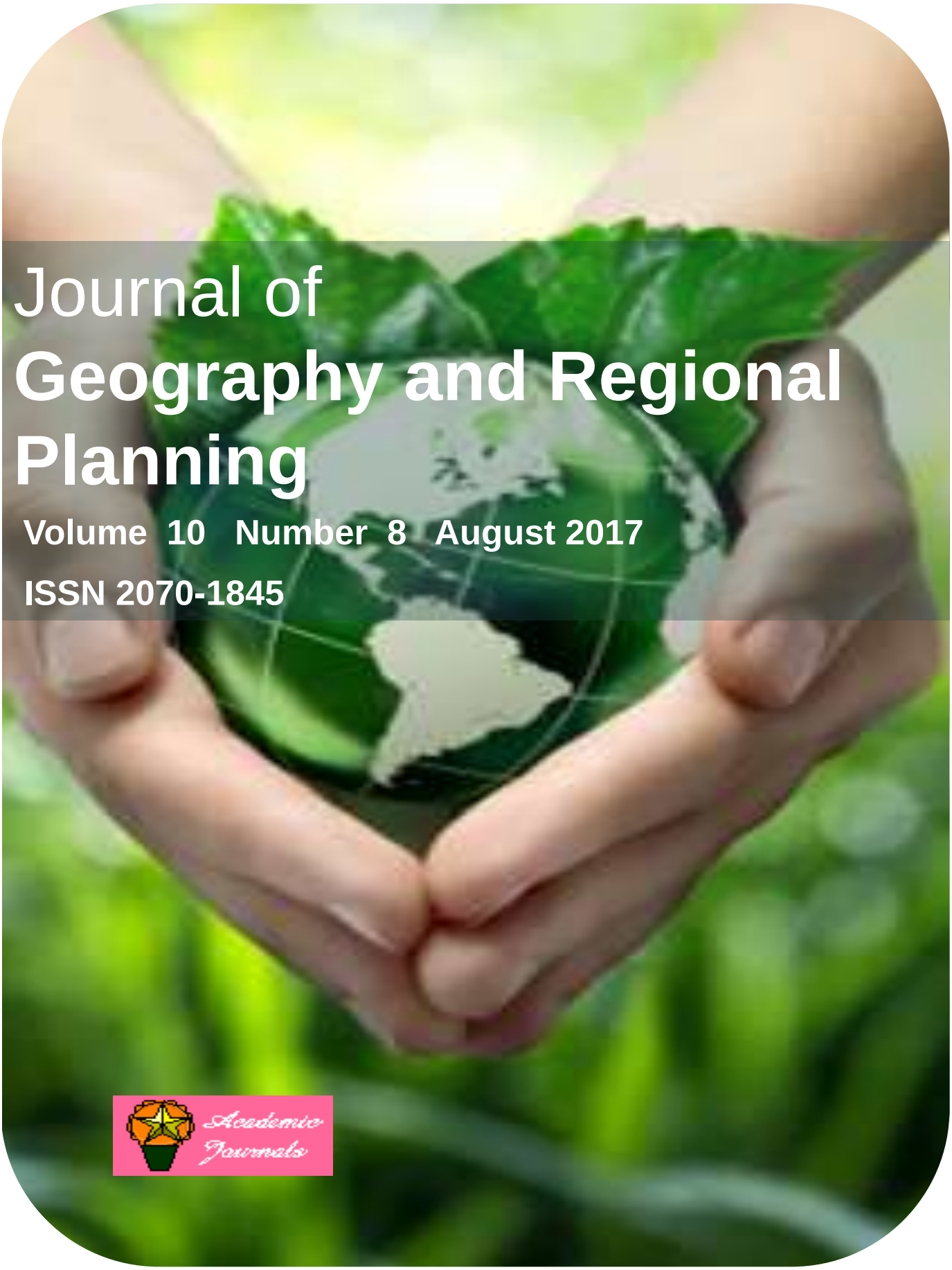

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Full Length Research Paper

Evaluation of the institutional arrangements for rural water supply in Enugu State, Nigeria

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This paper presents a qualitative assessment of the institutional arrangements for public water supply to rural communities of the Enugu State, Nigeria, in order to isolate strategies that can enhance institutional strengthening and improve service delivery in the area. The data used were obtained through questionnaire surveys, field observations and from records in the states agencies responsible for public water supplies. The data generated were analyzed through the use of descriptive statistical tools. The results of the study revealed the strengths and weaknesses of the institutional arrangements currently in use in the area. The principal and subsidiary agencies for public water supply have clear policies, functions, roles, responsibilities and programmes for rural water supplies; however, the rural population's access to potable water remains low in the area due largely to a variety of factors such as low investments, high recurrent and maintenance costs, over-aged water infrastructures, lack of political will, non-availability of fund, inadequate technology and institutional weaknesses. Over 85.6% of the water supply schemes have failed completely or partially. Only 14.4% of the schemes are functional; 83.3% of non-functional schemes are suffering from major breakdowns; 86.78% of the population is not served and 18 schemes have exceeded their estimated life span of 20 years. The implications of these findings were x-rayed. The way forward is to reform and strengthen the current institutional arrangements, adopt new management strategies, rehabilitate dysfunctional infrastructure, improve coverage and distribute water infrastructure equitably.

Key words: Institutional strengthening, institutional arrangements, reforms, rural communities, rural water supply, Nigeria.

