

CHALLENGES OF RIVER BASIN INFORMATION SYSTEM (RBIS) AS A FRAMEWORK FOR THE ASSESSMENT AND MONITORING OF SURFACE WATER IN NIGERIA

A.O. Eludoyin¹, O. M. Akinbode² and O.A. Ediang³

⁽¹⁾ Department of Geography, Obafemi Awolowo University, Ile-Ife

⁽²⁾ Department of Geography and Planning Sciences, Adekunle Ajasin University, Akungba – Akoko

⁽³⁾ Department of Training and Research, Nigerian Meteorological Station, Oshodi, Lagos, Nigeria

ABSTRACT

Most developing countries, especially in Africa, have been characterized by poverty and hunger, a situation that has been traced to the daily rapid reduction in the quality and quantity of available water resources. Less than 1% of the global water resource is reliably available for human consumption. A larger proportion of this percentage is polluted in most settlements in the developing nations. This therefore necessitates the call for adequate management of the existing source in these countries. One of the management options is the Geospatial information technology (GIT) as decision support tool in water resources management. Evidently, knowledge of this technology in the developing countries is low. Its application to some human endeavours in these countries is often fraught with some challenges. This paper presents the potentials of adopting the technology in the management of Nigerian surface waters. It envisages that the efficacy of the technology could reduce the present level of slow response to water quality assessment, fund wastage, duplication of duties, and ensure adequate distribution of good water to the people.

1. INTRODUCTION

Nigeria is one of the largest countries in Africa (1, 924, 000 square km) with the 9th largest population size (131, 859, 731) in the World (www.census.gov/cgi-bin/ipc/idbrank.pl). The country lies within the latitudes 4° and 14°N, and longitudes 3° and 15°E. It is bordered respectively in the north, east, and west by Niger, the Cameroon, and Benin Republic while the Gulf of Guinea, an arm of the Atlantic Ocean forms the southern border (Fig. 1). The drainage systems in Nigeria consists mainly the Niger-Benue, Chad basins and coastal rivers. Water bodies (excluding small reservoirs, fish ponds and miscellaneous wetlands suitable for rice cultivation) covers 149, 919 sq. km or 14, 9991, 900 ha of Nigerian land, and constitutes about 15.9% of its total area.

Theoretically, there is no water problem in Nigeria because the availability seems higher than the present use. Also, the location of the various rivers potentially spatially benefits all the sections of the country. However, studies have noted some problems using the water resources from these apparent sufficient sources. For instance, Nigeria is classified a water – short country, whose water resource is likely to reduce from 2, 506 cubic meters per year in 1995 to 1, 175 in 2025, if not properly managed (Fig. 2). Nigeria Demographic and Health Survey in 2003 revealed that 35% of urban population does not have access to safe drinking water while 70% of rural population depends mainly on unsafe sources of water such as open wells, rivers and streams for drinking. In addition, the World Water Fact Sheet revealed that 80% of diseases in the world today are water related. A large number of deaths accompany these cases in Nigeria.

The realization of the importance of adequate water management has probably encouraged the Nigerian government to establish a number of River Basin Development Authorities (RBDAs). Prior to 1960, water resources development was an exclusive preserve of the private individuals and groups. The government's major intervention came during the first National Development plan period (1962 – 1968) through the establishment of the River Niger and Lake Chad Basin Commissions. The number was

increased to 11 in 1976 to cover the whole country. The (RBDAs) were charged with the responsibility of a comprehensive water resources (surface and groundwater) development of Nigeria for multipurpose uses. In 1984, the RBADs were increased to 18 and renamed River Basin and Rural Development Authorities (RBRDAs) with similar functions to the RBDAs. With the change of the Military Administration in 1985, however, they were scaled down to eleven and retained the name RBDA. The functions were limited to purely water resources development. Despite this progress, development authorities have not made any impressive performance due to proliferation of unhealthy political rivalry, inconsistent government policies, and the organizational structure of some of the RBDAs (Akindele and Adebo, 2004). In addition, the authorities, and other government parastatals, such as the State and Federal water corporations or boards often duplicate their activities, leading in most cases to waste of resources, and occupational redundancy.

