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The Future Orientation of Geoinformation Activities in Africa

Synthesis

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The Future Orientation of Geoinformation Activities in Africa

An Extended Summary

Development Information Services Division (DISD)
United Nations Economic Commission for Africa

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The Future Orientation of Geographic Information Systems (GIS) in Africa

> *When planning future strategies for spatial information management, governments worldwide sometimes just concentrate on the technology and do not consider other influences or drivers – they do this at their peril. (Williamson 1999)*

Introduction

This study is part of coordinated activities by the United Nations Economic Commission for Africa (UNECA) to "raise awareness of African governments and other sectors of society on the importance of geographic information in socio-economic development and to identify practical mechanisms to facilitate spatial data collection, access and use in the decision-making process, both national and regionally, through a participatory approach." Emphasis is therefore placed on the whole structure for the acquisition, management and use of spatial data, and not only on the technology.

As data collection methods improve, vast stores of data are being collected for specific applications. These data sets can be used for other various purposes, but only if the potential users know that they exist. Attention is therefore shifting to the technologies for the efficient dissemination of the spatial data collected and stored in those large "electronic silos", to ensure easy access to them by all decision-makers and the community at large. This attention shift is also dictated by the recent "commoditisation" of data and information. The costs involved in data collection should taken into account in project planning; the data collected can be sold or traded for other considerations. Therefore there is a need for this type of data to be collected and placed in "data stores" (databases) for future use.

Creating, maintaining and using such data resources usually requires collaboration and co-operation of several user groups and professional disciplines. Such collaboration requires a strategic plan and clearly defined responsibilities and roles. One of the most important responsibilities is that of coordinating the contributions and utilisation of the resources by organisations at various levels and sectors of the society. Different users (which may be agencies or groups) have to be assigned custodianship responsibilities and use privileges for subsets of the data. General community users would then be able to expect the data to be available, and with network technology, to be accessible transparently. The data resources then acquire the status of an infrastructure, the spatial data infrastructure (SDI). It is only at this infrastructure level that the full investment of spatial data can be realised by all. Also policy makers, and other users can go about their business, doing what they are best at, relying on the infrastructure for their data needs.

Spatial Data Infrastructures

The main reason why spatial data are now being considered as infrastructure is to unlock the potential hidden in data and stimulate economic activity. Referring to LANDSAT images, the Vice President of the Unites States of America said:

> The Landsat program, designed to help us understand the global environment, is a good example. The Landsat satellite is capable of taking a complete photograph of the entire planet every two weeks, and it's been collecting data for more than 20 years. In spite of the great need for that information, the vast majority of those images have never fired a single neuron in a single human brain. Instead, they are stored in electronic silos of data. We used to have an agricultural policy where we stored grain in midwestern silos and let it rot while millions of people starved to death. Now we have an insatiable hunger for knowledge. Yet a great deal of data remains unused. (Gore 1998)

To put those data collections to use, the current trend in the development of technologies for widespread dissemination of spatial data is to treat spatial data as infrastructure, thus the spatial data infrastructure (SDI) concept.

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Components of the SDI

SDIs comprise the fundamental datasets (spatial data resource) as well as the interrelationships between these datasets, the management of them, and the means of access to, and distribution of, those data. The FGDC (1996) defined an SDI as an "umbrella of policies, standards, and procedures under which organisations and technologies interact to foster more efficient use, management, and production of geospatial data." It further explained that it "consists of organisations and individuals who generate or use geospatial data, of the technologies that facilitate use and transfer of geospatial data, and of the actual data." It should at no stage be assumed that SDIs are all about networks and technology (FGDC 1996). An SDI will not function, no matter how good the networking and technology is, if communication channels, standards and procedures, partnerships and data have not been developed.

SDI Issues for Africa

Policy and Coordinating Arrangements

African countries are going through a familiar phase that many other countries have gone through in their GIS development whereby different sectors engage in GIS activities without coordination. It is not uncommon to find different agencies collecting the same data at the same or different times. Geoinformation, just like other information resources, requires dedicated management arrangements. First there is a need for a geoinformation policy, within an overall information management policy. There is also need for management structures for coordinating the development, use and rationalisation of geospatial data activities, to realise the potential benefits of spatial data resources. The functions to be performed include the coordination of efforts among the stakeholders in the spatial data community to ensure cooperation and partnership, rather than competition. A model of such a policy, for adaptation by African governments is presented in Appendix 1.

