

## REMARKS ON NETWORKING AND TECHNOLOGY TRANSFER IN AFRICA

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**KEY WORDS:** Internet, Technology transfer, Geo-information, Data acquisition, Database.

### ABSTRACT

Rapid advancement of computer technology has opened wide possibilities for communication and networking over the World. Many universities and companies in Africa have already introduced the Internet as a basic tool for communication and transfer of information on the new technologies. It has great educate and informative aspects, specially in view of poor availability of new professional books and journals and limited access to professional international conferences in Africa.

Geo- information data are very useful for planning and execution of various engineering and environmental projects and therefore in some of African countries GIS technology has been introduced on different levels, usually as the pilot projects with involvement of external experts and funds. However, the main common problem is lack of up-to-date geometric digital geo-referenced information on terrain which is required as a frame for various thematic data. The graphical topographic maps and cadastral plans are not complete, out of data, and they often do not fulfil the required accuracy. The old fashion analogous instruments and methods, which are still used in most of African countries, can not satisfy the requirements for digital information which is requested from photogrammetry. Transfer of new digital technologies for mapping is very limited in Africa. This is not only because of financial restrictions but also because of organisational and managerial problems and sometimes negative approach for their implementation.

The author who worked at the universities in Southern Africa countries, Zambia and Zimbabwe, from 1984 to 1999 and after 15 years returned back to Europe, will discuss potentials, possibilities and restrictions for implementation of digital mapping technologies in Africa.

### 1 INTRODUCTION

Geo-information technologies and the networking via the Internet should be some of the integral tools for African Governments to assist them in management and exploitation of their environmental and natural resources, develop urban and rural areas, keep properly land registration and control the overall development of their countries for the benefit of their people.

The Internet has already opened many opportunities for national and private companies, universities and individuals in Africa. With the further development it should be the main tool for sharing various types of spatial data between involved companies and individuals.

The transfer of new geo-information technologies into Africa has not been progressing as well as one would expect. There are many different reasons and restrictions which depend not only upon financial restrains but also on some organisational and managerial problems. There is hope and belief that with the integration of all efforts and international and national financial supports the new technologies will be fully implemented to the African countries. In this paper, the analysis and some remarks and comments on development, constraints and role of Internet and Geo-information technology in the development of Africa, will be presented.

### 2 NETWORKING IN AFRICA

The Internet, as the modest tool for communication and technology transfer, has spread rapidly through Africa over the last few years. The implementation and development of the Internet technology has been important for any country across the World, however for Africa it has been extremely important since it has opened the real contact of

professional Africans with the World. Through searching web sites and through email system they can get information from over the world, share data within country, region and the whole World and have the fastest way of communication.

As it was reported by (Jensen, 1998), in the end of 1996 only 16 African countries had limited access to the Internet, when 18 months later over 75% of the capital cities had full Internet facilities. Presently, almost all African countries use the Internet as the tool of networking. However because of various technical and economical restrictions the access has not the same extent. When at the beginning, the Internet services were mostly established in the capital cities, presently many of the cities across the countries have the access. However, about 70% of Africans live in rural areas, where there are no phone lines and therefore no possibility to introduce these services. The cost of internet service is relatively high and therefore can not be reached by the average African citizen. However, National institutions, research organisations/projects, universities and some of the private companies, which employ most of the African professionals, use internet for communication and information/data collection and sharing. In the end of 1998 the estimates of the African Internet users ranged about one million. However, the majority (about 85%) were in South Africa. In the other countries of the African continent the average one Internet for every 5000 people was assumed.

The major constrains for the common use of internet in most of African countries, are;

- The extremely limited infrastructure and high cost of local telephone service,
- low computer penetration and literacy,
- limited national connectivity within countries, which is restricted only to the larger cities and limited direct connectivity between countries due to high cost and lack of digital circuits.