The present water management structure in the country is also likely (and has been noted) to create unnecessary rivalry between the authorities on the one hand, and the various state water corporations or boards on the other. It creates a lag in their operational efficiency. Similarly, many water projects have been carried out in Nigeria that has necessitated the call for informed decisions. For instance, about 3000 sq km. of forests and farmlands in Kano and Jigawa states have been drowned while construction of some lakes, e.g. Kanji, Tiga, Bakolori and Gurayo displaced an estimated 44, 000, 12, 000, 14, 000 and 20, 000 people in the last decades. More so that Nigeria, like most developing countries, still supplies less than the 120 litres / day of water for domestic use. Nigeria supplies 60 and 25 litres / day for many of its urban and rural population, respectively. The country also has a record for incessant power failure, a situation that has caused lost of money to her investors. These problems, among many other far reaching ones could necessitate an alternative that could ensure efficiency in the management of the water.

In this regard, catchment or watershed or river basin level of organization is still viable. Thus improving upon the existing structure will be advocated. This is because; the river basin approach remains a viable one in environmental studies (Bertolo, 2000). River basin has stable, well defined boundaries, which has made it a suitable areal unit for comprehensive and coordinated planning (Ayoade, 1988). The information system is viewed to comprise a network of the different RBDAs linked in a WAN to a master unit at the central. This is the idea behind the River Basin Information System (RBIS).

2. RBIS

RBIS is a computerized tool designed specifically to accept large volumes of data related to some catchments from various sources (Meijerink, *et al*, 1993; Molenaar, *et al*, 1993), and to efficiently store, retrieve, manipulate, analyse the data, and display the information derived from the data according to users' defined specification. The potential of the geospatial information system and its complementary technologies for capturing data and providing information to water resources practitioners has been recognized since the launch of ERTS – 1 in 1972. The satellite permits simultaneous measurements of various atmospheric and surface components of the hydrological cycle. Advances in computer and satellite communication have equally made possible an efficient management and manipulation of the acquired data such that it is possible to provide answers to complex questions in real time. In addition, with the recent improvement in spatial resolution of imageries collected using Remote Sensing, e.g. Digital Globe's Quick Bird commercial satellite with 0.61m panchromatic and 2.4m multiband images (Woerden, 1999); the ability to detect spatial response (e.g. with Landsat and Ikonos), or texture and dialectic responses (using Radasat), hydrological studies has greatly improved.

RBIS generally contains three subsystems, and each is made up of hardware, software, spatial data, procedure and trained personnel. They are:

1. Data acquisition subsystem, which includes all the components of hardware, etc. that are required for the acquisition of spatial data related to the river catchment. The hardware includes all the equipment for digital land surveys, hydrography and hydrological surveys, and their accessories. It will also include computer hardware with relevant operating systems, and accessories. Scanners and digitizers are also included. The existing laboratories in the country that have been managed by the River Basin Development Authorities should be co-opted into the system as supplier of all the laboratory results for quality assessment. The software system should include at least one raster and one vector GIS software, and CAD systems

This is likely to be the most expensive and tedious aspect of the application of the technology in developing countries. It will involve the coordination of many of the existing Ministries and government parastatals, including the Federal Surveys, the National Centre for Remote Sensing, National Space Research and Development Agency (NASRDA), Population Commission, and Ministry of Water Resources (in Nigeria) for data supply and ground truthing. A large degree of devotion will dwell on water resource inventory to produce a national aquatic data warehouse for the nation. Curling from the example of the New Brunswick's Aquatic Data Waterhouse (www.nbwaters.unb.ca/dwmanual/6.pdf), all information about the water bodies should be digitized, with each body assigned a unique code or identifier. Nigeria however is expected to provide its own conceptual framework for data inventory.

2. Data management subsystem: this is made up of the hardware, etc. required to process the data that have been collected in the earlier stage. The hardware system often comprises a Pentium based computer with a minimum of 64GB RAM, 256MB Hz, fully multimedia. The software components are the GIS software, with some third party software including CADs and CACs. It will also include statistical packages, database software, and advanced programming languages.
3. Information presentation subsystem is concerned with the requirements for the presentation of the results of the processed data for a problem solving scenario. The hardware selection will include a VGU display, plotter and color printer.