INTRODUCTION

Institutional framework for water supply refer to the set of formal organizational structures, laws, policies, guidelines, regulations, as well as agencies engaged in the planning, developing and managing water supply systems in an area (Rees, 2006). According to Saleth and Dinar (2004), such a framework is the prerequisite for any sustainable development and management of public water supply systems; as it shows the capacity possessed by organizations to carry out the task assigned to it. A well-balanced arrangement for public water supplies is the best assurance that the right quantity and quality of water will be delivered to water

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users (including the ecosystems), both now and in future and that the people will continue to live in a healthy environment (Ostrom, 1990).

Saleth (2008) observed that over the decades, humanity has learnt that water resources, although finite, must keep satisfying a variety of user demands (such as water supply for domestic needs, etc) and that the water must be sourced. They have also learnt that there are different approaches for sourcing water and that some approaches are more cost effective than or have more advantages over the others. The cultural, historical, physical and socio-economic conditions of a country dictate which specific approaches must take priority and hence determine the preferred institutional arrangements. Each institutional arrangement must however require a specific mandate, organizational structure and procedures as well as specific technical expertise (Gbadegesin and Olorundemi, 2007).

Ezenwanji (2012), noted that the organizational structure and the administrative procedures to implement water service delivery responsibilities in Africa is very much affected by the characteristics of the sub-sectors of the institutional frameworks and the functions they perform. The sub-sectors typically concern themselves with functions that are relatively distinct (such as construction, operation and maintenance of water infrastructure) and require specific expertise. Goni (2006) noted that institutional arrangements in the region differ between countries, as well as over time.

Although, the Millennium Development Goal Summit Report (1) indicates that appreciable progress has been made in attaining the MDG 7 target of reducing by half the proportion of people without sustainable access to safe drinking water by 2015 in many countries, recent findings clearly indicate that many countries in Africa still remain with limited access to potable water supplies (UNICEF, 2015). In many parts of Africa, especially sub-Saharan Africa, water supplies are inadequate and dwindling (Obeta, 2013). Adah and Abok (2013) noted that sub-Saharan Africa is lagging behind in the attainment of MDG as 34 million people still lack access to safe drinking water. The proportion of African population who had access to safe drinking water accounted for only 60% by 2010, an increase of 11% compared with the situation in 1990 (Obeta and Chukwu, 2013). In 2015, 663 million people in the continent still lack access to improved drinking water sources (UNICEF, 2015). This is inspite of the large array of institutions and agencies responsible for ensuring that government targets in the water supply sector are met in the region. .

Nigeria lags behind many African countries such as Serra Leone, Rwanda and Botswana in access to safe drinking water (UNICEF, 2015). These countries have met the 2015 Millennium Development Goal's target of halving the proportion of its people with regular access to potable water. In 2013, 71% of the Rwanda's population had adequate access to clean water (UNICEF, 2012). But in Nigeria potable water remains a dire need in almost all communities and sectors. Indeed, Nigeria is still one of a handful of countries around the world where access to potable water is actually falling rather than rising (Bob-Duru, 2007; Obeta, 2013). For instance, 37% of the nation's population had regular access to potable water in 1990 (Uboh and Etim 2007). In 2003, the percentage of the population with regular access to potable water declined to 32% and again to 28% in 2012 (Obeta and Chukwu, 2013). Currently, 90 million Nigerians are without safe drinking water and 130,000 under five children die annually from preventable and treatable water related diseases (Nwankwo, 2014).

In our study area (Enugu State) access to potable water is an arduous task. The state is predominately rural. About 80% of the population lives in rural areas. For a sizable proportion of the population, the major sources of water are unprotected wells, streams, ponds, private boreholes and harvested rain water (Figures 1 and 2). These sources are open to contamination by natural and anthropogenic factors, such as defecations, careless waste disposal practices, livestock, floods, etc. (Nwankwo, 2014). The problems of limited access to potable water in the area create the need for in depth studies to investigate the institutional arrangements for rural water supply in the state in order to isolate the strategies which can strengthen the agencies and improve service delivery of the existing supply schemes

Cleaver (2001) and WHO (2011), emphasized the need to identify specific challenges facing public water supply, especially in developing countries, and to strengthen policy-making, so that safe drinking water, can be brought to all urban and rural dwellers. Akpomunje (2010) and Peter (2010) shared this view and stressed that water is fundamental to human development and well-being. They noted that access to potable water is critical and essential for the sustenance of socio-economic growth and development. The objectives of this work therefore are to describe, analyze and evaluate the institutional arrangements for rural water supply in Enugu State of Nigeria, with a view to isolating their strengths and weaknesses as well as the strategies which can improve service delivery in the rural water supply sector of the area. The findings of this work, in our view, will contribute to the knowledge base for future research and development of water supply systems in the state. In addition, finding lasting solutions to the rural water supply deficiencies in state is a crucial step in setting the stage for sustainable development in most sectors of the rural economy as well as in improving the peoples well-being, and indeed, for the successful implementation of the post-2015 rural development agenda.

Area of study

Enugu State is located in Southeastern Nigeria

Figure 1. Abonyi River, near Ikem. Many River bank. Residents depend on this stream for all their water needs.