However, with the increasing world wide recognition of the importance of the Internet in accelerating development and the international financial and organisational assistance, the services have been continuously improving. The major strategies which have been undertaken, were;

- Support of implementation of local or internationally hosted web servers,
- focus on capacity building, through training, support desk and skills transfer,
- work out means to improve the awareness among the highest levels of national decision-makers,
- establish strategies for subsidising Internet services for the research, educational and the public sector which can not transfer the costs to the end – user,
- support pilot projects which experiment with new services,
- identify priority areas for building electronic information and applications, such as various geo-information on environmental issues, urban and rural development, scientific journals, broadcasting, distance education course material and many others.

As a very good example of using Internet services for international link in Africa is the Environment Information System Program in Sub-Saharan Africa (EIS-SSA), which is considered as the institutional and technical framework, essential for improving the flow and use of information in environmental management. This program aims at developing Africa capacity for the management of environmental information as an integral component of the sustainable development process. The program, which was initiated in early 1990 by the World Bank in conjunction with several bilateral and multilateral international agencies supports 19 African countries as they assess their priority needs in terms of environment and land information systems and analyse the technical, institutional, legal and economic issues concerning their possibilities of meeting these needs. The program is an international forum of donors and professionals from Africa and some other countries involved in EIS development in Sub – Saharan Africa (Advisory Committee), who together with Secretariat of program co-ordinate work related to;

- develop principles and practices for EIS development,
- facilitate the co-ordination of national and international programs related to EIS,
- provide a forum for sharing information on EIS activities through workshops, publications newsletters reports on state of EIS development in Sub-Saharan Africa as an input for debates on EIS policy and implementation.

All information, publications and reports are available via the web sites (Bjoerke, 1999) The links to EIS information and other relevant sources have been sorted in three levels;

- Information concerning the whole Africa, which involves; general news and highlights with reports of Secretariat and International Advisory Committee; background of program with general technical and administrative information on program; products with information on activities of working groups and publications concerning with the best study practices, as for example Zimbabwean case (Mbudzi and others, 1998).
- Information concerning Regions, which includes review of various regional projects, assessment and monitoring of EIS in Africa (Gilruth, at al., 1999), directory of earth science professionals, companies, associations, suppliers of software and equipment, workshops and other professional events and many other topics.

- Information concerning various countries, which includes the list of national organisations, research and educational institutions and private companies involved in EIS activity, map of country and info-hub with various information on transportation, accommodation, tourist opportunities, ethnic database (for example data on 41 languages in Zambia). The content varies from country to country but the general frame is the same.

With further development and implementation of the electronic networking in Africa the Geo-information data concerning cadastre, urban and rural development, data on environmental and natural resources, could be very easily shared between involved users. Networking in some other important areas, such for example as for distribution the educational curricula to standardise the education of different levels in Africa, to share experiences and knowledge between professionals and many other, would be very important

### 3 TRANSFER OF GEO-INFORMATION TECHNOLOGY

Geo-information technology has been growing rapidly across the world for the last two decades. Public administrations and private institutions regularly and systematically collect and disseminate spatial information which is used for a wide variety of purposes. The management of the geo-information which involves such issues as, the analysis of information system requirements, data acquisition, processing, system design, storage and integration of data, supply sharing and exchange of spatially referenced data, is necessary to support a diverse range of applications that use geo-information, such as, cadastre and land registration, urban management, rural development and environmental and natural resources management.

In cadastral organisations, information on the description of land and its user needs to be provided on a daily basis, and therefore the model and structure of data need to be organised in such way that one can respond to customer' request accurately and appropriately.

In urban management and planning, a number of standard products and non-standard geoinformation is requested by a variety of users and many organisations and private individuals are active in requesting, providing, processing and analysing spatial data. In many rural development and resource projects, geo-information products are needed at specific times, with specific accuracy, scale and content. Usually this kind of information is available in some forms in a variety of organisations, sectors and companies. However, all these geoinformation need to be organised in such data models, from which information can be extracted, processed and shared by many stakeholders at any given time.