These three subsystems and their components are to be linked in a Wide Area Network. This is to link all the RBDAs with the central unit in Abuja. The systems in each of the RBDAs will ultimately be linked to the central system somewhere in the FCT from which instructions or requests could be made at national level. Data exchange among the RBADs will be facilitated if the effort of the country to create a National Geospatial Data Standard (NGDS) is successful. Information of the aspect of NGDS in Nigeria has been treated by Kufoniyi (1998).

3. POTENTIALS OF RBIS

An important potential of this approach is the ability for inventory and storage of water resources information in a digital form. This will essentially facilitate retrieval, manipulation and updating of the data for any decision. Queries relating to water supply potential could also be generated for comparison with a selected population demand. Scenarios could be created with geospatial Information system to facilitate explanation of different financial and political demand (Meijerink *et al*, 1993). The approach is thus a potential powerful support tool for solving environmental problems, including impact assessments in water resources management.

RBIS, like its root, GIS (Geographical Information System), is capable of answering some queries relation to location or citation of some terrain objects relating to water resources. Queries such as trend or patterns or modeling questions are within the capacity of a geospatial information system. The theoretical concepts and applications of these in the broader GIS have been discussed elsewhere (e.g. Borough, 1985;

Aronoff, 1995; Bruce, 1996). Recently, with exposition to Artificial intelligence and expert systems, the RBIS can be trained to make decision from set incomplete and unsound information.

4. CHALLENGES OF RBIS IMPLEMENTATION IN NIGERIA

A review of many paper and digital information has revealed that the idea of RBIS implementation is not new to the management of water resources in the developed countries, especially in the US. Most of these states posses having this resource have succeeded in inventorying basic spatial and attribute information at the catchment level characteristics of water bodies. On the contrary most developing countries, especially in Africa are still within the paper file –carrying age, causing some deficient in the decision making processes in these countries. An instance of the realization of such deficiency in the management (Suwarnarat, 1991) could lead to education and training of the managers and /or government officials in the area of specialization.

In Nigeria, however, the Obafemi Awolowo University, University of Ibadan, the University of Lagos, RECTAS, and the Federal School of Surveying are the only institutions (out of about 150 tertiary institutions) that ‘accreditedly’ train students and professionals in the study of GIS. Of these, the collaborative educational training of the department of Geography, the Regional centre for Training in Aerospace science and the Centre for Space Science and Technology Education (CSSTE) and Obafemi Awolowo University, Ile-Ife, catches the view of inter-institutional cooperation. Both RECTAS and CSSTE offer postgraduate diploma in GIS but the Obafemi Awolowo University enjoys the cooperation of these international institutions to boost her M. Sc and PhD programs in Remote Sensing and GIS. The few institutions have not; however, for a singular event, witnessed any encouragement by any private or even public organization to boost its activity as applied to many Universities in the developed countries.

Meanwhile, the Ministry of Water Resources could encourage the training of its personnel by funding any of the available universities in Nigeria .This would help develop the training standard in these Universities while endorsing a local based, individualized training of the personnel.

Secondly, implementation of RBIS in Nigeria requires adequate data collection in required format. However, the gap in the availability of data between the developed and developing countries has been increasing seriously impairing the capability of countries to make informed decision concerning environment and development (Bruce, 1996) Nigeria like some of the focused countries has stepped ahead by launching Nigeria Sat 1 in 2003. Analysis of some acquired using the satellite however reveals the need for the improvement on its own sensors to acquire at larger resolution, and with reduced noise (especially in the southwest part of the country). In addition, Nigeria is striving towards the implementation of its Natural Geospatial Infrastructure to ensure uniform data standards among relevant organization.

Besides, the organizational and legal issues in the country are improving with current natural policy against corruption, it is behaved that the implementation is likely to be successful. However, the resistance to changes from some groups of personnel in the Ministry needs to be identified and addressed. This is understood because the fear of job shedding in the already overcrowded establishment, especially where cases of ineffectiveness have been noted. A good way to achieve this is introduce the system in phases in all the RBDAs; probably according to the subsystems. The existing data collection unit could be reorganized first by digitizing all the existing analogue maps, and converting all the paper files to digital. The achievement of the Mr. El Rufai, the present FCT Minister, in establishing a land information system (ABUJA GIS or AGIS) is a signal that RBIS is feasible. This phase will be accompanied by the output subsystem while the processing, manipulation and analysis subsystem will basically require the employment of competent personnel. The GIS analyst is responsible for the in house - training of the other employees as regards the establishment’s requirement.