Authoritative and Independent Management

The co-ordinating responsibilities should be high level enough to make policy and enforce standards and rules. This is in line with general information management practice. Being the currency of the information age, information requires a dedicated function charged primarily with managing corporate information resources for the good of all. There is a temptation to assign the management responsibility to one of the major producers or consumers of information products. In the case of geospatial information, this is usually the national surveying and mapping (or equivalent) organization. The management responsibility should not be given to such producers or consumers of the information. When this is done, the system over time would evolve to the cater more for the needs of this agency or person. The recommended practice is for the dedicated management function to be independent of the users, and also be high enough in the organisational structure to participate in policymaking and be able to enforce rules and standards.

Customer Orientation

Another common area of change is to shift from focussing on the requirements of the service providers to the needs of the "customer". A major component of spatial data resources are in domain of government agencies. In the past, governments generally did not think of consumers of their services as "customers"; they were citizens and should be grateful for the service. While the citizens are grateful, they still want to be satisfied. The result is that they have to come back several times to get bits of service before being satisfied. This results in an inefficient use of resources. Governments are now adopting a customer-centred approach to service delivery. Letting the customer decide on what service they need is not only efficient, but it also ensures success in relevant projects.

Spatial Data Standards

Standards and norms are important to facilitate exchange of data compiled by various data providers for common use. Graphic standards are needed for both raster and vector type of information, and also for non-graphic data and metadata. The International Standards Organisation, Technical Committee 211 (ISO-TC 211) have developed general GIS standards. It is recommended that African countries should

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keep themselves informed of these developments and adapt these international standards. Countries should make use of their academic and research institutions in interpreting and adapting these standards. It should be noted that some countries might not have enough experts, even within their academic sectors. Such countries should be encouraged to make use of the regional centres. The ECA secretariat could also coordinate and mediate the sharing of expertise between countries.

Foundation, Framework or Basic Data

Common to all geospatial data use is geometrical referencing of features and phenomena of interest. It is important that all data sets use a common geocoding geometric reference so that they can be combined and cross-referenced with one another. It will also enable data to be converted by existing conversion programs into a desired geometric fit. Creating foundation or basic data products, on which other layers are based, ensures this. Wherever possible, the provision of base data should be in digital form, with optional paper printout, and not vice versa.

The foundation data products are those data sets needed by more than one government agency for fulfilling their service delivery obligations. They include the location of geodetic control points that define the reference ellipsoid used, and its relation to the International reference frame. Another set of foundation information products is the topography, including the road network, railways, buildings, hydrography, administrative boundaries, etc. At large scales, the parcel layout with parcel boundaries and uniquely identifiable parcel numbers, buildings and district features, as well as toponomy, need to be included.

This also pertains to the digital elevation model in all forms, including raster, vector and TIN formats. These will enable digital image products resulting from processes such as differentially rectified satellite images or from a digital orthophoto to be combined with other information products. It also applies to the various elements of topographic information products.

The Awareness Problem

Several studies have pointed to the lack of awareness of the value and role of information in general decision making as a limiting factor in developing spatial data systems in Africa. Most decisions are made on the basis of interest groups and political expediency, rather than on objective decision analysis. This tendency is more acute in spatial decisions. Part of the reason for this is that the traditional visual techniques for processing map data is tedious and limited in scope. The decision makers are not yet aware of the new computer-based techniques. Some that are aware feel intimidated by the technology and do not have the confidence to learn the new concepts and techniques—some truly do not possess the prerequisite knowledge to grasp the new concepts, not having had the opportunity to be exposed to them.

The result of this lack of awareness is the emphasis on more visible and tangible projects like road construction and housing development. It is not always obvious to the decision makers that these projects would be executed more effectively and efficiently if proper planning based on information, were undertaken. The ECA and its regional centres could organise a series of short courses and workshops for the geoinformation community.

Utility Infrastructure

The information infrastructure depends on other utility infrastructures, such as, and especially, electricity and telecommunications. In many countries, electricity is only available in the urban centres, leaving large portions of the country without service. These rural areas are also the subjects of the data in the proposed spatial data infrastructure. In fact, much of the environmental and natural resources data would be about these rural areas. Access to the infrastructure should therefore eventually be provided from these centres.

In some countries, even when electricity is available, the supply is not constant and the frequent power outages and associated surges result in damages to sensitive computer and other equipment. The cost of

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computerisation therefore usually includes costs of ancillary equipment for stabilising and standby generators, costs that are not incurred in developed countries.

Telecommunications infrastructure is also poorly developed. In many countries majority of the citizens still do not have access to telephones, and the waiting lists for phone services are long. Telecommunications agencies, which are still mainly government monopolies, are still struggling to provide voice lines to more people. The provision of data-enabled high bandwidth lines is therefore not yet a priority. Spatial data sets are usually large in volume, especially if they include images and graphics.

