living of the African population of East Africa. One of the important recommendation of the Commission stated:-

Policy covering the tenure and disposition of land should aim at the individualization of land ownership and mobility in the transfer of land; which without ignoring existing property rights, will enable access to land for economic use."

Also in 1953, the Kenya Government appointed Mr. Swynnerton an Assistant Director of Agriculture, to draw up a plan for accelerated Development of African Agriculture in Kenya. The plan recommended that a reform of African cutomary land tenure and registration therefore, is essential is sound and production farming, irrigation or settlement are to succeed. Without it, holdings of economic size cannot be established where land is fragmented or they cannot be perpetuated where enclosure is now taking place. The African farmer should have access to medium or long term agriculture credit by offering his land as security to authorized bodies.

In 1956, a Conference on African Tenure in East and central Africa was held in Arusha at the invitation of the Secretary of State for colonies. A few of the conclusions and recommendations made at the Conference were as follows:

Government should encourage individual tenure in certain stated circumstances.

Where a system of individual land tenure is developing a form of title backed by registration should be introduced without delay and followed by land registration.

Cadastral plans are required to identify parcel of land subject to the rights recorded in the register.

The possibilities of aerial survey merit examination by Governments.

The Kenya Government accepted the general recommendations of the Royal Commission in this matter and issued a policy statement in 1956 to the effect that it encourages the emergence of individual land tenure amongst Africans, where conditions are ripe for it and in due course, would institute a registration of negotiable title. The first registration enacted to put these policy decisions into effect consisted of the Native Tenure Rules which were later to be proceeded by the Native Land Registration Ordinance and the present Land Consolidation Act.

The Working Party in African Land Tenure 1957-1958 was appointed by the Government to examine and make recommendations as to the measures necessary to introduce a system of land tenure capable of application to all areas of the native lands. Though at the time there was already in existence four ordinances relating to the registration of land, it was decided that to try to combine the recognition and organization of African tenures with a review of the existing processes might well have defeated the

principle purpose of the working party. As a result of the recommendations of the Working Party, a fifth ordinance was devised and it become law in 1959 under the title of the Native Lands Registration Ordinance which was later changed to the Land Registration (Special Areas) Ordinance. The Ordinance introduced for the first time general boundaries in Kenya for section 34(1) of the Ordinance stated:-

> **"Subject to the provisions of sub-section(2) of this section the description in the Register shall not or shall the Registry Map or any plan filed in the Registry, be conclusive as to the boundaries or extent of any land but shall indicate the general boundaries only."**

In 1961, another working party on the registration of title to land in Kenya set about the task of coordinating and so far as it might be practicable, unifying the existing system of law. Its terms of reference was:-

> **"To examine the existing law and procedure relating to the registration of land and the creation and transfer of interests therein and to make recommendations for the coordination and in so far as may be practicable, the unification of the existing systems."**

The Working Party prepared a draft of a bill whose aim was to provide, for the practical needs of the land owners of Kenya in respect of (a) to security and proof of title and (b) to facilitate for creating and transferring interests in land. The bill became the Registered Land Act 1963, which was based on the English system, particularly in respect of boundaries.

In 1965, the Kenya Government appointed a mission under the chairman of Mr. J.C.D. Lawrence to carry out a study of land consolidation and registration in Kenya, to advise on an accelerated programme of such work and its costs and to suggest the best means of implementing such a programme. The report of that mission contains many recommendations for improving the methods used for varying the process to suit the particular circumstances of the major categories of area processed i.e. consolidation areas on the one hand, and non-consolidation areas on the other, including lightly populated arable areas, areas suited to irrigation or other agriculture of a block-cultivation type, pastoral areas, and areas where the process is simply one either of enclosure or distribution. The major recommendations on the question of registration were that a new Land Adjudication act should be enacted providing a simplified and speedier process for application to non-consolidation areas where no consoldiation of fragments is needed; that the name Adjudication act should be applied to this new Act, and that the existing Act be re-styled Land Consolidation Act; and that provision be made for registration of title to land mission's recommendations, two new laws were enacted in 1968 namely: The Land Adjudication Act and the Land (Group Representatives) Act.

CADASTRAL PROGRAMMES IMPLEMENTED IN KENYA

GENERAL BOUNDARY SURVEYS

The Cadastral system under general boundaries has been operating in Kenya for over fourty years. During that period, the following programmes have been implemented:

Land Consolidation Programme
Land Adjudication Programme
Land Settlement Programme
Sub-division of Large Scale Farms
Sub-division or Mutation Surveys
Determination of Boundary Disputes

I will describe the different processes used in preparing maps under each of the above programmes and the factors that were considered when deciding the type of the map to be used for a particular programme. In Kenya, no attempt has been made to regulate the accuracy or type of map required to support registration of title under general boundaries. The responsibility for the preparation and maintenance of the map rests with the Director of Surveys for Section 18(1) of the Registered Land Act; the only act governed by the principles of general boundaries state:-

"The Director of Surveys shall prepare and thereafter maintain a map or series of maps, to be the registry map, for every registration District."

<u>Land Consolidation Programme</u>:

Land consolidation is defined as replanning the proprietary land units within a given area and re-distributing them in units of economic size and natural shape.

In Kenya, land consolidation was started in North Tetu Location of Nyeri and spread to other parts of Central province. In 1954, when Government decided to implement the Swynnerton Plan, land consolidation was taking place in various districts of Kenya. The operation of land consolidation consisted of first the ascertainment of what land each persons was entitled to and second, with a view of improving agriculture, eliminating scattered fragments of land of uneconomical size, by allocating in a planned layout, a single plot of land equivalent to the plot or to the aggregate of the plots where there were more than one to each person that has been found to be entitled.

During consolidation after fragment gathering and preparation of **"Record of Existing Rights"**; an allocation plan is prepared showing the intended arrangements of consolidated holdings and from this plan the boundaries are demarcated on the ground. Experience showed that the desire to possess land and to farm it individually was strong among the people concerned. The outcome of this was that, land that was originally transferred under group and cooperative ownership had been sub-dividided illegally among the membership in unplanned manner. This process of illegal sub-division created very serious social and

political problems in the areas concerned which called for a concerted programme of regularization.

In 1980, the Government decided that all the large scale farms owned by the Company and Cooperative farms be sub-divided to the members/shareholders. These land farms comprise a total area of about 2.2 million hectares consisting of 2,700 farms.

The sub-division surveys were to be carried out by Survey of Kenya, Land Adjudication surveyors and licensed surveyors. The sub-division surveys are carried out by ground survey methods and Registry Index Maps prepared by tracing the demarcation sheets. Emphasis is laid on the physical demarcation of the plots on the ground and the necessity of the new settlers to fence their parcels as the demarcation exercise is being completed.

Sub-division/Mutation Surveys

The Lawrence Report recommended that the Survey of Kenya should take over responsibility for sub-divisions in all areas, since then, Survey of Kenya has been undertaking mutation surveys in registered areas. These surveys are also undertaken by licensed surveyors. These surveys do not present any technical problems. They are done using simple chain surveying. However, we come across cases of bad maps that have been prepared by non-competent surveyors with the connivance of unprofessional and unethical licensed surveyors. In these instances, the map does not reflect the situation on the ground.

Determination of Boundary Disputes

Section 21(2) of the Registered Land Act states:-

"where any uncertainty or dispute arises as to the portion of any boundary, the Registrar, on the application of any interested party, shall, on such evidence as the Registrar considers relevant, determine and indicate the position of the uncertain or disputed boundary."

The above section gives the Registrar the powers to settle boundary disputes. Since the Registry Index Maps indicate only the approximate boundary of a parcel, a map should not be relied upon when solving boundary disputes since it is not an authority on boundary. When boundary disputes are being determined, a surveyor is like any other witness and his evidence has to be evaluated together with other evidence in ariving at the correct position of the boundary. In the determination of a boundary dispute the duty of the Registrar is to establish as far as possible where the boundaries were placed before first registration. He does this by:

Direct evidence of persons who know the position of the original boundary and the history of the dispute.

Original photo-enlargement, demarcation maps and development plans.

Registry Index Map as interpreted by the surveyor.

If the Registry Index Map differs from the original boundary as established by more reliable evidence it is the Registry Index Map and not the ground position which should be amended. It may appear from the foregoing that a surveyor has no role to play in the determination of boundary disputes. This is not the case. A surveyor's evidence in cases of recent sub-divisions is very important because all the ground measurements are available. In other cases his expertise in interpreting plans and other drawings will prove useful. The members of public have such faith with surveyors that a Registrar will not try to solve a boundary dispute without being accompanied by a surveyor as the disputants will not accept his verdict.

FIXED BOUNDARY SURVEYS

Fixed boundaries may be defined as boundaries of a piece of land which have accurately been determined by survey. Survey marks are placed at the corners and the actual boundary between two marks is an imaginary line joining these corners. Under such concept curvilinear or natural boundaries are surveyed and adopted as appropriate fixed boundaries but the definition of such boundaries must clearly be shown.

Fixed boundaries were introduced in Kenya through the Land Titles Act of 1908. The Government Lands Act 1915, the Registration of Titles Act, 1918 and Section 22 of the Registered Land Act, 1963 all have provisions for fixed boundaries.

The earliest registration with specific fixed survey provisions is the Land Titles Act of 1908. This is a combined adjudication and registration Act applied to the coastal strip which had been settled prior to any land registration and its purpose was the establishment and determination of claims and interests in this land. It would appear that at the time the survey capability for the extent of the exercise was sufficiently limited but a modified mode of survey was adopted. Boundaries adopted on the ground were surveyed by compass and chain and were plotted to small scale with the unadjusted field data recorded. Permanent boundary beacons were only established at intervals the rest were wooden pegs.

The combination of Government Lands Act, Survey Act and the Registration of Titles Act, each of which compliments the others, has established the fixed boundary system as we know it today. The Government Lands Act is an issuing Act dealing with alienation of vacant Government land, the Survey Act deals with the provisions in relation to surveys and the licensing of cadastral wurveyors and the Registrationof Titles Act deals with the registration aspect, of which the section where the Registrar requires the proprietor of any land desiring to transfer or otherwise deal with a protion of such land to deposit a plan with several measurements marked thereon certified by the Director of Surveys, is particularly worth noting. The Survey Act and its regulations provide for the conduct of surveys, the preservation of survey marks, boundary beacons, and boundaries the standards of accuracy and completeness of surveys. The correct reflection of the boundaries on the ground and on the plan is ensured by depositing the survey records with the Director of Surveys for his authentication, only

upon which is the survey officially recognized. He is strengthened in his control of this reflection by the restriction that cadastral surveyors have to be properly qualified, registered and licensed.

Section 22 of the Registered Land Act states:-

If the Registrar in his discretion considers it desirable to indicate on a filed plan, or otherwise to define in the register, the precise position of the boundaries of a parcel or any part therefore, or if any interested person makes application to the Registrar, the Registrar shall give notice to the owners and occupiers of the land adjoining the boundaries of his intention to ascertain and fix the boundaries.

The Registrar shall, after giving all persons appearing by the register to be affected an opportunity of being heard, cause to be defined by survey the precise position of the boundaries in question, file a plan containing the necessary particulars and make a note in the register that the boundaries have been fixed and thereupon the plan shall be deemed to define accurately the boundary of the parcel.

Where the dimensions and boundaries of a parcel are defined by reference to a plan verified by the Director of Surveys, a note shall be made in the register, and the parcel shall be deemed to have had its boundaries fixed under this section.

This section provides for the fixing of a boundary and when this is done, the filed plan will be deemed to be conclusive evidence of the position of the boundary. When titles under the Registration of Titles Act are converted to the Registered Land Act; the boundaries become fixed since they had been surveyed accurately and supported by authenticated survey plans.

The Cadastral systems in Kenya were designed and established to address the following issues in land ownership and development.

How to transform land within the former non-scheduled (Trust Land) areas from cognatic systems of land tenure to statutory freehold tenure through the accelerated programme of land consolidation, adjudication and registration in order to create security of tenure and provide incentives for better use and development of land;

How to transfer land ownership within the former scheduled areas (white Highlands) from foreigners to Kenyans through a programme of land purchase and resettlement in order to reduce the problems of landlessness and unemployment in the country and to give the landless and unemployed the opportunity to contribute towards the agricultural productivity of the land.

How to provide land within urban areas at reasonable cost for development for residential, commercial, industrial and special purposes in order to alleviate the shortage of residential accommodation in urban areas and to facilitate commercial and industrial development of the country.

While assessing the strengths and weaknesses of the cadastral systems the above challenges have to be considered. Land reforms pertaining to the first two issues are undertaken through the general boundary system while last issue was enhanced through the Torrens system of fixed boundaries.

The General Boundary System

The Lawrence Report recommended survey procedures which will produce for the first registration, a registry plan of sufficient accuracy to:-

Identify on the ground a plot shown on the register;

Assist in the relocation of a boundary should it be lost;

Enable subdivisions to be effected; and

For the calculation of plot areas.

The Lawrence Report conceded that the Registry Index Maps produced by the Survey of Kenya using the "r-fly" process were accurate and could be used as final registry maps. In my assessment, these are the only maps that satisfy the four requirements above and also the only maps that we can emphatically claim they satisfy the provisions of Section 18(1) of the Registered Land Act since they are prepared whole under the direction of the Director of Surveys. I share the Lawrence Reports' view that owing to the high cost of re-fly; the shortage of survey personnel at the time and the heavy programme that lay ahead in accelerating the Land Adjudication and Registration Programme the "re-fly" process had to be suspended.

Fixed Survery System:

The boundaries established under the Land Titles Act, although they purport to be precise, but due to the coarse degree of accuracy of the field survey and the inadequacy of the ground marking permit considerable latitude in redefinition and care has to be exercised to avoid gaps between or overlaps of contiguous parcels. Subsequent survey re-establishment is not absolute and infallible. The act failed to establish standards of accuracy to guarantee the safety of initial survey and any subsequent redefinition including subdivision and re-establishment.

The surveys carried out under the provisions of the Government Land Act, the Survey Act and the Registration of Titles Act have proved themselves over 80 years and must surely be of the most successfully secure cadastral systems in operation. The cadastral system requires that all surveys are under the direction of the Director of Surveys; and that every portion of land for which there exists a title is reflected on an individual deed plan. This deed plan must be authenticated by the Director of Surveys, who will only do so if the survey conforms with the requisite standards which are clearly spelt out in the Survey Act and its regulations. The only weakness in this system is that it is expensive in that lawyers and Government/Licensed surveyors man the system and the clients have to pay for their professional services. Since all survey records are to be send to the Director of Surveys; there are normally delays in the

registration, checking and authentication of these records sometimes extending to over six months and this hampers registration of title and delays development. There are very few boundary disputes and when they occur the surveyor, through the Director of Surveys, is the arbiter.

FUTURE CADASTRAL REFORMS

Analysis of the cadastral systems in Kenya will show that they have been implemented successfully. They have been flexible and have accommodated both urban and rural requirements. That is why, 1.4 million parcels of land comprising 7 million hectares have been registered through the Land Consolidation and adudication programmes, while 325 settlement schemes comprising 960,000 hectares of land have benefited some 120,200 families. 400 group ranches have been incorporated covering an area of 3 million hectares. The number of plots/farms that have been surveyed under the system of fixed boundaries is 220,000.

Although the present Cadastral system meets the needs of the country; there is need for improvement for it to operate effectively and efficiently and to achieve this objective the following are my recommendations:-

The standards of accuracy of the maps to support registration should be accurate enough to unambiguously define parcels on the ground. This can be achieved by making the Survey Department wholly responsible for preparing and maintaining all Registry Index Maps; and the introduction of the "Re-fly" programme that was suspended by the Lawrence Mission;

There are over twenty land related Acts of Parliament which influence and have a bearing on our cadastral systems. There is a need to have these land laws harmonized with a view to establishing a uniform law providing for a single system of land tenure which would be applicable uniformly to all land in the country;

Since the beginning of the century, the Survey of Kenya has approved and accumulated a lot of survey plans/maps and other documents in hard copies. The manual system of searching for survey data from such a huge collection of data has progressively become very inefficient and time consuming. A Digital Cadastral Database Management System should be introduced. The system should be able to capture not only survey geometric data for land property parcels and textual data and attributes for urban areas but also textual data and attributes for land property parcels in adjudication areas since they do not have coordinates. The system should be able to process, store, manage, up-date, analyze and present geographic and associated data. The system should include the digitization of topographical maps since topographical information will be required as a base for cadastral maps.

CONCLUSION

As we in Kenya enter into the next century with over 30 million people, there will be an immense increase on demand for land information services. Consequently the efficiency in the management of the information will be critical in sustainable development of the country. We should improve on the design of our present cadastral system to make it simple, secure, efficient and at low cost. The design can be strengthened by computerization of the cadastre.

CADASTRE AND LAND INFORMATION SYSTEMS IN SUPPORT OF LAND REFORM IN NAMIBIA

Karim Owolabi, Surveyor General, Ministry of Lands, Resettlement and Rehabilitation, Windhoek, Namibia

INTRODUCTION

Namibia is a new, independent and democratic nation lying within latitude 17°S and 29°S and longitude 12°E. It has a total land mass of approximately 825 000 sq km in area and a population of about 1.6 million.

It is bounded by two major deserts, viz: the Namib, lying along the west coast, and the Kalahari, on the southern and central eastern border with Botswana. The only perenial rivers lie on the country's borders, viz: the Orange River on the Southern Border with South Africa, and the Kunene, Okavango, Kwando and Zambezi Rivers on the northern borders with Angola, Zambia, Zimbabwe and Botswana.

Namibia is the most arid country south of the Sahara Desert with a low average and highly variable rainfall. Drought is always a possibility and the lack of water is an ever-present constraint in most part of the country. This climatic condition means that the potential for arable agriculture is generally limited to the northern part of the country where water is less scarce In the central regions, agricultural potential is confined to livestock farming while in the more arid south, only extensive sheep and goat farming is possible without irrigation.

The rate of population growth is estimated at 3.2 per cent per annum and the contribution by the agriculture sector to the current Gross Domestic Product is 10.5 per cent. Seventy per cent of Namibia's population live in the rural areas and are supported directly or indirectly by agriculture.

Upon attaining independence in 1990 Namibia found itself with a land distribution problem emanating from

past colonial policies where 95 per cent of the population were confined to homelands with communal tenure while 5 per cent of the population enjoyed the rights of freehold title covering 46 per cent of the land.

The freehold title registration and land delivery system designed during the colonial period worked well with the rather limited demand for title. However, with the inception of the new Constitution, it became the right of all persons in Namibia to acquire, own and dispose of immovable property. This created increased demand for urban land and a gradual increase in the value of urban land combined with a limited capacity to pay for essential land management services. This resulted in stretching the existing capacity in the cadastral system.

Consequently, a new flexible land registration system has been proposed which offers different levels of tenure (parallel) at different costs with the ability to move from one level to the other (interchangeable). The flexible land registration system aims at addressing the need for urban land for all sectors of the community. This would be achieved by providing access to affordable land for the poorest and most disadvantaged sectors of the society while at the same time retaining the existing well functioning freehold title system.

Over the years, there has been an apparent increasing pressure on land which has led to recent increased societal awareness of the fragile nature of land and its resources. Consequent upon this, there has been a realization that better management of information about the land and availability of accurate and up-to-date information on land and its resources are essential for better management of the land and its sources.

Namibia, like other developing countries, is striving to develop effective, efficient and co-ordinated Geographic/Land Information System to better manage its natural resources for the benefit of all its citizens, majority of whom live in rural areas.

It is against this background that interests have been geared up at developing modern GIS/LIS techniques for providing easy access to accurate, fast and reliable geographic/land information for development planning in general and land reform in particular. A computer-based geographic/land information system is in the fore-front in this respect due to continuing advances in computer technology.

LAND TENURE SYSTEM IN NAMIBIA

Land in Namibia falls into two broad categories: registered and unregistered land. These two categories are commonly referred to as commercial and communal land respectively.

Namibia currently has three forms of land tenure, viz: freehold, communal ownership and state-owned land. The freehold system gives the owner absolute ownership of the land, and is commonly found in the commercial farming areas and proclaimed urban areas.

Under communal ownership, the power of allocating and administering land is vested in traditional authorities; tenants have the right to use the land, but do not own it.

In terms of Article 100 of the Constitution, all land which is not 'otherwise lawfully owned' shall belong to the State. It is for this reason that some people refer to communal land as State land.

Freehold land, numbering some 6337 freehold title deed farms, covers approximately 43 per cent of the total land area of the country and is spread in the mid central and southern regions. The land use comprises large-scale livestock ranches and the land is owned and farmed by some 4200 large-scale commercial farmers representing 0.24 per cent of the total national population, each having an average landholding of approximately 8 620 hectares.

The communal areas support some livestock and arable farming (without land titles) in family units mostly in the north where rainfall is slightly higher. These communal lands form approximately 42 per cent of the total land area and are inhabited by some 1.2 million people or 70 per cent of Namibia's national population. The communal land operates under a number of different land tenure systems ranging from individual rights to residential and arable land to communal rights to grazing. Until recently, all communal lands – whether rural or urban – shared one important characteristic, viz: they could not be held under freehold title. As a result, communal land could not be sold or mortgaged. While freehold title could not be obtained in communal areas, land tenure arrangements differed slightly for rural (agricultural) land and urban land.

All rural land in the communal areas is held and managed according to customary tenure systems. Generally, land rights are allocated by traditional leaders. With regard to residential and arable land, all allocation confers use rights, usually for life. Upon the death of the holder of a customary land grant, the rights either revert back to the traditional leader for re-allocation, or are passed on in terms of customary laws.

Access to grazing, while open to the entire community, is regulated to a greater or lesser degree by customary land management rules. As a result of population pressure, socio-economic changes, notably the increasing commercialization of production on communal land and technological innovations, customary land tenure systems are gradually being eroded. The most obvious manifestation of this in many parts of the country is the privatization of grazing land through enclosures.

This process is facilitated by the fact that customary land rights are not protected by statutory legislation. Article 16 of the Constitution protects the rights of Namibians 'to acquire, own and dispose of all forms of immovable and moveable property. Since moveable and immovable properties in the communal areas cannot be owned and disposed off in a legal sense, the Constitution does not protect customary rights in the same way as outright ownership. In a very profound

sense, then, people in the rural areas occupy such land at the discretion of the State, with little or no protection from statutory law.

It follows from this that customary land rights are not registered in the formal registry. However, in some areas land records of allocations made for enclosures by tribal authorities have been established at the local level and are being maintained by the tribal offices concerned.

The main impact of the erosion of customary land management and tenure arrangements on communal land users has been that the gradual enclosure of communal pastures is limiting access to seasonal grazing areas. The process does not seem to have had any negative impact on existing rights to residential and crop land, so that tenure on agricultural land continues to be reasonably secure.

The process of establishing villages and towns was not uniform in the country. Formal urban centres developed first in the central and southern parts of the country in accordance with the procedures outlined in town planning laws and regulations.

In the northern communal areas formal urban areas did not develop until the 1960s, and then mainly in response to the administrative and military requirements of the colonial Government.

After independence these towns were proclaimed under the Local Authorities Act of 1992. In terms of the Act, the entire town area was registered in the name of the Government or a local authority. In accordance with the Townships and Division of Lands Ordinance No. 11 of 1963, the land will eventually be subdivided to create plots of urban land. These will be serviced and sold to the public to be held under freehold title.

Permanent structures in unproclaimed towns on communal land were held under a form of tenure called Permission to Occupy (PTO).

PYOs provide a limited personal right to occupy an identified site for 20 years with an option to renew for further 5 years. While occupation is reasonably secure, the Schedule attached to the PTO form sets out the conditions and limits of a PTO. These include a prohibition on the transfer, mortgage, cession, lease, sub-letting or alienation of rights, except with the permission of the Permanent Secretary of the Ministry of Regional and Local Government and Housing. Such permission can only be denied with just cause. In reality, therefore, PTOs are freely traded.

The value of the PTO is the expectation that the holder will have an option to purchase the parcel once the town is proclaimed. The fact that the PTO is not a freely marketable title constrains financial lenders from expanding the credit market.

Some of the obstacles which have prevented the needs for secure tenure from being met include: inappropriate legislation prescribing time consuming and expensive procedures, a shortage of people with the appropriate skills to carry out land surveying and land registration tasks and the limited financing facilities available to anyone other than freehold owners.

NATIONAL LAND POLICY

The National Land Policy identifies “access to and tenure of land” as the most important concern of the people in Namibia. It sets out to “redress the social and economic imbalances inherited from the colonial past”. In keeping with this concern and upholding the Namibian Constitution, the National Land Policy , inter alia,

> **Provides for a unitary land system for Namibia, in which al citizens have equal rights, opportunities and security across a range of tenure and management systems. Under the colonial regime there were, in effect, first and second class systems of land tenure, divided along racial lines. In independent Namibia, the full range of tenure and management systems will be given equal status and validity before the law.”**

Thus, in a significant departure from pre-independence policies and practices, the National Land Policy provides for different forms of land rights which will be given equal status before the law. These are detailed as follows:

- Customary grants;
- Leasehold;
- Freehold;
- Licences;
- Certificates or permits; and
- State ownership.

In addition, the National Land Policy proposes different categories of land right holders. These categories will be:

- Individuals;
- Families which are legally constituted as family trusts in order to assure specified individuals and their descendants of shared land rights;
- Legally constituted bodies and institutions to exercise joint ownership rights;
- Legally constituted bodies and institutions to exercise joint ownership rights;
- Duly constituted co-operatives; and
- The State.

The National Land Policy also proposes to amend the existing titling and registration procedures in order to reduce costs, thus enabling government to provide a starter title at a cost low enough to enable the poorest owner to benefit. Starter title will be upgradeable in stages according to the financial circumstances of the owner.

The National Land Policy proposes that programmes for upgrading informal and squatter settlements will be supported on the one hand by ensuring that additional local land is available for settlement of those people who may be displaced by the formalized planning of informal settlements and the provision of

secure tenure through the upgradeable tenure system and registration based on local land registries on the other hand.

In addition, the National Land Policy proposes that each informal housing structure, where not situated on public land, will be upgraded rather than be removed against the will of those people occupying it. Informal settlers will participate in this process.

LAND REFORM

Past colonial policies have led to a skewed pattern of resource distribution, including land and income. In agriculture, colonial Government policy had been directed towards the commercial farming sector in terms of facilitation of road networks, water resources, concessionary finance, direct subsidies, veterinary services, extension services and drought relief funding.

After Namibia's independence in March 1990, major discussions centred on land reform and the land question in an attempt to find ways and means of equitable access and distribution of land and landed resources. A National Conference on Land Reform was held in 1991 and another in 1996, involving some 500 participants representing all parts of the country and all interest groups. Thereafter, a Technical Committee on Commercial Farm Lands was established to make proposals for the development of a land reform programme.

Subsequent to these discussions, the Agricultural (Commercial) Land Reform Act (No. 6) of 1995 was passed to provide for the acquisition of agricultural land by the State for purposes of land reform and allocation of such land to hitherto deprived Namibian citizens and to vest in the State a preferent right to purchase agricultural land and/or compulsorily acquire certain agricultural land. The Bill on Communal lands is expected to be enacted during 1999.

The Communal Land Bill was developed using the basic principles and guidelines set out in the National Land Policy. It is intended to introduce numerous flexible, non-discriminatory and secure land tenure systems, making provision for the establishment of Regional Land Boards to exercise control over the occupation and use of communal land within communal land areas falling under their jurisdiction; and defines the powers of chiefs and traditional authorities in relation to communal areas.

PROPOSED URBAN LAND TENURE SYSTEM

The land policy stresses that account should be taken of the fact that not all citizens can afford freehold title immediately and that a number of different types of secure title, that may be held by groups as well as individuals, should be introduced as a matter of urgency. The titles aimed at the lower income groups must be upgradeable, as and when the owner's financial circumstances permit, by stages and if so desired eventually to freehold.

For the informal settlements that have emerged in and around the urban centres the policy proposes that government should support the present multi-sectoral programmes to upgrade the settlements. This should be achieved by ensuring that additional local land is available to settle those displaced by the formalized planning of such settlements and by the provision of secure tenure through an upgradeable tenure system and registration based on local land registries.

Parallel to the formulation of the National Land Policy, initiatives were taken to discuss the present land delivery system and possible options for improvements in more detail.. The Ministry of Lands, Resettlement and Rehabilitation initiated pilot studies to investigate options for *a parallel interchangeable property registration system*.

Consequently, two new forms of tenure are proposed in addition to the existing freehold as it is currently known to the common law and registration statutes of Namibia:

- Starter title – a new statutory form of tenure registered in respect of a block of land.
- Landhold title – a statutory form of tenure with all of the most important aspects of freehold ownership but without the complications of full ownership.

The starter title provides the holder with the following rights:

- The right to perpetual occupation of a site within a block or in a similar block (the exact site within the block is not defined); and
- The right to transfer or to otherwise dispose of the right, subject to custom or a constitution, of the group occupying the site.

As the site is not yet defined and in order to ensure simplicity, one will not be able to register personal or praedial servitudes or mortgages.

The landhold title provides the owner with the rights:

- To occupy a defined site in perpetuity; and
- The right to transfer or to dispose of the right. It would be mortgageable.

While the whole block as a single entity is registered in freehold ownership in the Deeds Office in Windhoek, the starter and landhold title will be recorded at a local property office sited in the district. The data are transferred via modem connections to the computer record held in the Directorate of Deeds and permanent copies are backed up from the computer and archived. Registry records should be easily available for inspection throughout Namibia. The transfer agreements and old copies of titles deeds are kept at the local property office which is audited by the Windhoek Deeds Office

THE CADASTRE

The Cadastral records maintained by the Survey Directorate are of vital importance for giving reference to the definition of boundaries of property rights and interests in order to facilitate the implementation of the National Land Policy and the land reform

programmes dealing with the resettlement of the landless people and the formalization of the informal settlements. The cadastral records depict accurate boundaries of plots and farms and show exact locations of each plot in relation to each other or features.

These Cadastral records are available in the form of original survey diagrams, General Plans and a series of cadastral maps commonly referred to as the Noting Plans. The Noting Plans cover very large areas and exist at various scales as indicated below:

Scale	Quantity	Coverage
1: 1 000	60	Urban areas
1: 2 500	250	Urban areas
1: 12 500	60	Peri-urban areas
1: 25 000	20	Peri-urban areas
1: 50 000	18	Farms and Rural Areas
1: 100 000	122	Farms and Rural Areas

These cadastral records are part of the vital documents required to effect any land/property transaction and registration through the Deeds registry.

Security of tenure, as well as access to credit, depends on an accurate and unambiguous definition of properties, their location and extent. Such a clear and unambiguous definition of property boundaries is provided by the cadastre. In fact, such a survey coupled with an efficient land registration system is the cornerstone of any land-based economy and is essential for stimulating investment and economic development.

It should be noted that the present cadastral system is largely confined to the historically commercial areas of Namibia. In the rest of the country, urban settlement areas are being proclaimed as townships and the cadastre is being extended to these towns However, this process does not cater for the informal settlements where about 30 000 inhabitants lack security of tenure. To increase the delivery of, and access to, secure tenure in urban areas, the Ministry of Lands has initiated a program to develop procedures and methods to extend the benefits of the cadastre to these communities.

The Survey Directorate's cadastral system plays a supporting role in the implementation of land reform measures such as land use planning, land acquisition, resettlement and issuing of secured titles to land. It also plays an active role in supporting the Ministry of Regional and Local Government and Housing in the proclamation of towns. The Survey Directorate undertakes the examination and quality control of all cadastral surveys of land and the approval of all diagrams and general plans that are required to support the registration process.

GIS/LIS IN NAMIBIA

The existing manual system in the Surveyor-General's office and the Registrar of Deeds' office are under increasing pressure to supply digital data to users.

The progress of technology has diminished the role of the once all-powerful photogrammetry and cartography disciplines in the map-making process. This progress has also diminished the role of the mainframe computer and its attendant experts. User-friendly technology now enables the geologists, the natural resource managers, the agriculturists, and the land-use planners to create their own maps provided they can overlay them on a sound base map of their choice.

This has resulted in a great deal of pressure on the Surveyor-General's office for digital topographic and cadastral base data. Where this has not been available these thematic map makers have undertaken their own digitizing and data collection. A duplication of digitizing and data collection has not been standardized and many budding systems are now stand-alone on incompatible hardware/software platforms and with incompatible database design

This has led to a variety of GIS/LIS activities occurring in Government departments, municipalities and private sector across Namibia which are proceeding in isolation on an ad hoc basis. Without going into details, the following illustrates the major activities and implementing agencies:

Digital Topographic Mapping – Surveyor General's office
Digital Cadastral Database – Surveyor Genera's office
Geodetic Database – Surveyor General's office
Digital Road Network – Department of Transport
Government Property/Asset Database – Department of Works
Geological Mapping – Geological Survey
Mines GIS and Tenure System – Department of Mines
Agricultural Mapping – Department of Agriculture
Land Use/Capability Mapping – National Remote Sensing Centre/Directorate of Lands
Borehole Database (water quality, pump status, etc.) – Department of Water Affairs
Woody Biomass Resources Mapping – Directorate of Forestry
Thematic Mapping with Landsat and SPOT – National Remote Sensing Centre

A number of GIS packages are being used for these applications; while the Surveyor General's office uses ReGIS (a South African GIS package), Department of Mines and Energy uses ArcInfo, and others MapInfo, etc. Presently, the Ministry of Lands has started the implementation of a land information systems strategic plan developed under the auspices of AUSAID to address the problem of lack of coordination, standard, quality, etc. The implementation is divided into the following components:

Component 1: Land Information Management

The objective of this component is to facilitate LIS/GIS development by strengthening coordination mechanisms and human resources skills. It incorporates the establishment of an LIS/GIS centre, education and training, improvement of the government land register, and property assessment.

Component 2: Control Coordinate Systems

The objective of this component is to produce modern and homogenous set of survey control coordinates suitable for all mapping scales, engineering and cadastral surveys, and LIS/GIS systems. It incorporates the establishment of a new satellite-based geodetic datum, and creation of a geodetic records database.

Component 3: Administration of Freehold Land

The objective of this component is to create Digital Cadastral Database (DCDB) both graphic and attribute. It incorporates the DCDB capture training plan and linking Topo to Cadastre.

It is envisaged that a functional National Land Information System will accelerate the implementation of land reform programmes. Other benefits of LIS/GIS that decision-makers can take advantage of are as follows:

Land Information Systems can provide decision-makers with access to common information resources. Information from different sources can be merged to produce new value-added information products. Timely information in suitable formats can be provided to those requiring it. Without LIS, some of these activities may be too time-consuming or expensive to perform.

Access to shared information resources allows the use of consistent information by those involved in the decision-making process. It also tends to increase awareness of the interdependence between departments, agencies, and the public and private sectors, and to encourage cooperation between them. In addition, minimizing the duplication of data collection and processing can result in financial savings.

Accurate topographic and planimetric mapping forms the base to which property, utility and environmental information can be related. These base maps can be used by planners, engineers and surveyors for a variety of purposes including site and development planning, route selection and slope analysis.

Many administrative activities of a local council are linked to parcel numbers or street addresses. Thus, property mapping and the associated parcel index are key elements in a local council LIS. The improved record-keeping can result in a more equitable property tax system. Financial benefits can occur through the identification of previously untaxed properties and the ability to reflect changes in property and ownership information more quickly.

The property maps also serve planning activities such as zoning and land-use analysis. Incorporating soil and topographic map overlays can indicate areas unsuitable for development, for example on unstable soil or steep slopes. An overlay of a flood plain map with a property map can be used to identify the owners and street addresses of parcels located within the flood plain. The parcel information, along with population details, can be used to generate boundaries of political, service and school districts.

Combining street network information with property mapping improves the ability to quickly dispatch emergency vehicles. It also can be used in traffic studies and planning bus, refuse collection and fire fighting vehicle routes.

Readily accessible information about existing utilities is a valuable benefit when undertaking repair or new construction work. Utility network information, together with property information, allows easy identification of areas services by individual lines. Adding population information to the system enables the load of each utility network to be determined.

Design and Implementation Issues

Land Information Systems imply the sharing of common information resources. Before this can take place, however, policies and procedures relating to the management of information have to be determined. Typical Land Information policies are concerned with such matters as: defining goals and objectives, determining priorities, assigning responsibilities, monitoring activities, assessing results, addressing legal and social issues.