Figure 2. Ajalli River near Iwollo. Most communities in Ezeagu. LGA depend on this stream for their water needs.

approximately between latitudes 05.55`N and 07.08`N and longitudes 06.35`E and 07.55`E (Figure 3). The state has an area of 9,102 square miles or 14,563.2 km^2, and a 2014 projected population of 4.7 million, 80.2% of which live in the rural areas (Nwankwo, 2014). The climate is tropical with high temperatures and high humidity as well as marked wet and dry seasons, though there are variations between north and south. Precipitation varies widely in both time and space, ranging from less than 850 mm per annum in the extreme north to 1050 mm in the south (Oformata, 2002).

The state is drained by numerous rivers, principally the Ebonyi, Adada, Ajali, Ivo and their numerous tributaries. Many of the tributaries are seasonal. The vegetation varies mainly with the rainfall and with topography. Natural vegetation is denser in the south and in the valleys and sparse in the north and at the top of the highlands (Nzeadibe and Ajaero, 2010). Generally, the rural areas have similar physical and socio-economic characteristics. For instance, many of the rural residents have no easily accessible, nearby, clean or hygienic water sources. Sources of such water vary widely from direct rainfall to water from runoffs, rivers, streams, boreholes, wells, and seepage. Many suffer from avoidable water related diseases (Mozie, 2011). Despite a process of industrialization extending to the creation of the state in 1986, agriculture remains the fundamental economic activity in all the local government areas. The leading economic crop is the oil palm which is grown in every part of the state. Cassava, yam, rice and maize are the most important food crops. The average life expectancy in the mid 1990s was 47 for men and 49 for females.

METHODOLOGY

The data used in this study were derived mainly through oral interviews, personal observations and from records in states agencies for rural water supplies. First, an elaborate field survey of the study area was carried out; we visited all the three rural water supply zones in the state at Enugu, Nsukka, and Udi to extract useful information from official records, observe existing water supply sources, equipment as well as to interview the principal officers of the state zonal water supply units. The three zonal water engineers at Udi, Nsukka and Enugu were interviewed; they provided relevant information on the contemporary situations of water supply services in their respective zones. In addition, a total of 15 rural water supply schemes were sampled with detailed investigations. The choice of the schemes depends on the distance from a previously chosen one in the locality, the wish of the owner(s) and availability for study. The water supply schemes had a total of 85 water distribution points/public taps. The water supply schemes are located in sampled communities in Figure 2.

Three focus group discussions (FGD) were conducted, one in each of the rural three water supply zones. In each of the FGD, 9 participants, comprising, the zonal water engineer, three borehole managers, three officials of the community water supply committees and two women leaders were involved. Participants discussed a wide range of issues; including, how to improve the contemporary water delivery services and how to mobilize the communities towards the realization of the objectives of the rural water supply schemes. The data collected from the aforementioned sources were analyzed through the use of various descriptive statistical tools-percentages, means, standard deviations, etc. The computations were done through the use the statistical package for the social sciences (SPSS) Version 20.