The full SDI is based on computer networks and the Internet. Internet access in Africa is very expensive compared to developed countries, due mainly to the telecommunications costs. In North America, local calls are free and in Australia they are charged per call and not timed. Users in these jurisdictions can therefore stay on the Internet for as long as it takes to search or browse for relevant information. The African user, on the other hand, faced with timed dial-up connections, will tend not to stay long on the Internet.

In spite of these differences in the availability of other enabling infrastructure components, the data collection should still be in accordance with an established national standard for the whole jurisdiction. While the full SDI should be computerised, emphasis should be on the information content, allowing small and/or remote offices to use “information sheets” to collect the information and have them keyed in at higher levels.

Streets and Road

One of the biggest mass-market applications of spatial information is in the area of navigation and finding directions. These applications depend on digital street and highway data. These data sets are now being ported to hand held devices and cell phones enabled with wireless applications protocol (WAP). Car manufacturers are now developing prototypes of cars with on board navigation systems, based on road network data. Online directories are now being linked to digital maps, with zoom and pan capabilities. In the Unites States for instance, a big industry is developing to produce these data sets for cities and towns. The industry is expected to grow as demand extends to more towns and cities, and to keep the data sets up to date.

Africa is a net importer of these technologies. Maps of Africa cities will also be required to be loaded on these products being exported to Africa. Without these maps being available, we may end up buying products with maps of European and American cities, or paying extra to have the features excluded, since production lines would have been standardized at that level of technology.

Governments, professional organisations and industry groups should encourage the spatial data industry to invest in road network data sets. These data sets are also used in delivery and collection services, like package delivery and utilities billing and customer services. However, some major African cities, even some national and State/Provincial capitals, do not have street addresses. Some of these cities may have unique plot numbers, which while very important for cross-referencing information in parcel-based databases, as described above, are not suitable for giving directions. In other jurisdictions, the two systems complement each other. Municipal authorities and planning organisations in Africa should be well advised to review their street numbering system for digital data applications.

Remote Sensing

Usually spatial data sets are developed, by converting existing maps and other data into digital form. Many African countries have not maintained their mapping programs and available maps may be as old as 30 years. Much undocumented development has taken place in that time, especially with the low use of

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information in their planning. The ideal solution to the problems of non-existent or inadequate maps would be to embark on fresh mapping programs. However, where this is done by traditional mapping techniques, the cost simply renders the option not feasible. Moreover, many African countries do not have dense enough control points for this option. The alternative is therefore to supplement whatever is available with satellite remote sensing images. Two case studies demonstrate how this has been done in Rwanda and Uganda respectively (Hardy 1987; Otto et al. 1987). Since then, the capabilities of remote sensing systems have improved. The IKONOS-2 satellite of Space Imaging can sample the ground at one metre resolution.

African countries should therefore consider remote sensing as a main source of spatial data, on equal footing with other data sources. This is especially important because the products are already in digital form and allow other processing that traditional data sources do not allow. However, the establishment of satellite receiving stations may not be cost effective at the national level. The possibility of establishing a regional facility for the centralised acquisition of satellite data for the continent should be explored.

Cost Recovery

1. Many African countries are struggling to balance their budgets. Demands on the available funds are therefore rationalised. Information management projects, including geospatial information, usually do not rank high on the list of priorities. This is mainly due to the low information awareness discussed above. One of the effects of the financial constraints is that national mapping agencies, and other geospatial data service providers, do not have access to modern cost-effective and time saving technologies for data acquisition and processing. The provision of foundation data should ideally be the responsibility of the government. Given the scarcity of funds to invest in creating the data sets and acquiring other related technology, the funding of the spatial data infrastructure becomes an important issue to address, and cost-recovery an important consideration.

Considering cost recovery approaches taken by other jurisdictions, and the results achieved, the appropriate pricing model for Africa should aim at encouraging greater usage of geoinformation and growth in the market. The principles of the Australasian approach commit governments to data exchange at transfer cost, but still provide for charging for value-added products. Aspects of the Australasian approach should be adopted and some data sets where the market has been established should be charged, with free access to educational and research organisations to enable them address the personnel problem. Furthermore, the brokerage principle of the Canadian approaches should be considered, but with the change that the broker need not be a government organisation. Experience with other services on the African continent suggests that government monopolies are inefficient. So, as further efforts to stimulate the spatial data economy and encourage private sector cooperation, the brokerage level could be licensed to a few large private corporations with the means to add-value to the base products before re-selling. These corporations will then invest in developing the components of the infrastructure with a profit motive, overseen and regulated by the government.