Legal and institutional issues which have to be resolved include: (i) the development and administration of standards with respect to the definition of cadastral parcels and parcel identifiers, the classification of land attributes, and the protocols for the exchange of land data; (ii) the determination of the ownership of information contained in land databases and the responsibility for maintaining distributed networks; (iii) the assignment of responsibility for errors or omissions in the databases; (iv) the development of regulations and procedures with respect to access, security and confidentiality of records.

Other issues which have to be resolved include the identification of those involved in the information processes, the manner in which the processes should be controlled and the methods by which the information products and services should be financed. In addition, there are concerns about confidentiality and security, about the management of large volumes of data, about the methods of ensuring quality and accuracy of the information and about the ways in which the system is to be implemented, maintained and updated, organizational framework, education and training requirements and the role of the private sector.

The identification of the real requirements of information users is crucial if land information management practices are to be improved. A detailed analysis of what information is required when, where, by whom and for what purposes must be a preliminary step in the design of a Land Information System. Through this process, issues such as data collection, information use and hence the flow of information can be addressed. In addition, accuracies, standards and linkages can be determined once the needs are known.

CONCLUDING REMARKS

Prior to independence many residents were prohibited from owning freehold title to land. The most secure form of tenure available to them was a Permission To Occupy (PTO) holding. The freehold title system is largely restricted to the commercial and long-established areas of Namibia. The centralized registration system is not available for the majority of people in the remote areas of the country.

One of the problems identified in the National Land Policy is that not all citizens can afford freehold title, but that they may aspire to it and the advantages it confers. At present, freehold title is the only form of secure, registrable title available in urban areas. As such it is the only title that provides the holder with ownership that is transferable, inheritable and provides collateral for a loan. While all people are not necessarily looking for rights to mortgage their land for example, most people wish to obtain some form of secure tenure. In order to satisfy these various demands, the National Land Policy proposes to introduce a number of different types of secure title. These types of title may be held by groups as well as individuals.

Urban areas in the northern regions, where half of the country's population resides, do not have access to the title registration system, and rural tenure in the north is largely informal. The problem exists in the southern regions but to a lesser extent than in the north. The Government has started to address these problems via various land reform programmes, formulation of a National Land Policy, promulgation of Commercial and Communal Land legislations.

In order to facilitate the implementation of these land reform programmes, modern computer-based cadastre and LIS/GIS are been introduced. Detail plans for the computerization of the cadastre has been prepared. The task will involve the development of a digital cadastral database (DCDB) which will depict every surveyed parcel in the country. This database will be of vital importance to the national departments, regional and local authorities and all bodies involved in development planning.

The reference ellipsoid currently in use is over one hundred years old. Though, this ellipsoid is adequate for general purposes, it is not very suitable for direct use with modern satellite-based positioning systems. The national geodetic control network is, therefore, to be upgraded and recomputed on the modern WGS 84 reference system which is the datum recommended and used internationally for global positioning system (GPS).

Plans are being finalized for the full computerization of the geodetic and cadastral records to give the users faster accessibility to the data and improve data reliability.

LEARNING BY DOING: LESOTHO'S EXPERIENCE IN THE IMPLEMENTATIONS OF LIS

Q.C. Selebalo, Department of Lands, Surveys and Physical Planning, Maseru, Lesotho

ABSTRACT

Land Information System (LIS) is the key to efficient and effective management of land resources, environment protection and other activities related to land occurrences as stipulated by Chapter 40 of Agenda 21. The industrialised countries have a number of favourable conditions for successful establishment of Land Information Systems, however, functional systems imported from these developed countries do not necessarily succeed in the developing world environment where conditions are not favourable. Pragmatic approaches have to be adopted to focus on key issues, which are not necessarily the same in developing countries.

In this paper I am urging that lack of information, institutional weaknesses and sheer inexperience with LIS necessitates that developing countries should implement LIS applications incrementally and prioritising by user requirement, rather than attempting to establishment multi-purpose systems seen in some developed countries. The paper discusses some of the factors that should be considered in the implementation of Land Information Systems in the developing world, based on a retrospective analysis of the good, the bad and the ugly lessons learned by Lesotho in the establishment and implementation of LIS.

INTRODUCTION

The introduction of LIS in African countries can be supported by a parallel that "what expectations could an international airline have without possessing a reservation database server or being 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?" (UNECA:1994). A country without modern information technology cannot realise fully the potential of the possession of a reliable and efficient spatial information infrastructure which is required for national plans upon which governments concentrate their efforts, such as health, education, transport, energy and others. Williamson, stating that "a well functioning land management system – with all its components – is essential for orderly urban growth, a dynamic private sector and an efficient housing finance sector" echoes this sentiment.(1994).

However, full-fledged multi-purpose systems cannot be achieved under the developing world environment, therefore, phased implementation seems the viable solution for the developing countries.

The broad use of LIS as a spatial information system leads to ambiguity, therefore the present discussion adapts GTZ's definition as: "an information system which provides strategic and operational tools for the management of land in urban areas" and "applies to smaller areas using individual parcels of land as their basic units" (1996). Customary tenure and traditional land rights in rural areas complicates LIS implementation, therefore urban centres are dealt with in this paper. The implementation of Land Information Systems in Lesotho was brought about firstly, to automate manual processes which could no longer be effectively done manually owing to the amount of data involved and the frequency of the operations. Secondly, external influences by way of exposing some of the staff to functioning systems in other countries, and an abortive attempt to support LIS implementation initiative through aid funding motivated the resolve. Finally, this was an attempt to establish a functional system that would be used to gain political support for implementation of a multi-purpose system.

THE CADASTRAL SYSTEM

The Land Act 1970, Act No. 17 of 1979, which is the principal legislation governing land issues in Lesotho, came into operation on the 16th June, 1980. To support this legislation, orthophoto mapping at 1: 2,500 scale covering all the urban centres was introduced as the base mapping for cadastral surveys. The reason behind this was to facilitate general boundary surveys where such boundaries could be identifiable on the map, as stipulated in the Land Survey Act 1980. Surveyed land parcels were plotted on these base maps and unique cadastral plot numbers generated.

The operational procedures involved producing dyeline working copies of the cadastral sheets from the original film copies (master copies); updating the master copies as more sites were entered onto the dyeline copies or as the copy got worn from use; and transferring the parcels information from the master copies to new masters as the new orthophoto mapping was produced. While the system had all the necessary checks and was accessible to all users it became difficult to keep updating the master copies due to the amount of data and the frequency of orthophoto mapping.

The mapping problem was addressed by introducing overlays, which were essentially registered plot boundaries and their numbers drawn on a transparency at the same scale as the orthophoto mapping. Therefore, when the need arises the overlay and the corresponding orthophoto map are combined to produce a working copy with all the cadastral data and the orthophoto backdrop. The disadvantage of this was that the currency of the working copy was limited since updating was done on the overlay therefore the working copy does not reflect the latest status about registered land parcels. After some time the process of updating the overlays could not be maintained due to the increase in land parcels being processed and shortage of staff, which meant that an alternative procedure needed to be adapted – the need for automated processing.

The perception at this juncture was to improve on the existing cadastral system since it was viewed to support the following principles that assist any procedure in maintenance of records of rights (Dale: 1995):

- "The first is to recognise the need for adequate mapping". The orthophoto mapping used as the cadastral base mapping caters for this aspect.

- "The second is to recognise that ultimately every system of registration should become compulsory". Section 30 of the Land Act 1979 provides for declaring certain areas compulsory registration areas, but the section has not been invoked, therefore cadastral data does not give a complete picture of land ownership and usage since registration is sporadic.

- "The third essential is that a system of registration will only be fully successful if it is supported by Public Opinion, and public opinion must thus be educated to accept the system." Currently registration can be done only to facilitate any land transaction such as subdivision, transfers, subleasing, mortgaging etc. Therefore most registration requirements have some urgency causing pressures on the processing systems.

- "The ultimate aim of registration should be to secure a complete and indefeasible record of all rights held." While the cadastral system cannot guarantee ones registered title, it instils security by ensuring that the unique plot numbers, which ultimately become lease-numbers are not duplicated, therefore data integrity is crucial.

The need for LIS or automation of the processes was necessary because the Cartographers could no longer keep up with the updating of the cadastral master sheets. This lead to other users such as Physical Planners not accessing the latest cadastral information for planning purposes, and the large amount of data meant that the Lands Administration section could not invoice leaseholders for ground rent in time.

CONSIDERATIONS FOR AUTOMATION

The need to automate production of overlays was perceived as a technical problem solving rather than a policy issue that required a wider consultation and to secure a political support. It was seen as a way of increasing productivity or meeting the customer demand, while other benefits related to LIS and cost recovery which could raise political interest were not envisaged. During that time of the late Eighties, Physical Planning Division within the Department had aid funding from SIDA, therefore unsuccessful attempts were made to secure funding for LIS implementation from the same organisation. Failure of this and other attempts to get aid funding can be

attributed to lack of political support, since people outside the Department were unaware of the need for LIS.

The following are some of the issues that were considered in the decision to automate the cadastral processes:

- The objective was to establish a graphical database of all registered land parcels within the urban centres from which cadastral overlays could be produced when required.
- Also to create attribute database to monitor processing of surveys and registered sites details.
- Data capturing to involve typing in of co-ordinates from survey files, digitising existing general boundary surveys, and conversion of data from other existing media.
- Cadastral Surveyors were requested to submit co-ordinate lists of large layout in digital formats that could be utilised for data capture.
- The existing personnel would be given on-the-job-training on these operations.
- The annual budget for orthophoto mapping would be used to finance hardware and software requirements.

The idea of getting support to establish a comprehensive LIS was never abandoned, therefore this automated cadastral system was perceived as a stop gap measure and it would form a component of this formal LIS. The system was therefore viewed almost as a pilot project, of a formal system that would have proper funding, trained personnel, and within an authorised institutional setting, as a result the initial terms of reference were inappropriate, and/or not thoroughly researched.

This approach, although not planned as such, coincided with a recommended approach that "by building function-specific LIS applications incrementally and prioritising by cost, need and financial viability it is possible to achieve multi-purpose LIS gradually, without the need for the very high levels of initial investment.."(Ralphs and Wyatt: 1998). This sentiment is supported by Land et al who observe that aid recipient nations are forced to spend large amounts of money on technology in a short time which "forces the technology to be prematurely delivered to end users before corresponding business application design, project teams, education and training programmes, support organisations and project management skills have been established to effectively manage the project implementation.." (1998). Therefore, in view of the preceding, failure to get aid funding for implementation of LIS could have been a blessing in disguise, since the restrictive annual funding allowed extended implementation time thus learning as the project progresses and adjusting to the situations.

LIS IMPLEMENTATION

I have pointed out that serious planning and project scheduling was not done, but the initial implementation steps were initiated in 1989. The implementation stages involved software identification and acquisition, hardware acquisition, initial data capture, training on operations and progress review including adjustments.

SOFTWARE ACQUISITION

In most cases organisations are trapped by aggressive hardware and software vendors who demonstrate purpose designed systems, promising that they will solve all the organisation's problems, and attracted by the fancy technology they find themselves burdened with systems which cannot meet their requirements. Since most organisations do not have experts who fully understand the hardware and software technology, it is important to at least know what the system should do, that is, come up with the company's user requirements. This will usually be based on the current operations of the company bearing in mind possible future trends and diversification.

The user requirements were defined based on the initial considerations for the system, but additional parameters were included that:

- It should be regionally developed so that training could be within easy reach,
- Developers or vendors should be able to customise it to meet for organisational requirements,
- It should run in DOS environment on PCs,
- It should have a proven track record in another organisation, and
- finally it should be affordable in the initial price and SMA.

A number of companies from the Republic of South Africa were invited to demonstrate their systems, and those that fulfilled most of the required criteria were asked to arrange visit to sites where such systems were operating. AOC was requested to do a pilot project using some of our data. In 1991, after this testing and comparing, the suitable software was chosen as UNIGIS supplied by AOC Systems of Johannesburg. Government acquisition procedures were invoked which involved consultation with Government Computer Centre.

UNIGIS utilised Procad as the CAD component and Dbase IV for attribute data database, yet Computer Centre's advice at this point was that all Government Databases should be on Oracle. ORACLE was therefore chosen as the relational data base for managing all attribute data. The vendors were notified about the decision to replace Dbase with Oracle and it was thought to be a simple procedure, but as it turned out it never was.

The vendors attempted over a number of years to develop interaction between UNIGIS and ORACLE, but the all the trials were unsuccessful, which left the graphic database and the attribute database as two

independent entities with no facility to do interactive analysis. By 1995 DOS was outdated as the working environment being replaced by windows for many other utilities. AOC also abandoned systems development, therefore UNIGIS was no longer viable.

In 1995 UNIGIS was replaced by ReGIS, another system developed regionally by Computer Foundation of Pretoria RSA. Likewise there were problems creating the links to Oracle Database. At this time investigations were ongoing for replacing Oracle with one of the simpler Database systems, since Oracle although powerful and has many utilities, it was found to be complicated requiring specialised training, MS Access was chosen for database, but before the proper links with ReGIS could be developed ReGIS was also discontinued in 1998 and replaced by Autodesk World, which has international recognition and can be linked to many different databases. The users have got used to operating this way where attribute data is accessed independent of the graphics.

The Local Area Network (LAN) was initially running on OS server, but in 1996 Windows NT Server was introduced as a suitable Network Operating System (NOS) to support the operations and users were advised to port applications to Windows so that all workstations could run Windows 95 or Windows NT.

Hardware expenditure

Component	Date	Cost per item	Total cost
4 Computers	March 1991	18,030.00	R72,120.00
Digitiser	October 1991	17,295.00	R17,295.00
Drum Plotter	October 1991	22,371.00	R22,371.00
486 file servers	July 1992	24,484.00	R48,968.00
Pentium Computers	July 1997	5,096.80	R25,875.00
Acer file server	July 1997	33,000.00	R66,000.00

upgrading all motherboards from the 286 to 486 processors by 1994. The users had to be content with the outdated equipment, thus making the best of the bad situation, and in the process learning to understand the capabilities of the equipment. The idea for changing a faulty card needed a specialist at the beginning but in due course this could be done internally, or determining the network problem.

By 1995, the coaxial cable network was experiencing problems due to many joints, and the segment length was longer than recommended length. A new network of twisted pairs with fifty-eight network points within the premises was installed. At the same time the file servers were replaced with two duel-Pentium processors and most of the workstations were also upgraded to faster INTEL Pentium processors and complementary memory and disk space.

Software expenditure

Software	Date of acquisition	Cost/ workstation	Total
UNIGIS	Jan 1991	10,500.00	R 42,000.00
LAN	Jan 1991		R 47,250.00
ORACLE	Aug 1992		R 27,490.00
ReGIS	Feb 1995		R107,000.00
Autodesk World	Oct 1998		R 9,000.00

*including annual SMA approx. R25,000.00

HARDWARE ACQUISITION

The hardware to carry out these operations have similarly gone through transformation to keep abreast with IT developments. The initial set-up consisted an AO HP drum plotter (Draftmaster), AO flatbed digitising tablet, two 486 file servers and ten workstations varying from simple ATs to 486 processors on LAN. Computer memory at this stage was expensive therefore in order to run UNIGIS and other utilities software, memory management programmes were essential, QEMM was used rather standard memory extension.

Hardware upgrading was done as and when funds permitted. This involved upgrading disk space on the workstations from the initial 40 MB to 203 MB and

DATA CAPTURE AND TRAINING

During the design of the system expectations were high about the existing data formats and the data media. It was envisaged that about 50% of the co-ordinates were already in digital format but on different media, therefore actual punching in of co-ordinates would not be a major task. There were co-ordinates dating as far back as 1975 on media of different tapes such as audio tapes, HP 9830 8” and 5 ¼ floppy disks, 3.5” stiffs and printed co-ordinate lists. However it turned out that the audiotapes and the 8” floppies could not be read by any of the systems, which meant that most co-ordinates data capture would be through typing. The graphics. The graphics data capture was checked by comparing that the plot from the system is the same with those on original working copies and the consistency check area. A rough initial data capturing check list is attached.

The second category of data was attribute data for registered land parcels, which is contained in paper files inside filing cabinets. The process required gathering and extracting relevant data from these files such that the data capturers can have easy access to this data. At this time it was estimated that the process would involve 30,000 registered.

capture process; internal capturing of this data using the existing staff on the understanding that experienced but enthusiastic cartographers and draughtsmen can be successfully and easily trained, as they understand, better than others, the mechanics of cartographic data representation; the second option was to subcontract to external data capturing companies. While there was no dedicated staff to the project, that all members of staff previous involved in cadastral surveys were involved, it turned out that some could not accept the change introduced the computerisation. At some stage, two trainee Cartographers deleted life graphics data, causing three months of delay. This experience affected their eagerness to participate in the project. The system developers AOC were requested to quote and the analysis below was based on their price.

Digital Mapping Schedule

Number of towns	Area in km²	Year photography	Cost
Three	225	1997	R 700,000.00
Ten	750	1998	R2,000,000.00
One (Maseru)	300 (100 sheets)	1999	R1,000,000.00

*Proposed mapping

A Decision to do data capturing internally was made based on the preceding costs. Users and data capturers were trained on site how to operate the system. Three data capturers whose major skill was typing increased the Divisional staff complement for the purpose. On rotational basis they extracted the data from the relevant files, typed the co-ordinates, and joined the points within UNIGIS to form plots attaching their plot numbers. This initial data capture was successfully completed after two years, and the current data capturing involved plots that are being registered now. The attribute data register now stands at 37,000 plots.

The graphics data of registered land parcels with their numbers, in its present form does not seem to be beneficial to other users. Its has turned out to be a technical solution for addressing the production of overlays, but it does not address the users' requirements. The Physical Planners, for instance, have to make special requests to have the overlays produced and combined with the relevant orthophoto. Once the frequency of these requests increase, the system fails which shows that internal consultations were not done. In view of this, the move is to introduce digital line mapping as the backdrop of the registered land parcels. The digital line maps will have other users outside the Department such as the utilities organisations which means partnerships development. Lesotho Electricity Corporation requires this mapping for their distribution lines and planning, whereby yearly maintenance agreements will be arranged. This digital mapping proposal is currently being implemented as the schedule shows:

Cost Summary

	In-house capture	Subcontracted capture
Inputs	3 persons @ R1,000/month = R3,000 monthly	1,200 plots @ R8.75/plot = R10,500 monthly
Duration	30,000 plots @ 1,600 plots per month = 18.75 months	30,000 plots @ 1,200 plots per month = 25 months
Total cost	18.75 months @ R3,000 per month = R56,250	25 months @ R10,500 per month = R262,500

LESSONS LEARNED

Lesotho has gone through the good, the bad and the ugly in the process of implementing LIS. The recent political unrest has revealed what could be the ugly side of LIS, where the burning of properties could be related to information about ownership and subleases. This means consultations have to be broadened to gain political support and relevant legislation to address individuals' privacy and related issues. Land et al concedes that "lack of support for and commitment to LIS will greatly affect the speed and effectiveness of LIS implementation" (1998). He further asserts that the key to the success and long term sustainability of LIS will depend on non-technical factors such as the marketing of the products. A view against technocratic approaches to project implementation is expressed by Carnall who argues that "it is now increasingly recognised that the key to success in projects is to gain effective user and specialist collaboration. This is often made the more difficult given the specialist jargon that both data processing and user departments may use" (1995).

The lessons learnt from implementing the LIS project have some bearing on the future developments and review of the project. Of these experiences some are good, while others should be avoided in future projects. The good aspects include the following:

- Training through practice. The operators of the system have learned to appreciate the capabilities of automation, and through the use of many different systems have gained experience such that they can operate in any systems. This is an important achievement, when one considers that trained personnel constitute one of the most expensive items in LIS implementation.

- Operating many systems over the years has also taught us the importance of data exchange formats, data structures and keeping abreast

with data media developments (see the attached digital mapping data structure). For instance the DXF format has been found to facilitate data transfer between many different systems, so much that we were concerned to find that Autodesk world did not have that feature, but it is has been recently included. Tape backups also need to be tested at all times and outdated systems replaced.

- The phased implementation has been beneficial since the initial capital outlay has not been too much, thus a smooth and gradual introduction to technology. It is evident from the cost lists that the hardware and software prices are going down, while the data cost at going up shown by the digital mapping costs. The existing data within the system should therefore be greatly valued.

- Some LIS failures and "white elephants" include systems that focused almost exclusively on technical issues, ignoring the need for institutional and legal reforms. Sophisticated systems within weak institutions without capacity to operate and maintain them cannot function properly. Large amounts of data collected may not be completely processed, and costs of updating and maintaining the information may not be considered (GTZ:1996). The "white elephant" situation has been avoided since the small cadastral data is still valid and will form part of the expanded system with digital mapping background.

The following omissions however still need to be addressed:

- Participatory implementation. The private sector and other institutions should be consulted about the proposed products, which should help develop a marketing strategy thus cost recovery and sustainability. Once the digital mapping coverage includes all the urban centres the use and revision of orthophoto mapping will be reduced, yet most customers have been conditioned to that product. The "de facto monopoly status as a data supplier" (Rhind:1998) should not be used to the detriment of the private sector and the public.

- Non-technocratic approach. The technocratic implementation of the systems has led to the system being useful only to the designers. The Physical Planners within the same Department cannot immediately benefit from LIS products which means it has become only the Surveyors' tool. LIS products which means it has become only the Surveyors' tool. Users in terms of the public and non-technical people should be catered for under such systems, so that even the decision-makers can understand the importance of the systems and offer support.

FUTURE PROSPECTS

The support status from decision-makers, has over the years, improved due to our annual budget justification for LIS, its publicity and acceptance at different forums globally. This appreciation of the importance of LIS has led to a support for a World Bank funded implementation to be carried out over the next three years. There will be international consultants engaged to assess the existing situation and propose refinements. Amongst other activities the improvements should cater for the following:

- Facilitate Physical Planning using digital mapping data once all urban centres are covered, and to provide for processing of planning applications with the system.

- To develop land tenure database that will improve collection of ground rent and other related taxes.

- Develop valuation and rating system that utilizes digital mapping data and existing cadastral data.

- Develop digital mapping maintenance procedures and marketing strategies.

- Improve private sector participation in data acquisition, maintenance and utilization.

- Develop legal framework to support the computerized systems.

- Strengthen institutional structures to operate LIS.

The activities will coincide with the Department's effort of decentralizing its activities, such that services are brought closer to the public. This means facility to make the LIS data accessible at these decentralized stations should be considered and options such as Intranet or telephone modem links should be assessed.

In conclusion one values the experience gained during the eight years of implementing LIS, it has prepared the ground for the current high technological advancement, such that technology is not feared but can be harnessed to achieve certain objectives. Initially the developing countries needed specialized software to assist in data capture since they lack data in digital formats, while the developed countries needed software to assist in data manipulation and analysis, but recent developments show that systems can perform most of these requirements. Under the current Internet facility information will no longer have regional barriers but there is move towards global markets, therefore developing countries should avoid being left behind.

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CADASTRE IN EGYPT

Eng. Moahmed Mosaad Ibrahim, Chairman & Chief Executive Officer & Eng. Shokry. A. R. Samaane, General Director of Cadastral Mapping Dept, Egyptian Survey Authority (ESA)

Egypt is an African country, lies at the northeastern corner of Africa. It has a part in Asia, that is the Region of Sinai. The population of Egypt is about 62 million. The total area of Egypt is about one million square kilometer, most of it is desert and mountains, which is not populated. The populated area is about 5.25 per cent of the total area, including:

- The agricultural old areas;
- The agricultural new reclaimed areas;
- The old towns areas;
- The new established towns

In addition to that 5.25 per cent area, there are new giant projects for urbanization and cultivation of new lands in Sinai in the north east and in Toshki in the south and in El-owinate in the south west. The area used for agriculture now (old and new lands) is about 42,000 square kilometers and that used as towns is about 10,500 square kilometers. The area of the new projects is about 5,600 square kilometers for the time being and extendable to 14,300 square kilometers within the next 20 years.

BACKGROUND

The Cadaster in Egypt is as old as 4,000 years and may be more. Along the history Egypt has created several kinds of cadaster. Most of them were for fiscal purposes and were partial (not for all the lands). The first comprehensive cadaster in recent era has been accomplished at 1907. It was fiscal cadaster in the beginning, and turned later in legal cadaster. Since 1927 a new cadastral coverage has been started to re-cadaster all Egypt because of the following:

- To be used as a tool to convert Deed registration into Title registration;
- To overcome the problem of the "no-up dating" for the cadaster of 1907.

The work has been stopped several times because of some reasons such as the 2nd World War, shortage of financing resources, ...etc. In 1970 ESA has started upgrading and improving processes to cope with the international status. One improvement was the automation of cadastral work. First by using the EDM and total stations surveying equipment and later by using the satellite-observation equipment for the measurements of geodetic network. This was accomplished by using some limited number of computers.

In 1980's ESA started the first step toward the international cooperation with the industrial countries to enhance the cadastral system in Egypt and to find solutions for the technical problems as an approach to automate the cadaster. ESA had some technical cooperation projects with some countries in different fields. In the field of cadaster, ESA had two main projects that are the Egyptian-American cadastral project and the Egyptian-German cadastral project.

For the former it was mainly focused on the modernization of the equipment, techniques, methodologies,.... and with mass production of cadastral maps and information. While the later was dealing with the conceptual part of analyzing the procedures, problems, and implementing new ideas and concepts.

THE CURRENT CADASTRAL SITUATION

In the old agricultural lands, the area is about 35,700 square kilometer. 80 per cent of this area has been surveyed and have new maps (20 per cent automated and 60 per cent traditional). About 55 per cent of the area has been introduced to title registration system, while the rest (45 per cent) still applying the Deed registration.

In the new reclaimed lands, the area is about 63,000 square kilometers. Most of them have only topographic maps. These areas had not introduced to the title registration system, however, some sort of deed registration is used. Moreover, these areas had not introduced yet to the administrative system. In 1998 the procedure just started to cluster the new lands to establish new villages administratively.

In the urban areas (towns and settlements), most of the towns and settlements have topographic maps and

Deed registration is used to register the urban lands and construction. Title registration is still foreseen (planned to be started in 2000 according to ESA strategic plan).

The Cadastral Administrative Units in Egypt

The state is divided into 26 Governorate. Each of them is divided into (+/-) 10 districts, each of them in turn is divided into (+/-) 20 villages and towns. For fiscal reasons the village are divided into "HODS", each of them is divided into parcels.

Cadastral Measurements Units

For the urban areas the metric system is used, while in the case of rural areas the units used are:

Feddan	1 feddan	=	4,200.83 square meters
Kerrate	1 feddan	=	24 kerrate
Sahm	1 kerrate	=	24 Sahm

In addition there are some historical units are still used by publics but they are not official.

THE VALUE OF REAL-ESTATE PROPERTIES IN EGYPT

To clarify the importance of cadaster and the resources, which are managed via the information of cadaster, the monetary value of lands may be good indicator for this aim. So excluding all constructions and buildings from this value, and considering only the current populated lands (i.e. excluding the new urbanziation projects). The estimated market value of land in Egypt (urban and rural) is about US$ 2,250 Milliar (US$ 2.25* 10 to the power 12). Of course, this value may be duplicated after considering the constructions, buildings, infrastructures, services, ...etc.

How much important is the information about this huge investments and resources....???

LAND TENURE AND LAND STATUS

Taking into consideration the long history of cadaster and ownership in Egypt, which has a considerable effect on the land status, one can find that:

The private real-estate ownership is protected by constitution and accordingly by the relevant laws and bylaws. The real-estate ownership can not be expropriated unless by court verdict or by presidential decree for public utility. The source of ownership are several according to the law it may by:

- Purchase from legal owner, auction,....etc;
- Long occupation (according to some specific condition);
- Will or gift;
- Inheritance;
- Court verdict; and
- Others.

Law protects the woman's rights and accessibility to land. The woman has complete fully equal rights as the man (the only difference is the inheriting share according to the Islamic rules). The civil law and some other land-related laws organized all types of rights and restrictions and responsibilities on land.

The land market is existing in a case-to-case basis. There is no administrative official body or private body to interfere or to control the land market.

Since 1952 and 1961 Egypt had two laws for agriculture land reformation. The first of them put ceiling for the private ownership to be 200 feddan. While the second put a ceiling as 100 feddan for the family and 50 feddan for person. In 1975 and to encourage the investments in land reclamation, this ceiling is opened for the new reclaimed areas. However still the first law exist for the old lands.

REGISTRATION SYSTEMS IN EGYPT

Since the beginning of legal cadaster in Egypt, it was intended to apply the system of title registration. However, due to some obstacles the deed registration has been applied instead. Starting from 1977 the application of title registration has been started (according to the law No. 142/1964 and bylaw No. 825/1975). Now about 55 per cent of all old lands had applied the title registration, the rest still applying the deed registration system. The work is ongoing to convert the rest (45 per cent) into title registration. The plan is to finish within 6 years including the new reclaimed areas.

MAIN PURPOSE OF THE CADASTER

Since the starting of cadaster in Egypt, it was mainly fiscal cadaster. Now it is mainly legal and fiscal cadaster. In addition, two main purposes, the cadastral maps and information are used in planning for agricultural purposes (establishing and maintenance for channels and drains) as well as other planning purposes (e.g. land expropriation).

Since she establishment of the automated cadaster system and database in cadaster, the purpose of the cadaster is changing now to be multipurpose cadaster.

RELATION BETWEEN CADASTER AND BOTH LAND REGISTER AND NOTARIES

Because the cadaster in Egypt is mainly legal cadaster, so the relation between cadaster and land register is very strong. The land register and the notary work are undertaken by "Real Estate Publicity & Notary, State Dept" (REPD). In all districts and governorates of Egypt, there are the REPD office and ESA office working together in one building in close cooperation. The coordination of the workflow between them controlled by the law and bylaws.

For any transaction of land property, the cadaster part is done by ESA office and the REPD office does the legal part and then the notary work is done in the REPD.

THE INSTITUTIONAL SET UP AND INFORMATION FLOW

According to the system in Egypt and considering the historical traditions, there are three main institutions involved in the cadastral work:

ESA for the cadastral and technical part
REPD for the legal part (registration and notary work)
Real – estate – taxes department for levying taxes according to the cadastral data;

The first two institutions are national ones, they are working in decentralized bases in the provinces (governorates), but the regulations instructions, planning, follow up, personal assignment and control administration and management are done centrally. The third institution (R. E. Taxes Department) is working decentraly on the provincial level, but the technical (fiscal) inspection and instruction are done centrally.

The Information Flow

Upon each transaction application, the application is submitted to REPD to be recorded in the hierarchy record.

Then send to ESA-office to be reviewed, recorded in the relevant-files and maps, to check the correctness of data and then to issue the cadastral certificate (identification form).

After that the application and the cadastral certificate are sent to the REPD office for legal review and registration and notary work.

After finishing the registration a notification is sent to ESA office and tax office for recording.

TECHNICAL SET UP

Contents of Cadastral Data

The graphic data contains:

- Boundaries of parcels and its numbers;
- Boundaries of Hods (the division of village);
- Administrative boundaries of villages, districts, and governorates;
- Number and names of the Hods;
- Names of the villages;
- Names and symbols of public utilities such as channels, roads, schools, hospitals, police stations, mosques, churches, water pumps and wheels,..etc.
- Some land use like orchards, cemeteries, barren lands, built up areas...etc.

The tabular data contains:

- Written description for all aforementioned graphical features;
- Areas of the parcels and description of boundaries;
- Names of the owners;
- Name of taxpayer (if different);
- The value of tax for each owner;
- The share of each owner in the area of the parcel if the parcel has more than one owner;
- Notes about all state-owned properties.

Some other data had been added in the automated system (tabular data base) as a multi-purpose data, such as:

- Owner address;
- Owner ID number;
- Taxpayer address and ID number;
- Land use in detail;
- Utilities data,....etc.

ACCURACY REQUIREMENT

Concerning the accuracy, there are two cases:

- The accuracy standards of the traditional system (manual system); and
- The accuracy standards of the automated system.

The Accuracy Standards of the Traditional System

In urban areas: In the traditional manual system which is still used up till now, tape up to 1 cm but the accuracy of the maps are graphical one. So it is normal to consult the field sketches each time lengths are needed, areas are calculated from the lengths. Anyhow the accuracy standard for lengths is +/- 10 cm (relative accuracy). Of course, in the traditional system there are no coordinates for the parcel corners, but as concerning the traverse points, the accuracy is (+/-) 5 cm (absolute accuracy). The boundaries are identified and mapped very precise, the legal power is given for the location of the boundaries according to the map, and according to the lengths in the field sketches.

In rural areas the measurements are taken to the nearest 10 cm. The accuracy of the cadaster is the graphical accuracy of the map scale 1:1000.

The Accuracy Standard of the Automated System

The accuracy in urban area is (+/-) 5 cm and that for rural areas is (+/-) 15 cm absolute accuracy.

CADASTRAL DATA

Data Collection Procedures and Sources

The data is collected from two main sources, either from field or from the already existing data at other institutions including ESA.

The data collected from field is mainly the surveying data, which is measured or the ownership data which is collected from the owners and others, or the descriptive data about land.

The data collected from the institutions is mainly the state ownership data, tax data, and land-use-data. The procedures to collect these data are:

Institutional data: The procedures is mainly sending representative with some forms to each relevant institution to collect the data from the original files and records, then this data is revised and confirmed by the institution relevant person. In the same time a notification is sent to each institution to prepare the needed documents, files and records.

Field Data: The ownership data is collected directly in the field from owners and relevant-persons, after seeing the documents if available. All data collected is revised at the office and compared with the original documents, which are stored in the office (ESA office and REPD office). The descriptive data is collected during the field measurements by the survey with

direct viewing. As concerning the cadastral surveying data, it is measured using different kinds of instruments such as steel tape, total stations, GPS receivers, which has introduced into service in ESA in 1980.

The Custodians and the Involved Institutions

ESA, according to law, is the custodian of all the cadastral data, but other are partners such as:

The REPD is the custodian of the legal data concerning the ownership;

The Tax Department is the custodian of the tax data;

Each relevant institution is custodian of the land use data;

Additionally there is an administration belongs to the municipalities has the mandate as a custodian of all the properties which owned by the state;

The main role of each institution is to provide and or make available the data to ESA to be recorded in the cadaster. The main role of REPD is to insure legally the names of the owners and their rights and responsibilities. As concerning the role of all the aforementioned institutions in the multi-purpose cadaster, it is still in negotiations.

Graphical Descriptors

The graphical outputs of the cadaster are:

In Rural Areas: Mainly parcel maps with scale 2500 reduced from basic original maps of scale 1000. In very exceptional cases, Orthophoto maps are used in the scale of 2500 or as needed.

In Urban Areas: Mainly parcel maps with scale 500. Sometimes according to demand, individual plans with scale 1000. That although the photomaps and Orthophoto maps are available but the demand is still very poor.

Graphic Source Base

Mainly is field surveys. Some experiments have been done to use the “Base-topographic map” which is created from aerial photogrammetry as a support for the field surveys, but this is not encouraging.

Data Storage and Manipulation

ESA started its new cadastral courage (as mentioned earlier) in 1927 and still working to finish it. For this reason, the automated cadaster when started at 1990 had the first priority to complete the cadastral courage not to replace the old one. Accordingly, both manual and automatic cadastral coverage (storing and manipulation) are existing. Because of this, a technical problem had been raised this is the manual produced maps and the automatic produced maps do not match together. To overcome this problem, inter alia, a technical cooperation-international project had been called and it is expected to start at the begging of beginning 1999.

GIS Manipulation

GIS manipulation had not accomplished yet. ESA is creating now the automated system, in the same time negotiations with the relevant authorities and institutions are ongoing to achieve the coordination and to come to a clear identified role for each institution. On the other hand, ESA is creating the automated system as a multi-purpose cadaster system to be adequate for any GIS purpose.

BENEFITS AND APPLICATIONS

Direct and Indirect Products

The outputs of the cadastral system contain several products, in the traditional manual cadaster as well as in the automated cadaster, ESA produces the analogue/paper products, in addition to the digital from the automated system. The products include maps with different scale, standard scales are 500 in urban areas and 2500 in rural areas (parcel maps), as well as large-scale (500,2500) topographic maps for some individual demands and cases besides some other maps with different scales according to request.

ESA also produces Orthophoto maps according to request but the demand is still poor. In some projects when desert land (unsurveyed) is used, ESA produces the so-called “special survey maps” are considered as semi-Cadastral maps because the ownership investigation is not done in completed way.

As concerning the indirect products, we can find the statistics of the seasonal crops, the cadastral work concerning the land expropriation, valuation of land, solving land-disputes, assisting other (not private) institutions to find location to set up their own projects. In all of these cases, ESA give the product in form of graphical and alpha-numeric output.