RESULTS AND DISCUSSION

Institutions and NGOs involved in public water supplies

The State Ministry of Public Utilities

The State Ministry of Public Utilities is responsible for

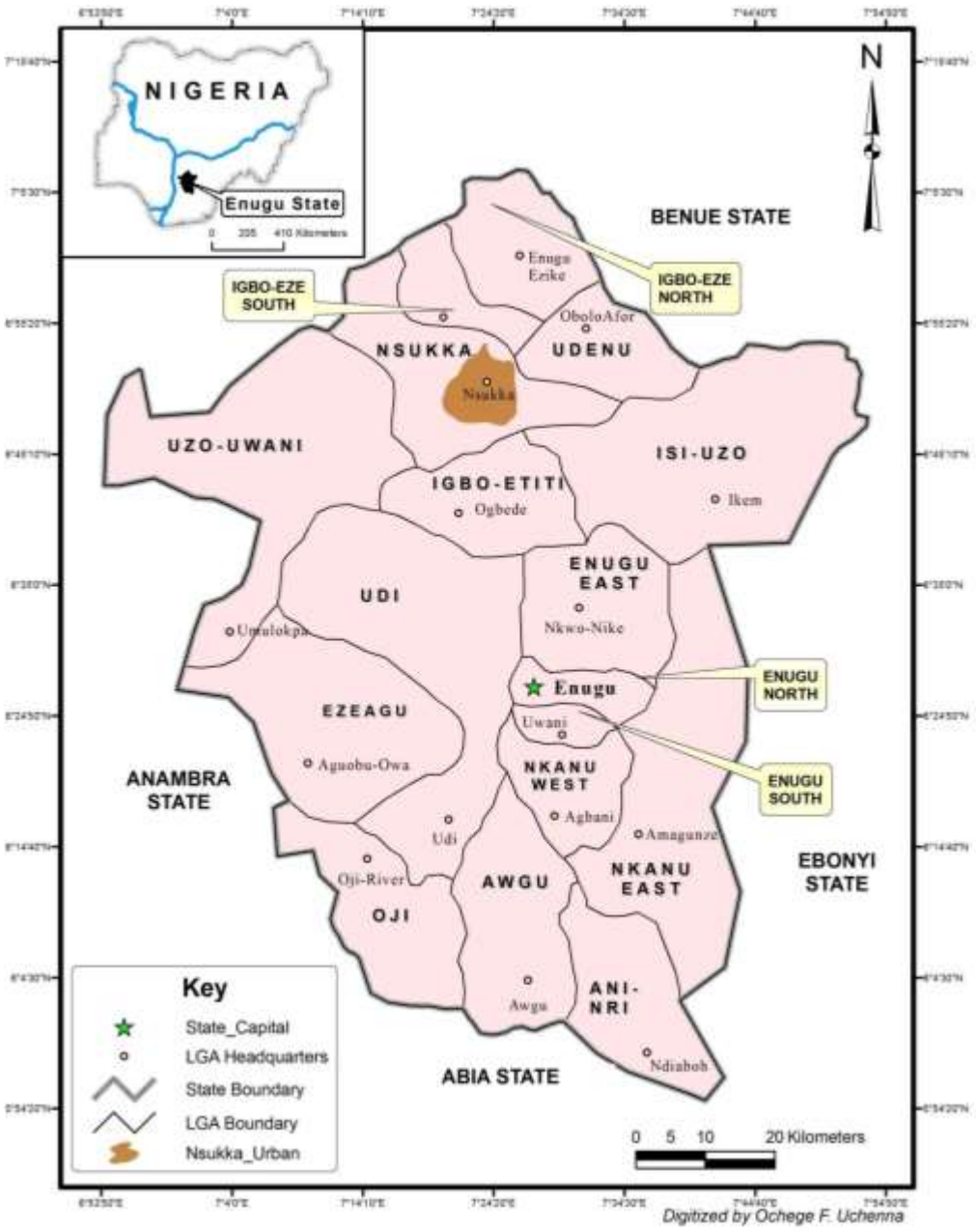

Figure 3. Map of Enugu State showing the Local Government Areas (GIS Unit, Department of Geography, University of Nigeria, Nsukka).

implementation of water resource policies in the state. However, the ministry has no direct involvement in rural water supply services other than licensing and registering non-governmental agencies involved in public water supplies.

The Enugu State Water Corporation (ESWC)

The ESWC has the overall responsibility for urban and rural water supply in the state. This institution was established in 1997 and charged to provide adequate, sustainable water supply for improved personal, household and community wellbeing. Prior to the 1960s, the responsibilities for water resources, in our study area, were divided among: (1) Ministry of Agriculture, for irrigation and rural water supplies to farming communities; (2) Ministry of Public Works, for rural water supply, as well as for the installation maintenance of supply facilities; (3) Ministry of Health, for aspects

relating to hygiene.

In December 1963, a Water Bill to govern public water distribution and management was passed by the Eastern Nigerian House of Assembly. The bill provided for the establishment of a regional water corporation to develop/provide adequate and safe water to the people of the region. This law of December 1963 profoundly modified the water policy strategy in Eastern Nigeria, from where the state was carved out in 1986.

For instance, the 1963 Water Bill, according to Obeta (2009) and Ezenwanji (2012):

(1) Led to the establishment of a regional water corporation to develop and provide adequate household water to the people (urban and rural);
(2) Outlined a number of general guidelines/principles, concerning the operations of the water corporation, which at the time was quite innovative;
(3) Established legislation and regulations for pollution control, initiated innovative water management policies and established the institutional structure for water resources development within the region.

The 1963 Water Act brought considerable improvement in water resources development in our area of study (Obeta, 2013). The provisions of this act were however, repealed by Edict No. 16 of 1978, which established the Anambra State Water Corporation to develop, provide, conserve and distribute water (in the state) for public, domestic and industrial purposes. Following the creation of the old Enugu States from Anambra, the Enugu State Water Corporation came into being. Currently, the State Water Corporation has three rural water supply zones, with headquarters at Udi, 9th mile Corner (Ngwo) and Nsukka. Each of these zones maintains a number of rural water supply schemes that provide potable water to the rural communities.

The functions of the Enugu State Water Corporation

This institution was established in January 1997 as a public corporation having perpetual succession and a common seal which may sue and be sued in its corporate name and hold and dispose of real or other property in any manner whatsoever for the purpose of carrying out the duties lay down by Edict No. 1 of 1997 (Obeta and Chukwu, 2013). Edict No. 1 of 1997 which set up this corporation assigned a dual role to it, namely:

(1) The main role is to develop, provide, conserve and distribute water in the state for domestic and other purposes at the most minimal cost.
(2) The corporation was equally assigned subsidiary water-supply related duties, such as to: (a) establish, operate and maintain public water supply facilities; (b) collect and monies due to the corporation such as the monies form budgetary allocations and discharge debts own to the corporation; (c) sign, accept, negotiate, endorse and receive any negotiable instrument on behalf of the corporation; (d) authorize the disposal of securities of any kind belonging to the corporation; (e) open and operate current, deposit or credit accounts on behalf of the corporation at approved banks or financial institution; (f) assist in negotiating and obtaining loans on behalf of the corporation and in determining in the nature and conditions of such loans; (g) design, build, manage and maintain a network of water supply facilities in the state; (h) compile priority lists of communities in need of water supply facilities and to build or provide same; (i) develop technical standards and preserve the environment; (j) initiate and carry out researches on fields that are related to their activities such as water pollution, rainwater harvestation, and cost effective water supply strategies; (k) prepare and publish audited annual accounts of the corporation; (l) undertake sector planning, coordination and recommend, at the request of the state government, water supply projects for donor funding; (m) provide guidance and technical assistance to suppliers in the private sector; (n) review form time to time, the status of water supply schemes and recommend appropriate actions to the state government.