The acquisition and suitable management of geoinformation is a long process and needs high cost infrastructure and high skilled people and also awareness of national decision makers and community on possibilities of geoinformation technology.

In Africa, the awareness on advantages of geoinformation technology has been growing continuously from the number of years because of information transfer through electronic networking, participation in international, regional and national workshops and seminars, many internationally sponsored projects, long and short term training of African professionals in Europe, USA and African regional training centres ( such for example as within Southern Africa the Regional Centre for Services in Surveying Mapping and Remote Sensing in Nairobi, Kenya or Satellite Applications Centre in Pretoria, South Africa), and implementation of principles of geoinformation technology to the national education programmes. Therefore, this technology has been already accepted in a long term plans of most of African countries. However, the speed of implementation of this technology is much slower than in other parts of the World because of organisational, institutional and technical problems and restrictions.

The main problem is lack of up-to-date geometric, Geo- referenced digital information on terrain which is required as a frame for various thematic information, particularly;

- the up-date, accurate and uniform geodetic networks,
- the up-date digital maps (topographic and large scale) and 3D digital data bases used for cadastre , utilities, and other applications.

The Geo-referenced information which must be consistent and homogeneous can only be available if there exist a homogeneous Geodetic Network, which is the basis for any further surveys on the land. In most countries the geodetic networks were established a few decades ago and the accuracy, reference systems and other required standards are not uniform and sufficient. The importance of such homogeneous Geodetic Network for African countries has been recognised and the African Doppler Survey campaign (ADOS), which was co-ordinated by the International Association of Geodesy (IAG) and the International Union of Geodesy (IUGG) and sponsored by many countries and organisations, took place from 1981 to 1986. The results of the ADOS campaign showed that the main problems were not solved. The UN has subsequently recognised that except for Kenya and Zimbabwe, most African countries have not maintained their geodetic network, their base-map stock and their mapping capacity.

The implementation of GPS technology in most of African countries would help to solve this very important task but it still might take quite long time. The Regional projects, internationally sponsored, for establishment of the homogeneous Higher order regional GPS networks, have been started (like for example for the part of Southern Africa Region) but it will take time to finish it and subsequently to correct and adjust all national lower order networks.

The mapping in Africa is very poor. The scale of topographic maps range in principle from 1:50 000 to 1:250 000, where map at scale 1:50 000 is used for developed areas and smaller scales maps are applied for areas of desert land. Only in a few countries map at 1:50 000 covers the whole area. As it was reported by (Konecny et al. 1996) the percentages of mapping for Africa by 1993 were for 1:25 000 – 2.9%, 1:50 000 – 41.1%, 1:100 000 – 21.7%, 1:250 000 – 89.1%. There are also a few countries (such as Ethiopia, Eritrea, Sudan), where topographic maps are only for less than half of a country (Petrie, 1996).

In most of countries, however, topographic maps are in graphical form and they have been revised at only small extent since they were produced 20 ÷ 40 years ago. In many cases, because of poor archives, the maps are in very poor condition as an accuracy and quality are concerned. Therefore, they need to be first verify due to both accuracy and quality before taking decision on their revision and transfer to digital form.

Conversion of maps from graphical to digital form has started slowly in quite number of countries but the data needs to be revised and supplement on base of new aerial photography or/and satellite imagery. The old fashion analogous instruments and methods which are used in most of countries for mapping, made it impossible to use digital satellite imagery, which would be much cheaper for revision of topographic data basis and digital maps than aerial photography. There are only a few countries in African continent where the digital photogrammetric technologies have being implemented in the last few years, such for example as South Africa (Clarke, 1997). However, the majority of countries in Africa have not reached such stage, but still are on the level either graphical or computer supported stereoplotters and analytical plotters, where only optical photography is accepted.