Benefits

The tangible benefits are:

- Facilitating and accelerating the land-transactions and consequently, the investments on land;
- Levying taxes in justice basis;
- Enabling the easy, justice application and executing of some laws concerning the land, taxes, planning, environment, housing, agriculture, ...etc;
- Security of real estate ownership and the related rights.

The intangible benefits are too much to be counted such as:

- Recording the court cases due to reducing disputes on land and ownership;
- Improving the economy of the country in general and the household of the individual persons as a result of the healthy atmosphere of ownership and land market;
- Land market is improving and growing up;

- Security of the country and people will be better as a result of reducing disputes;
- Enabling better planning and policies for agricultural processes as a result of having better land management based on real up-to-date information;
- More control for environmental issues; and
- Better administration of land resources....etc.

As concerning the beneficiaries:

- The primary beneficiaries are the people themselves, particularly the women;

- While the secondary beneficiaries are those institutions who are directly related to the land such as:

  Tax department offices at the municipal level;

  REPD offices at the municipal level;

  The agricultural offices at the provincial level;

  The planning offices at the provincial level;

  The environment offices at the national level; and

  Public utilities companies at the national level.

- The Tertiary beneficiaries:

  Are the whole country in general, particularly, Ministry of Finance, Ministry of Rural Development and a lot of others.

CADASTRAL SYSTEMS AS OPTION TO LIS

As it had mentioned before ESA has now three different types of cadaster:

The old cadaster from in 1907 with poor updating procedure;

The new traditional cadaster which started since 1927 and has not completed yet, but including an updating procedures;

The automated cadaster which has started since 1990.

60 per cent of lands covered by new traditional cadaster, 20 per cent of lands covered by automated cadaster, and 20 per cent of lands are still using the cadaster of 1907 as the only available source of information about lands. Therefore, in the Egyptian experience the first and second aforementioned cadaster can not serve as information system. They had been created to serve only two purposes, fiscal and legal ownership purposes and they were manual.

The automated (third) cadaster, had been designed and implemented as a multi-purpose cadaster. Although it had not been completed yet, but we are sure that upon completion it will serve as LIS. Anyhow it is already serving now to some degree most of the needs of land management purposes. The completion of the MPC depends upon the identification of clear roles for each partner.

According to the Egyptian experience ESA is doing now four different things together in one time:

Establishment new cadaster;

Automating the cadaster;

Building up the MPC; and

Conversion the legal system from deed to title registration.

Although the work size is very huge to build up the new systems upon the old one, but we realized that this approach is more economic, more justice and reliable concerning securing and maintaining the rights and ownership and more faster. In order to build MPC as an option/alternative for LIS upon the existing manual system can be done with the following pre-requests:

The existing system is using the parcel number as criterion to order the information:

The cadaster is up to date or to be updated;

The partners in the MPC (the other institutions) should cooperate and coordinate the roles and works between them;

The information flow between partners should be regular and granted; and

Each partner should committed to update his own information in the MPC.

Constraints

The huge budget needed, the long run nature to establish such system, VS, the urgent needs of society and country, and the coordination between the partner institutions particularly, considering the urgent need of the partners. In order to overcome this problem, the importance of the system should be familiar for the relevant institutions, ministries and other bodies. This will facilitate negotiation (if happened) to got loans or grants to establish the system.

As well as to design a fair pricing policies for the outputs and products of the system to help in improving the cost recovery ration and to allow to repay the loans. In this field, the external support may be called for to assist in form of loans or grants if available.

Cost benefit of building New Cadaster System upon the Existing Ones VS Creation of New System and attaching the Old

Building an automated cadaster system/MPC upon the existing one is more cost benefit because:

It saves time where creating a new one is considered as time consuming. It does not need higher

qualification and consequently training as in case of creating new system.

RECOMMENDATIONS

Before taking the decision of creating/building new system, the following recommendation noticed:

1. The current (in-force) laws should not be contradicting with any of the components of the cadaster system. On the other hand, we have to avoid changing the law to match with the system. The system should match with the existing law, otherwise a long time may be needed to change the law establish the system.

2. The land policy should be clear, particularly:

Concerning the land management: Who will do what and when? What is the role of each partner? Who is custodian about what? Who will finance and who will make benefit from what?

Concerning the land market: What rights, responsibilities and restrictions are allowed or not allowed? Or existing? What legal basis of ownership? What legal basis of ownership transfer?

3. The contents of the system (the data collected) should exceed the safe limits. It should be defined carefully.

4. Exaggeration in quality standards, accuracy and other specification is very harmful, costly and time consuming.

5. The economic feasibility, inter alia, should be considered especially as concerning the equipment, methodology and procedures.

They should be as to just meet the legal and technical needs and requirement now and in the short run.

6. Clean data – flow and work – flow should be identified.

7. The institutional set – up should be considered within the designing the system, not after.

8. The institutional set – up should be clear and identified roles should be adequate in the frame of the social and legal status.

   The question that is always arrived is:

   Should we have one institute for cadaster, registration, notary work and tax-collection.

   Or, should we have separate institutions each of them has one segment of the system? This question should be answered in advance.

9. The private sector should have a considerable part in the Cadastral activities, but should be prepared and qualified first in case of need, the Cadastral institutions may give support to the role of Cadastral private sector should be identified according to clear specification and fair contracts.

Last but not least, the cost – recovery – principal or the revenue – generating – principal should not be on short-term basis.

SPECIAL REVIEW OF CADASTRE SYSTEMS IN GHANA

Naa Alhaji Iddirisu Abu, Director, E. Addo-Tawiah and S. Oppong-Antwi, Survey Department, Ghana

ABSTRACT

Governments in developing countries have been saddled with multifaceted problems of land registration and delivery. This is as a result of the weaknesses in the cadastre systems in place with it' associated major problem of litigation which stifles development. There is therefore the need for diverse, detailed, current and cost effective methods for the processing and management of land tenure and registration systems.

This paper reviews the cadastre systems in Ghana in respect of existing legal, institutional and technical set up. The benefits and applications of the automated cadastre system at the Survey Department, the national survey and mapping organization, are mentioned.

LEGAL AND INSTITUTIONAL SET UP

Background

Land administration in Ghana is governed by both customary practices and enacted legislation. There are basically two types of land ownership: public or state lands and private lands. Public or State lands are defined as lands compulsorily acquired by the government through the invocation of the appropriate legislation, vested in the President and held in trust by the State for the entire people of Ghana. In contrast, private lands in most parts of the country, are in communal ownership held in trust for the community or group by a stool or skin as symbol of traditional authority or by a family. Stool or skin lands are a feature of land ownership in almost all the Akan traditional groups in southern Ghana and in most traditional groups in northern Ghana. Sandwiched between the public and private lands are vested lands, which are a form of split ownership between the state and the traditional owners.

However, scattered all over Ghana are a number of traditional groups which do not recognize a stool or skin as symbolising private communal land ownership. In such instances, the traditional arrangement is normally that of vesting land ownership in the clan, family or individual. This practice is prevalent in the Volta Region and in some traditional areas in the Central, Eastern, Greater Accra, Northern, Upper East and Upper West Regions of Ghana.

Fundamentally, land ownership is based on absolute "allodial" or permanent title from which all other lesser titles to, interests in or right over land derive. Normally the "allodial" title is vested in a stool, skin, clan, family and in some cases individuals. The traditional arrangement for making land available and accessible for land uses in Ghana consist largely of the exercise of rights under allodial title and the rights of the usufruct as limited by the allodial title.

For the purpose of land inventory and registration the usual classification of land ownership within the Ghanaian customary and legal concepts can be identified very broadly into four types. These are Stool and Skin Lands, Public and State Lands, Family Lands and Individual land Holdings. There are five classes of interest in land which can be registered. These are allodial title, customary law freehold, an estate of freehold or an interest less than freehold, leasehold and lessor interest.

Guided by the existing customary practices the state had accordingly fashioned a formal administrative framework consisting of a number of land sector agencies, mainly under the Ministry of Lands and Forestry, to facilitate a rational and relatively orderly system of land administration. Enabled by enacted legislation, these agencies variously perform the following functions:

- administration of public lands,
- administration of vested lands,
- administration of stool lands,
- settlement of stool land boundary disputes,
- collection and disbursement of stool land revenue,
- determination of land and other property values for various purposes where government has an interest (rental, purchases, etc.), ratable values, and compensation for public land acquisitions,
- Undertaking of national land surveys and mapping, licensing of surveyors and verification of survey plans,
- maintenance of up-to-date scientific data, maps and plans, geographic database and information system,
- registration of titles and protection of interests in land throughout Ghana,
- formulation of land development standards, co-ordination of land development activities and approval of settlement development plans.

Purpose of Cadastre

The purpose of the Cadastre in Ghana is to provide a machinery for registration of title to land and interests in land. Various researches on land tenure in Ghana have revealed major weaknesses in the system of registration of instrument affecting land under the Land Registry Act, 1962 (Act. 122). The chief among them is litigation, the common sources of which are the absence of documentary proof that a person in occupation of land has certain rights in respect of it; the absence of maps and plans of scientific accuracy to enable the identification of parcels and ascertainment of boundaries; and the lack of prescribed forms to be followed in case of dealings affecting land or interests in land.

Apart from litigation over land, a variety of problems associated with agricultural tenancies and credit facilities have been encountered by farmers in many parts of the country. Several occasions have also arisen where a farmer has bought land from Chief and his elders and after cultivating the land, has been confronted with documents of title to the same piece of land by another person who has not developed the land but who claims title to the land by virtue of an earlier grant to him by a former Chief and his elders of the same stool.

The above mentioned problems do not afford the security of title for agriculture, housing and other facilities which the nation requires if it is to function effectively. Consequently, the Government has introduced a system of compulsory land title registration throughout Ghana. This is being implemented in stages beginning with the Greater Accra Region and designated agricultural areas.

The primary purpose of the system of land title registration is twofold: first, to give certainty and facilitate the proof of title; secondly, to render dealings in land safe, simple and cheap and prevent frauds on purchasers and mortgagees.

A secondary purpose is the use of the cadastre registry map to plan and design utility and infrastructural schemes. The cadastral map in conjunction with a base map can also be used for inventory of houses for the purpose of valuation and taxation.

The cadastre system under the land title registration law, PNDCL 152, 1986, is based on general boundaries. The registry map and plan is deemed to indicate the approximate boundaries and the approximate situation on any parcel shown thereon. However this has nothing to do with the method and accuracy of the survey. In cases where uncertainty or dispute arises as to position of any boundary, precise position of the boundaries are ascertained and fixed.

It is envisaged that under this system boundaries of stool/skin, family and individual lands will be properly demarcated to avoid conflicts and litigations. This will

further encourage community participation in land management development at all levels.

However, though the Land Title Registration law says that where ever Land Registration is declared the Deeds Registration ceases to operate, large areas of Ghana are still under the deeds Registration. Thus the two systems are operating side by side presently in Ghana.

INSTITUTIONS INVOLVED IN LAND ADMINISTRATION

One of the fundamental requirements of land policy formulation is the identification of the ends to which land as a resource would serve. This is because land like all other natural resources, is of no value or significance, unless there is an end to which it must serve. Such ends may be housing and industrialization in the urban areas, and agriculture in the hinterland. Thus, it would appear that before any meaningful approach to land policy formulation is attempted the national must be certain of its housing, agricultural and other policies which a land policy would serve directly. Various institutions exist in the country which have both a direct and an indirect participation in land administration. These are briefly discussed.

Lands Commission

This is the primary institution in the management of public lands. Article 258(1) of the Constitution of the Fourth Republic together with the Lands Commission Act, 1993 prescribe the functions of the Commission to include the formulation of recommendations on national policy with respect to land use and capability. In the land management sector, the department which also comprises Deeds Registry is the source of records and information about land ownership, and instrument affecting land. The Commission has branches in all the ten regions of the country and revenue collection offices in some districts.

The Office Of The Administrator Of Stool Lands

This is another institution which has been established by the Constitution (Article 267(2)). The main function of this department is to collect stool land revenue, and to regulate the disposition and development of stool lands. It has offices in all the ten regions of Ghana.

The Land Valuation Board

The land Valuation Board is the key institution in the assessment of compensation and other payments such as Stamp Duty, related to land administration. It has offices in all the ten regions.

The Survey Department

This is one Department which is at the centre of land administration in the country. The database developed in the Survey Department provides the basis of scientific decisions making in the land sector. It is regulated by an Act of Parliament, Survey Act 127, 1962 and has offices in all the ten regions of Ghana. Presently we are in the process of establishing offices in all the one hundred and ten (110) districts of Ghana in the land administration sector the Department provides.

- Topographic maps to Town and Country Planning Department and the Lands Commission.
- Registry Maps showing the parcel fabric for each Registration District
- Land Title Plans for each individual parcel of land for which title certificate is issued.

The Land Title Registry

This was established by the Land Title Registration Law, 1986 (PNDCL 152), and is another major instrument in our land administration system. Basically, the Registry seeks to register all transactions in land and issue land title certificate. The registration provides a guarantee of the titles so registered and; thus, invests the holder of the title with the confidence to deal in his land.

There are Land Title Adjudication Committees created by the Chief Registrar of Lands for the resolution of disputes in the land title declared areas.

The Stool Lands Boundaries Settlement Commission

The Commission was established under the Stool Lands Boundaries Settlements Decree, 1973 (NRCD 172) to adjudicate and resolve boundary disputes among stools. The commission is centralized with the only office in Accra.

The Town and Country Planning Department

The Department is charged with the planning and management of the development and growth of human settlement, their environs and hinterland. The department has offices in all the 110 districts capitals of the country.

DEPARTMENTAL RELATIONS

The relations and flow of information among the departments involved in land administration mentioned above is as shown in figure 1.

TECHNICAL SET UP

INTRODUCTION

The Survey Department provides cadastral plans for registration. The function of the cadastral plans is to lay the foundation and satisfy the initial requirement of the land registry by defining the parcels of land which constitute the objects and units of record. This function enables an orderly and comprehensive basis which is necessary if the construction and conduct of the register is to be economically effected throughout the country. The process of plan preparation after data capture had been manual until recently when the process has been automated.

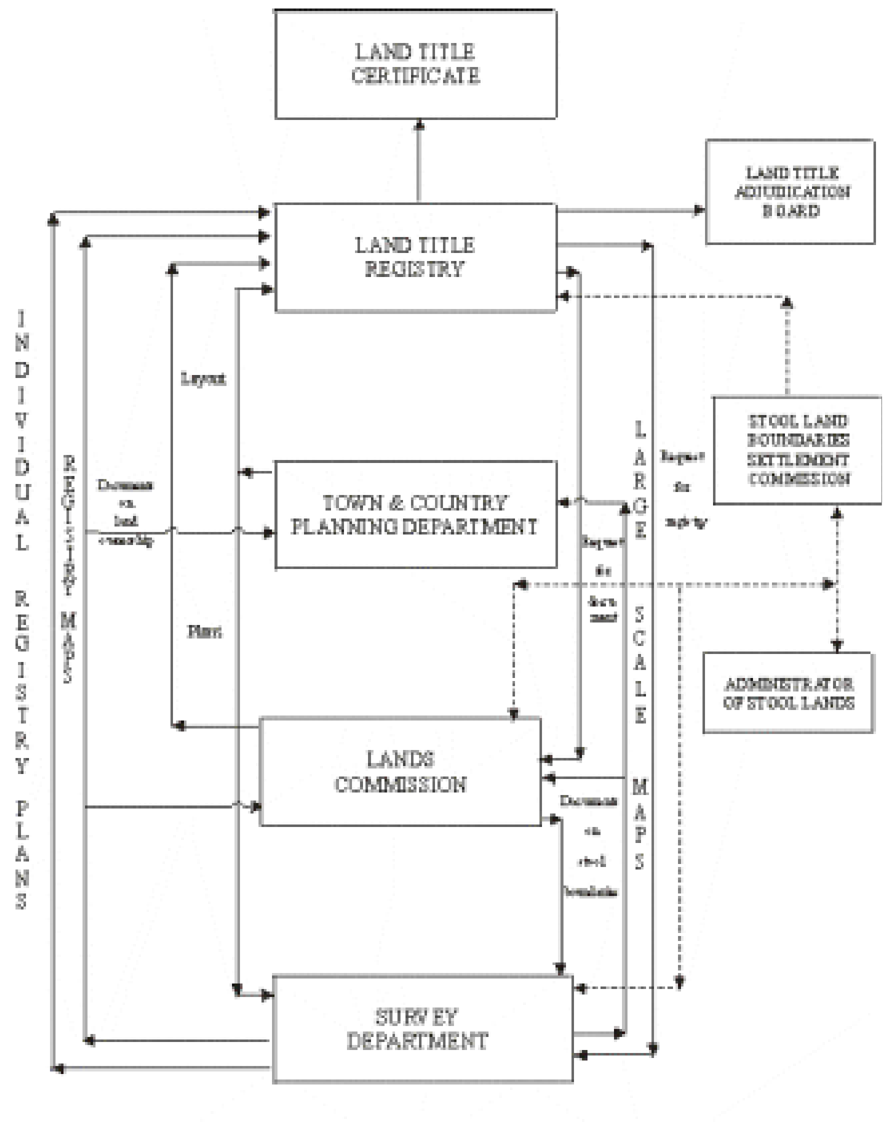

Figure 1: Technical Relations and flow of Information

THE MANUAL PROCESS

Definition and Mapping of Land Title Sections

The Land Title Registration Law, 1986(PNDCL 152) requires the Chief Registrar to direct the boundaries of all lands within a registration district be demarcated and surveyed. The Chief Registrar is authorized to divide a registration district into registration sections. Section 34 of the Law provides that the Director of Surveys shall prepare registry maps for each registration district and that parcels within each section are to be numbered consecutively.

In general, section boundaries follow boundaries of settlements or communities. Section maps are prepared at a scale of 1:2500. The number of parcels within sections varies considerably. On average, there are about 1200 parcels per section map. Twenty registration districts have been declared in Greater Accra Region.

Procedure for Registration

The process begins with the Minister of Lands and Forestry declaring a registration district upon the advice of the Chief Registrar of Lands (CRL). The CRL then requests the Director of Surveys (DS) to divide the declared districts into sections, and sections into blocks and blocks into parcels and to number them consecutively. The Director of Surveys then prepares the sectional maps using private consultants whiles the Survey Department sees to the quality control of the work.

Upon receipt of application for fist registration, the cRL requests the DS to prepare plan in respect of that land under the application. Field inspection and survey are carried out. Computations and subsequent plotting of the plan follows. The work is then checked by the Examiner and the Chief Cartographer. if standards are met, the work is sent to the lithographic section for printing. The printed output is checked and forwarded to the DS for approval. The applicant then pays and the approved plan is forwarded to CRL.

CRL advertises in the dailies and after two weeks, if no objection is raised, the Land Certificate is issued.

AUTOMATION OF THE LAND TITLE PLAN PREPARATION

Introduction

The manual process of plan preparation is slow, laborious and time consuming. This has led to the slow registration of individual parcels. Over 500 applications are received by the Chief Registrar of Lands to be forwarded to the Survey Department per week. To produce the plans manually it was found out that a draughtsman takes about three days to prepare one parcel plan. This was found to be too slow so to accelerate the parcel production, a “proof of concept” of using digital technology in the production of the plans was undertaken using existing equipment in the department. This proved successful and the Department sought for financial assistance from the Land administration Component of the Ghana Urban II

Project, to sponsor training and computerization of parcel plan preparation using Arc/Info Software on Personal Computers. Six senior were trained locally by the consultant and they are now implementing the programme.

To date four out of the twelve completed districts sectional plans have been digitised and plans are being issued using the automation procedures developed. A sectional plan has about 1,200 parcels on the average. A district comprises of about 30 sections. This gives a figure of completed parcels of 144,000 which go through the automation process. It takes about four days after the day of presentation to have plan forwarded to the title registry instead of about two months using conventional methods.

The Department's next line of action was to speed up the process of preparing the registry map in digital format using Photompas. This is as a result of the Directorate's aim of improving mapping, land titling registration and conveyancing in the main urban areas as well as develop cost effective methods of adjudicating disputes on lands and issuing of titles. The Department has to date used this method to prepare nineteen (19) photomap based sectional maps in Kumasi and twelve (12) in Accra. A photomap sectional map contains about 2000 parcels. This method has to date yielded 38,000 parcels in Kumasi and 24,000 parcels in Accra.

Document Assembly for Automation

There are several documents required to prepare an automated Land Title Plan, these are:

- Sectional map (original stable base manuscript),
- Existing parcel map production key,
- Block outlines,
- Photomaps,
- Field Surveys Data

Sectional Map

The original map must be duplicated the photo-laboratory onto a stable base material surface with the emulsion side down. This new material copy is used for all detail automation. It is advisable to ensure that all streets, rivers and other like linear features are named prior to digitizing as this will improve the character of the final Parcel Plan. We have found evidence of manually drafted grids which are below the expected accuracies achievable for such work. Where this problem arises one has to make multiple registrations and always works within the bounds of these registration points. In most cases seen to this point it has been found that registering the sectional map in approximately four quadrants, as opposed to the normal, one registration setup at the extremities of the sectional map, is sufficient. In the event of poorer grid then one may have to register as many times as there are interior grid squares to resolve the problems.

Existing Parcel Map Production Key

The automated sectional map used for the production of Parcel Plans is also used as a database to track the production of Parcel Plans. In order to ensure that the database reflects the Parcel Plans produced prior to automation we need to flag each lot for which a Parcel Plan has been issued by the Survey Department.

Block Outlines

The block outlines prepared by the Cartographic Section must be transferred to the sectional map being automated. Care must be taken to ensure that the block lines are shown distinct from the sectional boundaries then the lot boundary is digitzed first and that line is, or those lines are, copied to the block coverage. This ensures that coincident lines are mathematically coincident and not simply close.

Photomaps

Photomaps acquired by the Department are used to prepare Sectional Maps. Property boundaries that are visible on the Photomaps are identified and marked. Where property boundaries are not clearly identified on the photomaps, corners are established from well defined reference features on the photomaps, so that coordinates of the property comers are computed and plotted on the photomap. Digital mapping technology is then used to prepare registry maps.

Field Survey Data

Computed Field data in the form of coordinates are obtained from the field surveyors. Using the Arc/Info Software points and lines are generated to form the parcel fabric. A check plot is made to check with the field diagrams and the necessary corrections made.

DATA AUTOMATION

The automation of the sectional map is divided into several distinct steps, each of which is described in the following section. Some of these steps yield a physical digital or paper product while others provide insight into the quality of the actual automation process. The process is now guided by a series of PC Arc/Info macros and menus which allows both rapid data conversion and minimal operator training. It is important to recognize that these macro procedures are not static as staff of the Department have been trained to improve and add to the library of macros to further improve the data loading procedures.

Data Automation

The automation steps include the following: Entering of lower left and upper right co-ordinates of the sectional map to generate the grid/tic coverage.

Data capture: The lot, block, and linear coverages are captured separately. The annotation to each lot, if it exists, is added. Lot numbers are then added.

Error Plot is then prepared to check for road access, curve boundaries, etc.

The lot and block coverages are overlaid to form the registry map.
Parcel map preparation.

Quality Control

There are a number of automated and semi-automated quality control procedures that provide for the following checks.

- Digitising accuracy;
- Road access to all lots;
- Parcel having no or inappropriate numbers;
- Block numbering, sliver polygons (lot and block);
- Spelling of Street and other linear feature names;
- Confirmation of prior existing parcel map production.

Detail Description of the Automation Process

The entire process is guided by a menu system written in the PC Arc/Info procedural language known as Simple Macro Language (SML). This menu system attempts to guide the operator systematically through all of the steps required to automate an existing Sectional Map, detect any errors in the data, produce quality control maps and finally produce a Land Title Registry Plan.

The automation process creates, providing the CONTROL file exists via a menu choice, the following Arc/Info coverages: GRID, LOT, BLOCK, LINEAR.

The GRID coverage is produced without operator intervention and comprises a series of grid lines spaced 1,000 feet apart in northing and easting. The ground coverage corresponds to the bounding grid values: minimum (x,y) and maximum (x,y) within the control file. The coordinate of each intersecting pair of grid lines is used as registration points for the digitization of all spatial data. Since these points are computed and not scaled from an existing sectional map the grid is mathematically perfectly square. These computed points allow us to determine how accurately the grid has been drafted on the sectional map prepared by the cartographic technician. The GRID is used to both assist in the automation of the sectional map and in the final plotting of a Parcel Plan. The GRID coverage is derived directly from the bounding coordinates contained in the CONTROL FILE. In the event that a change is required to the extent of the GRID coverage after it has been created then the operator must manually KILL the GRID coverage and make appropriate changes to the CONTROL FILE using a text file editor. Once the changes have been made to the CONTROL FILE, the same menu choice is used to re-create the GRID coverage. If the LOT and the BLOCK coverages already exist these will not be altered by this process.

In the event that the operator needs to introduce TICs (registration points) that are not located at the intersection of the 1,000 foot grid lines then these TIC identifiers and coordinates must be entered in the TIC file using the TABLES component of the Arc/Info software. This possibility rarely occurs and is generally only required when the sectional map does not have a regularly spaced grid and or the grid only comprises of an exterior box which has not been prepared on a standard 1,000 foot interval but on an interval of some hundreds of feet. The operator can introduce the TIC values any time during the automation phases. These odd valued TICs are usually only required in the LOT coverage but could be entered in the BLOCK and LINEAR coverages as well.

The LOT, BLOCK and LINEAR coverage created via the menu choice are all blank, that is they do not contain any data. The process simply creates a series of empty coverages and establishes the correct processing tolerances. Each coverage contains the identical boundary and registration data as does the GRID coverage.

The LOT coverage is the digitized parcel fabric taken from the hardcopy sectional map. This coverage contains parcel boundaries and parcel numbers, the road corridor is also assigned a quasi-lot number. Care must be taken to 'close' the polygons formed by the road corridors at the borders of the map.

The BLOCK coverage consists of the exterior District and/or Section boundary and the interior block boundary lines. Each block is uniquely numbered and the exterior Section and/or Districts are named by placing a text string consisting of the appropriate District or Section number just outside of the exterior boundary. These names are used to complete, the Parcel Plan where the District or Section names are required due to the location of the parcel within the section more especial for parcels close to the exterior boundary.

The LINEAR coverage contains the centre line of streets, rivers and drains. These features are use to add character to the Parcel Plan. These linear features are not analytical in nature and it is advisable, though not mandatory, to simply digitize these lines as disjointed vectors and attach the attribute of feature name. It is not necessary to topologically connect these linear features as they are only graphical in nature. Each of these linear features is assigned a unique feature code.

The final coverage is the REGISTRY coverage and this is created by the topological union of the LOT and BLOCK coverages. If the REGISTRY coverage is acceptable then the two basic coverages, LOT and BLOCK, used to create the REGISTRY must be archived and removed from the digital workspace in which the REGISTRY coverage exists. This will ensure that the only parcel fabric available for the production of Parcel Plans as well as available for future changes to the parcel boundaries, subdivision, consolidation, boundary adjustment and road access provision, is the final REGISTRY coverage.

A menu choice will load the Arcedit software and provide another series of menus to guide the operator in the digitization and editing of the LOT, BLOCK and LINEAR coverages. This is no requirement to digitize

these in any particular order however experience has shown that it is most efficient to do so in the order listed above. There are a few 'rules' which need to be flowed in order to end up with LOT and BLOCK coverages which will meet the parcel mapping requirements and the subsequent topological overlay process. These are:

Coincident lines between the LOT and BLOCK coverages must be digitized first in the LOT coverage and subsequently copied into the BLOCK coverage, these lines must not be digitized twice;

The lot line must not have any intermediate vertices as each line must be digitized with only two (2) points. This will ensure that the system can automatically compute the bearing and distance of each boundary;

Each lot must be given a unique numeric number within each block. It is possible that there are non-unique lot numbers per sectional plan (i.e. there could be two lots each having the lot number '3') but when looking at the combination of lot number and block number there is a distinction (i.e. block 5 lot 3 and block 7 lot 3 is acceptable);

Lots that have not been assigned a number or have been assigned a non-numeric identified must be re-numbered prior to automation. In the event that either of these renumbering steps are required then the operator must note this in the DMS file that pertains to the sectional map being automated. Failure to do this will result in a parcel that has no lot number or potentially has a non unique lot number (i.e. bloc 3 lot 5 is the same as block 3 lot 5A as characters are not permitted by the system). This parcel will not be capable of meeting the minimum requirement for subsequent Parcel Map production.

High quality sectional maps will require only one registration process (lower left and upper right corners of the sectional map). Sectional maps of relatively lower accuracy may require multiple registrations, possibly one per grid square in extreme cases. The multiple registration process is needed to obtain the 'best fit' between the automated sectional map and the prior hard copy.

The automation process speed up the parcel plan preparation. It takes seven minutes to prepare and print four copies of a requested parcel plan. In principle it takes four days to have a request plotted and sent to the Director of Surveys for signature and onward submission to the Chief Registry instead of 4 to 9 months using the manual methods. To date four land title registration districts of Accra, comprising of about 120 sections with about 144,000 parcels, on the average of 1200 parcels per section have been captured. Samples of the sectional maps and parcel plans at three different scales are attached as appendices 1,2,3 and 4.

BENEFITS AND APPLICATION

The provision of the Land Information System is to enhance the provision of cadastral plans for stools/skin and all other parties interests in land. The automation process will allow the addition of all transactions in terms of attributes connected to the parcel of land. Sub-division and Combination of parcels of land become easier and so is the ease of conveyance. Retrieval of information about a land in the database also becomes easier.

The Cadastral Information System developed at the Survey Department of Ghana is georeferenced. It therefore provides a comprehensive base for all other information from land delivery agencies to be added. A committee had therefore been set up to network all land administration institutions for data accessibility and exchange. Some of the benefits of cadastral information are as follows:

1. Security of tenure
2. Safe, fast and simple dealings in land
3. Property valuation to determine compensation values
4. Property ratings for taxation purposes
5. Reduction in land disputes.

It is intended to structure the database so that more attributes will be added for use in a Geographic Information Systems environment to assist in the socio economic development of Ghana.

Despite the above, the Survey Department is beset with the problem of lack equipment, office accommodation and shortage of manpower due to inadequate funding. We shall be most grateful for any assistance (technical or financial) from any quarters to expand our activities to meet the demands of fast and simple registration and conveyancing.

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CADASTRE IN THE DEMOCRATIC REPUBLIC OF CONGO AND CADASTRAL AND TERRESTRIAL INTEGRATED SYSTEMS

Professor Joseph Mangombi Deiilonga, General Manager of the G.I.C.

Our talk shall revolve essentially on:

1. General Survey on the Cadastre Missions
2. Cadastre Organization in DRC
3. Logistic Means for the Cadastre in Congo
4. Prospects and Potentialities for the Cadastre Valuation in DRC;
5. Approach Suggestions on Integrated Cadastral and Terrestrial Information Systems
6. Conclusion

GENERAL SURVEY ON THE CADASTRE MISSIONS

Since the cadastre is in charge of the census of all land ownerships, of the search for their owners, of the recognition and definition of those ownerships boundaries, of their description and valuation, it always remains an essential data bank for soil occupation and management.

The real estate inventory filing cabinet must be susceptible of providing any necessary information on soil occupation as well as any real estate ownership title so much for the State and for the Private.

a) The fiscal mission consisting of the revision and valuation of unbuilt properties in order to establish the land tax and of built properties to establish local taxes.

b) The legal and land mission consisting of identifying and determining physically the properties as well as their owners. Each part of land is methodically itemized.

c) The technical mission essentially consisting of the elaboration of a great scale plan that shall progressively cover all the national territory and permanently updated.

What emerges from those three missions is that the cadastre remains not only a data bank for the public services, but also a potential source of incomes for the public finances. However, in DRC, since 1995, the incomes coming under the cadastre are classified within the national and administrative incomes category managed by the D.G.R.A.D. (General Management of Administrative and National Incomes).

Moreover, the Tax Office General Management (D.G.C.) that manages the Land Dues and Taxes on the Letting Revenues (C.R.L.), has not yet succeeded to work with the cadastral survey so as to make profitable and rationalize the sector. The C.R.L. are rated on an inclusive basis at 20% of the gross income from the registered rent. In fact, that is a real organization and valuation problem of cadastre in DRC so that the latter might respond to this fiscal purpose.

CADASTRE ORGANISATION AND STATE IN DRC

During the colonization period, King Leopold II of Belgium created and legalized the real estate by the Decree of August 22, 1885 completed by the one of September 15, 1886.

The first one concerned only the lands occupied by the "Indigenous people" and the "non indigenous" during the precolonial period, whereas the second one concerned later acquisitions to be distinguished as follows:

- cystinart kabds
- lands belonging to a private estate or to the State
- registered lands.

However, it was the October 13, 1889 Decree that created and organized the Congolese cadastre. The latter, after several revisions, was repealed by the land law no. 80-008 of July 18, 1980 which now regulates the real estate in DRC. It institutes the registration certificate as the sole unassailable document establishing the title deed. So the country is split into land cadastral areas whose unit is the parcel.

Those three missions described above are insured in each area notably by:

- the land cadastral survey (technical),
- the fiscal cadastral survey
- the title deeds service

Nonetheless, only the cadastral survey (technical) and title deeds service are organized and operate with rudimentary means.

The fiscal cadastre service which should serve as basis for the proportional tax on rental incomes is not made profitable.

The land cadastre survey (technical) has no updated cadastral plans since several decades. No means is brought into play for a general overview working-out.

Housing estate works are carried out in isolated manner creating several non-integrated unreliable, and non-homogeneous networks. That is a genuine technical problem requiring an urgent intervention.

Besides, several network points (geodesic points) destruction as well as the network non-densification did not enable the cadastre survey to find any basis for trying up the supplementary network, that must bring the network density to a point valid for 100 hectares.

The land cadastral survey has not developed in such a way to insure great scale levers checking and coordination as carried out by other public services such as:

- the national company of electricity
- the water supply company
- refuse collection and drainage office

- posts, telephones and telecommunication office, etc.

Plans and cadastral documentation keeping that is graphical and numerical information as well as the title deeds information, is also a daily concern for the Congolese cadastral administration.

As a matter of fact, all the existing information are kept on ordinary and non-digitized paper. That is a genuine logistic problem that shows the rudimentary condition of the sector management so vital for the economic health.

LOGISTIC MEANS FOR THE CADASTRE IN CONGO

The cadastral administration in DRC has not got at its disposal any electronic or modern means for handling and managing data, documents production and information backing up be they graphical or numerical. No graph plotter, no computer for backing up, handling and data interpretation, no calculation centre for information handling.

Cadastral services like many others have not got at their disposal high precision topographic tools of this generation. With a personnel in majority at the retirement age, without refresher courses, the tool's great age, there is a genuine data reliability problem concerning documents (plans) and alphanumeric information. Young well educated executives are neither motivated nor attracted to work due to low salaries granted by the State service.

Despite this dark picture in connection with the Congolese cadastre, it emerges that the sector offers several opportunities and some prospects may be contemplated because of its potentialities.

PROSPECTS AND POTENTIALITIES FOR THE CADASTRE DEVELOPMENT IN DRC

The picture that the cadastre presents in DRC leads to some thoughts regarding its future. It presents several opportunities since the whole country is a vast construction site. By this very fact, on the technical level, the cadastre always remains a data bank for the land and property management.

A harmonious land management is achieved through cadastre standardization and rationalization. It is of public interest to have at its disposal a genuine and reliable inventory of property ownership and real estate for the public services and the private. It is an essential tool for urban and rural regions planning and management. Cadastre rationalization and modernization shall allow to cut down land and real estate conflicts constituting the majority of civil lawsuits, that is 80%.

Since the country is in search for financial resources, cadastre shall allow to dispose of a reliable base for the land tax. The Congolese cadastre modernization shall serve in the polyvalent cadastre creation, that is also the networks, forests, mining, rural cadastres, etc.

APPROACH SUGGESTIONS ON INTEGRATED CADASTRAL AND TERRESTRIAL INFORMATION SYSTEMS

From the foregoing, it fits to understand that it is urgent to have at one's disposal adapted spacial reference systems, since they are really future bearing.

In thus doing, it emerges that an adequate spatial reference information system must be a computerized system, made up of material, software, data and applications.