The various roles assigned to the water corporation are necessary and in keeping with the global policy of providing, to the best possible extent, all population groups with access to safe and adequate drinking water supply and adequate means of sanitation. However, our findings revealed that many of the roles are not receiving adequate attention at present. For instance, the corporation is yet to provide regular and efficient water supplies to the people; and extend services to many deserving areas.

The management structure of Enugu State Water Corporation

The edict, which established the new Enugu State Water Corporation (Edict No. 1 of 1997) raised the status of the corporation to a self-accounting and self-sustaining public corporation. The edit stated specifically that the corporation will be headed by managing director who is empowered to disburse funds without recourse to any higher authority. The present management structure of the corporation is as shown in Figure 4.

As shown in Figure 4, the Enugu State Water Corporation is headed by a managing director, who according to Edict No. 1 of 1997 must be a professional water engineer of very high standing. The managing director is charged with carrying out the executive an administrative work necessary to enable the corporation carry out the duties and functions assigned to it. The managing director, in addition, is promote and encourage

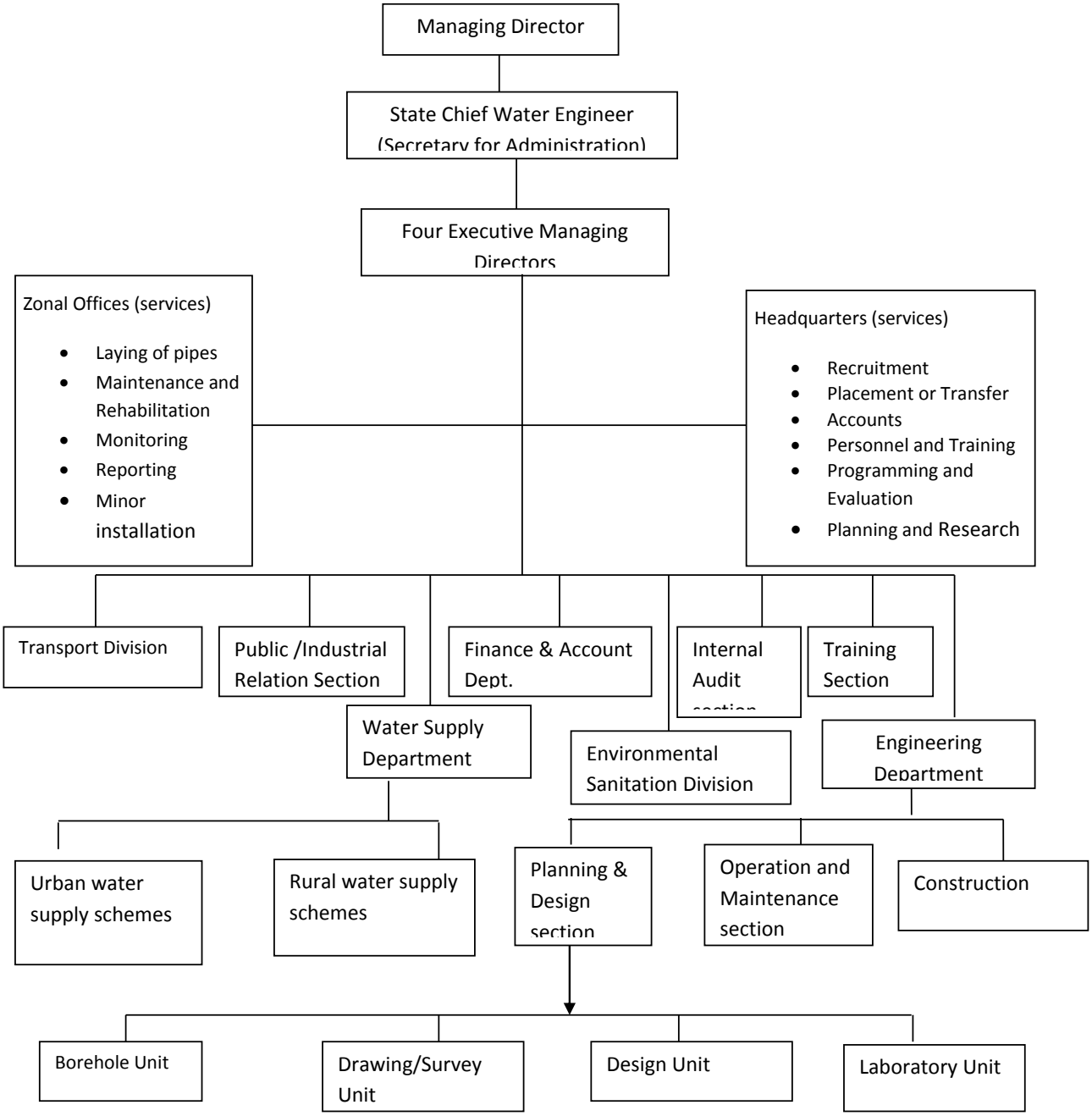

Figure 4. Management structure of the Enugu State Water Corporation (Enugu State Water Corporation, Headquarters Enugu, 2015).

the development of efficient service delivery programmes within the state, and where necessary, coordinate the activities of donor agencies involved in water supplies in order to active maximum benefit and economy of supply services to the public. The managing director is assisted in his administrative and executive functions by the states chief water engineer who is also the secretary for administration. Apart from discharging his statutory functions, the secretary, in addition, carry out directives (usually water supply-related) from the ministry of public utilities. The state chief water engineer is assisted by four executive managing directors who are also professional engineers (at present only 2 are in the service of the corporation).