Self Analysis

Implemented SDIs have been preceded by several studies, sometimes conducted by international consultants. However, even the best consultants cannot manufacture success if the local practitioners are not fully involved in it. It is also important that before the consultants are engaged, there should be a preliminary description of the problem and expectations of the project. Therefore, an in-house preliminary problem analysis should be undertaken before engaging consultants. It may be discovered after the supposed preliminary in-house analysis that there is really no need for an external consultant. In line with experience in the successful jurisdictions, the geospatial information industry in Africa should embark on an analysis of its role in, and impact on, the overall economy. Such a study will then help it to decide their future directions and whether an international consultant is required. It should be pointed out here that the consultant who is engaged to set strategy should not be mandated to implement the strategy. Defining the direction and strategy should be a separate project from implementing the strategy.

Conclusion

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This paper started out to discuss the “future orientation of GIS in Africa”. It was established early in the paper that the future orientation of GIS does not lie in the technology itself, but in its use to process data to support spatial decisions and services.

Experience in some African countries suggests that emphasis on the technology might result in the acquisition of hardware, software and peripherals with no clear plans on how to use them. Others might go a step further and use the technology to digitise maps and simply automate map productions, creating large digital databases, which would be locked away for departmental use, with all the flaws of the present manual systems.

Following experience in other jurisdictions, emphasis should be placed on data management. The vision is to ensure that spatial data permeates every aspect of society and that they are available to people who need them, when they need them, and in a form that they can use to make decisions with minimal pre-processing. Also the collected data sets should be put to the maximum possible uses by publicising their existence and making them easily available to the widest possible audience. The most efficient and effective way to achieve these two related objectives is to establish spatial data infrastructures, using GIS technology to maintain and exploit the SDI. The future orientation of GIS in Africa is therefore as a ubiquitous tool that is integrated into the SDI concept, rather than as an end in itself.

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Appendix 1: Model Policy and Institutional Framework for SDI

Vision

The geoinformation management vision is to encourage and continually increase the use for geospatial data in the decision making processes for sustainable development, economic growth, resource and environmental exploitation and management, and social progress and to make appropriate geospatial data and information available and easily accessible to the entire community of users.

Principles:

1. Spatial data and information are essential to economic planning and development, and are much a part of the nation's infrastructure as its other elements (e.g., the transportation network, the health care system, telecommunication) and should be accorded the same level of support.

2. All data collected with public funds form part of the nation's corporate data resources and the individual agencies involved in their collection and management are viewed as custodians, and not owners, of such data.

3. The cost of collecting geospatial data using public funds should not be charged to any consumer who should only be charge the costs of distribution, customizing or value-addition.

4. The private sector is encouraged to be a partner of the public sector in the management of geoinformation, and its rights will be recognized and respected.

5. National agencies, producers and users of geospatial data and informaton should support the geoinformation management vision enunciated here and shall cooperate in the implementation of its objectives.

6. The state should endorse, own and commit itself to the vision stipulated above.

Policy Guidelines:

1. There shall be established a national geoinformation framework to enable the following:

    a. The setting up of a national geoinformation committee whose functions are specified in Annex I and with broad representation from the wider society.

    b. Communication between institutional producers and users of data and information to develop partnerships.

    c. Easy access to geoinformation resources by the entire community of spatial data users, employing appropriate information and communication technologies.

    d. Development and maintenance of fundamental data sets.

    e. Establishment and maintenance of a comprehensive geospatial metadata system according to the guidelines stipulated in Annex II.

    f. Development of a critical mass of skilled personnel to maintain the framework and data sets.

    g. Development of appropriate levels of knowledge and skills in the community to effectively use geoinformation products.

    h. Development of appropriate pricing mechanisms for geoinformation products.

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2. Every publicly funded development plan shall include a section detailing the geoinformation requirements for its implementation.

3. Every public project proposal dealing with infrastructure development and maintenance, environmental and natural resource management, and spatial facilities shall include an information budget detailing:

    a. The data sets required and their likely sources

    b. Expected processing and analyses

    c. Anticipated Information products

Annex I

The functions of the National Geoinformation Committee are:

1. Advise government on necessary reorganization of government functions to achieve the geoinformation management vision.

2. Oversee the development and management of geoinformation products.

3. Promote the expansion of all sectors of the geoinformation industry, including the identification of new applications.

4. Liaise with all professional bodies concerned with the geoinformation industry to harmonize their activities.

5. Promote awareness about geoinformation products and services at all levels of society.

6. Arrange for the production and maintenance of fundamental data sets.

7. Coordinate the production, maintenance and sharing of various geospatial data sets.

8. Develop guidelines on the appropriate methodology for setting up geoinformation infrastructures.

9. Ensure the nation’s active participation in regional and international geoinformation activities.

10. Advise the government on changing trends in the geoinformation industry.

Annex II

Adapt relevant extracts from appropriate national, regional and international standards.