It must allow to digitize and edit, back up and reorganize, modelize, analyze and represent spatial reference data in graphic or numerical mode. So we suggest following options for integrated cadastral and terrestrial information systems:

Appraisal of Cadastral Systems Utilized in Different Countries and Their Integration Level in Decision-Making

Today, cadastre development can be conceived only in the experience framework and information exchange.

This exchange shall allow a calling into question of data and methods that have become obsolete with a view to constantly adapt them to the technological progress in the regional or continental overall framework. So, decision-makers shall profit from others' experiences while adapting them to the particular context of each country.

A permanent exchange crossroads creation must allow to formulate appropriate approaches to development and national cadastral services profitability. To improve cadastral systems, many African countries need to make an appraisal that can allow establishing a deep diagnosis which shall end up in assessing the situation and propose appropriate remedies, that is, remedies that are technically effective and inexpensive, so as to integrate within the multiple priorities to extract from national development plans.

A problem is set out about the needed credits to allot to such a step, that cannot be mobilized by our States because of the recession they are found in. Nonetheless, the appraisal results shall allow different decision makers to be conscious of the stakes and potentialities that a well managed cadastre offers.

On the other hand, a regional scale valuation shall allow to harmonize different cadastral systems and a large scale (continental) consciousness-raising for the sector development.
Besides, the pilot projects creation aiming at the improvement of serviced lands supply to build is an approach susceptible of promoting the African cadastre. It is a question of creating housing estates that are endowed with all the various networks, that is, serviced lands which shall allow, on one hand, decision makers to propose title deeds with a high added value, and on the other hand, cadastre survey to have at their disposal necessary information on modelized sites.
This experimental stage shall have the purpose at the same time to create and test a computerized model of data base whose the following plan can be an illustration.
Success in such an experience depends on the volume and quality of spatial reference information to put at

the disposal of public users and decision makers. This step aims at searching methodologies that could allow

CADASTRAL DATA BASE

Plans	Register	Particular Exploitation
Plan for land register	Descriptive State of Parcels	Polyvalent Cadastre
Overall Plan	Counting	Numerical model of Ground
Thematic Plans	Surface Statistics	
Transfers Plan	Transfers Chart	Statistics

USERS

This model shall have the following distinguishing marks:

- appropriateness to reality, speedy adaptation
- data homogeneity
- possibility to use and adapt data since they are subject to numerous changes
- precision guarantee
- quality data long-term keeping and backing up, complete and updated
- data consistency.

one to partake in the construction of the whole and to the whole to reflect each one's identity.

That is one of the major challenges to take up so that the Territory information systems whose cadastral systems serve not only to store and refer to, but also these may be used as genuine tools capable of intervening in the processes of study, planning and decision making help. Certainly, the modelization phase constitutes the essential of the step..

The approach results shall help in proposing quick models of updating old cadastral and coherent integration systems of badly matched data and stemming from various sources.

Information systems use impact on rational resources management in accordance with populations needs

Rational management of natural and national resources needs a spatial information control. Most existing information systems do not have at their disposal any more infrastructures capable of responding to different appeals. Adapting these structures capabilities to the needs development is an urgency deserving of reflection and solution.

It is imperative to create or adapt national geographical information systems "GIS" in each country to serve as a base for rational management of spatial information. The demographic growth experienced in Africa today often leads to strenuous activities with an evolution of development modes or space operating.

In many countries, it is often observed that the demographic dynamic mentioned here goes with significant transfer of land space use: quick urban quarters extension, agricultural industrial and touristic activities heaviness.

But all these undertakings cannot be harmonious without a precise identification of properties and rights, without cartographic base and effective space management tools.

To do so, effective information systems shall serve as multiple purposes reference. To illustrate, we can consider lumbering, in Central Africa, whose durability comes through the forest inventory and exploitable lumbers volumes assessment.

Geographical information systems by satellite earth observations can provide precise and qualitative and quantitative data in due time at a reasonable cost. It is the same thing for mineral, agricultural, hydrographic and touristic resources management etc. Hence, information systems promotion presents genuine socio-economic and technical stakes for patialoptimal management in Africa.

This approach shall allow decision-makers and different actors to have at their disposal an accessible and reliable information in opportune time for a harmonious and coherent territory management.

Taking into account the Sociological Approach in Cadastral Systems Setting-up

The execution of any land reform cannot succeed unless the concerned populations are effectively implied. In Africa, man is always tied in with his land. Customary law and written law cohabitation often poses a problem in the lands allotment and distribution, with land and agrarian conflicts as a consequence. Land represents an existence symbol and a symbol of custom perenity, and any disruption due to modernism causes several reactions sometimes bringing about many projects thwart. Hence, the interest to integrate the sociological dimension within the land reform for an effective implication of concerned populations.

That is a very complex matter calling for an in-depth study to make out the lands allocation system. It is sometimes difficult to be unaware of the fact that according to many customs only the head of the village who has got his power from ancestors and from God, is entitled to allocate resources use titles. It is soil conservation memory. If his attributes (authority) are ignored and if decisions are made arbitrarily, that may lead to considerable conflicts between communities. It is the case, for instance, in the East of DRC.

This approach shall even allow to create, besides the urban cadastre, the rural cadastre in many States to help modelize the overall and dynamic management of the rural environment.

Geodesic Networks Regional Homogenization

Geographic information systems cannot be integrated at the regional level unless one has at his disposal a geodesic network with a reliable base. It shall serve as a skeletal structure for all cartographic matters and all questions of support to cadastral systems. With today's technological progress, it is a problem that can find a solution inexpensively with the GPS and other information acquisition techniques such as satellites and photogrammetry.

Africa cannot miss to profit from these high-performance tools for optimizing its geodesic networks and homogenize them. Hence, the cadastral works quality, today called into question, shall find all its reliability. The overall plan of action will be made up of:

- tools and methods of acquisition and of spatial information surveys (satellite pictures,aerial photographs, GPS);
- computer equipment enabling to manage important data base and handle numerical information stemming from photo-interpretation or from photogrammetric reproduction;
- spatial information handling tools, that is G.I.S. and T.I.S.;
- computer software and materials needed for management and cadastre modernization, the creation of national calculation centres to enable supervision, integration, standardization and topographic works homogenization.

At last, to be successful, all these proposals needed the decision-makers implication, i.e. public powers, since those information are in connection with the territory security and linked with the development of each state.

CONCLUSION

The Congolese cadastre, though presenting a dark picture due to its tool's old age, its personnel ageing and demobilization, presents potentialities and opportunities for its development; it is in fact an important exploitable resource for public finances. Modernizing and equipping this sector shall allow to set up an important data base for tax services which have no reliable tax calculation ending up in a loss of incomes for public finances and for political and executive decision-makers who would then permanently control the expansion and urban-rural changes, and for the various interveners (Civil Engineering) who would have at their disposal a reliable information system for uniting, homogenizing and works integration, etc.

A well managed and updated cadastral information system is an essential tool in assisting public decision-makers.

At the African level, taking into account the potentialities and opportunities importance that cadastral systems offer within the framework of national development plans, mostly for public finances, goes through a large scale consciousness-raising that may be made possible by the creation of a crossroads information exchanges.

Also, the ECA should help promoting the operation of pilot-projects that are susceptible of serving as reference cores.

The spatial information must be developed at the same rhythm as other medias and oriented to a multiple finality referenial. Geographical information systems (cadastral and terrestrial) must be essential tools for the planning. They must benefit from credits and attract the attention of public leaders at the same degree as the medias, the mines and other sectors generating incomes for the public treasury. The ECA should incite different states to draw up a charter serving as support for public decision-makers to manage the resources effectively and so contribute to the gross income increase.

Operating and utilizing spatial reference information systems lay down though in-depth thoughts on the data nature, data management methodologies and exploitation, as well as their integration within the study or decision-making process.

These systems applications must aim first at the management of numerous institutional data, to display an ambition to end up in a tool capable of intervening significantly and efficiently in decision-making process.

The ECA should approach African decision-makers by forums susceptible of making them understand the necessity to set up reliable cadastral and terrestrial information systems that are to cover the needs not of one service but an overall of services, indeed all the partners concerned by the spatial development.

Hence, the necessity of an overall approach and a coherent vision of the Territory and of data describing the territory shall imperatively make itself felt. Those systems shall serve as memory for decision-makers and shall revolve not only around the acquisition, updating and data visualization but also on simulation, management and help in decision-making. They will also aim at data and services integration.

They shall allow the reunion of local partners, the needs analysis, the models and data catalogue definition, the data handling and keying-in coordination and organization as well as the spatial referenial exactness and thematic order guarantee. This shall enable to avoid wasting and redundancy.

To succeed, such a step goes through the regional partnership that the ECA may promote besides African decision-makers.

MISE EN PLACE D'UN SYSTEME D'INFORMATION CADASTRALE: CAS DE LA COTE D'IVOIRE

M. Fofana, Secrétaire Générale, CNTGI, Abidjan

CONTEXTE

Les pays africains dans leur développement sont confrontés à d'énormes problèmes d'investissement dont les financements dépassent largement les ressources propres de l'Etat.

Les financements dans le domaine de l'éducation, de la santé et des infrastructures socio-économiques constituent des investissements prioritaires que l'Etat n'arrive pas à satisfaire pleinement .

Face aux difficultés de la conjoncture actuelle, et surtout face aux restrictions imposées par les bailleurs de fonds les pays africains sont obligés de développer des ressources internes beaucoup plus importantes.

L'imposition foncière connaît un regain d'intérêt dans cette optique car le foncier constitue une source de revenus potentielle des Etats qui apparaît encore mal exploitée.

Les Etats africains conscients de l'enjeu économique que constitue l'impôt foncier tentent d'assainir sa gestion et de la rendre plus performante. Cependant ils sont confrontés à d'énormes difficultés dans le recouvrement des impôts.

La Côte d'Ivoire n'échappe pas à cette situation préoccupante au niveau de sa gestion foncière.

Les problèmes majeurs rencontrés sont:

- la faible connaissance du portefeuille foncier. En effet , à ce jour, il n'existe pas un recensement exhaustif de tous les titres fonciers existants.

- Le chevauchement des compétences au niveau de l'attribution des parcelles. Plusieurs structures sont impliquées dans la gestion foncière, malgré la règlementation existante. Les préfectures, les Mairies, le Domaine Urbain et le Cadastre n'arrivent pas à coordonner leurs activités.

- Les attributions informelles de lots.
  Cette situation est créée soit par les structures citées plus haut soit par les particuliers ou des communautés villageoises. Il en résulte souvent des attributions de la même parcelle à plusieurs demandeurs.

- L'archivage lourd et difficile d'accès.

- Les procédures d'accès aux titres fonciers longue et qui relève d'un parcourt peu simplifié.

- Enfin le recouvrement difficile des impôts fonciers malgré les lettres et avertissements adressés aux contribuables.

Face à tous ces problèmes énoncés, ci-dessus, le CNTIG propose une gestion informatisée des biens fonciers. Ce système intégré aussi bien la maîtrise de l'espace (plan parcellaire) que la base de données associées relative à chaque parcelle.

APPROCHE METHODOLOGIE

Le système consiste à mettre en place un outil de localisation précise des contribuables et des matières imposables.

- **Phase preparatoire**

  1ère étape : réalisation de la carte de base,
  2ème étape : conception du questionnaire.

- **Phase de la mise en place**

  3ème étape : enquête fiscale et foncière sur le terrain
  4ème étape : création de la base de données alphanumérique
  5ème étape : mise en relation informatique de la base de données graphiques et alphanumériques.

PHASE PREPARATOIRE

1ère étape : la réalisation de la carte de base
Elle consiste à la collecte de plans de lotissement, de mappes foncières et de plans cadastraux au niveau de toutes les structures habilitées à traiter les parcelles foncières.

Ces documents sont ensuite numérisés et assemblés selon une organisation spatiale hiérarchisée. Pour localiser précisément les contribuables et les matières imposables une codification des parcelles est mise en place par rapport aux quartiers, aux îlots, aux parcelles.

Cette codification (unique) numérisée sur les plans parcellaires constitue la clé entre la base de données graphique et la base de données alphanumérique issue de l' enquête de terrain.

2ème étape : la conception du questionnaire

Elle a consisté à l'analyse du cahier de charges imposé par le commanditaire.

Le questionnaire reprend de manière synthétique tous les paramètres permettant d'identifier un contribuable, les matières imposables et surtout d'évaluer de manière pertinente une parcelle.

Les informations recueillies peuvent être subdivisées en quatre groupes :

- <u>Informations administratives</u>

- nom de quartiers, des secteurs
- Toponymie (nom et identification de la voirie)

- <u>Données topographiques de repérage</u>

voiries (rue, avenue, boulevard)
- édifice remarquable
- plan d'eau

- <u>Données foncières et cadastrales</u>

- numéro d'Ilot
- numéro de lot
- numéro de parcelle
- type de bâtiment
- nature du titre foncier

- <u>Données socio-économiques</u>

- nom du propriétaire du lot
- nom du propriétaire de l'activité économique
- type d'activité
- nature et montant des taxes perçues

PHASE DE MISE EN PLACE

3ème étape : enquête fiscale et foncière

Les enquêtes sont menées sur l'ensemble des parcelles, des logements, des activités de la ville de la commune. Il est procédé au recueil exhaustif de l'ensemble des données en se repérant par rapport à la carte de base. L'enquête est organisée et suivie par le CNTIG et réalisée par des enquêteurs chevronnés à un niveau de Maîtrise.

4ème étape : création de la base de données

La base de données est créée à l'issue de la saisie informatique des données de l'enquête de terrain selon une structure qui permet de codifier les parcelles, d'identifier les propriétaires, les utilisateurs et les différents usages qui sont faits des parcelles.

5ème étape : mise en relation informatique de la base de données alphanumérique et du graphique du parcellaire.

Toutes les informations recueillies au cours de l'enquête sont saisies et intégrées dans la base de données graphiques grâce à la codification fixée au départ.

Cette codification qui représente non seulement la « clé » de la mise en relation des deux bases devient surtout l'élément d'identification individuelle de chaque parcelle. Inscrite sur le plan, elle permet d'orienter l'enquêteur en vue de localiser la parcelle de manière précise sur le terrain. La parcelle est donc identifiée par rapport à certains éléments socio-géographiques caractéristiques :

- le quartier (unité administrative)
- les rues ; avenues et boulevards
- le numéro de l'îlot
- le numéro de lot
- le numéro de parcelle
- le code rattaché à la parcelle
- le nom du propriétaire
- l'adresse postale et le numéro de téléphone du propriétaire
- la nature du titre foncier
- l'affectation de la parcelle (habitation, commerce...)

RESULTATS

Le produit final est un système informatisé intégré de l'espace parcellaire et des informations qui sont rattachées.

Les techniques d'enquêtes de terrain adoptées et la validation des informations collectées permet au système de disposer d'une base de données fiables.

La conversation en numérique de tous les documents cartographiques et de leurs données analogiques permet un archivage et une consultation aisée des documents.

Le système ainsi structuré permet d'apporter des solutions aux préoccupations essentielles des gestionnaires du foncier par :

- la détermination exacte du nombre de lots dans chaque circonscription administrative,
- l'identification exacte du nombre de lots avec titre foncier et l'état d'avancement de chaque parcelle dans la procédure d'accès au titre foncier (lettre d'attribution, permis de construire etc...)
- l'identification des types de bâtis et l'usage réservé à chaque parcelle.
- L'appréciation réelle de l'état de mise en valeur des lots. Cette solution est d'un apport capital notamment dans le cadre de la gestion des demandes et des attributions de terrain.

Après les opérations pilotes réussies dans les communes de Cocody et Treichville dans le domaine foncier, le gouvernement à travers le Ministère de l'Economie et des Finances a initié un vaste programme national de réforme fiscale et foncière.

Le système d'information cadastrale tel que proposé par le CNTIG apparaît comme l'élément moteur du succès de cette initiative gouvernementale.

CHAPTER TWO

NEW WAYS OF DATA COLLECTION

FUTURE PROSPECTS FOR MAPPING FROM SPACE

A REVIEW OF THE EXPERIENCE ON THE APPLICATION OF NEW SPATIAL DATA COLLECTION METHODS IN EAST AFRICA

FUTURE PROSPECTS FOR MAPPING FROM SPACE

Gotfried Konecni, University of Hannover, Germany

Mapping from Space has become possible through the phenomenal development of space platforms and space sensors during the past generation.

Mapping from Space may be considered a technology driven activity, but it is vitally needed for the provision of basic information required for sustainable development.

GLOBAL ECONOMIC DEVELOPMENT AND TECHNICAL COOPERATION

Human activity is based upon economic development. Throughout human history economic development has gone through four different stages from

- nomadic to
- agricultural to
- industrial to
- service oriented.

Due to different conditions in different parts of the world influenced by

- climate
- soil conditions
- mineral resources
- labour
- education
- technical innovation and
- motivation

this economic development has progressed at different rates in different parts of the world.

UN statistical yearbooks list a number of parameters, according to which this progress is usually measured in the countries of the world:

- the percentage of employees in agriculture, industry and services
- the GNP or GDP per inhabitant
- the percentage of food supply
- the inhabitants per medical doctor
- the child mortality.

The countries of the world can usually be divided into three categories:

1) the low level income countries characterized by a GNP/yr under 600 $/inhabitant, a predominance of agricultural economy, and a shadow economy of over 50 %. These countries have recently shown a decline of the GNP/year.

2) the medium level income countries with a GNP/yr between 600 and 3000 $ per inhabitant, a predominance of industrial activity and a shadow economy under 20 %.
To these count the
- socialist reform countries with a stagnating GNP/yr
- the tiger countries of Asia with high foreign investment and the highest GNP/yr growth rates
- the debtor countries mainly of Latin America with stagnating GNP/yr growth rates.

3) the high level income countries with a GNP/yr of over 3000 $/inhabitant. They are service oriented, and their shadow economy is less than 10 %.
To these count the donor countries with small GNP/yr growth rates and the oil exporting countries with stagnating GNP/yr growth rate.

One of the major achievements of the United Nations System has been to stimulate high level income countries to share some of their wealth with the countries of lower income to stimulate their economic development through technical cooperation.

Of these four countries alone account for over 50 % of the total economic cooperation of 58 B $/yr for example available in 1991

- the USA 11.3 B $
- Japan 11.0 B $
- France 9.5 B $
- Germany 6.8 B $

Most of the development funding went to Subsaharan Africa with 32.5 %, but a significant portion also went to South East Asia with 27.1 %. This is proof that the system worked.

There have been many mutual discussions to make sure that some of the difficulties encountered, particularly in the poorhouse of the world in Africa, can be overcome.

They stem from institutional, financial, and educational difficulties in the countries, but they sometimes also relate to unsuitable technical issues.

GLOBAL TRENDS AND SUSTAINABLE DEVELOPMENT

The major trend in economic development is due to population growth. With the current 6 billion population, mankind will most likely double in number in the next 50 years.

Because of this there is additional need for food production and the need for sustainable development to preserve the global ecosystem with respect to a sustainable water balance, the mitigation of drought, and the preservation of coastal waters.

This leads to the necessity to monitor

- degraded forests
- poor crop yields
- dumps
- drought areas
- floods
- sedimentation
- soil erosion and desertification
- the growth of urban areas

The UNCED-Rio de Janeiro Conference of 1992 in their Agenda 21, Chapter 40 clearly describes the monitoring needs.

Continent	Population 1996	Population 2025	Growth 1995-2000 %	Urban Population %	Urban Growth 1995-2000 %
Africa	784 M	1496 M	2.7	34	4.3
Asia	3513 M	4960 M	1.5	35	3.2
Europe	727 M	718 M	0.1	74	0.5
Central and South America	490 M	710 M	1.7	74	2.3
North America	296 M	370 M	0.9	76	1.2
Oceania	29 M	41 M	1.4	70	1.4
World	5804 M	8294 M	1.5	45	2.5
developed countries	1171 M	1238 M	0.3	75	0.7
countries under industrialization	4633 M	7056 M	1.8	38	3.3
poorly developed countries	592 M	1162 M	2.7	22	5.2

FIGURE 1: POPULATION STATISTICS AND PREDICTIONS

Another U.N. conference, Habitat 2 in Istanbul in 1996 has clearly pointed out that this population growth mainly occurs in the poorly developed countries with 2.7 % per year and that it goes hand in hand with urbanization of up to 5 % per year in these countries (see figure 1).

The urban population is at present about 45 % of the total. 80 % of the world population is expected to be urban by the year 2025.

Most of the highest urban growth rates are expected to be in Asian cities, such as Dhakar (7.8 M) 5.7 %, Jakarta (11.5 M) 4.4 %, Karachi (9.9 M) 4.3 %, Mumbai (15.0 M) 4.2 %, Shanghai (15.1 M) 2.3 %, and Bangkok (7.1 M) 2.2 %.

THE NEED FOR BASIC DATA SETS IN GEOGRAPHIC INFORMATION SYSTEMS

In the last 20 years geographic information systems have been developed as computer systems capable of input, storage, manipulation, analysis, and output of geographic data.

In its wider definition a GIS is, however, a data system of managing the environment for sustainable development for

- analysis of data for gaining information
- for planning with information
- for decision making and
- for implementation and monitoring of decisions.

It is to be realized that hard and software of a GIS rarely exceeds 20 % of its cost. The data are the most expensive part with 80 %. Thus a data system needs to be kept up to date.

A GIS due to its data integration capability from various sources has the advantage of being at least 4 times more cost-effective than the simple computer automation of a task.

THE NEED TO PROVIDE TIMELY BASE DATA SETS AT

VARIOUS SCALES

A survey of data acquisition costs for various purposes shows a scale dependence. The larger the scale, the costlier. Costs of less than 100 $/km^2 can only be achieved with satellite imagery. Aerial or ground survey tools, which can supplement such surveys, are in general at least 10 times costlier per km^2 (see figure 2).

Mapping and GIS consist of a base map coverage with integrable thematic layers and references to non-graphic data in data bases in table form (see figure 3).

It is this interpretation of information which makes efficient data management possible and affordable.

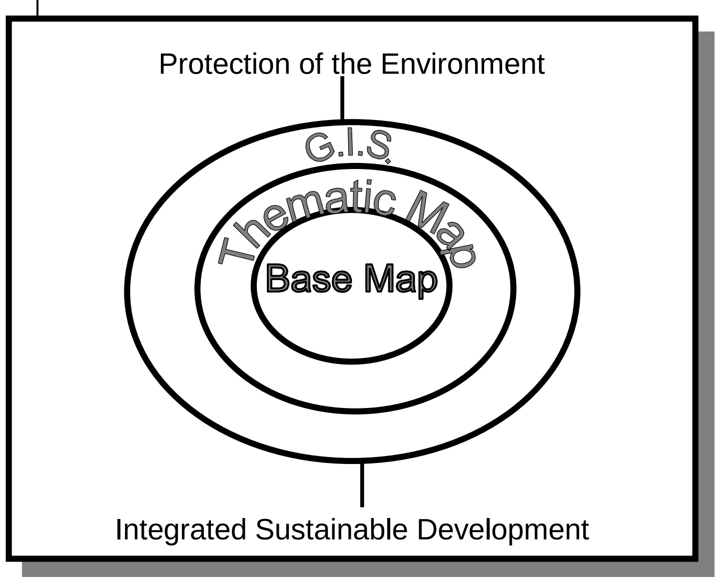

FIGURE 3: MAPPING AND GIS

Field	Type	Scale	Imagery	Cost/km^2
AGRICULTURE	Phenol. Change	1:1 000 000	NOAA	80 $/km^2
BIO-MATERIAL	Biomass Change	1:1 000 000	NOAA	80 $/km^2
FORESTRY	Forest Mapping	1: 250 000	MSS	6 $/km^2
GEOLOGY	Reconnaissance	1: 100 000	TM	20 $/km^2
FORESTRY	Forest Development	1: 100 000	TM	20 $/km^2
IRRIGATION	Watershed Mapping	1: 100 000	TM	10 $/km^2
REGIONAL PLANNING	Planning Study	1: 100 000	TM	25 $/km^2
LAND USE	Land Use Mapping	1: 100 000	TM	13 $/km^2
BIO-MATERIAL	Biomass Inventory	1: 100 000	TM	20 $/km^2
EROSION	Vegetation Cove	1: 100 000	TM	20 $/km^2
DESERTIFICATION	Change Detection	1: 100 000	TM	35 $/km^2
FOOD SECURITY	Cultivation Inventory	1: 100 000	TM	25 $/km^2
ENVIRONMENT	Environment Inventory	1: 100 000	TM	50 $/km^2
REGIONAL PLANNING	Feasibility Study	1: 50 000	Spot-XS	40 $/km^2
ENVIRONMENT	Risk Zone Mapping	1: 50 000	KFA 1000	150 $/km^2
URBAN DEVELOPMENT	Urban Change	1: 50 000	KFA 1000, Spot-P	45 $/km^2
TOPOGRAPHY	Base Map	1: 50 000	aer. phot.	120 $/km^2
GEOLOGY	Photogeology	1: 25 000	aer. phot.	150 $/km^2
TRANSPORT	Road Design	1: 20 000	aer. phot.	180 $/km^2
TOPOGRAPHY	Orthophoto	1: 12 000	aer. phot.	24 $/km^2
WATER SUPPLY	Base Map	1: 10 000	aer. phot.	800 $/km^2
FORESTRY	Forest Inventory	1: 10 000	aer. phot.	350 $/km^2
LAND USE	Land Use Mapping	1: 10 000	aer. phot.	520 $/km^2
BIO MATERIAL	Energy Study	1: 10 000	aer. phot.	250 $/km^2
TRANSPORT	Photogr. Map	1: 10 000	aer. phot.	700 $/km^2
CADASTRE	Orthophoto Map	1: 10 000	aer. phot.	400 $/km^2
TOPOGRAPHY	Base Map	1: 5 000	aer. phot.	2 000 $/km^2
TOPOGRAPHY	Orthophoto	1: 5 000	aer. phot.	78 $/km^2
CADASTRE	Photogr. or Survey Map	1: 2 000	aer. phot.	10 000 $/km^2
CADASTRE	Orthophoto	1: 2 000	aer. phot.	1 000 $/km^2
TOPOGRAPHY	Orthophoto	1: 1 000	aer. phot.	800 $/km^2
URBAN CADASTRE	Base Map	1: 1 000	aer. phot.	20 000 $/km^2
URBAN CADASTRE	Multipurpose Cadastre Utilities, Topography	1: 500	aer. Phot.	40 000 $/km^2

Figure 2: Survey Costs

THE NEED FOR SATELLITE DATA SYSTEMS TO PROVIDE THE DATA

The U.N. Secretariat has tried to monitor existing base map data for the different countries and continents at different scales (see figure 4).

The result has been that a global coverage only exists at scales smaller than 1:250 000. At 1:50 000 about 2/3 of the land area are covered and at 1:25 000 about 1/3.

What is even more alarming is that the present update rate for the 1:50 000 map is only 2.3 % and that of a 1:25 000 map 4.9 %. Thus the average age of a 1:50 000 map is 45 years and that of a 1:25 000 map 25 years

Again, the developing continents have much smaller update rates than Europe or North America.

It becomes clear that the existing map technology based on aerial photography and ground methods is too slow to provide the required data sets. Thus satellite systems must be utilized.

PRESENT CAPABILITIES OF OPTICAL SATELLITE SYSTEMS

Geostationary low resolution satellites such as GMS, Insat, Goes and Meteosat offer images of the earth's surface every 30 min at 5 km ground pixels. NOAA satellites offer 1 km resolution at least twice per day. Such data are ideal for global monitoring.

Resource satellites such as Landsat, Spot, JERS and IRS 1A and B offer medium resolution data between 10 and 30 m ground pixels several times per year.

The latest development are high resolution satellites such as IRS-1C and MOMS with about 5 m ground pixels without the present capability to obtain a global coverage as yet (see figure 5)

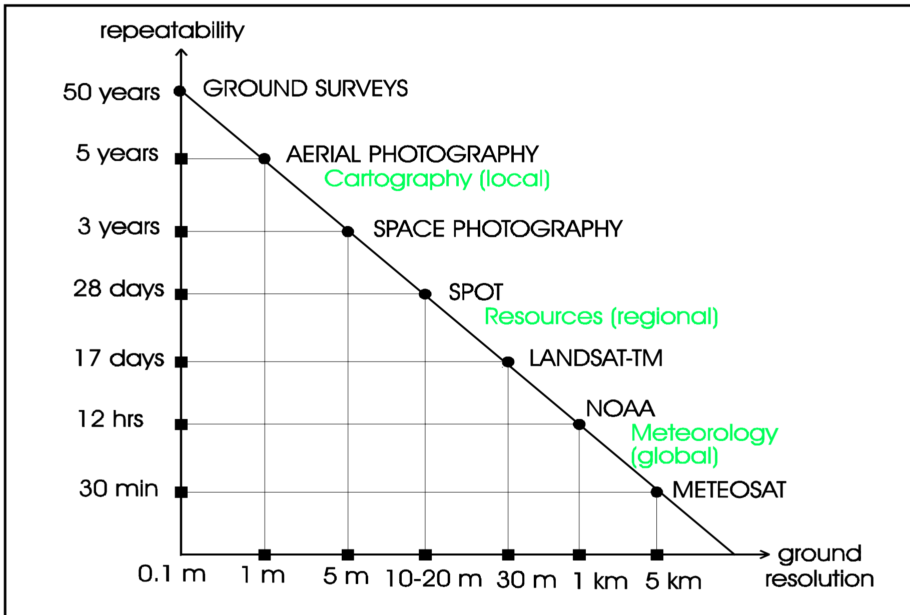

Figure 5: Resolution and Repeatability of Remote Sensing Systems

Resource satellites such as Landsat, Spot, JERS and IRS 1A and B offer medium resolution data between 10 and 30 m ground pixels several times per year.

The latest development are high resolution satellites such as IRS-1C and MOMS with about 5 m ground pixels without the present capability to obtain a global coverage as yet (see figure 5).
Experiences with these systems have shown that the use of satellite images for mapping is

- at least four times cheaper than using conventional methods
- but that at present resolutions quality standards must be relaxed
- visual interpretation of these images is still more effective
- but GIS integration is of advantage
- cloud cover is still a handicap opening ways for radar satellites such as JERS-1, ERS 1,2 and Radarsat.

Even 5 m resolution systems cannot compete in quality to aerial photography with 1 m resolution in 1:25 000 mapping (see figure 6).

The suitability for mapping from a particular type of imagery has already been investigated in the early 1980's. There are three criteria to be met:

- planimetric accuracy, which is scale dependent
- elevation accuracy, which depends on parallaxes created by the different image geometry from two different imaging positions
- detectability, which relates to the spatial resolution, which may be achieved by a particular sensor system.

Even though aerial photography, which has been digitized into different pixel sizes on the ground can hardly distinguish more than 6 bits of grey values as opposed to recent digital sensors with 10 or more bit of grey level distinction these early results are still generally valid:

Planimetric accuracy of a map is generally related to ±0.2 mm at publishing scale according to U.S. mapping stan-dards. This crite-rion mainly relates to worldwide map-ping practices for the original map-ping scale, but not for generalized maps at smaller, derived scales, in which the plani-metry is often shifted to accom-modate conflicts in the depiction of objects. Even in the original map-ping scales buil-dings or building blocks, roads and rivers are shifted in some national map bases for this purpose.
But in general this means from the data acquisition side, that the following planimetric stan-dards are usually accepted:

Scale	σ_p
1: 10 000	± 2 m
1: 25 000	± 5 m
1: 50 000	± 10 m
1:100 000	± 20 m
1:200 000	± 40 m

Elevation accuracy is generally a function of terrain slope. Depending on terrain slope a certain contour interval is specified. The reliability of contouring is generally accepted as being 5 times the point measuring accuracy in height, regardless of whether the contours are originally measured in a photogrammetric plotting instrument, or whether they are interpolated on the basis of a measured digital elevation model (D.E.M.) grid.

Contour interval Δh	Point measurement accuracy $\pm \sigma_h$	Terrain type
1 m	± 0.2 m	flood plane
2 m	± 0.4 m	"
5 m	± 1 m	"
10 m	± 2 m	"
20 m	± 4 m	"
50 m	± 10 m	"
100 m	± 20 m	high mountains

In this scenario mapping from satellites constitutes a

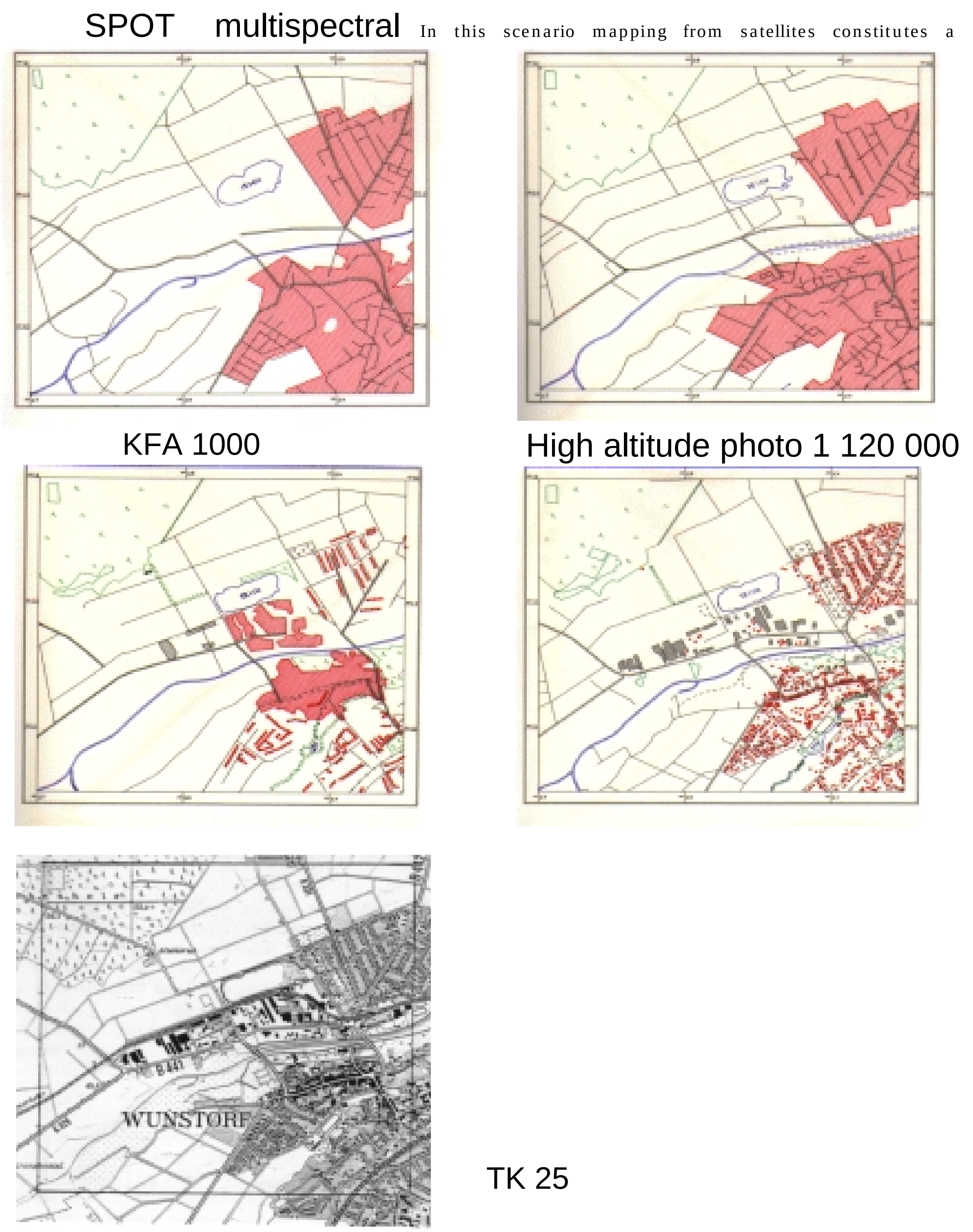

Figure 6: **Mapping from Satellite Imagery from Spot MS (France), Spot Pan (France), KFA 1000 (Russia), aerial photography 1:20 000, existing map 1:25 000**

The detectability of objects, given sufficient contrast as a function of grey level discrimination, was formerly measured in terms of photographic resolution stated as line pairs per mm (lp/mm). Nowadays this photographic resolution must be compared to 2 to 5 pixels at image scale related to IFOV on the ground.

Early tests with photographic resolutions have been carried out for specific objects to be recognized and identified from the imagery. They established a minimum pixel size for the detectability of the following objects:

The highest resolution from space, which is currently accessible on the civilian market is Russian KVR 1000

Object	Pixel size
urban buildings	2 m
foot paths	2 m
minor road network	5 m
fine hydrology	5 m
major road network	10 m
building blocks	10 m

photography, digitized to 2 m pixels, in which individual houses can still be clearly identified (see figure7).