The State Water Corporation is, for purposes of efficiency and operational effectiveness, sub-divided into two major divisions, namely: the division responsible for urban water supplies and another section responsible for

rural water supplies. The division responsible for rural water supplies is in addition, sub-divided into zones with headquarters at Nsukka, Udi and 9th mile corner (Ngwo). Each of the zonal headquarters is headed by a zonal water engineer, who according to Edict No. 1 of 1997 must also be a professional engineer with considerable experience. The state water corporation headquarters, at Enugu is empowered to carry out a number of very strategic functions, which as shown in Figure 1, include recruitment, placement and transfer, accounts, personnel and training, programming and evaluations, planning and research as well as major administrative, managerial and technical functions.

The zonal headquarters, on the other hand are charged with carrying out less strategic functions, such as lying of pipes, routine maintenance and rehabilitation, monitoring reporting and minor installations. In addition, the zonal water engineer oversees the technical and administrative officers and workers of the zonal. In plain terms, the zonal water engineer is at the head of the zonal administration. He is responsible to the corporation for overall administration in terms of reports management of zonal resources, recommendations, requisitions, zonal stores and statistics.

Finally, the zonal water engineer coordinates and oversees a number of rural water supply schemes otherwise called rural water supply centers. These rural water supply canters are charged with the responsibility of supplying water to the various autonomous rural communities within the area of operation-usually on local government basis. The rural water supply centre is headed by a centre coordinator who oversees the activities of the technical staff under his unit. The local government councils and communities (128 at present) have water committees whose duties are to handle minor repairs and serve as a link between the communities and the zonal water corporation. The communities also carry out surveys of existing facilities or facilities required to meet the consumption and demand of water supply in their areas. They also assist to formulate proposals and prepare estimates for meeting future water demands. The duties and functions of the other units are as shown in Figure 4.

Finance and accounts department

This department, headed by a financial controller, oversees all finance related activities of the corporation. It operates three main sections, namely:

(a) Financial accounting section is responsible for receipt expenditure on funds, ledger and financial accounts, staff claims, zonal accounts, payroll and pensions;
(b) Assets and project costing section deals with assets and stores record, project costing, budgets and budgetary controls, and physical stores;
(c) Commercial section is responsible for billing, investments, etc.

Personnel/Establishment section

This section deals with all establishment matters such as new appointments, staff on leave, in-service training, resignations, terminations, dismissals, retirements, pensions, etc.

Training section

This section organizes short term training courses for the corporation's staff, such as craftsmen-plumbers, fitters, plant operators' security and other department of staff. This section also organizes trade tests for the junior technical staff of the corporation.

Engineering department

This department is made up of three sections, namely; operation and maintenance, planning and design and the construction sections. The operation and maintenance section oversees all matters related to the design and construction of water infrastructures, laying of pipes, installations, pipeline extensions, monitoring and supervision, and ensuring quality standards in service delivery, etc. The planning and design section on the other hand is made up of the design unit, the borehole units, the drawing/survey unit and the laboratory unit. The borehole unit is in charge of drilling borehole and installation of pumps. The design unit prepares structural details while the laboratory unit is responsible for testing water meant for human consumption. The engineering department is probably the most important unit in the state water corporation. The department is at present, headed by a professional water engineer.

Environmental sanitation division

The functions and duties of this division include sewage, drainage, public health, sanitary inspection, pollution control, etc.

Internal audit section

The internal audit detects and tackles the incidents of fraud, forgery and embezzlement, especially those in which staff is involved. In addition, this section pre-audits salaries and wages, contractor's bills and periodically tours zonal offices of the corporation on cash surveys.

Public/Industrial relations section

This section handles all preparation of press releases,

advertisements, and briefings, while the remaining departments (legal units, transport division, and security section) carry out essential supportive duties and services that are necessary for the realization of the overall objectives of the state water corporation.

The Governing Board of the State Water Corporation

Edict No. 1 of 1997, which set-up the state water corporation also recommends that a governing board for the corporation be constituted as follows: (i) The commissioner for public utilities or his representative chairman; (ii) Director general, Ministry of Public Utilities-member; (iii) General manager, Enugu State Water Corporation-member; (iv) Chief engineer, Enugu State Water Corporation-member; (v) A member representing the interest of consumers (presently none has been appointed).

According to Edict no. 1 of 1997, the governing board shall ensure that the pre-set performance criteria were met and that the corporation meets its overriding objectives. In addition, the board shall perform the following functions:

(1) Advice the ministry (of public utilities) on suitable management systems for potable water supplies;
(2) Advise the ministry on suitable arrangement for disbursement of available funds end-users;
(3) Examine existing laws governing the operation and management of water supply schemes and advise the ministry on necessary amendments.
(4) Consider and approve all expenditures exceeding fifty thousand naira (#50.000). The board shall, in the performance of its functions, have regard to: (a) any general policies of the government notified to it by the commissioner of public utilities; or (b) any general or specific directives given by the commissioner.

In the performance of its functions, the board is required to establish and maintain a system of coordination, cooperation and consultation with other bodies, within or outside Enugu State, which have similar or related functions and the board was dissolved in August 2010 and to date, is yet to be reconstituted.