Conventional photogrammetric technologies based on optical aerial photography are too slow and expensive for production and revision of medium and small scale topographic maps and creation of topographic digital data bases for the very large continent of Africa. Potentials for satellite mapping in Africa have been already recognised and with the new generation of high resolution (present and future) satellite imagery the speed of mapping could be extremely increased (Petrie, 1996, Bujakiewicz, 1997, Mwanza, 1997). However, the promotion and distribution of such imagery must be arranged by the regional remote sensing centres in Africa. The implementation of photogrammetric digital automatic technology based on digital ortophotography and 3D data acquisition should be seriously considered. Availability of digital aerial photography would be additional constrain. The high resolution scanners are too expensive to be procured for only one mapping company in a country. It should be available for more than one company/country in the Region to share the cost of high investment. This would require very close co-operation between mapping organisations within the Region.

The cartographic data received from topographic maps, aerial photography and satellite imagery for the whole country would create the digital topographic (framework) database for comprehensive data information systems (GIS) build up for rural development and environmental and natural resources management. In Africa, there are many different information systems, which have been established in different time and forms in various organisations and company, usually sponsored internationally, to be served to particular users.

Unfortunately, most of them were created on the base of different standards and specifications and therefore generally are hardly accessible by all potential users. All these data bases need to be organised in such models, from which information can be shared by many stakeholders at any given time. The national organisations, such as Environmental Ministries or Councils need to set up the general rules, specifications and standards and co-ordinate the overall work. The example of such activity is the ongoing Environmental Support Programme (ESP) on the Environmental Information Network and Monitoring System (EINMS) in Zambia, controlled by the Environmental Council of Zambia (ECZ).

The general development of urban and suburban areas, initiation of free market for land and privatisation process in many of African countries require well organised digital databases for urban areas with all utilities and databases for cadastre/land registration. With the support of international projects, the data bases were created for some of capital and other cities, on base of large scale photography and field survey (Mbumwae, 1997). However, to be useful for planning and urban management, they must be well organised and continuously revised and data structure must be standardised to be shared between various involved users. This is a very comprehensive task and involves efforts and financial support of many national, municipal and private organisations and international donors.

The separate urban problem is concerned with actual data on informal settlements around the cities, which is very difficult to control but very important in view of planning and setting up the basic infrastructure there (Mason, 1997).

Presently, there are many internationally sponsored projects in Africa which are concerned with building up of GIS systems for various compounds and informal settlements.

Cadastral and land registration data are in form of poor quality plans in most of African countries. Their conversion to digital form has been already started but the data quality and quantity is usually very poor and needs verification and supplementation. To complete scanning of all cadastral material and subsequent revision, supplementation, quality improvement and building up the multi-purposes cadastral information system for the whole country would take many years (Johnson, 1997 ). However, the solution of this problem is of national importance and should be priority of national plans.

#### 4 CONCLUSIONS

Design and implementation of various geo-information systems in Africa require many technical, organisational and managerial aspects to be considered and the comprehensive technical and financial plans must be done. The cost of infrastructure is high but this is not the main constrain to implement the new technologies in Africa. The organisational and technical problems concerning establishment of standards and specifications of the source material and their acquisition and availability of the manpower are the main constrains. Proper national co-ordination and management are needed. The African professionals have been properly trained in methods of data acquisition and GIS processing and management, during their long and short term studies in and outside countries, and they are able to undertake many of these tasks. However, many of local professionals leave a country or profession before they seriously start to use their knowledge, because of very low wage level for professionals in most of African countries. Training of African professionals takes a long time and needs a lot of financial support, which is often paid by international donors, particularly as the degree study and short term upgraded training are concerned, but finally the country with the poor economic status must again rely on international experts, because the local ones would leave country or profession if they can not effort to feed their families. This aspect must be widely discussed to increase awareness of national decision makers that the computers and software or survey/photogrammetric modern systems can be pursued in a short period, if money are available, but proper education of local experts/professionals take ten or more years and need at least one decade to replace them.

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