Such images may be used for the creation of planimetric image maps at the scale of 1:10 000, but the lack of a large number of ground control points to differentially rectify the image maps on account of image deformation to planimetric map accuracy standards at that scale renders the expected planimetric accuracy more to the 1:25 000 level.

Moreover, the height determination from images generally depends on the height-base ratio of the imagery flown:

$$\sigma_h = \pm \frac{h}{b} \cdot \frac{h}{c} \cdot \sigma_{px}$$

with σ_h = point error in elevation
h = orbital height
b = orbital base
c = principal distance (focal length) of the camera objective

σ_{px} = parallax measurement error in the order of the point positioning error σp of about 10 µm in a photographic image, corresponding more or less to the pixel size on the ground with the image scale used.

Due to the very long focal length of the KVR camera of 1 m the stereoscopic overlap conditions of that imagery will not permit a smaller and more favorable height-base ratio than 10, rendering the expected height accuracy of less than ± 20 m.

The present KVR 1000 high resolution images are therefore suitable for planimetric map updates 1:10 000 or 1:25 000, but not for digital elevation model measurements.

Cartographic satellites, which permit a better height determination, even if they do not reach the same detectability are the French panchromatic Spot system with 10 m pixels and the Indian IRS-1C system with 5.8 m pixels. Due to their capability to incline the sensor by a mirror in cross-track direction a favourable height-base ratio of up to 1 may be achieved from subsequent orbits. This, however, is often a handicap due to changing cloud cover, which severely limits stereoscopic coverage for a time period in which the radiometry of the ground has not changed.

The best test result achieved thus far with Spot Pan and IRS-1C stereo imagery are in the order of ± 5 to 10 m in elevation and ± 3 to 5 m in position, making these sensors suitable for 1:50 000 to 1:100 000 mapping in mountainous areas.

Another approach has been provided by the inflight stereo capability of the German Stereo-MOMS system. It consists of a triple line scanner looking forward, vertically down and aft, which has been flown for 10 days on the U.S.-German Space Shuttle mission D2 in 1993 and which since 1996 operates on the MIR-Space Station's Priroda module with interruptions.

On MIR the vertical sensor yields 5 m panchromatic ground pixels and/or 15 m multispectral ground pixels, and the fore and aft sensors give 15 m panchromatic ground pixels. Figure 8 shows such an image over the German city of Augsburg, in which the vertical panchromatic 5 m pixels have been fused with the vertical multispectral 15 m pixels.

Figure 10 shows an oblique view of three processed fore, down and aft panchromatic stereo images after the generation of a D.E.M. and the resulting orthoimage over the area of Barcelona, Spain.

The advantage of in-track stereo sensing is that all images to create a DTM, orthophotos and oblique views are taken at the same time.

The cartographic requirements for these images show, that planimetric requirements can be met for the 1:25 000 scale, that elevations can be determined with ± 5 to 10 µm accuracy and that the detectability is suitable for 1:50 000 mapping.

PRESENT CAPABILITIES OF MICROWAVE SATELLITE SYSTEMS

Optical satellite systems have sofar shown difficulties with marginal resolution and with cloud coverage. For this reason the European Space Agency ESA has launched the ERS radar satellite series followed by Japan with JERS and Canada with Radarsat.

Radar signals follow a very different geometry from optical devices. The existing satellite systems have also not been designed for land, but for ocean coverage, giving differences in the amount of foreshortening or shadows to be encountered. Moreover, radar

Figure 8: Digitized KVR 1000 image (DD5) with 2 m pixels over the city of Hannover,

backscattering does not behave like optical reflection. Thus the criteria for planimetric accuracy and for detectability of objects from radar images do not easily correspond to pixel size resolution of optical systems. Depending on the grey level differentiation desired radar processing can be executed (e.g. for ERS-1) to 12.5 m or 25 pixels related to the ground.
Thus radar images are more suitable for image fusion with optical images rather than for mapping alone.

Radar, when used in multitemporal mode or multipolarization mode, on the other hand, compares to optical multispectral differentiation capabilities, when classifying area objects. Yet satellite radars have a very distinct advantage, they generate coherent radiation. Coherent radar signals influence radar geometry since the images are reconstructed using phase and Doppler informations. They can only properly be reconstructed if a D.E.M. is used in the reconstruction.

On the other hand phase information may be utilized for D.E.M. generation using interferometry principles. While radar interferometry has been carried out using repeated images from quite different orbits (as for JERS-1 and Radarsat), as long as there is a base between the two imaging stations, the conditions for interferometry were greatly improved during the ERS-1/ERS-2 tandem mission which directed the 2 ERS satellites so that corresponding radar coverages over the same area were obtained one day apart with a small base between orbits.
Radar interferometry requires not only that the base between orbits is known, but that the sensor position and the sensor attitude is accurately determined. In the present satellite systems such possibilities have not been available with sufficient accuracy.

In the Hannover area a digital elevation model generated from radar interferometry has been fitted by a 7 parameter transformation to the few identifiable common control in the radar images. In most areas the comparison with an existing and accurate conventional D.E.M. resulted in average discrepancies of less than 10 m for 90 % of the points, but in hilly areas discrepancies of over 100 m were encountered.

This confirms that radar interferometry may be useful in differential changes of image portions, which are due to dynamic changes of the terrain, but it sofar fails in reliable elevation determinations.
An improvement of this situation has been suggested by the U.S. German SIR-C Space Shuttle Mission in 1999, which not only will use three radar frequencies (X-band, C-band, L-band) to resolve atmospheric ambiguities, but also will have two types of receiving antennas mounted on a 30 m long beam, the positions and attitudes of which are continuously monitored by differential GPS. In this way it is hoped to obtain a system capable of rapid D.E.M. mapping for large areas to ± 10 m.

Figure 8: MOMS-Priroda image over Augsburg, Germany (5 m pixels)

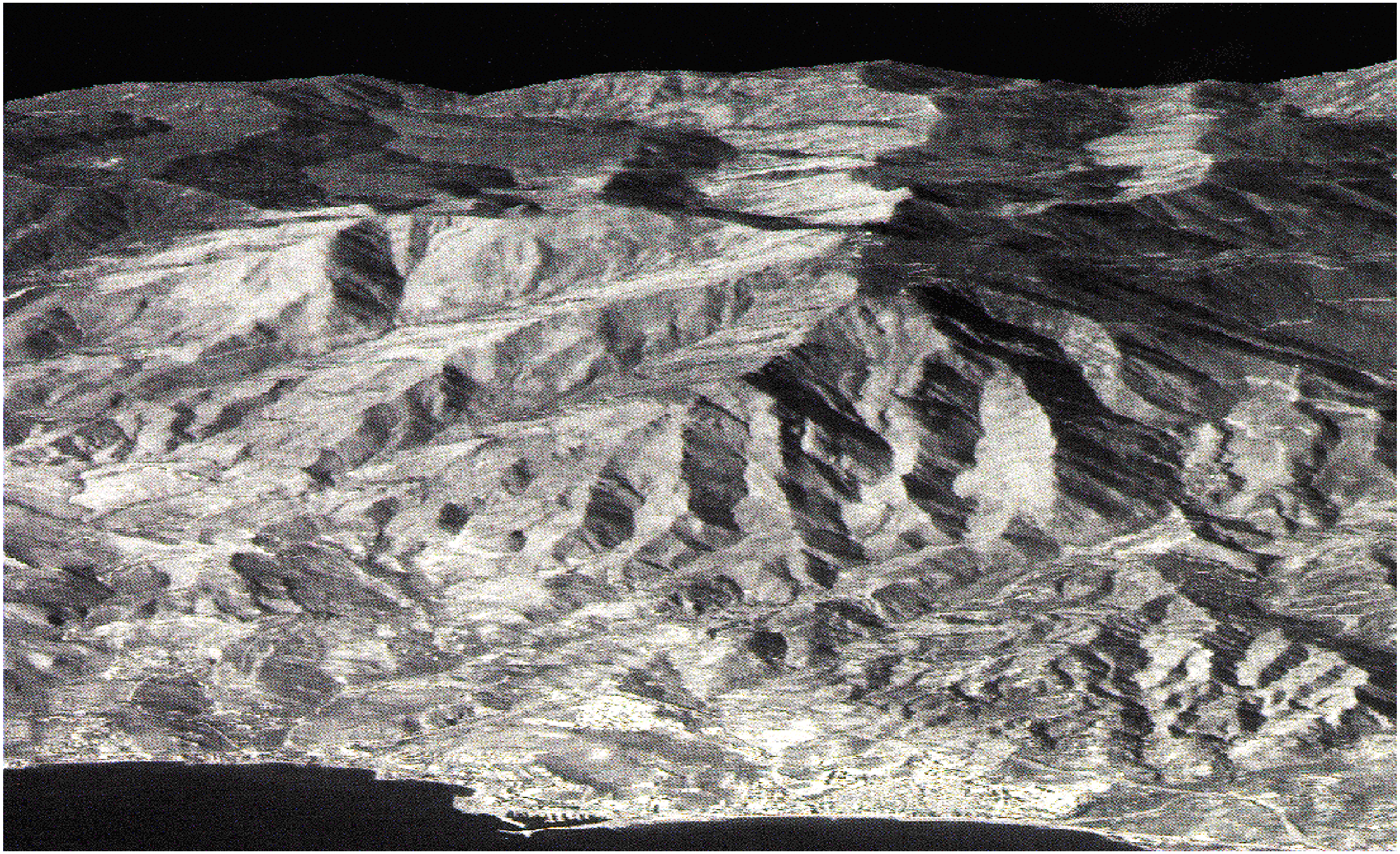

FIGURE 9: OBLIQUE VIEW OF DIFFERENTIALLY RECTIFIED MOMS-PRIRODA STEREO IMAGES OVER BARCELONA, SPAIN

DIGITAL ELEVATION MODELS

There are currently at least six alternative methods considered for future generation of digital elevation models, competing in accuracy and price:

- the digitization of existing line maps at 5 to 20 m accuracy, depending on the original map quality, at prices of 1 \$/km²
- the existing US Military global coverage at 20 m accuracy, obtainable for some portions of the globe, at prices of 1 \$/km²
- aerial photogrammetric mapping at 5 m accuracy for 40 \$/km²
- the future use of US commercial optical satellites, following the Stereo-MOMS principles, but at higher resolution with 5 m accuracy for 50 \$/km², with the advantage to map areas, when aerial photography is not available
- optical stereo sensors following the Stereo-MOMS or the SPOT/IRS-1C principle with 10 m accuracy at 5 \$/km²
- interferometric SAR of the SIR-C type with 10 m accuracy at 5 \$/km².

USE OF SATELLITE REMOTE SENSING SYSTEMS

The use of existing satellite images for monitoring the environment in the largest sense is manifold. The choice of imagery is always a compromise between availability and spatial, spectral and temporal resolution considering repeatability, swath, and pixel size. All remote sensing conferences in Asia and in other parts of the world show that weather and meteorological dangers (storms, cyclones) can be monitored by global satellites such as Insat. NOAA satellites permit to measure sea surface temperature, pigment and chlorophyll concentration of ocean and coastal areas. But they are also able to monitor the state of vegetation on the basis of the normalized digital vegetation index to follow patterns of drought or floods, the health of tropical forests or the devastation by forest fires. There would be no hope to gather the amount of this type of information without satellite remote sensing systems. These interpreted results together with socio-economic data constitute the needed thematic information which needs reference to the base mapping system in form of a geographic information system. Noteworthy are the recent activities of the Committee on Earth Observations by Satellites CEOS, an organization of the space agencies formed on the initiative of the 67 group. CEOS propagates the creation of an information locator system which helps the user to find pertinent information via the Internet. This CEOS-ILS is to contain types, locations, and times of satellite sensor images taken, if possible with reduced content quicklooks. In addition value added products such as digitized maps and metadata of various kinds are to be located in the system to offer the user a more complete information potential.

FUTURE CAPABILITIES OF MEDIUM AND HIGH RESOLUTION SENSORS

There will be many more satellite systems available in the near future by many nations. The European Space Agency ESA divides them into scientific “Explorer Missions” and operational “Earth Watch Missions”. ESA, for example, plans at least four explorer missions in the 2003 to 2011 time frame, which are directed toward scientific goals

- to measure the earth’s gravity field from space
- to get quantified values for earth radiation
- to explore the spectral capabilities of image spectrometry in a land mission
- to determine missing parameters of the earth’s atmosphere through cloud profiling and the measurement of the wind field.

All these missions are to enable scientists to develop better models for climate, atmosphere and other physical parameters, which could help to explain gaps in scientific understanding. The Earth Watch missions plan to improve the current capabilities of resources and cartographic satellites. To these count the Japanese, Indian, European, and American missions ALOS, IRS-1D, Envisat, Spot 5, and Landsat 7. But of foremost interest are the U.S. commercial ventures for high resolution imagery. A summary compiled by L. Fritz in October 1997 is shown in figure 10 with relevant parameters.

This will vastly improve the present sensing capabilities. The novel approach shall be an end-to-end data provision system including corrections for calibration and reference systems, cataloguing, value added processing and distribution. Satellite imaging and processing capabilities may become a serious competitor to the traditional aerial survey industry unless the two approaches are merged and used in supplementation. Thus Mapping from Space is by no means a dream. Conceptually and on the experimental level it is now a reality soon to become operational on a competitive basis.

CONCLUSION

If one looks at the global scenario of development from the historical perspective one can conclude:

- The 19th century was the century of interference and control between nations, a time when colonial powers used to introduce their limited mapping systems for their own resource exploitation by inadequate means.
- The 20th century became the century of independence and competition between nations. In this century mapping for national resource management became possible through the World War proven aerial photogrammetric techniques propagated through the United Nations often with the help of donor countries.
- The 21st century is likely to become the century of interdependence and cooperation between nations. In satellite remote sensing their is hope in the coordination activities of CEOS to globally plan satellites for global and regional needs. There is also hope in the recent formation of international consortia to build sensing systems for satellites and to process these products as GIS input in an end-to-end system.In this scenario mapping from satellites constitutes a contribution to preserve living conditions on this planet by providing the necessary information for it.

Systems	Earth Watch "Quick Bird"		Orbital Sciences "Orb View 3"		Space Imagery "Ikonos"		West Indian Space Ltd. "EROS"		Earth Watch "Early Bird"		Resource 21 "Resource 21"			GEROS		Kodak "Cibsat"		
partners	Ball Hitachi Telespazio MDA		Orbital Sciences		Lockheed Martin E-Systems Mitsubishi		Israeli Aircraft Ind. Core Soft-ware Techn.		Ball Hitachi Telespazio MDA		Boeing Farmland GDE ITD			Geophys. & Env. Res. Corp. Space Vest				
launch	1. 1999 2. 2000		1999		1. failed 2. Sep 1999		1. failed 2. 1999 to 6. 2003		failed		1. 2000 (2) 2. 2001 (2)			1. 2000 (2) 2. 2001 (2) 3. 2002 (2)		cancelled		
mode	Pan	MS	Pan	MS	Pan	MS	Pan		Pan	MS	MS			Pan	MS	Pan	MS	hyper-spectral
quantization	11 bit	11x4 bit	8 bit	8 bit	11 bit	11 bit	10 bit		8 bit	8 x 3 bit	12 bit					11 bit	11 bit	
resolution	0.82 m	3.28 m	1 & 2 m	4 m	0.82 m	4 m	1.3 m		3.2 m	15 m	10 m	20 m	100 m		10 m			
channels	1	4	1	4	1	4	1		1	3	4	2	1			1	5	60
swath	22 km		8 km		11 km		13.5 km		6 km	30 km	205 km					112 km		
pointing in track	± 30°		± 50°		± 45°		± 45°		± 30°		± 30°			-		2 convergent sensors		
pointing cross track	± 30°		± 50°		± 45°		± 45°		± 28°		± 40°			-				
sensor position	GPS		GPS		GPS		GPS		GPS		GPS			GPS		GPS		
sensor attitude	star trackers		2 star trackers		3 star trackers		-		1 star tracker		star trackers			star trackers		2 star trackers		
expected accuracy with GCP's	horiz	vert	horiz	vert	horiz	vert	horiz	vert	horiz	vert	5 m abs.			horiz		horiz	vert	
	2 m	2 m	7.5 m	3.3 m	2 m	3 m	6 m	4 m	6 m	4 m	1 m rel.			3 m		5 m	3 m	
Without GCP's	23 m	17 m	12 m	8 m	12 m	8 m	800 m		150 m		30 m			25 m				

Figure 10: Commercial Earth Observation Satellites

A Review of the Experience on the Application of New Spatial Data Collection Methods in East Africa

Martins W.L. Chodota, Senior Surveyor, RCMRD. Kenya

ABSTRACT

Gathering spatial data using artificial Satellites techniques have been in use since the early 1970s. However, currently the application of the Global positioning System (GPS) has been highly refined that, now it has almost become one of the essential utilities in daily life in addition to television, telephone, radio, etc. Scientists and planners can now get spatial data generated using GPS satellites through Differential GPS service satellites and/or even the internet.

The geoinformation community is becoming very much dependent on GPS as source of spatial data. In addition, highly accurate spatial data can now also be generated through the digitisation of accurate geometrically corrected satellite imageries.

Russian satellite imageries such as the TK350 and KVR-1000 are also sources of accurate date in addition to the well-developed data from digital photography. This paper we outline the experience in the application of these new technologies for gathering spatial data for use in Geoinformation for development projects in the Eastern Africa sub-region.

INTRODUCTION

The application of artificial satellites for collection of spatial data has been going on since the 1970s starting with the Transit NNS Doppler navigation Satellites developed by the US Navy for defence purposes. They were later modified to enable them to be used for positioning. This was followed by the deployment of the Global Positioning System NAVSTAR Satellites in the late 1980s which by 1991 had a full constellation of 21 satellites.

Now GPS has become so widely used in the acquisition of spatial data that, it has become another essential utility in addition to the radio, telephone, television and other utilities taken for granted by the society.

GPS has so much simplified the collection of spatial data that users are now questioning if a surveyor is any longer necessary as a professional. This is because the receiver does not require a professional surveyor for operation.

Also there are now several other resource satellites which are continuously photographing the earth's surface to generate several types of satellite imageries. Examples of these are the NASA LANDSAT satellites, the SPOT satellites, the Indian and Japanese Satellites; and the Russian satellites.

All provide a range of imageries from which useful spatial data can be obtained.

There are several projects carried out in the Eastern Africa sub-region which have demonstrated the usefulness of these modern data gathering systems. The AFRICOVER E.A. project is one such example.

GPS has also been extensively applied to provide mapping control and other survey and mapping data for a number of projects in the region.

This is a review of the experience in these projects.

A Review of Modern Spatial Data Gathering Method Experienced in East Africa Sub-region

GPS Surveying Technique

Conventional surveying methods continues to be used, although there has been great advances in the instrumentation.

Now the theodolite and distance meter have been combined into a total station. Further even the total station has been improved such that partial data processing can be carried out in the field. The instrument is now easily interfaced with the PC or data is automatically transferred to a computer for final processing and map/plan preparation; or directly fed into GIS database.

This development has highly increased the speed at which large quantities of spatial data can be collected and made available to planners and decision-makers involved in development project.

Total stations are now available in most of the surveying and mapping institutions; both public and private, in the region. However, the greatest revolution in geoinformation spatial data acquisition is the application of artificial satellites in positioning. The satellites in use are the NAVSTAR, Global Positioning Systems Satellites.

The constellion of 21 satellites ensure that at least 4 satellites are visible from any where on the earth's surface throughout the 24 hrs.

In addition to the consistent and well-maintained satellites, to ensure regular and reliable signals; a service provided by US Department of Defence (DOD), there is a large range of GPS receivers available to the surveyor. By January 1999, there were more than 50 manufacturers of GPS products according to a survey carried out by GPS World.

Their use and accuracy also varied in as many ways.

However when we discuss spatial data gathering, we limit ourselves to receivers accurate enough to support land surveying and the creation of LIS/GIS spatial databases.

In the region several government departments have acquired and are using GPS technology. Examples of such surveying departments are Ethiopia Mapping Authority and the Surveys and Mapping Department of Tanzania.

Various training institutions have also acquired the technology for training research and project implementation. Further a number of private companies are also applying the technology. The net result of this development is that project implementation in the concerned countries is now faster, accurate and timely.

As an example, rural Tanzania under the new national Land Policy is divided into 8000 village units and the surveying authority was required to provide cadastral data for the boundaries of all these villages.

Using conventional surveying methods, such a task would have taken a very long time and would be very costly. However, using GPS technology this task is being implemented without a strain to any of the other programmes.

Another example where GPS technology was used was the survey and mapping of a 1000 km proposed oil pipeline route in Tanzania. Using conventional data gathering methods the 1000 km would have taken at least six months to finish, however the task was accomplished in 60 days using GPS technology.

Various other projects have been rapidly and efficiently achieved in several countries of the sub-region, using this method.

In most of the project the method used is either static or differential GPS. The differential GPS technique could have been more useful, accurate and timely if the region had a DGPS service. However, outside USA and Europe, in Africa, the only operating DGPS service is in South Africa. As GPS method is increasingly being adopted by all the countries, this forum should come out with a recommendation, for the establishment of a DGPS service to be operated by one of the regional organizations, and probably coordinated by ECA.

This would ensure uniformity in the use of the GPS technology, which would facilitate easy spatial data exchange and simplify the creation of regional databases.

Use of Satellite Imageries

Mapping using satellite picture is what is called as mapping by remote sensing techniques. In the region the application of remote sensing in 1977 when the Remote Sensing Department was established at the Regional Centre in Nairobi.

Several development projects have been implemented in the region using this method. The AFRICOVER E.A. Project is one of these on going projects.

This project is unique in that through its operations the region will have several new digital mapping techniques, which could be used in future, in implementing other development projects.

It was planned that the project would use satellite imagery, which would be geometrically collected using geodetic data. The geodetic data would either have come from existing maps or derived from GPS observations, where there are maps or the existing maps are not suitable.

At the beginning, especially for Somalia and Kenya, correction data was obtained from existing maps. However later new developments came up.

The Russians offered support to the project by providing their satellite high-resolution pictures. These were the TK-350 topographic camera pictures and the KVR-1000 High-Resolution Camera pictures.

They were to be used to provide data for the geometrical correction of the satellite imageries to be used in the AFRICOVER project. Tests were carried out in Egypt from which it was shown that the ground control data obtained from these pictures met the set out project specifications.

Another new development, which happened during the project implementation, is data received from the NASA/NIMA Global Land Mapping Project. The AFRICOVER E.A. project benefited by the receipt of ortho rectified Landsat TM data, which will be used to generate spatial data for the geometrical correction of satellite imagery for use in the project.

These two developments might replace the costly GPS surveying operations, in the provision of ground control small scale mapping projects, especially in the difficult equatorial areas.

The other advantage of this source of data is that the resulting digital data will be uniform through out the project area as the NASA/NIMA GLMP covers the whole area up to north of Tanzania. This again removes the need for the lengthy geodetic computation to derive the transformation parameters, which would have been necessary for the derivation of a uniform mapping datum for the region.

Further the Orthorectified TM spatial data at scales of 1/100,000 to 1/250,000 will form an up to date land cover for most areas of Africa. This could be the start of the creation of a uniform spatial database for our region.

RECOMMENDATIONS

From this review, the following recommendations can be made to the Africa Geoinformation community.

All countries in Africa should endeavor to acquire GPS technology.

Spatial data collection standards should be established between neighbouring states and regions. This will facilitate an easy data exchange as well as the establishment of regional spatial databases.

Modalities should be established to enable a number of DGPS services to be established in the region. This will improve the accuracy of GPS spatial data and ensure timely delivery for use in development projects. The ECA could coordinate this effort.

Following the out put and experience obtained from the AFRICOVER E.A. Project, the countries should approach FAO to enable them have access to the NASA/NIMA GLMP data, in addition to the AFRICOVER E.A. project products.

As most countries acquire GPS technology, there will be a need to intensify training especially in data processing and analysis.

CONCLUSION

In conclusion, the experience so for obtained in the East African Sub-region shows that, in addition to the conventional surveying techniques, the use of artificial satellites has the advantages of accuracy, uniformity, large data volumes and areal coverage; as well as timely delivery.

There is a big economic advantage in acquiring and adopting the new technologies for the production of spatial data for use by planners and decision-makers for development.

CHAPTER THREE

IMPACT OF GEOINFORMATION ON DEVELOPMENT

SOCIAL AND ECONOMIC BENEFITS OF GEOINFORMATION

Prepared by André B. Bassolé, Chairman of the Advisory Committee, EIS Network in Africa, consultant , for the Economic Commission for Africa. Delivered as a key note address to the First meeting of the Committee on Development Information, CODI, Addis Ababa, 28 June 1999

Mr. Chairman,
Distinguished delegates,
Ladies and gentlemen
Dear colleagues

Standing before you is a great honor, and I would like to thank you in advance for the attention you will pay - I hope - to the subject I am going to talk about. Before doing that, allow me to thank the United Nations Economic Commission for Africa – ECA, for giving the opportunity to the EIS Network in Africa through my modest person, to address the distinguished delegates attending the first meeting of the Committee on Development Information. My intention is to share with you a few ideas about geoinformation, in the context of social and economic development in Africa. I was asked to cover this subject, as a an appetizer for us, before the big meal we are invited to have together here, in the framework of the African Information Society Initiative, at this first CODI meeting. I am not a good cook, but I am certainly of good will and I do hope that together, we will prepare our minds for contributing effectively to some good output for this important meeting.

It is not a secret that Africa is struggling to keep an honorable position in the community of nations, - I should say community of regions – in a context of growing global economy. The effects of globalization on Africa can be illustrated by the last argument between the US and the EU about the banana business. Given the positions adopted on the issue, does Africa have any alternative but being and staying excellent? To my opinion, the message was clear enough to take away our illusions about a privileged treatment of African products or those of the developing world, on the basis of social considerations. Africa probably has an alternative: targeting first the large market of its own 778 million people, especially in this economic context where the raw materials' prices escape from its control.

In this sense, the Abuja treaty, calling for regional integration of economies as Phase One towards a full-fledged African Economic Community, is a good political response to the challenge facing our continent. But why talk about political economics when I am expected to talk about geoinformation?

The reason is that:

1. the globalization process is a consequence, and is empowered by streams of inter-related sets of information, turning our world into a small village, as it is so often said;.
2. in this information age, space and geographic location constitute a reference for strategic thinking;
3. geoinformation appears to be an enhancing factor for decision making, able as it is to influence the course of events, in a positive way or in the opposite, but in any case for the interest of those who use it.

There is no need to insist on the abundance of information flows nowadays, thanks to the new technologies of information and communication. But abundant flow of information does not necessarily mean relevant information. There is also no need to elaborate on the usefulness of information for decision making. Nevertheless I would like to quote Paul C. Rump who wrote in his source book on state of the environment reporting the following: **"Access to improved information does not guarantee better decisions. However, it should reduce the risk of unsustainable policies and actions"**. It is very true, since there is no way of imposing the use of the relevant information to decision makers. But the decision maker who voluntarily neglects to use the right information provided to him/her can be blamed, and should be blamed. Here again, the recent wave of political and social protective measures against the chicken threat is a good example of the risk for decision makers of not using the right information.

Information being very broad, the absence of specification about the type can lead to vague and finally boring intellectual developments. In the geomatics sphere, we want to be specific about what exists or what is happening, but mostly we want to emphasize on the "where". Therefore we distinguish between attribute data and spatial data, the two being combined in a Geographic Information System (GIS) to generate geoinformation.

Geoinformation is therefore the result of a data collection and integration work. Analysis of geoinformation combining spatial data and descriptive data on the basis of pre-defined criteria, facilitates the decision making process, and is therefore very useful for socio-economic development. This is because the goal of all the socio-economic development policies is wellbeing of people. The importance of geoinformation in the present end of millenium is reinforced by notions like sustainable development or wellbeing of nations, targeting the wellbeing of both the people and their ecosystems.

At community or local level, geoinformation analysis will for example lead to a precise knowledge of the available resources, their quality, their geographic extent and their predictable duration in a given environment of management. At national level, geoinformation provides the best basis for sustainable development planning, or for a specific issue to be studied and illustrated in all its dimensions through spatial analysis. A combination of social infrastructure data can be made with census data and provide a picture of the spatial distribution of the population, natural resources in relation with the national socio-economic investment efforts. At sub-regional or continental level, a global view revealing a outstanding phenomenon can be shown by using appropriate analytical tools with geoinformation. A typical example is the management of watershed generally developing beyond national boundaries.

Mr. Chairman,

Unfortunately, all this is easily said, but the reality is most of the time quite different. The difficulties limiting a spread use of geoinformation analyses in the decision making process are of various nature. The most common in African countries are the lack of expertise, the lack of coherence in datasets and the processes followed for

producing geoinformation, in relation with institutional considerations, and of course the lack of technical equipment. At country level, the result is a situation where datasets are fragmented, of different formats, making them impossible to integrate. The same applies for the sub-regional and continental levels where trans-boundary phenomena are difficult to show because of the differing characteristics of the information sources.

The relation of all these considerations with national and sub-regional economies can be considered at two levels.

1. The economic consequences of decisions taken without the help of geoinformation analysis;
2. The waste of resources resulting from a bad coordination of geomatics activities at country or sub-regional level

The first level can have disastrous consequences for the economy and the people, by hiding predictable situations to the policy or decision makers. Where geoinformation management facilities do not exist, the risk taken is making hazardous decisions that can generate bad economic and social effects.

The second level of economic implication of geoinformation is the potential waste of resources. When there is no coordination in the geoinformation management sphere, duplication of data collection generally takes place. This duplication is expressed in terms of efforts and time spent, which can be translated in monetary figures, beside the inherent direct costs of the data themselves. It is a waste of resources. The worse is that data collected in isolation for a narrow geoinformation management purpose cannot necessarily be used in combination with data collected differently from other sources. Considering that the data collection and integration phase accounts for 60 to 70% of the total cost of setting up a stand alone geoinformation system, it is easy to have an idea of the total loss in macro economic terms, if such incoherent ways of producing geoinformation are repeated in a country. The resulting fragmented data sets are almost useless in a global perspective, or need to follow a long and costly transformation process before they can be shared. Sometimes the transformation process is not worth doing, since it may be more costly than restarting the data collection process from the beginning.

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In order to avoid these situations in countries and sub-regions, it is necessary to set up geoinformation management policies leading to a harmonized development of the geoinformation capacity. It is exactly what the EIS Network in Africa is aiming at by promoting the use of good geoinformation management policies in the countries and strengthening their capacities through a participatory process. Fortunately there are good examples of initiatives undertaken on the continent, among which I would like to mention only two:

(i). The EIS Network in Africa is assisting an Information Working Group set up by WRI and USAID, with the contribution of African Experts, by coordinating the development of case studies in West Africa. These case studies aim at assessing the impact of geoinformation analyses on policies and facilitating the dialogue between decision makers and GIS analysts. Burkina Faso, Côte d'Ivoire and the Gambia are involved in these case studies.

(ii). Benin is completing the development of an EIS called SISEI, standing for "Système d'Information et de Suivi environnemental sur Internet" with the contribution of OSS/UNITAR and the EIS Network in Africa. The SISEI is a good example of an institutional setting and national synergy built around the issue of environmental data management and exchange over the Internet.

Such geoinformation management facilities can be linked and lead to the emergence of national, sub-regional and continental geoinformation infrastructures (sometimes called spatial data infrastructures or integrated data infrastructures). With such an infrastructure, geoinformation is made available online, because of an harmonization process that allows to combine contributing datasets and because of regulations agreed upon, that govern the generation, access, use and dissemination of the shared geoinformation.

Mr. Chairman

One of the main issues to address in this geomatics sphere is how to treat geoinformation in economic terms? Basically there seems to be two main streams in the approach to economics of geoinformation:

1. the concept of geoinformation as a public good
2. the concept of geoinformation as a commercial product.

Depending on the most influencing option, the policy adopted for geoinformation management can lead to quite different situations from country to country.

The first stream flows from the surveying and mapping field. In the surveyors and cartographers community, the map is considered as a public good and every country is expected to mobilize the necessary resources to produce it. Still, there is an optional and stronger branch in this stream coming from the army where maps are perceived as sources of strategic information, whose dissemination should be done very cautiously. The common denominator here is that maps fall into the sovereignty domain of nations. When we consider that more than 60% of the spatial component of geoinformation comes from existing maps, one can easily understand how this way of thinking influences the expansion and use of geoinformation. In this context the production of geoinformation will be guided by a social motive, or by national security concerns. In any case, setting up a geoinformation infrastructure in such a context is not seen as a development tool, but at best as a social duty. From a user's point of view, the positive aspect in this stream is that the price of maps and consequently that of geoinformation could be subsidized in order for the community of users to afford them.

The second stream stems from the information technology sphere where information is seen as a good, bearing a commercial value. In this environment, the value of information is assessed through the improvement or the enhancement it generates in decision making: it reduces the uncertainty and offers cost avoidance opportunities. Geoinformation being part of the information family, it should be treated according to the supporters of this idea, as a commercial good whose value is regulated by the law of demand and offer. A consequence of this option is the fact that geoinformation should bear no restriction on its access if the free market

rules are to be applied. In addition to that, new opportunities are emerging for business.

This way of picturing the streams of ideas about geoinformation is somewhat exaggerated, but it shows the complexity of the issues facing Africa in the field of geoinformation management. The economics of geoinformation resides in the value added to information. In that sense one can understand the position of classical surveys departments vis-à-vis the geoinformation specialists. The former are at the origin of ground data collection and their transformation into meaningful maps on paper. The latter reap the good fruits by secreting the cream from the paper maps, using high technology to generate enhanced products readily usable for decision making. Fortunately, by now, this dichotomy tends to be an abstraction, since our national mapping agencies have developed skills in geomatics and acquired adequate equipment.

In summary I would like to say that geoinformation contributes to a better economic and social management, offers new opportunities for the private sector, but the lack of geoinformation management policy has serious drawbacks on national economies.

The economic benefit of a wide spread use of geoinformation is better seen at continental level. Imagine if all the countries were using the same continental geoinformation datasets covering economic sectors like industrial production, agricultural stocks, natural resources, national currency rates, in addition to local time information, air traffic programs, meteorological conditions etc, The availability of continent-wide information would facilitate exchange and trade within the continent and reverse our continental import /export ratio. It would all together, by cost avoidance, reduce the waste of financial resources due to the consequences of inappropriate decisions taken. It would create more opportunities because of less time spent looking for the right information and speed up the development programs.

I know, Mr Chairman, Distinguished Delegates, that, as we say in French "Avec si, on peut mettre Paris dans une bouteille" meaning that using if's, one can easily insert Paris into a bottle. But this is by definition the essence of dreaming!

Coming back to the globalization phenomenon, I would say that Africa should not miss the opportunity to make the best use, and draw the highest benefit from its information potential. The dream in this area is to progressively build a continental geoinformation infrastructure. Such an infrastructure would meet all the information needs for national, sub-regional and continental level programs in fields like

Environmental impact assessment;
State of the environment reporting;
Trans-boundary ecosystems management;
Natural hazards forecasting;
Famine early warning;
and many more

This dream should not wait too long to become a reality if we take into consideration 4 major things:

1. the African Information Society Initiative;
2. the increasing level and size of geoinformation experts in Africa;
3. the recent progress made in information and communication technologies facilitating geoinformation spatial analysis on the Internet;
4. and the availability of the international community to support the development efforts deployed internally by the Africans.

The African Information Society Initiative seems to me a good policy framework. The Committee on Development Information (CODI), together with active organizations on the continent like the EIS network in Africa, UNEP, OACT, AARSE and more, are some of the actors that should contribute to the accomplishment of that dream.

Mr. Chairman,

I cannot anticipate on the conclusions of the first CODI meeting, but I am convinced that it will lead to a promising future for geoinformation management, in a continental information framework called the African Information Society Initiative. As far as the EIS network in Africa is concerned our constituency and all our potential are available to contribute the best way we can, to the achievement of ECA's objectives in organizing this important meeting.

Distinguished delegates,

At this point, I would like to apologize for the length of this address, wish full success to our deliberations and thank you for your kind attention.