NGOs INVOLVED IN RURAL WATER SUPPLY INSTITUTIONS

A variety of multi- and bilateral organizations and donors, and NGOs support and develop water supply schemes and provide services in the area. Many of these organizations also invest in capacity building of key stakeholders to strengthen the water supply sector and improve service delivery in the area. Currently, these subsidiary rural water supply institutions operate in the area:

(1) National Water Rehabilitation Project (NWRP);
(2) African Development Bank (ADB) Assisted Rural Water Supply Programme;
(3) Petroleum Trust Fund (PTF) Assisted Rural Water Supply Programme;
(4) Directorate of Food, Roads and Rural Infrastructure (DFRRI) Rural Water Supply Project; and
(5) UNICEF, UNDP and World Bank-Assisted Rural Water Supply Projects.

NWRP intervenes to increase the supply of potable water in the study areas by rehabilitating dysfunctional water schemes in order to restore them to designed capacities. NWRP has successfully rehabilitated 18 rural water supply schemes spread across 8 LGAs in the study area prior to the year 2005.

ADB is also involved in rural water supply development in the study area. This agency assists through the procurement of operational equipment, institutional strengthening and sponsorship of rural water supply projects. Findings revealed that ADB has assisted in the pipeline extension of 5 schemes spread across 5 LGAs in the study area.

PTF was established several decades ago (1998) to halt infrastructural decay and accelerate the speed of rural development in Nigeria. Like the NWRP, PTF also assist in the procurement of operational equipment, institutional strengthening and in the drilling of hand pump boreholes. DFRRI was established in 1986 to develop rural feeder roads, water supply projects as well as to stimulate economic and other activities necessary for improved quality of life in rural areas. This agency developed 32 hand pumps (none is functional at present) pumps, equipped with boreholes in Ani Nri, Nkanu, Ezeagu and Uzouwani LGAs. Finally, UNICEF, UNDP and the World Bank also assist in improving the living standards of the rural communities in the area through the development of rural water supply sources. These agencies have sponsored water projects in Udi, Igbo Eze and Udenu LGAs of the study area.

EVALUATION OF THE INSTITUTIONS INVOLVED IN PUBLIC WATER SUPPLY IN THE STATE

All the public institutions involved in rural water supply in the study area have clear functions, responsibilities and programmes for rural water supply in the study area. The functions, roles and responsibilities of the agencies are clearly defined and are essential. The functional relationships between and within agencies are highlighted. However, there are several disturbing weaknesses in the current arrangements which, in our view, are holding back progress in the states rural water supply sector. These observed weaknesses are briefly

discussed as the following.

Firstly, the current structure of the State Water Corporation, illustrated in Figure 1, is cumbersome and perceived as ineffective even by the officials of the state water corporation.

For instance, all the zonal water engineers agreed that reporting lines are long and tortuous, and that numerous support-services are often shared by two or more sections. Presently, a simple request for the replacement of faulty equipment, say, the simple pressure filter, in a rural water supply center such as Ikpamodo (Igbo-Eze North L.G.A) at the lower end of the structural hierarchy must pass through 5 line officers before approval can be given. Naturally, this causes delays and avoidable hardships. This contrasts sharply with the position in private water supply schemes, where the field officer can report directly to the chief executive and get faulty parts repaired in hours.

Secondly, our investigations revealed that the current accounting systems within the ESWC provide little information to support a critical analysis of the corporation's operations. For instance, there is no up-to-date revenue account. Accounts are kept on a cash basis, and the accounting system uses very broad headings, which involve a great deal of aggregation. Items like administrative', 'electrical and mechanical' costs frequently cover several functions, and there is no simple way of identifying the specific expenditures attributable to specific aspects of rural water supply. In such a situation, a researcher cannot tell how much the corporation spends on routine and periodic maintenance costs; the breakdown of costs between overhead-labour, equipment, repairs, pipeline extension and construction. Such poor accounting systems make it difficult, if not impossible, for even the managing director to establish consistent spending priorities.

Thirdly, our investigations revealed that there is a dearth of effective management information system at the zonal headquarters of the Enugu State water corporation. For instance, none of the field officials of the zonal water corporation interviewed knew the annual budgetary allocation released to his zone in the 2014/2015 fiscal year. None too, knew the exact amount which accrues to the zone as revenue from rural water supplies, and only a mere 11% had any idea of the total population which the installed supply facilities in their area of operation are supposed to serve. These features are characteristics of agencies which deliver poor quality services, which face no market discipline/competition, and have poorly motivated managers who are not held accountable for results.

Fourthly, massive failures, frequent breakdowns in the supply system and general under performance of potable water supply schemes were reported in the field. Table 1 provides summary information on the existing schemes, their functional status and other related information in the three rural water zones in the study area. The reality, as shown in Table 1, is that the number of functional water schemes in the study area is very low (14.4%). The state government and the subsidiary water providers allowed many water schemes to go bad. Why is this so? The zonal water engineers attributed the situation to a variety of factors, principally paucity of funds; 'we lack operation and maintenance funds' as a result 'the physical components of the schemes cannot be regularly checked, maintained and repaired' they complained. In addition, many of the schemes are old and experience frequent technical problems. The schemes are also unevenly distributed, with 65.15% (86 out 132) located in 5, central, water deficient LGAs.