5. THE ROLE OF THE EDUCATIONAL INSTITUTIONS IN TRAINING THE PROFESSIONAL: OBAFEMI AWOLOWO UNIVERSITY EXAMPLE

Probably because of its specialty and relative newness, there is dearth of GIS professionals in Nigeria. The department of Geography, Obafemi Awolowo University, Ile-Ife, in collaboration with professionals and facilities from the RECTAS and CSSTE, awards M. Sc (Academic), M GIS (Professional), and PhD degrees in the discipline as a way to meet one important challenge. It accommodates applications in Biogeography, Cartography, Hydrology, Climatology, Transport, Health and Population, Geography, and Urban Planning. The department offers admissions to graduate of various relevant disciplines of various relevant disciplines with at least second class lower division, civil servants, government officials and professionals who are good degree holders. The course content is shown in Table 2. The PhD is primarily a Research programme although admitted candidates take courses on Research Methodology in the first semester.

CODE	COURSE TITLE	UNITS
GPY 602	Advanced Quantitative Technique	3
GPY 617	Photo Interpretation & DIP	3
GPY 628	RS Technique & Platforms	3
GPY 620	GIS Analysis& Management Issues	3
GPY 630	Advanced Cartography	3
<i>Plus 1 elective (for M.GIS) or 2 (M. Sc.) from the following courses</i>		
GPY 607	Advanced Biography	3
GPY 612	Water Resources Evaluate Land Capacity	3
GPY 613	Land Capacity Evaluation	3
GPY 615	Urban Planning Technique	3
GPY 616	Regional Development Strategies	3
PHY 616	Physics of The Earth Geomagnetism and Gravity	3
GPY 627	Thesis	3

6. CONCLUSIONS

It has been revealed that Nigeria, like many other countries, is faced with the problem of its water resources. This has attendant effects on the inadequate satisfaction of the demand of its enormous population. It has also been revealed that the geospatial information system in respect of RBIS posses a potential to solve the problem, given that the basic infrastructural structure is in place. Knowledge of the geospatial data management is however in its infancy in Nigeria but the institutional preparation to develop such knowledge is soaring. Manpower is rapidly been built although not without some bottlenecks, including the low level of technological development in the country, inadequate funding, duplication of efforts by the management, and bureaucratic upheavals – necessitated by the existing analogue approach.

These challenges could not be met when the developed nations become interested in the growth of technology in the Third World countries. This could be achieved by the followings:

1. collaborating with the local institutions (in these developing countries) in researches involving GIS application
2. exploitation of the local institutions as potential markets for GIS related companies, including software vendors and hardware marketers.
3. funding of the GIS departments in the developing countries, among others

Finally, governments in the Third World countries are advised to make their countries viable for interested investors by making corruption and bureaucratic bottlenecks past tale. Political stability and policy consistence are to be encouraged by these nations.

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Fig.1

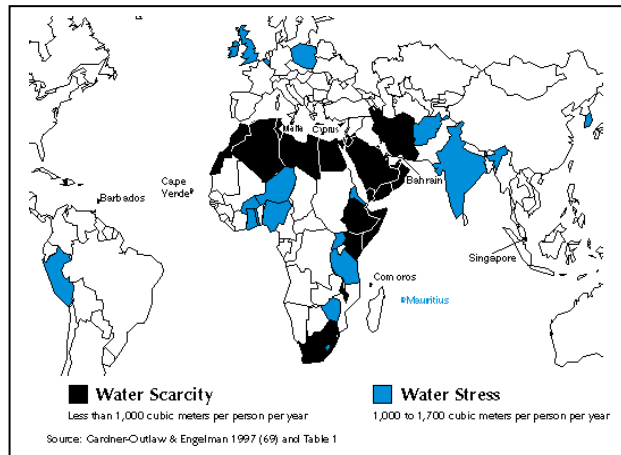


Fig 2.