Thank you

CARTOGRAPHIE ET AGENDA 21 – UN PANORAMA DE L'ACI

Michael WOOD, Président de l'Association Cartographique Internationale (ACI)

INTRODUCTION

Le mot " cartographie " est encore souvent associé aux cartes traditionnelles imprimées sur papier, qui ont, naturellement, joué un rôle important dans les domaines conjugués de l'histoire et de la science – en ce qui concerne l'analyse, l'exploration, la représentation et le stockage des données localisées. Tout au long de son évolution la cartographie a bénéficié des progrès technologiques mais ce n'est qu'au cours des dernières décennies que des changements considérables se sont produits. Ces derniers n'ont pas seulement contribué à en transformer le champ mais aussi à accroître largement le potentiel scientifique de la " nouvelle " cartographie. Plutôt que de rester dans l'ombre ou hors circuit, la cartographie (sous forme graphique ou sous forme numérique) est devenue tout à fait banale et se trouve être l'élément le plus distinct de la nouvelle

science de la géoinformation.

Durant les 40 dernières années l'Association Cartographique Internationale (ACI) a développé activement l'étude du sujet et a recherché les moyens de le mettre en œuvre. Bien que ses objectifs premiers aient été scientifiques, l'ACI concentre à présent son attention sur des applications spécifiques. Elle prend également en compte les aspects sociaux et éducatifs des problèmes qui se posent au monde. Tout en offrant un panorama des activités actuelles de l'ACI, ce document explique comment l'Association a toujours mis en valeur les thèmes clés qui devaient devenir centraux lors du Sommet de Rio sur la Terre en 1992 et continue dans cette voie.

ACI ET AGENDA 21

Alors que d'autres organismes internationaux concernés partagent activement le même intérêt pour les problèmes de la planète et le futur de l'humanité, l'ACI, en particulier, inclut les thèmes clés de la déclaration de Rio dans ses objectifs directeurs, à savoir :

- Contribuer à résoudre les problèmes mondiaux par l'intermédiaire des cartes
- Diffuser l'information sur l'environnement par le biais des cartes
- Aider à l'échange des nouvelles techniques cartographiques entre les nations
- Favoriser la recherche scientifique multinationale et ses applications
- Accroître la formation cartographique
- Promouvoir l'utilisation de normes.

Bien que la plupart de ces objectifs aient été mis en place dès les premières années qui ont suivi la création de l'ACI, l'on ne saurait s'en contenter mais s'en servir comme solide point de départ de nouveaux projets.

THÈMES SPÉCIFIQUES À L'ACI

L'ACI a été créée par des gens qui aimaient les cartes et croyaient au potentiel cartographique mondial. Sur ces bases s'est édifié un puissant réseau d'organismes membres nationaux et affiliés dont les scientifiques et techniciens ont cherché à prendre conscience de ce potentiel cartographique et à le développer. C'est essentiellement sous la direction du comité exécutif de l'ACI et avec le soutien des comités nationaux pour la cartographie que les commissions, cellules et groupes de travail de l'ACI ont concentré leur enthousiasme et leur savoir sur un éventail de thèmes qui peuvent être groupés sommairement comme suit :

- Thèmes généraux : Enseignement et formation, Histoire, Aspects théoriques et définitions, Utilisation des cartes.
- Fabrication des cartes : Production cartographique, Cartographie dérivée de données satellitales.
- Normes de données : Qualité des données localisées, Normes d'échange de données localisées, Généralisation cartographique.
- Innovation : Visualisation, Atlas nationaux et régionaux.
- Problèmes environnementaux : Cartographie marine, cartographie planétaire.
- Personnes : Cartographie à l'usage des enfants, Egalité des sexes et cartographie, Cartes et graphiques pour aveugles et mal-voyants, Cartographie du recensement.

Un examen approfondi des termes de référence et des activités de ces groupes révèle leur mode de contribution, à la fois directe et indirecte à Agenda 21. De par sa nature, l'ACI (et ses membres) opère sur plusieurs plans. Certains projets évoluent au sein des commissions mais d'autres sont le résultat d'une stimulation et d'une expérience acquises des travaux en cours de l'ACI, et s'appliquant à des secteurs ne relevant pas de la compétence directe de l'Association, à savoir en résumé :

1. par des actions spécifiques et ciblées lancées par le comité exécutif et au sein de commissions ou de groupes de travail,
2. par des sous-thèmes et d'activités spécifiques au sein de commissions ou de groupes de travail.
3. par l'enseignement et la formation,
4. par la mise au point d'une nouvelle technique cartographique en réponse aux nouvelles technologies,
5. par des contributions au développement des normes de données en matière d'infrastructures de données localisées nationales ou planétaires,
6. par une participation à des projets dans lesquels sont impliqués d'importants membres actifs de l'ACI.

Voici un panorama illustré de certaines de ces activités.

ACTIONS CIBLÉES DU COMITÉ EXÉCUTIF ET AU SEIN DE COMMISSIONS OU DE GROUPES DE TRAVAIL

Initialement établie comme cellule présidentielle de travail en 1987, **la commission de l'ACI sur l'égalité des sexes et la cartographie** est devenue un groupe de travail en 1991 et une commission à part entière en 1995. Si l'on se souvient que les participants à toutes les sections de l'ACI ont demandé à effectuer du travail à plein temps, ce groupe a fait des progrès impressionnants au cours de la dernière décennie. Ses termes de référence actuels sont de se pourvoir en moyens nécessaires à son action spécifique, de faciliter les contacts professionnels sur le plan international, d'accroître les chances d'un développement professionnel pour les femmes, les jeunes cartographes et les cartographes des pays en voie de développement, et de proposer des systèmes qui assureront l'existence de chances égales au sein de l'ACI pour les groupes qui la composent. Son programme d'action riche et énergique comporte de nombreuses facettes, notamment la création d'une bibliographie et d'un annuaire concernant les femmes dans le domaine de la cartographie, de la topographie et des systèmes d'information géographique (SIG) ; l'organisation de projets communs avec d'autres groupes de l'ACI et l'accroissement des contacts avec des groupes frères au sein de l'Union géographique internationale (UGI), de la Fédération internationale des géomètres, etc. ainsi qu'avec l'UNESCO, en vue de se concentrer sur les problèmes d'égalité des sexes et de développement ; l'organisation de séminaires et d'ateliers scientifiques ou technologiques sur le plan international, mettant en avant les femmes et autres membres des groupes ciblés en les prenant comme présentateurs, afin de fournir des forums pour le développement des compétences professionnelles au sein de ces groupes. Ce n'est pas un groupe féministe de pression mais un

rassemblement d'hommes et de femmes cherchant à promouvoir l'égalité pour tous au sein de la science et de la profession cartographiques.

Le prix Barbara Petchenik récompensant les cartes d'enfants fut établi en mémoire d'une femme exceptionnelle qui devint vice-présidente en 1991, mais qui mourut, tragiquement, dans l'année qui suivit. Reflétant l'intérêt qu'elle a porté tout au long de sa vie aux cartes et aux enfants ainsi que ses connaissances en la matière, ce concours, dès ses débuts en 1993, a fait l'objet de milliers d'inscriptions présentant une incroyable variété de styles artistiques et de thèmes imaginatifs, mais dont la plupart révélèrent un net intérêt pour l'environnement sur le plan à la fois local et planétaire. Un premier lien d'importance fut établi avec les Nations Unies lorsque l'UNICEF accepta d'envisager l'insertion des œuvres primées dans ses fameuses séries de cartes de vœux. Grâce à un travail efficace, notamment de la part du Canada, beaucoup d'œuvres primées figureront par la suite dans un cédérom lancé par les Nations Unies et intitulé " Ma ville " (un jeu éducatif interactif destiné aux écoles et aux enfants, basé sur la convention des droits de l'Enfant). Ce dernier a été montré au Sommet mondial sur le développement social à Copenhague en 1995 et plus tard la même année au Sommet des femmes à Pékin. Plus récemment, une carte murale éducative, comprenant également les cartes primées et celles provenant de l'UNICEF Canada, a été réalisée, permettant aux enfants d'exprimer un intérêt pour les problèmes essentiels du développement de l'environnement. L'importance de ce concours mondial organisé par l'ACI a été prise en compte par les Nations Unies en 1995 en raison de " l'importance de son but qui est de sensibiliser encore plus les jeunes à la géographie et les en rendre encore plus avertis " et ces dernières l'ont considéré comme " un salut aux Nations Unies pour leur 50ème anniversaire ". Cette initiative encourageant les enfants à créer des cartes de leur monde peut être considérée comme l'une des réalisations les plus importantes de l'ACI à ce jour. Des milliers d'enfants, dont l'éducation cartographique et géographique a été tristement négligée dans bon nombre de pays, ont pu ainsi avoir la chance toute particulière de comprendre et d'analyser les plus importants problèmes du monde actuel – le monde d'Agenda 21.

La création d'un **groupe de travail sur la cartographie à l'usage des enfants** fut indubitablement influencée par le succès du concours Barbara Petchenik et l'intérêt porté de longue date par les cartographes de tous horizons au développement de la connaissance de notions de cartographie en insistant sur une meilleure compréhension de la relation qui existe entre l'enfant et les cartes. Ceci est encore un exemple de la reconnaissance par l'ACI de l'importance des jeunes dans l'avenir de la planète, et le programme de ce groupe devra certainement inclure les questions pertinentes figurant dans la déclaration de Rio.

Bien que fonctionnant avec un budget très restreint (les cotisations des divers pays membres n'ayant pas augmenté depuis 1987) le Comité exécutif de l'ACI a décidé en 1996 d'allouer une **bourse de voyage** essentiellement aux jeunes candidats (moins de 35 ans) provenant de pays en voie de développement. Ceci a été fait en considération de l'importante recherche scientifique effectuée actuellement dans maintes parties du monde où, faute de bourses ou par rareté de ces dernières, les jeunes étudiants ne peuvent assister aux conférences. Comme elle l'a fait avec les enfants, l'ACI cherche à encourager d'autres jeunes à participer à la résolution de problèmes mondiaux au niveau international.

SOUS-THÈMES ET ACTIVITÉS SPÉCIFIQUES AU SEIN DES COMMISSIONS U DE GROUPES DE TRAVAIL

Tout en ne souhaitant pas minimiser d'autres activités importantes de l'ACI, cette section souligne le travail des commissions et des groupes de travail contribuant plus spécifiquement à la résolution de problèmes d'ordre mondial.

La **commission permanente sur la production cartographique** a peut-être ses plus fortes racines dans ce que l'on pourrait appeler la cartographie traditionnelle. Ses premiers travaux et les publications de l'ACI fournissent d'excellentes indications sur les méthodes pré-numériques et ont été avidement recherchés pendant plusieurs années par des groupes au sein de pays en voie de développement ou de pays qui ont conservé très longtemps les méthodes et procédés de production les plus traditionnels. La demande concernant ces indications n'a pas entièrement disparu mais les actions actuelles se concentrent essentiellement sur les nouveaux thèmes numériques. L'objectif principal de cette commission est à présent de diffuser l'information sur les nouvelles technologies de production cartographique, spécialement par le biais de séminaires internationaux en coopération avec les commissions sur l'enseignement et la formation d'une part, et les atlas d'autre part.

La **commission sur la cartographie marine** a récemment concentré son attention sur l'une des zones de mutation environnementale les plus sensibles - le littoral. En dehors de recherches spécifiques sur le sujet, les membres du groupe collaborent depuis quelques années avec la commission de l'UGI sur les systèmes littoraux à la direction d'une série réussie de symposiums sur les SIG littoraux (le prochain se tiendra en France en septembre 1999). Cette activité ciblée de recherche contribue à une meilleure connaissance du littoral, à sa sensibilisation aux facteurs locaux et planétaires de mutation et aux problèmes importants de gestion dans le siècle à venir.

Les activités de la **commission sur la cartographie dérivée de l'imagerie satellitale** portent essentiellement sur le rôle de l'imagerie satellitale dans la production et l'exploitation des bases de données opérationnelles (ou semi-opérationnelles) nationales ou régionales. Avec l'arrivée de systèmes de prise d'images de précision inférieure à un mètre, il est important pour les scientifiques cartographes d'en étudier le potentiel en termes de facteurs d'analyse des problèmes environnementaux.

Le nouveau **groupe de travail sur la cartographie censitaire** reconnaît l'accélération des échanges commerciaux à l'échelle globale qui a eu pour conséquence d'accroître la demande d'informations statistiques et cartographiques internationales servant à l'analyse des problèmes régionaux, économiques et environnementaux. Dans les pays en voie de développement il a été également reconnu qu'une solide base cartographique, bien intégrée aux données économiques et sociales recueillies par le biais d'études

et de recensements effectuées à l'échelle nationale, est essentielle pour stimuler le développement économique et social. Une mutation technologique rapide a influencé les méthodes cartographiques et a offert de nouvelles possibilités ; l'adoption de ces technologies par certains organismes de recensement leur ont permis de contribuer de façon significative à l'édification d'infrastructures de données localisées nationales. Par exemple dans certains pays en voie de développement, les cartes de recensement contiennent souvent des informations actualisées sur les nouvelles routes et autres caractéristiques physiques ne figurant pas sur les cartes topographiques locales existantes. Le travail de ce groupe devrait contribuer efficacement aux études de fond d'Agenda 21.

ENSEIGNEMENT ET FORMATION

Au cours des ans la **commission permanente sur l'enseignement et la formation** s'est révélée le plus actif et le plus productif des groupes de l'ACI sur le plan international. En dehors de son beau record de publications pédagogiques, elle a joué un rôle décisif dans l'organisation de réunions mixtes avec d'autres commissions ou groupes de travail de l'ACI. Celles-ci ont fréquemment pris la forme d'ateliers de formation ou de séminaires techniques qui ont eu lieu dans des endroits aussi éloignés que l'Amérique du Sud et l'Indonésie. Le travail de la **commission sur les cartes et graphiques pour aveugles et mal-voyants** est de traiter également de sujets portant sur l'enseignement et la formation avec l'organisation d'un atelier de formation en Tanzanie en 1998. L'ACI est fière de pouvoir agir aussi régulièrement et aussi efficacement dans le domaine éducatif, l'une des parties les plus importantes des " Moyens de mise en œuvre " du chapitre 36 d'Agenda 21.

MISE AU POINT D'UNE NOUVELLE TECHNIQUE CARTOGRAPHIQUE EN RÉPONSE AUX NOUVELLES TECHNOLOGIES

La conception de cartes fonctionnelles s'est améliorée durant ces dernières décennies. Une combinaison de solides expériences acquises avec les premiers produits, l'acceptation progressive de certains résultats bien connus de la recherche conceptuelle et un certain talent artistique instinctif en matière de conception peuvent aboutir à des produits tels que l'atlas de Suisse par exemple. Ce type de conception devra toujours être privilégié pour une sortie sur papier et, grâce à une utilisation experte des outils logiciels graphiques, il est à présent de plus en plus facilement et rapidement réalisé. Cependant la carte statique n'est qu'un exemple du produit cartographique moderne. Avec la pleine application d'une technologie informatique en développement, la cartographie reprend de l'énergie et de l'efficacité. Grâce au travail de la **commission sur l'utilisation des cartes** et aux recherches continues de quelques scientifiques cartographes et géographes créatifs, la cartographie a acquis de nouvelles dimensions (incorporant les multimédia, l'animation, etc.). Aujourd'hui la cartographie peut être décrite comme un outil de visualisation de données géographiques fonctionnant à plein, incorporant de nouveaux moyens d'exploration, analysant et présentant tout aussi bien données et informations. Cette évolution et cette croissance ont été reconnues par la création d'une nouvelle et dynamique **commission sur la visualisation cartographique** dont les travaux se sont étendus rapidement depuis ses débuts en 1995. Elle a commencé par étudier le rôle grandissant des cartes dans le domaine de la science, de la prise de décisions, de l'expression politique et de la société en général, en raison de l'avènement de cartes dynamiques et intelligentes conçues comme des outils de pensée visuelle d'aide à la décision. D'autres aspects ont retenu son attention, à savoir (a) les recherches sur les implications de l'évolution d'une cartographie focalisée sur une carte optimale unique vers une approche aux perspectives multiples (certains soutiennent actuellement que la solution d'une carte statique unique devrait être considérée comme contraire à l'éthique) ; (b) le développement de modèles (outils conceptuels pour la visualisation de processus spatio-temporels et de l'information sur la qualité et la fiabilité des données) ; (c) l'examen de l'impact d'outils cartographiques d'aide à une décision localisée sur les stratégies de prise de décisions et sur l'issue de cette prise de décisions ; (d) l'étude du potentiel des outils de représentation en trois dimensions et les implications correspondantes de l'affichage en trois dimensions et de la tendance générale qui y est associée, vers le réalisme (contre l'abstraction) dans la représentation scientifique. Les premières recherches sur les liens entre visualisation scientifique et visualisation cartographique dans le but d'identifier et de faciliter l'échange d'idées entre cartographes et autres spécialistes des problèmes de visualisation, ont eu des résultats très intéressants. Une collaboration de trois ans a été établie avec un groupe spécialisé dans le traitement graphique informatisé (ACM SIGGRAPH) afin d'étudier les moyens d'intégrer efficacement les points de vue et les techniques des deux communautés – cartographie et traitement graphique informatisé – dans le contexte des fichiers de données cartographiques et localisées.

La conception de l'atlas national, aujourd'hui presque vieille de cent ans, a joué un rôle très important dans la mise en valeur des traits caractéristiques de la géographie régionale. Plus récemment, il s'est révélé l'un des plus efficaces bancs d'essai pour l'application des nouvelles technologies, telles que les multimédia. Sous sa première forme électronique, sur disque souple, il avait des limites, mais il s'est solidement implanté depuis, d'abord comme produit cédérom (il y en a présent des centaines d'exemples) et aujourd'hui comme service INTERNET. En reconnaissance de l'importance grandissante de l'atlas électronique, la **commission sur les atlas nationaux et régionaux** prépare un " manuel de pratique " permettant de fabriquer un atlas. C'est un autre moyen d'étendre et de populariser le domaine de la nouvelle cartographie tout en offrant de nouvelles sources d'aide à la décision.

CONTRIBUTIONS AU DÉVELOPPEMENT DES NORMES DE DONNÉES EN MATIÈRE D'INFRASTRUCTURES DE DONNÉES LOCALISÉES NATIONALES OU PLANÉTAIRES.

Les infrastructures de données localisées furent décrites en 1993 par le comité des sciences cartographiques des Etats-Unis, leur commission sur les sciences et les ressources de la Terre et leur Conseil National de la Recherche comme " le moyen de rassembler les informations géographiques décrivant l'agencement et les caractéristiques du relief et des phénomènes terrestres. L'infrastructure comprend le matériel, la technologie et le personnel requis pour acquérir, traiter, stocker et diffuser ces informations en vue de répondre à une grande variété de besoins ". Les décisions concernant

leur avenir, prises sur le plan national autant que planétaire, dépendront de l'évolution des technologies des besoins des sociétés et des structures des nations et institutions. Ces structures, auxquelles le monde entier finira par accéder grâce aux réseaux, prendront des proportions importantes au siècle prochain et seront essentielles pour la prise de décisions se rapportant aux problèmes qui seront traités dans le cadre d'Agenda 21. Bien que n'étant pas essentiellement impliqués dans les activités des infrastructures de données localisées nationales ou globales, le groupe de travail de l'ACI sur la **généralisation**, ses commissions sur la **qualité des données localisées** et les **normes d'échange** de ces dernières leur ont apporté une aide importante et exceptionnelle en la matière. La dernière commission, en particulier, cherche à mettre au point un fichier des caractéristiques universelles des métadonnées servant à l'évaluation de toutes les normes de métadonnées nationales et internationales dans le monde. Ces groupes prennent activement part aux activités du comité technique ISO 211 sur l'information géographique et la géomatique.

PARTICIPATION À DES PROJETS DANS LESQUELS SONT IMPLIQUÉS D'IMPORTANTS MEMBRES ACTIFS DE L'ACI

Le travail d'un membre de l'ACI n'est pas celui d'un employé à plein temps d'un organisme commercial, industriel ou gouvernemental. Le travail de ce dernier est clairement défini et comporte des engagements. Celui du premier n'est pas clairement défini et est essentiellement bénévole, mais néanmoins potentiellement efficace. Cependant les personnes qui sont actives au sein des groupes de l'ACI peuvent participer par ailleurs à des projets cartographiques connexes. L'ACI peut s'intéresser officiellement à ces entreprises et être représentée dans les comités concernés ou simplement s'y associer. Deux exemples importants sont donnés par **Elada 21** et le **Projet de Cartographie du Globe**. Le concept de carte du globe est né au Japon en 1992 et aujourd'hui y participent activement les directeurs et les experts des organismes cartographiques nationaux du monde entier, au sein du comité directeur international de la cartographie du globe (ISCGM). Les spécifications actuelles comprennent une résolution spatiale de 1 km (semblable à celle de la carte au 1:1.000.000) et un contenu où figurent l'altitude, la végétation, l'occupation des sols, les rivières et les lacs, les routes et les voies ferrées ainsi que les limites administratives. Les activités de l'ISCGM ont conduit les Nations Unies à reconnaître que la carte du globe constituait un apport important, si ce n'est nécessaire à la mise en œuvre d'Agenda 21. Avec la pleine participation des organismes nationaux et internationaux concernés, l'on espère achever la carte du globe vers l'an 2000. ELADA 21 (Atlas Electronique d'Agenda 21) est un projet entièrement différent, conçu pour promouvoir la mise en œuvre d'Agenda 21 en offrant un accès informatisé aux informations figurant à l'Agenda 21. Cet atlas électronique multimédia pilote sur cédérom, couvrant le chapitre biodiversité d'Agenda 21, est considéré comme la réponse clé aux engagements pris par le Canada lors du Sommet sur la Terre. Un grand nombre de partenariats nationaux et commerciaux s'établirent en vue de participer à son développement et c'est par l'implication individuelle très active de plusieurs de ses membres, notamment ceux de Varsovie (Pologne) que l'ACI y a largement participé. L'intention première était de prêter une aide au contrôle, à la rédaction de rapports et à la prise de décisions dans le cadre des projets d'Agenda 21 et aussi de servir de forum d'échange d'expériences ou d'études de cas par l'intermédiaire de réseaux électroniques. C'est là un autre exemple d'utilisation de produits cartographiques nouveaux pour sensibiliser le monde aux problèmes internationaux importants et aider à les résoudre.

CONCLUSION

La cartographie n'est certainement plus ce qu'elle était ! Son influence est encore d'ordre mondial mais de nouvelles technologies et une communication à l'échelle planétaire ont changé son caractère et accru son potentiel au sein de la recherche scientifique. Ses nouvelles capacités et sa grande souplesse d'emploi sont essentielles pour relever des défis tels que ceux lancés par l'Agenda 21, et elle continue à s'imposer de plus en plus dans le domaine étendu des sciences de l'environnement. En sa qualité de représentant mondial du sujet, l'ACI maintient de vraies traditions “ familiales ” et la variété de ses intérêts et de ses activités n'a jamais été aussi grande. Sa force repose sur une motivation sous-jacente et un engagement volontaire d'envergure de la part de ses membres et groupes de membres internationaux recherchant et partageant connaissances et compétences au profit de tous.

CHAPTER FOUR

SPATIAL DATA ACCESS AND HANDLING

CHALLENGES AND OPPORTUNITIES FOR NATIONAL MAPPING AGENCIES: DEVELOPMENT OF NATIONAL GEOSPATIAL DATA INFRASTRUCTURE (NGDI)

GLOBALLY ENABLING ACCESS TO SPATIAL INFORMATION: THE GLOBAL SPATIAL DATA INFRASTRUCTURE

THE SOUTH AFRICAN NATIONAL SPATIAL INFORMATION FRAMEWORK AND CONCOMITANT COMMITTEE FOR SPATIAL INFORMATION

CHALLENGES AND OPPORTUNITIES FOR NATIONAL MAPPING AGENCIES

DEVELOPMENT OF NATIONAL GEOSPATIAL DATA INFRASTRUCTURE (NGDI)

Dick Groot & Menno-Jan Kraak, ITC, Geoinformatics, The Netherlands

INTRODUCTION

Reasons of history, culture, physical and political geography etc. have caused differences between the mandates of NMA's in different countries as well as the manner in which these are accomplished. Basically however, NMA's are the stewards or custodians of the archive of the national positioning system (Geodesy) and the national topographic mapping system. Sometimes they are also the custodians of the national cadastre. The introduction of Information and Communication Technology (ICT) in the last thirty years has altered the operating environment of these organisations significantly. Confronted with growing government deficits almost all countries were also subject to a significant change in political philosophy in which deregulation and reduction of government's operational involvement in society was strongly pursued. Both the technological and the political factors have forced NMA's to critically review their mandates and determine how the biggest return on the investment in national surveying and mapping by society can be realised. Examples include the Major Surveys Review in the Federal Government of Canada (Canadian_Government ,1986), the Report on the Handling of Geographic Information of the Government of Great Britain (Chorley ,1987), the report of the National Research Council of the USA (Mapping_Science_Committee ,1994), similar reports from Australia and New Zealand (ANZLIC ,1996), and the Dutch Advisory Council on Spatial Information (RAVI ,1995). Hence there is some convergence in what is preoccupying NMA's world-wide.

Following a short overview of the changes in the mandates of NMA's in the last 30 years, the role of NMA's in the NGDI is explained. The paper closes with a brief overview of how ITC intents to contribute to this process by education and research.

THE CHANGING MANDATE OF NMA'S

Since the introduction of CTI and the change to a more liberal political economy in which the government intervention was reduced to at least slow down the growth of government deficits, NMA's have been trying to justify their mandates as government funded organisations. In countries with industrial surveying and mapping capacity NMA's were asked to contract out production work. In countries with a strongly decentralised administrative system provincial and municipal surveying and mapping agencies were encouraged to take up part of the national production tasks or at least to do their work using data standards that would reduce duplication of surveys between the various levels of government.

The following stages in the evolution of the mandate of a fictitious NMA in an industrialised country can be discerned as they pertain to the mapping component:

Generally speaking a mission statement for an NMA in the time of analogue and standard map production would have looked something like this:

- ***pre 1970***
  To produce and maintain topographic maps at the scales….., according to the standards of the national topographic mapping system.

There is an implicit assumption that the government is in control of the specification of the topographic mapping system, and there is no evidence of an orientation on clients or any influence by them on the standards or specifications. It appears therefore as a supply driven system. Considering the question about the role of government in the data acquisition this mission statement could be developed further into the following:

- ***mid 1970's***
  To ensure the timely availability of up to date topographic maps at the scales….., according to the standards of the national topographic mapping system.

This statement leaves it open for the NMA to decide who, on the basis of arguments of efficiency, should carry out the surveys or produce the maps. It could decide to leave this to a competent private sector as long as there are a sufficient number of firms to ensure competition. The NMA should however always control the standards and specifications as well as the quality management. It is now almost everywhere an accepted fact that a competent and competitive private sector can play an important role in achieving the objectives of NMA's. The inclusion of "timely" begins to suggest a degree of concern for the clients, while "availability" indicates a degree of openness for the use of the maps, therefore also an indication of client orientation and recognition that maps should be used widely to be of value. The word "up to date" is a form of wishful thinking certainly in the analogue era when it was technically and financially impossible to update maps with all new information coming available.

If we take it one step further and into a digital information environment the mission statement may develop into the following:

- ***end 1980's***
  To ensure the timely availability of up to date topographic information of national scope,

according to nationally accepted data standards, and standards of integrity, formats, etc....

In this statement we have left the question: "who produces?" open as in the previous statement, but in addition we have not specified that the output must be in maps or data files or any other output. This clearly depends on the user demand. The organisation will have to determine this in the market place. The addition of "up to date" is a bit less wishful thinking if the data is in digital form.

As we shall discuss further down the main difficulty at this stage was that the digital topographic information mentioned was considered as the standard topographic maps in digital form. This decision has been one of the major reasons for the difficulties encountered by NMA's to serve the requirements for a digital topographic framework in a reasonably up to date and timely fashion in the GIS community. The complexity of the digital topographic map is partly due to the problem of confusing symbology with data definition and has led to major frustrations in the user community as well as excessive costs and time for the production of these data files let alone their maintenance.

The development of the mission statement indicates a growing concern with the clients. However, it still suffers from a degree of passivity on the part of the NMA. To this end the next mission statement could be amplified as follows:

- ***mid to end 1990's***
  To ensure the timely availability of up to date topographic information of national scope, , according to nationally accepted data standards, and standards of integrity, formats, etc....
  and to actively promote the use of this information in value added applications relevant to the market, on the basis of prices which will ...(for example support the maintenance of the data bases).

The second part of the statement makes sense especially in a user environment where digital capacity for data handling, spatial analysis, and modelling (GIS) is implemented. However, in this mandate statement the potential conflict begins to emerge between value added production activities by the government on its public information if there are also private companies capable of doing this. The first part of the statement is in almost all cases accepted as an "infrastructural" role of the government, the second part may be carried out in the private sector as long as there is a competitive environment for that. One can see that this grey area can be an arena of conflict if the NMA's budgets depend on a form of cost recovery imposed by the government.

If the NMA's involvement in a value added market oriented activity is complicated on the basis of rules governing competition by government with the private sector, the revenues can be generated from royalty payments and rights to the use of the data for particular purposes. Or, the NMA could develop a capability to take both courses of action depending on the situation and what would be best under the circumstances. However, this requires additional competency in the organisation for dealing with the market and writing and administering contracts of this nature and particularly with a new breed of clients.

In the late 1980's and early 1990's National Geospatial Data Infrastructure emerged as an issue in the context of expectations at the highest political levels in the USA and Europe of the social and economic benefits to society of the "information society".

NATIONAL GEOSPATIAL DATA INFRASTRUCTURE

The term National Geospatial Data Infrastructure (NGDI) hit the headlines when President Clinton signed Executive Order 12906 : "Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure"(April 11, 1994). It is important to note that the NGDI was clearly seen as a part of the National Information Infrastructure(NII) which, when the Clinton administration took office in 1992 was the centrepiece of a well orchestrated set of government strategies, including a variety of social, economic and technological policy areas.

The NGDI is a institutional and operational arrangement necessary to provide open access to spatial information government departments have collected for their own primary purpose, i.e. to govern. This sets (N)GDI aside from the many existing "enterprise- wide information infrastructures" in for example banks and insurance companies, logistics companies, the systems associated with supply and demand management such as "just in time " delivery schemes. These enterprises have no statutory obligation to make their geospatial dat infrastructure accessible to the public. Hence the NGDI deals with the geospatial data infrastructure at the national level while there may be a multitude of GDI's at provincial or municipal levels. These organisations have a public duty in common i.e. to provide public access to their geospatial data, in so far as this does not conflict with the legislation concerning the protection of the privacy of individuals or companies.

In simple terms, the purpose of GDI is:

- to save time, effort and money in accessing geospatial data and using it responsibly;
- to avoid unnecessary duplication in the harmonisation and standardisation of required data sets by promoting the sharing of available data.

Hence, GDI *facilitates access* to, and the *responsible use* of, geospatial data at *affordable prices?*

'Facilitate access' means letting the user know what information is available and where, what the conditions of access and use are, and how much it will cost. The reference to 'responsible use' implies an obligation on the part of the data suppliers to include qualitative information about the data, which lets the user determine how fit the data is for use in his/her

application. The reference 'affordable price' signifies that a degree of price differentiation is possible depending on what the user is prepared to pay for the information or the associated information service. The economic characteristics of government owned geo information as an 'imperfect public good' strongly influence this process (Coopers_&_Lybrand ,1996)

NMA'S AND THE NGDI DATA SETS (foundation, framework & application specific)

National Geospatial Data Infrastructure (NGDI) can be thought of as a set of networked GDIs, each set up to serve a certain application domain, in terms of the objectives stated above. These application domains lie in, for example, the fields of environment and physical planning, or agriculture, or transportation, etc. Furthermore, a particular application domain may require data from the municipal, provincial or national level and data connectivity and harmonisation between those levels. This implies a requirement for data at different resolutions or scales. This, in turn, has consequences for the relationship of the data definitions and semantics from the larger scale level to the smaller scale level. It should not always be assumed that it is possible to derive the smaller scale level from the larger scale level by automated means. It is expected that the semantic aspects of the data standards will, in many cases, remain a bottleneck that can only be alleviated by human intervention for the foreseeable future, and increasingly by closer co-ordination in defining the associated semantic data models.

Figure 1 recognises foundation data sets such as geodetic data (which determine the spatial reference system), fundamental topography (used by many applications as an additional geometric reference represented in the terrain), the digital elevation model, administrative boundaries and postal codes (essential to link socio-economic data to physical data), official geographic names (for many applications these are still the most used reference). Sometimes digital orthophotos are part of the foundation data, but these require skilled interpreters, not frequently encountered among the users.

It should be recognised that the fundamental topography is not necessarily a digital copy of the topographic maps. For example, in the Netherlands the national topographic survey produces a topo database in vector form at the scale of 1:10,000 (TOP 10 Vector). This still contains approximately the density and attribute values of the 1:25,000 topographic maps, far too much information for most users. There is now a major consultation with the user community to define the content and density of attribute values for a suitable and affordable core topographic data set, although it will be based on the TOP 10 Vector product. The current TOP 10 Vector contains many artefacts from the past. Are we really waiting for data designed for Napoleon's infantry almost two centuries ago? On Dutch topographic maps, and as such in the database, object categories can be found that were defined based on their being an obstacle to the infantry. Examples are canals wider than 3 m, fences higher than 2 m, and escarpments

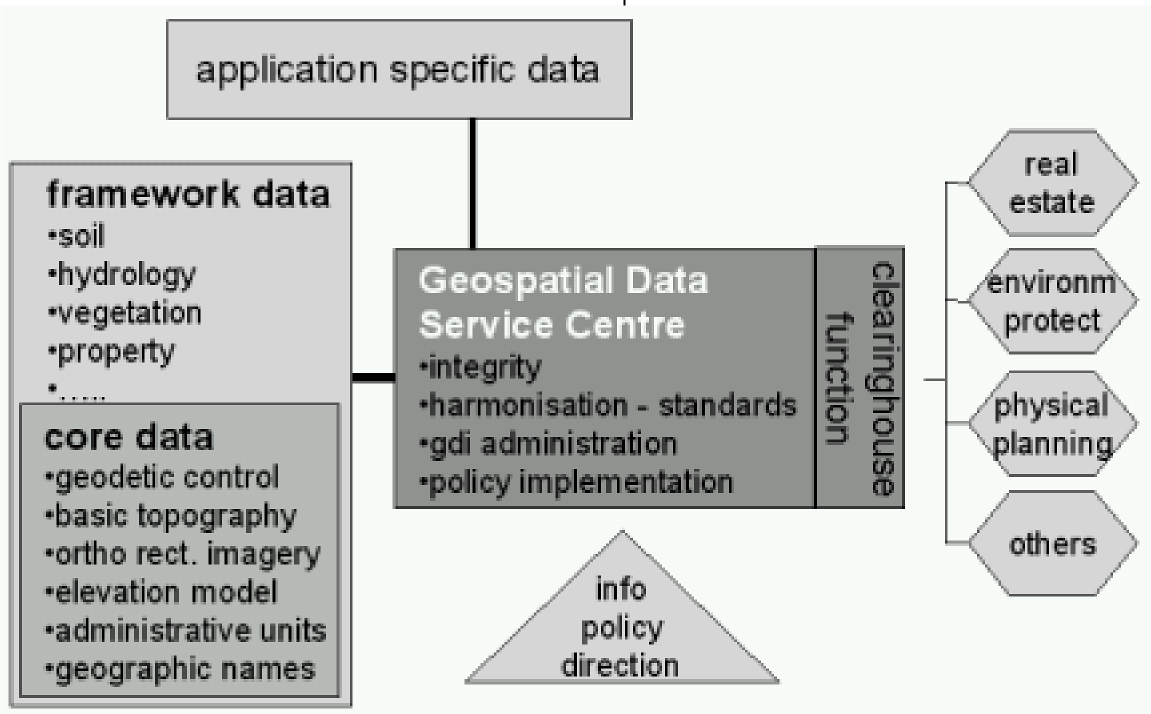

Figure 1. Structure of the Geospatial Data Infrastructure (GDI)

higher then 1.5 m. Is this what we need with respect to the National Geospatial Data Infrastructure, or a modern topographic map? In the last section of this paper we return to this problem.

With the possible exception of the administrative boundaries, it will be recognised that the foundation data are produced by the national geodetic/topographic survey organisation. Administrative boundaries are often produced and maintained by the national statistical organisations, i.e. those responsible for the national census and a variety of social and economic surveys.

Figure 1 also recognises framework data sets. These are data sets, which usually provide thematic information in a national context. This information, for example on vegetation, land use, land cover, and hydrology, may be surveyed directly in the field or by means of remote sensing. Or it may be derived information, such as land suitability for particular purposes. Population distribution and population density by geographic areas are also important framework data sets. At any rate, framework data sets provide the thematic geographic framework of the country. The data are produced, maintained, published, distributed and safeguarded by national survey organisations, such as the national soil survey institutes, geological surveys, hydrological and climatological organisations, etc. The last class of data set indicated in Figure 1 is the application-specific data set. These contain information surveyed specifically for a particular application, such as pollution measurements, water chemistry, smog indices, etc. Although these may be useful in a national context to show, for example, the occurrence of smog across a country, they are mostly only relevant to a particular application area.

When we think back to one of the objectives of GDI, the reduction in duplication of harmonising and standardising data for applications, we can conclude:

a. Data sharing opportunities are very high for foundation data, decrease somewhat for framework data and are even less for application specific data.

b. National survey organisations must be encouraged and give high priority to defining the foundation and framework data with the user community, and to ensuring that these are produced and maintained to appropriate GDI standards.

Access to and responsible use of the above data files at an affordable price is administered through a Geospatial Data (SD) Centre, as indicated in Figure 1. This is done so according to a set of transparent policies which ensure that all users know and understand the conditions for access to and use of the data, how much it costs, how their own data will be protected through the SD Centre, etc. The legislation is sometimes in conflict. For example, a balance needs to be found between free access to government data and the need to protect information of the state concerning the protection of the realm, the safety of citizens, relationship to other governments, etc. Furthermore, the legislation governing the privacy of the individual and corporations may conflict with that dealing with the commercialisation of government information.

What is the role of NMA's in the development of the NGDI. They should work on the foundation data for this infrastructure. This should be composed of:

a) A national positioning system,
b) A national digital topographic template,
c) Elevation model
d) Geographic names
e) Administrative units

And sometimes, depending on the local situation, it might concern:

f) A national property register,
g) Thematic databases linked to the above,
h) Appropriate standards for data classification, structuring, qualification and digital communication in support of optimal and multi-purpose use of geoinformation
i) One best authoritative source of any type of geographic information,
j) A clear definition of which organisation is responsible and accountable for what databases in the constellation.

It is easy to state these elements of the foundation data. It is quite another matter to define their content in relation to the user community. Experience in most countries embarking on the process of defining the content of their foundation data sets is that it is a slow and tedious process involving many stakeholders. The main reason why so much time and effort is being put into the relationship to the user community is the following.

The economics of establishing and maintaining NGDI has not yet been studied extensively. Consequently it is also difficult to decide what would be a reasonable budget for NMA's to provide their contribution. However, it is well known that the investments necessary to set up a well functioning NGDI are significant. It is therefore essential that the data, which become accessible through the NGDI are appreciated by a large user community. It would be calamitous if in the end the NGDI would give access to data which are either very expensive to use for reasons of excessive complexity or too out of date or incomplete. In practical terms the result will be a compromise of what the user community indicates it needs, how much it is prepared to pay for the data, as well as the financial and human resources of the NMA because new budget increases will be highly unlikely in almost all countries.

Of particular concern is the readiness of the NMA to change the organization and methods of working in line with the requirements of this mandate and especially the growing need of the user community for a diversity of products rather than standard ones (Rhind ,1997) .

Figure 2 presents a schema of the production lines in a modern NMA while Figure 3 presents the associated organization schema.

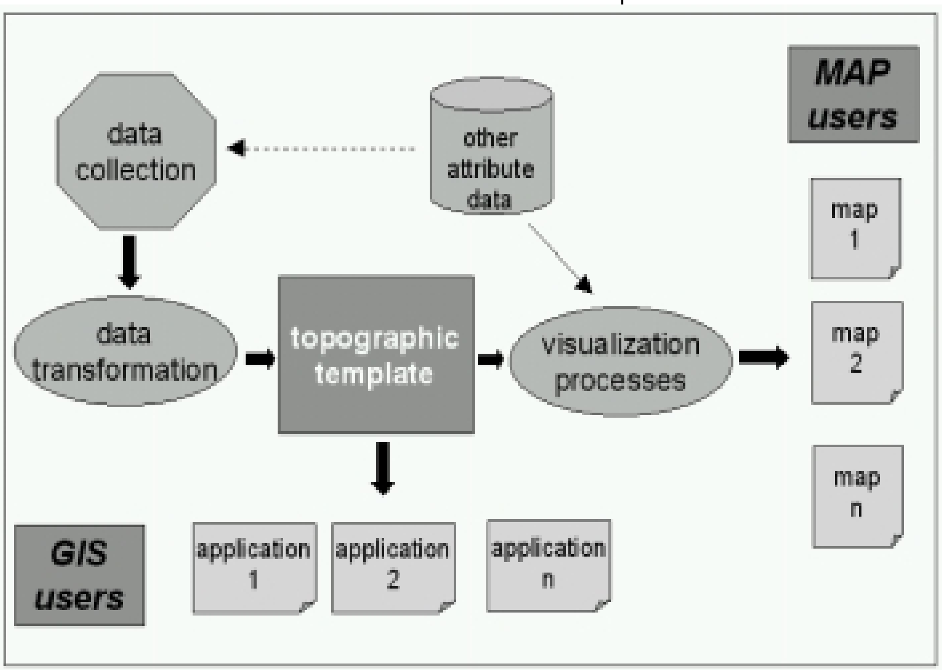

Figure 2. Generalized production process

In this concept, the topographic template is a standard output for GIS users through the NGDI. At the same time it is used for the production of

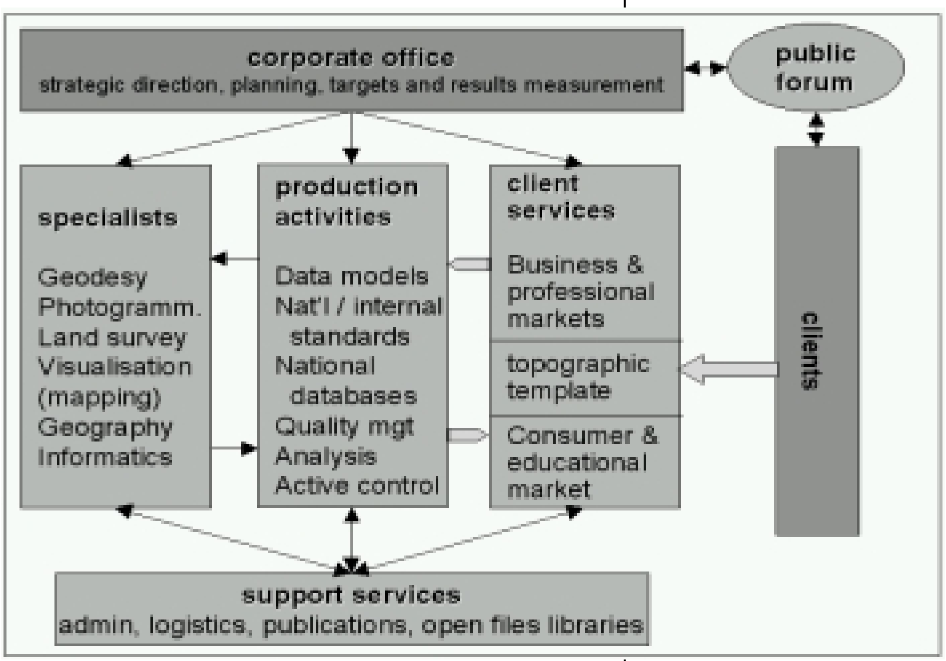

Figure 3. Example of a Modern National Mapping Agency Concerned with Systematic Surveys and Mapping in Response to Client Demand incl. NSDI

topographic maps and other demand driven products. However this is a different production process than before. The production process is characterised by a far smaller degree of standardisation than before. Also the choices that need to be made in the acquisition of the attribute data to meet specific client demands requires making well considered choices in terms of time, and financial constraints against client requirement. As a consequence and due to the need for responsiveness to client demands a completely different philosophy of quality management needs to be implemented. Namely one whereby individuals work in a fully integrated manner in product/ service oriented teams and carry full responsibility for the whole process including the quality of the output. The principle is to do it right the first time and to not rely on checkers to find ones errors as used to be frequently the case in the conventional processes.

This is obviously a radically different form of organisation than the one reflected in traditional NMA's. It requires a totally different kind of management, it is flexible and responsive to demand driven processes. This requires a different staff composition as well. Most professional staff must be at home in the integrated world of Geoinformatics however, each with their own specialisation. They need to work in teams, which are formed and disbanded as the need arises. They need to master new tools such as workflow manage-ment, business process redesign, process manage-ment in addition to the tools of their speciali-sation.

Optimisation of geoinformatics processes is an important method to find the necessary balance between client requirements and financial and time constraints in the design of production processes.

To move from the traditional organisation to the one shown above is a very demanding and in most cases time-consuming task. The most recent and quite comprehensive description of such a transition has been written in (Rhind ,1997) However, it should be kept in mind that he describes in fact the conclusion of a process which had started about five years or more before the period he relates to. That was what one might call the necessary incubation period in which the organisation absorbs the fact that in order to survive it must change, but it doesn't really know how to go about it. Rhind was at his arrival in OS without a doubt a most effective agent of realising this change. To realise the type of fundamental change in the character and culture of the Ordnance Survey is a difficult and significant accomplishment. An organisation like so many National Surveys with a long and proud tradition

ITC APPROACH

The relation between the National Geospatial Data Infrastructure and the National Mapping Organizations, who are considered ITC's customers, ITC's Geoinformatics divisions have started a research project called Common Database Project. The aim of the project is to define the minimum requirements of a (topographic) foundation database, and to establish a local mini GDI for educational and research purposes.

The project will demonstrate the need for a integrated geoinformatics approach. Each of the participating divisions (Data acquisition, GIS, Cartography and Geo-infrastructure) will provide expertise to create the database and to establish production lines for specific product. Processing steps will be recorded to get a feel of the time and costs needed to put the data in a usable format. The final database will allow us to compare different national approach and evaluate their effectiveness for particular applications.

The project will focus on the municipality of Enschede. This is a data rich environment including the national 1:10.000 database, the municipal 1:1000 database, the cadastral database and large and small scale aerial photography, as well as laser altitude data. From this data rich environment the minimum data set will be defined, based on experiments and in cooperation with customers of the data dealing with framework and application specific data

The database material will be used throughout the divisions educational programs, the Geoinformatics courses (GFM) and the Geoinformation Management courses (GIM). The use of the data in the educational programs, among them MSc research, as well as staff research will ensure attention for problems such as multi-scale characteristics, update frequency, coordinate systems, accuracy, dimensionality, time (versions) and meta-languages. While studying these topics the application environment is considered.

The final result will be the availability of a mini-geospatial data infrastructure within ITC. It allows us to confront the students with real world problems, illustrating the theoretical approach. The fact that the data collected are covering the municipality of Enschede, ITC's home base, which includes both large urban and non-urban areas, and to Dutch standards even has considerable height differences, the students can see the reality behind the data used, in the direct environment of the ITC building. The World Wide Web will play a significant role in this infrastructure, since it allows us to disseminate our knowledge outside our own organisation as well.

Knowledge gained from the project will allow us to improve our educational program, and help us better advise our customers, the national mapping agencies.

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GLOBALLY ENABLING ACCESS TO SPATIAL INFORMATION : THE GLOBAL SPATIAL DATA INFRASTRUCTURE

Derek Clarke, Deputy Chairman, GSDI Steering Committee, Chief Director of Surveys and Mapping, South Africa

INTRODUCTION

Good public decision-making and development planning is dependent on relevant spatial information. Should this spatial information not be readily available in an accessible form then it cannot be expected that good public decisions are made or that development projects are properly planned and executed. It has been reported that one of the main reasons why development projects fail is the lack of information appropriate for that project.

In most of the developed countries it is widely acknowledged that spatial information is part of the national infrastructure and extensive effort and resources are being expended on this. The same cannot be said for developing countries. Although this is changing. Developing countries are starting to establish digital spatial databases – largely with the assistance of foreign donor aid. These national initiatives are going beyond just establishing databases for specific projects but towards harnessing the information resources of all government departments and agencies. This new direction is geared to minimise duplication of effort and data between agencies. This requires national policies and infrastructures. There is no doubt that spatial information at the national level is the priority of all countries. However, many issues, such as atmospheric pollution, global warming and water catchment management, do not know national boundaries and transcend the national interest only.

These global issues require spatial information at the regional and global level. To make decisions on global issues requires spatial information at the global level. This information must be shared across national boundaries. The requirement for this then is a global spatial data infrastructure.

GLOBAL SPATIAL DATA INFRASTRUCTURE

The Global Spatial Data Infrastructure (GSDI) was conceived only in recent years although the concept has been around for a lot longer.

"... By the early 1980's, the notion of 'information as a corporate resource' ... and the information resources management movement encouraged individual organisations to implement collective approaches to the collection, management and sharing of designated hardcopy and computer-based data holdings of 'corporate-wide' interest ...

... The manifestation of these data sharing precepts evolved from early dreams of centralised 'land information databanks' through the 1960's and 1970's ... into the vision of more complex distributed land information networks in the 1980's. This vision conveyed the idea of linking together organisations responsible for the management of land-related information in a jurisdiction into a network to form a 'virtual' geographic information system which could be queried in a manner similar to a single database ...

... critical mass has now been reached in a number of more recent enterprise – or jurisdiction-wide efforts. At least five important reasons account for this acceleration ... Increasing prominence of spatial data handling within organisations ... robust, easy-to-be-use and relatively inexpensive tools ... ubiquitous data ... ubiquitous communications ... greater availability of experienced people ... ubiquitous and expensive positioning, tracking and navigation capabilities of GPS ...

... By the early 1990's, the concept of spatial data infrastructure (SDI) development was being proposed in support of accelerating geographic information exchange standards efforts, selected national mapping programs and the establishment of nation-wide spatial information networks in the United States ... the United Kingdom ... Canada ... and the European Community...

... Finally, the Santa Barbara Statement prepared from the Interregional Seminar on Global Mapping for Implementation of Multi-National Environmental Agreements (held Santa Barbara, California, USA, in November 1996) made a strong plea for the accelerated collection, promotion and use the output from national and global mapping programs and the coordinated development of a global spatial data infrastructure ..." (Coleman and McLaughlin, 1997).

The GSDI has been as envisaged to encompass the broad policy, organisational, technical and financial arrangements needed to support ready global access to geographic information. The definition of the GSDI adopted at the 2nd GSDI Conference is (GSDI 1997);

"... The policies, organisational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives..."

Benefits And Beneficiaries

One of the central finding of the 2nd GSDI Conference is that the GSDI is of vital importance to implementation of Agenda 21 of the Rio Summit and to multi-national environmental conventions and that it should be placed as central support for decision making before the meeting of the UN commission on

Sustainable Development in 2001. Further, the GSDI is critical to the attainment of substantial and sustainable development in both the developed and developing countries of the world.

Some of the benefits of the GSDI can be found in the concept of the Digital Earth (Gore 1998). The Digital Earth is seen as a multi-resolution, three-dimensional representation of the planet, into which we can embed vast quantities of geo-referenced data. The applications that will be possible with broad, easy to use access to global geospatial information will be 'limited only by the imagination' (Gore, 1998). Some current USA-based examples cited in the Digital Earth announcement are:

> "... **Fighting crime**: The City of Salinas, California has reduced youth handgun violence by using a GIS to detect crime patterns and gang activity. By collecting information on the distribution and frequency of criminal activities, the city has been able to quickly redeploy police resources.
>
> **Preserving biodiversity**: Planning agencies in the Camp Pendelton, California region predict that population will grow from 1.1 million in 1990 to 1.6 million in 2010. This region contains over 200 plants and animals that are listed by federal or state agencies as endangered, threatened, or rare. By collecting information on terrain, soil type, annual rainfall, vegetation, land use, and ownership, scientists modeled the impact on biodiversity of different regional growth plans.
>
> **Predicting climate change:** One of the significant unknowns in modeling climate change is the global rate of deforestation. By analyzing satellite imagery, researchers at the University of New Hampshire, working with colleagues in Brazil, are able to monitor changes in land cover and thus determine the rate and location of deforestation in the Amazon. This technique is now being extended to other forested areas in the world.
>
> **Increasing agricultural productivity:** Farmers are already beginning to use satellite imagery and Global Positioning Systems for early detection of diseases and pests, and to target the application of pesticides, fertilizer and water to those parts of their fields that need it most. This is known as precision farming, or 'farming by the inch'..."

The many players potentially involved in and potential beneficiaries of the GSDI have been identified to include (Coleman and McLaughlin, 1997 and Rhind, 1997):

- "Public sector as data providers, as consumers of information and advice, and as service providers;
- Not-for-profit organisations;
- Science/social science research organisations;
- International aid/development organisations;
- Educational organisations;
- Private sector information/content providers;
- Private sector service providers;
- Private sector software and hardware vendors; and most importantly
- Individual citizens."

Coleman and McLaughlin (1997) and Rhind (1997) expand on the potential benefits to three particular stakeholder communities:

> "... **The Military**: ... The military ... has played a significant role in developing and eventually spinning off the technology components which support global geospatial data infrastructure today. Some of the best-known examples of this – GPS, remote sensing, special-purpose computer hardware and software, and even the Internet itself, were developed to support basic mapping, surveillance, and command & control systems ... Future warfare will be 'multi-dimensional', requiring the integration of information to support land, air, sea and even space-based operations in the process ...
>
> **Science and the Environment:** ... A number of global change initiatives have been implemented to improve quality of observations and interpretation, manage large quantities of global change data, and communicate the results of global change research to the international community. Examples of key international programs include ... Global Change Data and Information System ... World Climate Research Programme ... International Geosphere-Biosphere Program ... Human Dimensions of Global Environmental Change Programme ... Committee on Earth Observation Satellites ... Global Mapping Initiative ... Cost and availability of appropriate spatial data coverage – either on a global basis or over selected areas – remain key concerns of scientists in these programs ...
>
> **The International Maritime Community:** The commercial shipping industry world-wide depends upon up-to-date information for safe and efficient navigation ... The real challenge continues to be financing the construction of the marine geospatial data infrastructure ... the use of Electronic Chart Systems and precise GPS dramatically reduces the risk of groundings, improves operational efficiency and reduces insurance costs ..."

ESTABLISHING THE GLOBAL SPATIAL DATA INFRASTRUCTURE

To date there have been three meetings of the GSDI. The concept of the GSDI started to be formulated at the first conference of GSDI held in September 1996. The main goals of the conference, as described in the conference proceedings (GSDI 1996) were :

> "... to minimize duplication of national efforts, the cost of Research & Development (R&D), and to identify the critical opportunities and threats inherent in creating a global spatial data infrastructure ...

... create a standardized vocabulary and the new concepts needed to facilitate an ongoing dialogue between diverse professions to design, implement and extend spatial data infrastructures needed in building and using geo-information products and service in a global spatial data infrastructure ..."

The conference agreed :

"... it is apparent that some body or forum is needed to review and comment upon the real, practical problems being faced today by global GI projects ...

... The will for good cooperation and of sharing ideas about infrastructure architectures and solution between the nations is clearly given. It is seen that every ground related decision has to be based on coordinates of an event including the time ...

... All people and especially the politicians have to be convinced of the importance of spatial data, which makes only sense if they are available globally and if infrastructure is functioning. It is necessary to contemplate properly the next steps in this direction and to take into consideration that not the techniques itself is the problem; the ability to use the brain is the main point ..."

The 2nd GSDI Conference, with the theme 'Toward Sustainable Development Worldwide', was held in Chapel Hill, North Carolina, USA, in October 1997. The main goals of the conference were :

"... clarify worldwide activity related to SDI development;

Identify specific benefits and raise awareness of GSDI within the world community;

Generate a blueprint for realizing the GSDI vision ..."

The conference found (GSDI 1997), in addition to the central findings mentioned above, that :

" ... It is necessary to seek involvement and support of decision-makers at the highest levels of business, government, and academia in establishing the GSDI; and to generate support at the local, national, regional and international levels. In particular, it is important to involve the G7 countries, the UN Institutions, and the World Bank in the creation and use of the GSDI ...

... Numerous international activities are seeking to forward aspects of the GSDI ... It is important that all international groups working toward the development of the GSDI participate in future processes of its evolution and that they communicate, coordinate, and collaborate to the fullest extent practicable ...

... There is a need to foster education and research activities that go beyond treatment of geospatial data in solely a technical fashion. It is important that such activities include the creation of suitable tools in universities, government and the private sector to foster the use, demonstration, spread of good practice, and thoughtful application of results of this research ..."

The conference resolved that :

"... There is a need for an organisational nucleus to encourage the creation, development and linkage of local, regional and global geospatial data infrastructure ...

... Permanent regional committees for geographic information ... are important to the success of the GSDI. There is a need to encourage development of these permanent committees ... in regions where currently they do not exist, such as the Americas, Africa, and the Middle East ...

... It is essential to have a family of standards as the foundation for technical implementation of the GSDI, and all standards created or utilised for the GSDI should be international standards ...

... There is a need to explore the extent to which local, national and regional data sets can be translated into international ones, and how data definitions can be harmonized without losing their primary relevance or compromising the political and legal diversity amongst nations ...

... The problem solving capabilities and social and economic benefits of the GSDI should be advanced and clearly demonstrated ..."

The 3rd GSDI Conference was held in Canberra, Australia, in November 1998. The conference theme was 'Policy and Organisational Framework for a GSDI'. The main goals of the conference were to :

"... Focus attention on the policy and organisational framework for a GSDI ...

... Address specific initiatives to harmonise existing data (and other infrastructure) ...

... Demonstrate proven global / regional applications ..."

The conference found (GSDI 1998), in addition to the central findings mentioned above, that:

"... The achievements of GSDI will depend upon partnerships among many groups including industry, consumers, academia and government. GSDI must develop outreach activities to ensure that institutions and organisations that can and will benefit from an improved global spatial data infrastructure have an opportunity to participate. At this meeting it was obvious that national mapping organisations/agencies, state level mapping organisations/agencies, industry, academia and a variety of governmental agencies are very interested in GSDI development ...

... Agreement on the goals and objectives of GSDI will be vital to promoting the efforts to establish NSDI's and leverage resources at the national level ...

... It will be important for GSDI to encourage and facilitate capacity building efforts in developing countries in transition so they can effectively participate ..."

One of the major resolutions from the conference is to request the Statistics Division of the United Nations to submit the following statement to an appropriate United Nations body for consideration :

"... Recognising that implementation of the objectives of Agenda 21 requires transnational understanding and analysis of environmental data the ECOSOC urges countries, to the extent possible and consistent with national priorities, to develop national spatial data information systems and cooperate to develop international spatial data standards ..."

A Technical Working Group is tasked with development of detailed proposals by or before the next GSDI Conference that

- propose reference models or best practice recommendations for data documentation and data discovery and access;
- define core data catagories, their resolution and content for the GSDI;
- provide a working model of this core data using metadata and clearing house best practices; and
- define a single standard for spatial referencing by geodetic coordinates that may be adopted as a standard to which countries may move toward and – in the interim - to which countries relate their own respective standards.

The GSDI is being managed at this stage by a multi-national GSDI Steering Committee. The business of the GSDI Steering Committee will be undertaken through four initial working groups:

- **Operations Working Group** - to oversee the implementation of the umbrella organisation structure, and general administrative issues related tot he GSDI.
- **Technical Working Group –** to advise the Steering Committee on technical aspects of the GSDI.
- **Communication and Awareness Working Group** – to inform the broad community about GSDI and the value of spatial data, and to promote the GSDI concept.
- **Legal and Economic Working Group** – to advise the Steering Committee on economic, legal and funding mechanisms underpinning the GDSI.

CHALLENGES

There are many challenging issues to address before the GSDI will become a reality:

- Raising the level of awareness, acceptance and support. The GSDI concept is not widely known, let alone well accepted and supported. Given the requirement for a broad group of stakeholder interests to be satisfied this presents a significant communication challenge. Perhaps the most important task at this present juncture is to gain the support of the senior-most members of government, non-government, business and community groups, and in doing so influence legislative, policy and financial decisions that are critical to effective GSDI implementation;
- Recognising and complementing related initiatives. The GSDI is but one of many global, regional and national initiatives aimed at improving access to geographic information. It is essential that these initiatives are identified. Recognised and appropriately supported so that the maximum synergy can be obtained from their collective outcomes. This requires a continuous scan of the external environment and effective communication networks amongst those involved.
- Including all stakeholders. For the GSDI to be seen to be truly successful by its stakeholders they must be appropriately involved in, and contribute to its design and realisation. Given the breadth of the GSDI stakeholder group – government and non-government organisations, education and research institutions, the commercial sector, and the general community – it is not surprising that many, if not a majority of stakeholders are not yet included.
- Engaging the less developed economies of the world. Much of the thought, discussion and effort thus far in defining and implementing the GSDI has been from the perspective of the more developed economies of the world - Europe, North America, parts of Asia and Australasia. Most of the globe – generally the less developed economies of Africa, Asia, the Middle East and Oceania – has played only a minor role, if any role at all. If the GSDI is to be a truly global initiative and confer its benefits to all global citizens then a way must be found to bring these nations on-board.
- Maintaining enthusiasm and momentum . Having made the previous point it would be unfair and misleading not to recognise the many individuals and groups who have contributed to the GSDI thus far. This enthusiastic and committed global group must be encouraged to expand their efforts and bring others on-board, thus increasing the momentum of the GSDI initiative.

- Delivering beneficial outcomes. The final, and arguably the most important, issues of all to be addressed is ensuring that the GSDI delivers benefits that can be described and measured in some way, and are regarded as important by the relevant stakeholder group. If this does not occur for some time, or not at all. Then the significant effort in involved in realising the GSDI will be questioned and potentially compromised.

THE WAY FORWARD

As stated above the momentum must be maintained in developing the GSDI and also to extend the GSDI initiative to all countries. The GSDI Steering Committee extends an invitation to all countries to become involved and to participate in the GSDI meetings. The following GSDI meetings or related meetings have been scheduled for the near future:

- 12 to 14 July 1999 – EDIS 99 Conference, Pretoria, South Africa. A special session and workshop will be held.
- 15 July 1999 – Africa SDI, Pretoria, South Africa. This will be a workshop dedicated to extending GSDI and related technical issues to Africa.
- 16 July 1999 – meeting of the Technical Working Group of GSDI, Pretoria, South Africa.
- 18 July 1999 – meeting of the GSDI Steering Committee, Cambridge, England. A formal meeting of the GSDI Steering Committee.
- 13 to 15 March 1999 – 4th GSDI Conference and meeting of the GSDI Steering Committee, Cape Town, South Africa. This conference will specifically encourage African involvement.

African countries are being challenged in particular to join the global community in furthering the needs for spatial information. The place to start is at 'home' with the development of a national spatial data infrastructure and then to extend this to the regional and global levels. Efforts towards a NSDI should be in conformance with the guidelines of the GSDI, thereby ensuring the later global connection. Developing countries can also learn a lot from the experiences of other countries through participating in the GSDI. This will benefit them in setting up their own NSDI's.

Further information on GSDI can be obtained from the Internet web-site at //www.gsdi.org/.

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THE NATIONAL SPATIAL INFORMATION FRAMEWORK AND CONCOMITANT COMMITTEE FOR SPATIAL INFORMATION

Submitted by South African Cabinet Office, South Africa

In April 1999, the South African Cabinet endorsed the creation of the National Spatial Information Framework (NSIF) to facilitate co-operation with regard to the gathering, management and utilization of spatial information within the public sector. The Department of Land Affairs, being responsible for surveys and mapping and the basic spatial data sets, has been tasked with implementing the NSIF and government agencies involved in spatial information directed to co-operate with the NSIF.

There are currently many initiatives to develop Geographical Information Systems (GIS), at all levels of government, to enable information driven governance and decision making. This is not surprising, as most government-held data have a spatial component, examples including the location of investments by government agencies and census statistics. The rapid ongoing development of Geographical Information System (GIS) technology which makes the capturing, storing managing and analysing of spatial and spatially related information easier to accomplish, will lead to continued growth in the utilization of and reliance upon spatial information in future.

The viewpoint behind creating an NSIF is that spatial information systems should be developed in such a way that it is possible to transfer information between them for maximum benefit to the public service. Not

only will the sharing and reuse of spatial information eliminate the duplication of cost and effort in the capture and maintenance of spatial data, but it also activate latent synergies between these information systems. The full benefit of using spatial information and GIs technology is achieved through integrating a variety of spatial data for the purpose of spatial analysis and decision support. Examples of where the exploitation of GIs could lead to improved service delivery include disaster management and the provision of emergency services. A study to quantify saving which have been and could be achieved through the utilisation of spatial information has been commissioned jointly by the Departments of Land Affairs and Public Service and Administration, the latter being responsible for IT/IM policy in government. This study will be completed in October 1999.

A new component was created within the Department of Land Affairs in 1997, dedicated to the establishment of the NSIF. The NSIF has been focussing on the development of a system for publishing information about existing spatial data sets (held by both the public and private sectors), the development of standards for geographic information, policy guidelines which will foster the sharing and reuse of information and the identification of certain 'core' data sets, which can provide the spatial fabric into which further information can be pinned.

The Spatial Data Discovery Facility (SDDF) is a catalogue detailing information about spatial data sets and can be accessed by anyone, free of charge, through the internet (http://www,nsif.org.za/). Tools enabling data producers to document their data sets and to publish this information through the SDDF are distributed free by the NSIF. The SDDF has largely been constructed using components developed previously by the Federal Geographic Data Committee (FGDC) of the USA, which enabled it to be built speedily and cheaply.

Globalisation means international standards must inform a national standard if the sector is to be competitive in the global economy. In addressing the issue of developing a national standard for geographic information, the NSIF has largely been focussing on providing input to ISO TC211, which is charged with developing ISO standards for geographic information. However, in anticipation of the emerging international standard, work is also proceeding on developing a standardised spatial feature catalogue, as the GIs community identified this as a priority for enabling spatial data to be shared and used appropriately.

Co-operation at a technical level by the role-players within the GIs industry in South Africa has been fostered by the NSIF to data. This co-operation has been encouraged through the establishment of task teams which include technical experts from within both the public and private sectors, as well as academia, to investigate and make recommendations on the standardisation of data formats and provision of access to information about spatial data sets. Ongoing consultation takes place through workshops, for participation in task team driven activities. Information concerning meetings and requests for feedback are regularly circulated via e-mail to an ever growing list of people interested in being informed about and participating in the development of the NSIF. The Sniff's web-site is also used as a vehicle for communication.

In addition to collaboration and co-operation at a technical level, a higher level forum was identified as necessary to ensure that the NSIF develops in such a way as to benefit the Public Service as a whole, as well as address policy issues associated with the use and dissemination of digital spatial data. The Cabinet also approved the establishment of a Committee for Spatial Information (CSI) to fulfil this role. On the CSI will be represented all sectors and spheres (i.e. national, provincial and local) of government who rely on spatial information in order to perform their functions, through senior managers in these components. The CSI will provide direction to the NSIF and ensure that the benefit deriving from investment in spatial information gathering and management is optimised. Further, it will also serve to institutionalise co-operation between role-players, which is an important for improving access to spatial data and facilitating the interchange of data, as are technical mechanisms. This forum would also provide the platform for communicating progress with regard to the development of the NSIF and the receiving of feedback concerning this development from senior managers. The CSI will meet biannually, with its first meeting scheduled for 1 September 1999.-

CHAPTER FIVE

COMMERCIAL ASPECTS OF GEOINFORMATION TECHNOLOGY

COMMERCIAL ASPECTS OF GEOINFORMATION TECHNOLOGY

Commissioned paper, presented at the first meeting of CODI, Addis Ababa, 28 June 1999, prepared by Prof. O.O. Ayeni, U. of Lagos

INTRODUCTION

Geoinformation Technology, also known as Geoinformatics, is one of the products of Digital Revolution, which has evolved within the past three decades as a marriage between the Geosciences(Geo) and Information Technology (informatics). Various branches of Geosciences such as Geodesy, Surveying, Photogrammetry, Remote Sensing and Cartography have utilized sensors to capture and measure spatial data which in turn have been computer processed, stored, analysed, interpreted, and displayed and made available for a wide variety of applications within the context of Geographic Information Systems (GIS). Geoinformation is therefore a multi-and cross disciplinary technology in nature and applications. Different aspects of Information Technology (IT) which have made and will continue to make a great impact on Geoinformation Technology (GT) can be identified as ; Linders (1996)
Computer and Communications
Object - oriented Databases
Image Processing (Raster Technology)
Artificial Intelligence and Expert Reasoning
Computer Graphics

The result of this impact can be observed in recent advances in GIS [object-oriented (o-o) and Expert GIS], Geodesy(Global Positioning System), Surveying (Digital Surveying), Photogrammetry (Digital Photogrammetry), Remote Sensing (Digital Image Processing) and automated Catography with each discipline producing Geoinformation in its own right. The impact of Information technology may also be observed in the development of these disciplines which have been mutually linked to "GIS" environment hence the term integrated GIS. The impact of Information Technology has also influenced the merging of associated disciplines which has given rise to a new terminology called Geomatics or Geomatics Engineering, an integrated approach in which two or more of the modern disciplines of Geosciences are combined with GIS technology within the context of surveying and mapping fieldwork and workstation environment.

Perhaps the greatest impact of Information Technology, which is not often acknowledged, is the tremendous influence on the commercial value of Geoinformation Technology. It is useful to remember that Information Technology vis-a-vis Digital Technology being a hi-tech was borne in a commercial environment with a high rate commercial value which fortunately has been decreasing ever since, thereby bringing Geoinformation Technology within reach of a low- budget corporate or individual enterprise or organisation. One of the objectives of this paper is to discuss the commercial aspects of the various technologies which constitute Geoinformation Technology, such as the hardware and software market, the capital market, commercialisation of Geoinformation products and services including some legal aspect of commercialisation, training, research and education. The paper will also discuss some reasons for the rapidly expanding Geo-information market.

SURVEYING AND MAPPING INDUSTRY AND TYPES OF GEOINFORMATION

Four surveying and mapping systems which produce Geoinformation can be identified as

- Terrestrial (Surveying) Mapping Systems (TSMS) - Table 2.1
- Terrestrial Mobile Mapping Systems (TMMS) - Table 2.2
- Airborne Mapping Systems (SMS) - Table 2.3
- Spaceborne Mapping Systems (SMS) - table 2.4

TERRESTRIAL SURVEYING AND MAPPING SYSTEMS (TSMS) FOR GEOINFORMATION

Surveying is a Foundation Technology for Geoinformation. It has the singular honour of establishing the Geodetic Spatial Reference System (GSRS) on which other spatial reference systems for mapping and GIS are based. GSRS provides a uniform reference framework for GIS and Land Information System (LIS) at any scale within a geographical area defined by local, state, national, regional and continental boundaries.

Surveying Instrument Market

A survey of surveying instrument market reveals that three classes of instruments are dominant viz. Total Station Instruments, Inertial Navigation (Surveying) System(INS) and Global Position System (GPS). Total Station Instruments have witnessed some innovation with the introduction into the market of electronic notebook, programmable instruments, automatic targeting instruments, and lightweight telescopic levelling rods. This has given birth to new super Total Station which describes the market customisation, automation and efficiency of computerised field operation of some Total Station Instruments. The fact that the number of such instruments introduced to the market increased from 4 to 15 between 1996 and 1997 is indicative of the fast technological development in this market sector.
Interested readers should see GIM Product Survey on High-end Total Stations [GIM(1997 Sept.)] for the latest total Stations instruments in the market.

Global Positioning System (GPS)

There is no other technological innovation which has exerted a greater impact on the surveying industry more than the GPS technology. GPS has given surveying one of its fastest and most accurate tools for all types of survey work. GPS has indeed revolutionalised surveying profession with the introduction of various versions of GPS viz.hand-held GPS, differential GPS, Kinematic GPS, and Geodetic

GPS. A recent market survey on Geodetic GPS receivers reveals the following (GIM 1996,1998):

- Some measure of cooperation exists between GPS receivers manufacturers as exemplified by Zeiss which offers receivers with NovAtel technology.
- The trend is towards increasing number of dual frequency receivers which are often advertised in the market as GPS Total Station, compared to single- frequency receivers which are on the decline.
- The number of brands, receivers (and software) in the market is still growing.
- The introduction to the market of GLONASS a Russian Global Orbiting

Navigation Satellite System developed in parallel to GPS has provided users with more GLONASS satellites which can be combined with GPS satellites for faster and more precise positioning, compared to using GPS alone, Walsh and Daly (1998).

Table 2.1 shows that Total Station has been successfully combined with GPS (Paiva et al (1999) and CCD camera Walsh and Daly (1998) to produce data for GIS. GPS has also been combined with GIS, Cannon (1994). The dominant instrument is the total station and the dominant functionality and product is the Spatial Reference System. Static terrestrial survey systems therefore provides primarily discrete function but could be adapted for a continuous mapping function.

TERRESTRIAL MOBILE MAPPING SYSTEMS (TMMS) FOR GEOINFORMATION

As illustrated in Table 2.2 the dominant technology of this system is the kinematic GPS and it combines other advanced surveying technology such as the digital photogrammetry, GIS, Inertial Surveying System (INS) and a work station which are mounted in a vehicle with odemeter, to produce a Multi-Sensor System. Of special interest is the integration of GPS and INS. With such a combination of technologies, the TMMS has increased its functionality and end products from spatial referencing, a discrete mapping function, to soft and hard copy maps, ortho image and visualisation which are continuous mapping functions. It represents one of the greatest potentials for the Geoinformation market for large scale applications, if the TMMS can be directly linked with GIS technology.

AIR-BORNE MAPPING SYSTEM (AMS) FOR GIS

The Air-borne Mapping System (AMS) consists of aircraft equipped with Kinematic GPS, strapdown INS, CCD digital or optical frame camera and other sensors and a workstation digital or analytical) in a photogrammetric establishment for producing Geoinformation more efficiently and accurately. A survey of the market will show that raster technology represented by Digital Photogrammetry has taken over AMS in recently times although opinions are divided as to whether it will completely replace Analytical Photogrammetry in future.

AMS probably provides one of the richest sources of Geoinformation and Mapping functionalities such as DTM, orthophoto, triangulation, 3-D visualisation, topo mapping, digital mapping and spatial frame reference for small and large scale applications. As an example of such richness, the Israeli National GIS was implemented with photogrammetric mapping from 1:40,000 scale aerial photo using a softcopy workstation. Zilberstein (1994), in Table 2.3. A most recent survey of Digital Photogrammetry Workstations (DPWS) available in the market can be found in, GIM 1999, Vol. 12 (2). The most cheering news in the market is the advent of low-cost DPWS which are cheaper and faster than the optical - mechanical ancestors and also the integration of DPWS with GIS technology by Laser-scan Ltd., by means of object - oriented GIS, Hardy (1999), (See Table 2.3). It is believed by some DPWS suppliers that there will be a rise of CAD/GIS oriented market for Digital Photogrammetry which will be called “Volksphotogrammetry” or People’s Photogrammetry”.

SPACE-BORNE MAPPING SYSTEM (SMS) FOR GIS

Space-borne mapping system has long been associated with GIS. There are indeed many publications in which the integration of Satellite Remote Sensing and GIS small scale applications have been highlighted (see Table 2.4), Derenyi (1996), Hofmann (1996).Nualchawee et. al (1996). A survey of (existing and future) sensors are published in Konecny (1996). This survey includes commercial satellite data systems available or in preparation. The imagery from these sensors can be processed by a Digital workstation to give a diversity of sources for Geoinformation via Digital Image Processing and GIS technology. Products and functionalities resulting from such systems are ortho image, image maps, topo maps (small and medium scales), visualisation, DTM etc. The introduction of MOMS 02, large format cameras and SPOT Panchromatic with their stereo capability has given photogrammetry an entrance to space-borne mapping system which had hitherto been dominated by Satellite Remote Sensing, Ayeni (1998a), Fritsch (1994).

GENERAL OBSERVATION ABOUT SURVEYING AND MAPPING MARKET

The advert of GPS Technology has influenced every branch of surveying and mapping industry including the surveying market. It can be observed from Table 2.1 - 2.4 that GPS is applied to all the four types of mapping systems which have all been assisted to produce more accurate and reliable Geoinformation. Some traditional analogue and non-electrical instruments have therefore become extinct in the market.

The prices of both software and hardware are going down with increased number of users, Fig. 2.1. Another factor influencing reduction of prices is the competitive markets into which new technologies were conceived and delivered to the public. This trend has also equally given rise to reduction of the prices of Geoinformation. For example there are four distinct types of GPS - engine code (low cost), hand held (low-mid cost), cm level C/A code (mid-range cost) and P codeless 2 frequency (premium cost) whose costs are

generally reducing but the spread in cost from the lowest to most expensive is growing wider.

There is a dearth of information about market structures in the surveying and mapping industry. For example a cloud of darkness seems to cover the capital market of surveying and mapping in many countries. It is only in some advanced countries where some information is made available. For example, in Australia like many countries where mapping is primarily a government function at both federal and state levels, it was estimated that in the 80's surveying and mapping was about a AUS$1000million per year industry employing around 20,000 people, Perry (1994). In 1988, the private land surveying sector of the surveying and mapping industry wascomprised of over 1,100 enterprises with a turn over of about AUS$309million, Perry (1994). A survey of Russian surveying instrument market gives some data of the market structure (i) of demand for types of surveying equipment, (ii) of types of users of such equipment and the type of survey work carried out with these equipment, Geoservispribor (1996). Such surveys of the surveying and mapping industries are lacking in most developing countries, particularly in Africa.

COMMERCIAL GIS

GIS is the "cinderella" of Geoinformation. It has brought a high commercial value and has expanded the scope of Geoinformation applications. Without GIS, Surveying and Mapping may perhaps have been relegated to some set of classical applications, but with GIS, the sky is the limit for Geoinformation applications. Unlike Surveying and Mapping Technology, the commercial aspects of GIS Technology are well-studied and researched. There are two notable GIS industry research firms, such as Dataquest Inc. and Daratech Inc. which feed the GIS world community with useful market statistics. The global market place reveals that there has been a steady growth of GIS market since 1980's. For example in the software market section of GIS which is the fastest sector, sales in 1994 were 15 times those of 1985 according to Dataquest. Growth rates were high, increasing by 30 - 50 percent from 1985 to 1988. Government sales according to Dataquest (1992) account for about 30 percent of GIS software purchase in the global market place between 1990 and 1994. According to GIS World Sourcebook, 1995, the top 15 GIS vendors have more than 300,000 installations. With the increase in Desktop Mapping and GIS on PC the installations could run into a million.

Global Capital Market

Fig. 3.2 shows that in 1991 GIS/Mapping sector shared about 12% of the market shares compared to three other sectors of the capital market. According to Dataquest GIS market grew by 9.5 percent to US$15.8billion in 1991 and the forecast was that the market will grow at a compound annual rate of 9 percent through to 1996. Dataquest (1992). AM/FM which is the largest sector of GIS market was forecast to grow approximately from US$157million in 1992 to US$300million in 1997. It is said that map making, the most traditional of GIS activities is no longer playing the role of a market driver. Fig. 3.3 which depicts the geographical distribution of market share in GIS, indicates that U.S.A. led the world in the 1991 GIS capital market. Indeed U.S. companies still hold the lead in GIS world market.
Fig. 3.4 shows that the number of U.S. Federal Agencies using GIS nearly doubled between 1988 and 1990, this has outstripped all projected data, Hoch (1995). Table 3.1 clearly puts Integraph and ESRI ahead of others.

Fig. 3.5 gives the picture of GIS capital market shares in Europe in 1991 with Germany showing the lead with 36 percent of the total European share. It is well to note that in 1989 the UK, Germany and Italy were the market leaders in Europe. France seemed not to have caught the GIS vision. The picture in 1999 could have changed.

According to the Institute of EuroVista (1994) compared to its European counterpart France is not among the leaders in the field of Geoinformation in spite of a potentially high number of users. Some useful GIS market statistics for France valid only in 1994; are as follows: 80 distributors delivered more than 140 software packages in GIS; there were 62 different GIS available in the French market out of which 35 percent require workstations, minis or mainframes and 47 percent were dedicated to micro-computers; (Fig. 3.6) The leading local government administrations represented the largest market and all 35 cities with more than 100,000 people use GIS. Fig. 3.7 describes the software average price in French Franc while Fig. 3.8 depicts the types of software offer in terms of percentages.

From Fig. 3.3 showing the percentage distribution world source of GIS revenue Africa's share together with other developing countries is included on the 5 percent. There is paucity of data on GIS Capital Market in Africa. A new magazine called Geoinformation Africa and Middle-East, the only type of such magazine, published in conjunction with EIS, reported that GIS Business owned by Geoinformation International solution (GIS BS) has become the largest Black-owned GIS Company in South Africa, GA (1998). Hollard, BMW and NBS are among the few firms applying GIS in their operations. For example BMW applies GIS map technology to manage its motor clan services. Customers whose cars break down can call centre operators who will identify the callers location and dispatch a breakdown team or find the closest service station. GIS technology has assisted in tracking and emergency services systems. In Nigeria none of the GIS Companies is quoted on the Nigerian Stock Exchange Market., This suggests that the traditional activities of GIS in most African countries is mapping since none of surveying and mapping companies are not quoted on the Stock Exchange Market.

Although Australia is among the 5 percent shown in Fig.3.3, the country together with New Zealand has a veritable GIS/LIS programme. The Land Information Council creates awareness for an increasing number of Government and private establishment wishing to adopt the new technology. It is believed that 25 percent of Research and Development (R & D) Australian dollars is related to GIS/LIS matters, Perry

(1994). It is anticipated that firms which have already adopted GIS/LIS technology will increase from 5 to 25 percent over the next few years.

GIS Software Market

GIS World has been conducting annual GIS software survey since 1988 which is usually published annually in the GIS Sourcebook™. It contains detailed information about GIS software type, vendors, consultants, data suppliers, GIS companies and hardware vendors. Fig. 3.9 shows the picture of GIS software worldwide core business in 1993 according to Daratech Inc. GIS annual market study,

ESRI and Integraph continued to dominate the market in 1994 accounting for over 50 percent of the total market share (see Table 3.1). Also according to Datatech Inc., GIS software revenues accelerated by 19 percent in 1992 over those of 1991. In 1993 an estimated revenue of US$456million were recorded which represents a strong growth of 21 percent over 1992 revenue. There is reason to believe that this trend will continue for some time. There were over 350 GIS software package in GIS World Source Book in 1995.

Environmental Systems Research Institute Inc. (ESRI) with an expected revenue of more than US$160million in 1995 is undoubtedly the world's largest GIS company. In 1996 it was ranked the 34th largest software company in the world by InforWorld Magazine.

One of the significant development in the software market in the 90's is the adaptation of GIS software to personal computers (PC). This development has attracted new users into the GIS field. The sales of GIS software for PC has grown much higher than GIS software on other computer platforms. A significant decrease in the prices of GIS software is also noticeable in the market. The number of application softwares are also on the increase over the years. Some software are hardware specific while others are more easily adaptable to a variety of hardware.

GIS Hardware

The basic hardware platform for GIS is the computer, which can be divided into five categories viz personal computers (PC), workstation, minicomputer, mainframe and network with server(s). Dangermond (1991) The PC has become the most popular among the various platforms. The prices of computers have been on the downward trend particularly the PCs.

Other hardwares used in the GIS field but which are not GIS specofic are scanners, and digitizers for data acquisition, and hardware related to Photogrammetry, Surveying and Remote Sensing are also used for GIS data acquisition. A survey of Digitizers in the market was reported in GIM 8(5) in 1994. Black and white and colour plotters and printers have flooded the market place in recent times. The general trend in hardware market is towards varying degrees of automation and gradual reduction of prices leading to a corresponding increase in GIS users. One can assert that GIS technology is getting cheaper and is spreading like wild fire.

GIS Database and Spatial Data Market

There is a growing number of commercial firms offering services in data capture, data conversion, data design, data editing, data automation, database creation, database implementation and management and database maintenance (including data updating, data archiving). Database development remains the most demanding, expensive and time consuming aspects of GIS business because it is a complex task.

Some organisations such as The Open GIS Consortium Inc (OGC) an open membership organisation with 114 corporations, universities and government agencies are working towards full integration of geospatial data from multi-soucrce GIS database. Issues related to Geo information (GI) infrastructures such as standards and metadata are being addressed by various organisation viz: EDI (Finland) EUROGI (European Umbrella for GI) NSDI (USA), NGDF (UK), ANZLIC (Australia/New Zealand), NSDIPA (Japan), CEN, and ISO, Canadian General Standard Board has established Geomatics Dataset Cataloguing Rules.

These efforts are geared towards usable spatial information. Other Market concerns for useable Geoinformation are related to easy availability, resolution, accuracy, completeness, currency and cost. Metadata has been proposed as a means of promoting the data market, however Kuhn et. al. (1996) has proposed modularisation of data into manageable units and packaging them with suitable operations. There are some commercial firms which provide users with previously created digital databases of Geoinformation in some firm suitable for exchange. Dangermond (1991) referred to them as Database Publishers.

SOME OTHER COMMERCIAL ACTIVITIES

There are some other commercial activities in Geoinformation Technology apart from Software, Hardware, Capital and Database Market activities so far described. These are Consultancy, Training and Education and Publishing.

Consultancy

There seems to be a conflict between the professionals in Geomatics and in GIS. In many countries by tradition, a Surveyor regards himself first and foremost as a consultant whereas a GIS professional takes it for granted that he is a consultant or a business man or both in Geoinformation services. Since Geomatics has conferred a new role on the Surveyoors, his image is band to change. The author is convinced that the many Surveyors will soon see themselves as both consultant as well as doing business in GIS. Presently both Surveying and GIS companies and individuals offer consulting services The latter have more expertise in LIS and Cadastral application than other aspects of consulting services.

Training and Education

Training is a wide spread and integral activity in both Surveying and Mapping and GIS Technologies. This covers short-term training on hardware, software, by vendors and on the job or in-house training. Every vendors by convention includes a training component in the contract. However, some vendors and general-purpose GIS firms and higher institutions of learning sometimes conduct some short-term but more extended theoretical and practical training. This can also take the form of seminars, workshops, conferences and symposia on Geoinformation technologies and their applications, sometimes conducted by Professional societies with or without the collaboration vendors.

Formal education in Geoinformation (GI) Technology is not often regarded as a commercial activity. This attitude influenced the pioneering GIS educational programmes because the technology evolved from the Surveying and Mapping technologies which are traditionally studied like other disciplines in tertiary institutions. Today the picture is changing. There are university based degree and higher degree programmes in GIS technology established on commercial basis. There are some diploma and degree programmes in GI Technologies, organised on the principles of distant learning. Such distance learning packages are advertised openly in magazines. There are also computer self training packages with multi-media techniques for teaching Remote Sensing, Photogrammetry and GIS. The aim of training and education in GI technology is to acquire necessary skills and create awareness amongst potential users with a resultant benefit of an expanding market for GI Technology products and services.

Publishing

Publishing has become a thriving business in GI Technologies. Amongst the commercial oriented magazines which have emerged in the past decade or so are the Geo-Info Systems, (a magazine devoted to Applications of GIS and related spatial information technologies), GIM (Geomatics Information Magazine), GIS World, GIS Europe, GPS World, Surveying World (Journal of Land and Hydrographic Survey and Land Information Management) and the latest addition Geoinformation africa (Published in conjunction with EIS news). Regardless of the above titles all these magazines cover the whole garmut of new Technologies albeit with varying degrees of emphasis suggested by the titles. There are special publications with commercial bias, such as GIS Yearbook, GIS Source books, Geographic Technology Markets and GIS World Warehouse. (A type of shop for Spatial Technology resources from around the world). There are several society journals which specialise in Geoinformation Professional practice and research but admit like the commercially oriented counter parts listed above, advertisements from vendors, commercial companies and consultants.

COMMERCIALISATION OF GEOINFORMATION TECHNOLOGY PRODUCTS AND SERVICES

The products and services which can be derived from Geoinformation Technology are many and varied. Some of the products have been indicated in Table 2.1 - 2.4. Some of the services include consulting in GIS development (hardware and software) and visualisation and database creation and maintenance. Given the cost intensive nature of GI Technology it is only natural to seek a way of cost recovery or cost benefit model which will guide GI Technology establishments to arrive at the appropriate pricing for their products and services. Adverse world economic climate, characterised by huge debts, and rising inflation and unemployment in a market economy makes cost benefit model compulsory for GI products and services in both private and public sectors of the economy.

An important step towards commercialising GI products is to develop a well defined policy on pricing and commercialisation. The staff of the establishment must understand the policy and be determined to implement it religiously. Finegan and Ellis (1992) and Finegan et. al. (1992) have proposed a model based on the principle of project management for Remote Sensing in Australia. Ayeni (1997) has proposed a cost model which can be established based on the following factors:

- Define main objective of the project
- Identify the key tasks to be carried out in the project
- Define the immediate objectives of each task
- State the output from each task
- Identify the activities leading to the realisation of each output
- Cost the input elements of each activity
- Establish a budget for the project and a cost model

$$\text{Cost Benefit} = \frac{\sum(\text{Quantity of product}) \times \text{Product value}}{\sum(\text{Total cost of GI Technology project})} \quad \text{---- eqn (1)}$$

Costing the input elements will involve the following: cost of hardware, software, materials, labour (man-hours), time taken, bank interest rate for loan if any, overhead, instrument life-cycle maintenance, inflation and local factors. In case over laps occur in the costing of these elements, necessary adjustment should be made.

Dickson and Calkins (1988) have an established formula for evaluating the cost of GI product which the author has midified as follows:

The cost of input elements will assist in determining the denominator of eqn (1). The product value can be determined such that the cost benefit is greater than one so as to make profit. The product value can be carefully determined based on inflation and local factors so as to attain a certain level of desired profit.

Clarke (1991) has also proposed a basic economic equation for cost analysis of GIS projects which can be applied to GI products, when compared with the cost of operation before introducing GIS.

Eqn (2) provides a means of comparative cost between a GIS product and an existing non-GIS products in project implementation. It can be used to convince decision makers or clients to fund GIS projects. Eqns

(1) and (2) do not however consider non-quantitiable benefits of GI Technology.

Other considerations of commercialisation of GI products include the problem of selling digital or soft copy products which are more flexible and can easily be updated or revised to give rise to different products. Does the client pay additional cost each time a soft copy product is used?. Equation (1) can be modified to accommodate the value added to soft copy by determining the appropriate product value projected for a period of time when perhaps the data will drastically depreciate.

Geoinformation can be regarded as both an economic as well as a legal entity. If there is copyright law (Intellectual Property Law) on digital information how can piracy be prevented so as to prevent economic loss?. If piracy occurs how can offending party be prosecuted or discouraged? Tables 2.1 -2.4 indicate that some mapping system carry Trade Mark ™. This means that the issue of patent for Geoinformation should be addressed. In 1995 and 1996 EUROGI commissioned a study on the legal protection of Geoinformation in the member states of the European Union. In June 1997 a study on bottlenecks in copyright laws was published by EUROGI. In September 1998 the President of ISPRS wrote a letter of opposition to the European Patent Office (EPO) for awarding a patent to a Norwegian company, Metronor titled "Method of Geometry Measurement". The author cannot agree more with ISPRS objection because the patent is a common photogrammetric method which was legally and exclusively given to a private company. Patient Authority particularly regional or international Authority, should verify applications for patent with both national and international professional societies relevant to such applications before undergoing a judicial review.

Government pricing policy is more complex than equation (1) can solve because National Mapping Agencies must satisfy national interest and as well meet the need of users of Geoinformation such as the military, utilities, urban planning and local government.

Apart from National interest or strategic objectives pricing policy of Government is also strongly influenced by sources of funding and financial target for income generation as estimated in the annual budget. Government pricing policy more often than not, is meant to strike an average balance between amongst full cost recovery, market-based prices, and marginal cost. Table 5.1 shows some statistics on expenditure and cost recovery in relation to Geospatial data at the Ordinance Survey, U.K. It is obvious that some government department were more favoured than others. Leathedale (1996) described the pricing policy for geospatial data from government as "Immature, segmented, fragmented and price - sensitive" and I should add inconsistent. Table 5.2 indicates comparative picture for some other government mapping agencies. OS has the highest percentage of cost recovery. Table 5.2 shows the importance of copyright protection law in pricing policy.

Operating cost of the system to be replaced by GIS
- operating and capital cost of proposed GIS
+ quantified benefits of proposed GIS

= net economic benefit of the proposed GIS ± sensitivity ---- eqn (2)

PROMOTIONAL ACTIVITIES FOR GEOINFORMATION MARKET

Commercial Firms

The new Geoinformation Technology has witnessed an explosion in its development and applications within the past decade. GIS has been the catalyst for this explosion. GIS has indeed surprised - Information Technology (IT) by virtue of this explosion. The commercial firms have contributed in no small measure in this rapid development through various activities. Geoinformation journals and magazines are consistently bombarded with various advertisements of vendors of new and well researched products and innovative services. The commercial companies also collaborate with profession bodies and societies to organise conferences, seminars, and workshops at which commercial exhibitions take a pride of place. Many companies organise training for buyers and potential users.

The Publishers

The publishers have also made a great impact on the GI market. Most of the magazines listed in para. 35 have special columns on <u>Business news</u>, <u>Product news</u>, <u>Product Survey</u>, <u>advertisers index</u> and the <u>market place</u>. Publishers also sponsor award winning competitions annual conferences and exhibitions. These activities have mobilised existing and potential user markets nationally and globally.

Internet and Geoinformation Technology

The Internet the Super Electronic Highway is perhaps the greatest market mobiliser for Geoinformation market. The journals and magazines are sometimes restricted to Professionals mostly in Surveying and Mapping and to some applied Remote Sensing scientists. Almost all GIS related companies including Surveying and Mapping companies have hundreds of Websites with some servers. The World Wide Web (WWW) constitutes an ideal medium for providing data to the public at large and passing on information about the capabilities and products and services of a commercial company. Website browsers open the public to inspect geoinformation from a number of sites. GIS World organises a "Best of the Net" competition annually because some sites are better looking, more informative and easier to use than others. The Internet Technology has indeed surprised the GIS Industry. Many of the commercial firms can also access their competitors through Internet or corporate Intranet. This is good for healthy competition and cooperation among the firms. Three

tiers of market for Gei-information products and services can be identified because of the influence of Internet. Viz the image aware specialists who create information, the integration aware users who are information processors and the Web-oriented information aware users operating within an MS Office environment who constitutethe fastest growing group of users, Loedeman (1999).

Internet GIS is responsible for the fastest growing branch of GIS market today which is the Image-based spatial data market. This is not meant to down play the contribution of high resolution space imagery and visualisation techniques in nurturing the rapid growth of this market.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

From the discussion of the various technologies involved in the production of Geoinformation and related services it is obvious that GPS, Raster and GIS Technologies appear to be in the forefront of rapid technological advances in Geoinformation. Information Technology and Digital technology constitute the bed rock of the advances.

Hardware and software prices appear to be in the downward trend. The market for Geoinformation has been expanding rapidly due to the promotional activities and awareness campaign of professional societies, commercial firms, vendors and publishers, and also due to the use of Internet by these promoters. The fastest growing GIS market is the Geographic Imaging market.

GIS industry is making its impact felt both in the capital market and in the market place in Europe and in the USA as shown in Figs. 3.2-3.9. Some companies in Information Technology for example IBM are incorporating GIS business into their range of services.

Commercialisation of Geoinformation products and services were discussed. Some formulas were proposed for computing appropriate pricing. Government Pricing Policy was also discussed.

Although GIS industry is booming in the developed countries, it is still in its infancy in many developing countries. The few GIS projects implemented in some of these countries were made possible through technical assistance to national or state governments. Very few developing countries have established a national GIS infrastructure. Private sector participation in GIS project is almost nil in many developing countries. This is partly due to lack of funds, inadequate man power and lack of identification of existing and potential users of Geoinformation,

RECOMMENDATIONS

There is need to do a geoinformation user requirement survey particularly in the developing countries so as to determine the potential of GIS market. A good market analysis of the data so collected will give an idea of the viability of GIS market.

Regardless of the result of the survey, GIS promotional activities by vendors, tertiary institutions and professional bodies should be embarked upon in developing countries. The power of GIS and its applications for efficient management of natural resources and social services should be demonstrated by means of careful selection of suitable pilot projects Ayeni (1998).

Developing countries should be given technical assistance to develop their GIS infrastructure and to offer GIS services on a commercial basis. Tertiary institutions should be assisted to develop and implement sound GIS educational programmes.Vendors of hardware and software should consider preferential prices for educational institutions.

Although GIS in the public sector has been well researched, the study of private sector participation seems to be neglected. Other areas which need attention and study are adequate pricing policy for Geoinformatics products and services, copyright protection laws and data transfer standards.

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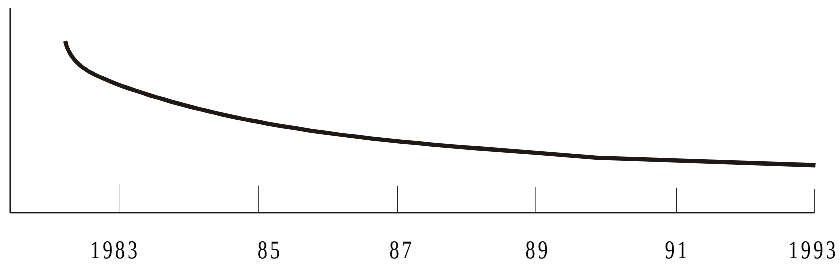


Source: Cannon (1994)

Fig. 2.1: **Receiver Cost trend**

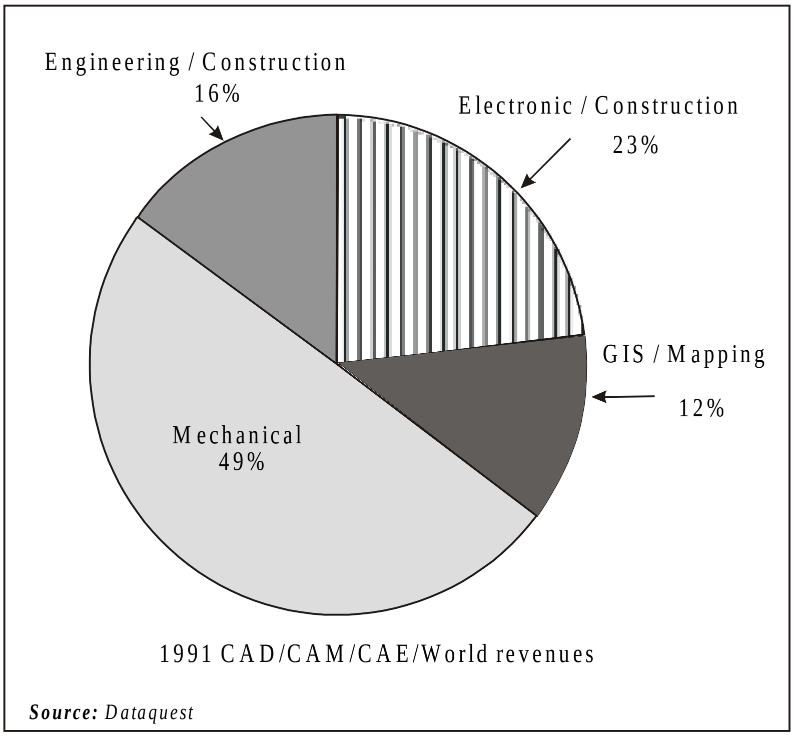
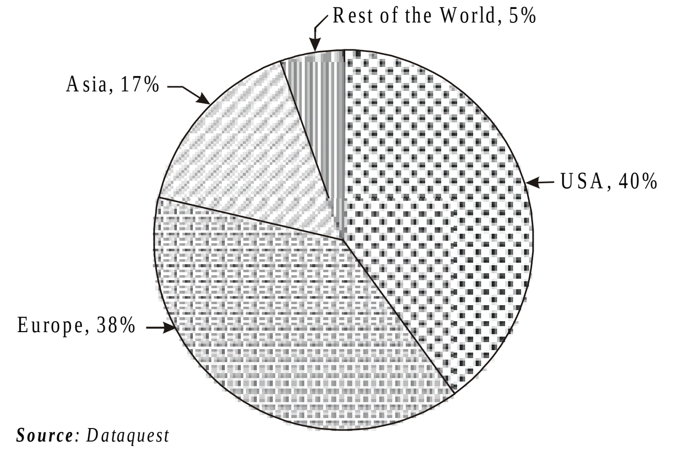
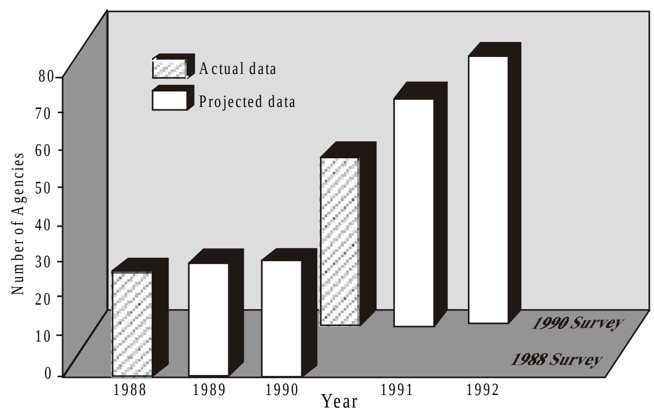


Fig. 3.2: **1991 GIS Market shares (Sectorial)**



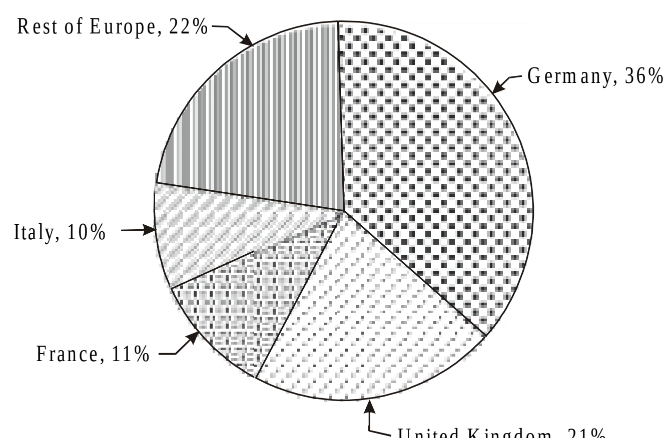
Source: *Dataquest*

Fig.3.3: **1991 GIS Market shares (Geographical)**



***Source**: Fed. Interagency Coordinating Committee on Digital Centography*

Fig. 3.4**: Federal Agencies with GIS Programs**



Source: *Dataquest (May 1992)*

Fig. 3.5: **1991 European GIS Market**

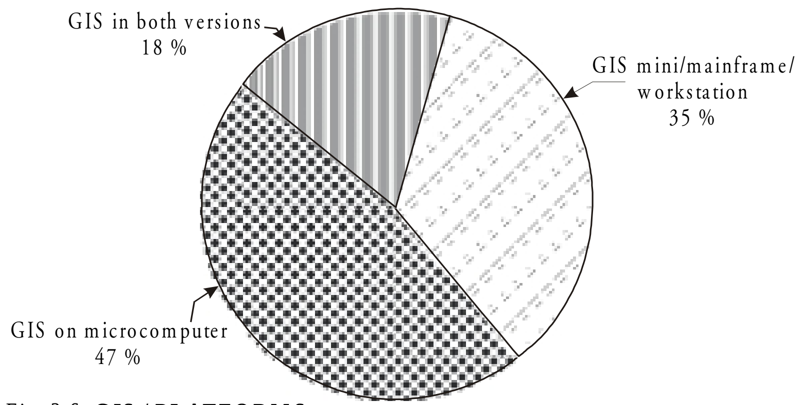


Fig. 3.6: **GIS / PLATFORMS** ***Source:*** *Institute Euro Vista (1991)*

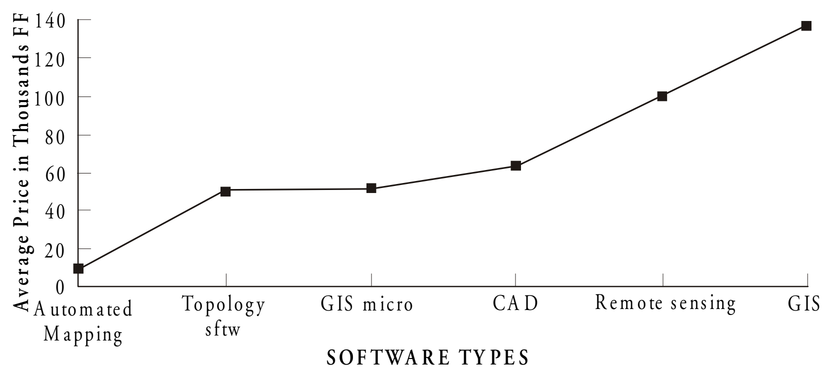


Fig. 3.7: **SOFTWARE AVERAGE PRICE** ***Source:*** *Institute Euro Vista (1994)*

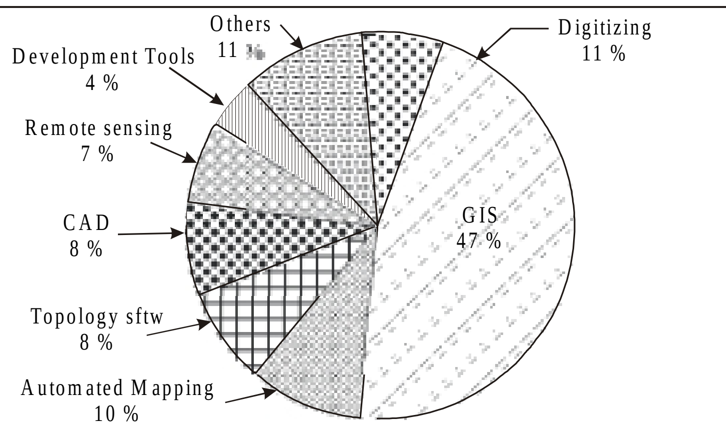


Fig. 3.8: **SOFTWARE OFFER / TYPE** ***Source:*** *Institute Euro Vista (1994)*

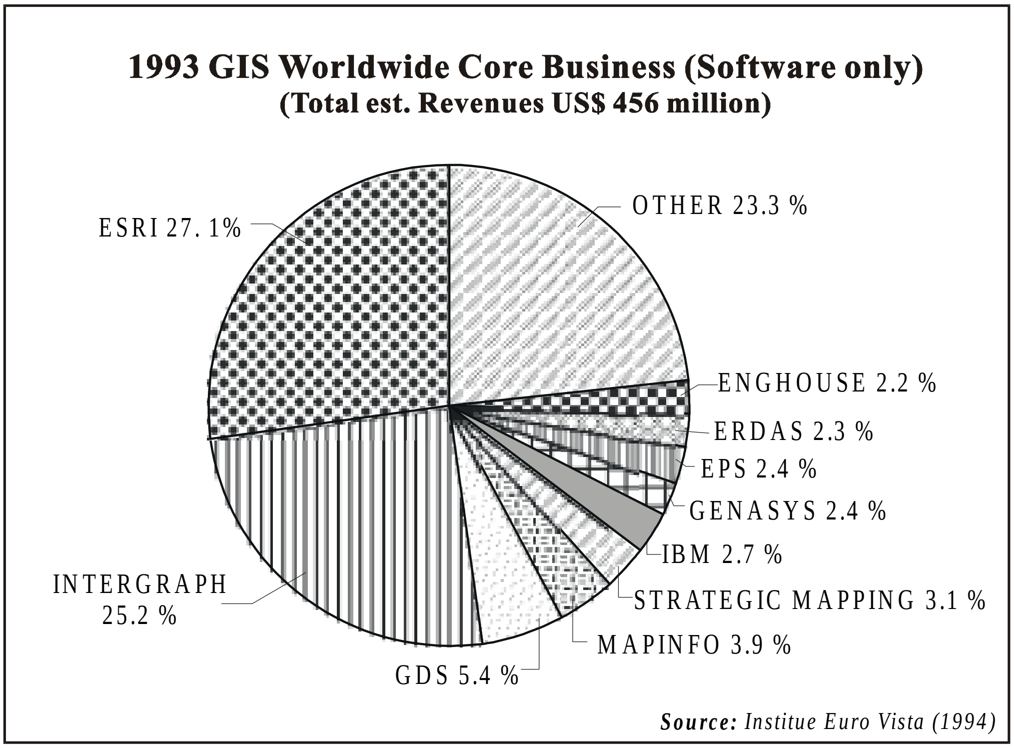


Fig. 3.9: **1993 GIS Worldwide Core Business (Software only)**

COMMERCIAL ASPECTS OF GEOINFORMATION TECHNOLOGY