Ordinarily with the high number of water supply schemes dotting the landscape of the study communities, one would expect that at least 80% of the residents should have adequate/regular access to safe water supplies, but findings showed that majority of the respondents (83.3%) depend on alternative sources, particularly, private boreholes, water vendors, streams, etc.

Fifthly, the state government and other service providers in the area tend to focus more on project development than on the functioning throughout the entire life cycle of water supply schemes. Findings show that rarely do the government and other providers set aside resources for the operation and maintenance of developed schemes throughout their designed lifetime. Regrettably, users in the study area tend see water supply projects provided by governments as 'dividends of democracy' (free gift/reward from governments which they helped to install) and so object to contributions for the maintenance of the schemes. Without appropriate maintenance, the schemes quickly degrade and collapse.

Finally, the participation of benefiting communities in the rural water supply activities in the study area is so limited in all the zones. For instance, only five communities have active VWCs and the involvement of village water committees (VWCs) (water users) was limited only to the protection of water facilities against vandalization, purchase of fuel for power supply, collection of water and reporting of leakages. The communities are not involved in the planning, design, maintenance, installation, operation, allocation and extension of water service delivery.

THE WAY FORWARD

The current water supply situation in rural communities of Enugu State presents a unique opportunity for the state government and the subsidiary NGOs to rethink their strategies in the rural water service delivery sector. Although, government funded water projects exist in nearly all the rural communities, majority of the projects were found to be non-functional (Table 1). The distribution systems of the few functional ones are not reliable and many rural communities have inadequate on non-water supply systems at all. As a result, most

Table 1. Existing water supply facilities in the sampled communities (Enugu State Water Corporation, 2015).

Rural water supply zones	No. of water schemes developed by the Enugu State Govt.	No. of functional schemes	Proposed population to be served	Actual population being served	No. of-schemes requiring major repairs	No. of water schemes developed by NGOs	No. of schemes that have exceeded its life span (20 years)	No. of schemes with active VWCs
Nsukka zone	56	08 (14.3%)	410,736	57,248	46.	05	08	03
Ngwo zone	48	05 (10.4%)	313,448	31,780	43	03	06	03
Enugu zone	28	06 (21.4%)	212,368	32,680	21	01	04	00
Total	132	19 (14.4%)	924,552	122,196 (13.2%)	110 (83.3%)	09	18	05 (3.79%)

households (86.78%) resort to buying of water for drinking and cooking from vendors or trekking long distance to collect water (of questionable quality). Potable water supply is a major problem in all the study communities. The characteristics that have defined service delivery in the water supply sector in the communities according, to our respondents, are limited access, declining quantities supplied, increase in demand due population growth, and low investments. All these can be traced, in part, to the institutional weaknesses on the part of the supply agencies and to state government's inability to priorities potable water supply in Nigeria.

The rural water supply sector in the state requires urgent structural reform and wholesale restructuring. Consequently, the way forward is for the state government, for the good of the rural dwellers, to have the right political will to confront the obstacles causing decay in the rural water supply sector. Specifically, the state government needs to prioritize the maintenance and rehabilitation of rural water supply facilities in the state.

Rehabilitating and up-grading, existing rural water supply schemes is necessary in other to restore them to the designed capacity, boost operational efficiency and enable the schemes benefit from new and better technologies.

Research and transparency in agency management

Secondly, the state government must prioritize research and transparency in system management in order to improve services. Why, for instance, is many of the schemes non-functional? What happens to internally generated revenue and locally mobilized resources? Are the resources provided by government inadequate, misapplied or embezzled? The state government needs to find correct answers to the problems limiting progress in the rural water supply sector through research. Research will isolate the best options to accelerate growth, cut cost, extend services, and promote cost recovery in the rural water supply sector.

Increased budgetary allocation to the water supply sector

Officials of the state water supply agencies reported that necessary rural water projects and maintenance programs are delayed, postponed or avoided due to low budgetary provisions. This, according to these respondents, creates even larger problems in future and partly explains why we have wide-spread dysfunctional water schemes in many rural communities of the state. A way out of this may be for the state government to increase budgetary allocation to rural water supply sector.

Partner with the private sector

Fourthly, water resource development in the study area should not be left to governments alone, the private sector and users must join hands in financing rural water supply infrastructure. This can be done by tapping or deploying private sector resources towards water resources development. Encouraging private water providers through favorable policies, capacity up-grading and provision of micro-credits at subsidized rates may assist in providing viable and sustainable solutions to water supply inadequacies in the study area.

Employ site specific approaches to solving the problems of water supply schemes

Finally, the problems limiting potable water supplies in the rural communities of Enugu State should be considered on a case-by-case basic across the communities as the problems vary

from one project/community to another. The various cases of breakdowns, abandonments and maintenance backlog will benefit from case-by-case-in-depth analysis, unique insights, and use of project-specific solutions.

Conclusion

When a proper institutional framework for public water supply is not in place, the water service delivery will be problematic. A weak institutional arrangement for water supply often give rise to declining services, leading to inadequate access, poor cost recovery, and maintenance backlog (Foster, 2013). After many years of attempting developing/managing public water sources, majority of the rural population in our study area still have no choice but to drink dirty water from the same streams and shallow wells used by animals and bird, due largely to weak institutional arrangements. Efficient institutional framework is a very critical for long term sustainability of water service provision. Therefore, there is an urgent need for a strong, dedicated commitment on the side of the government for the provision of a framework that can guarantee sustainable water supplies to communities in the study area. The government must draw-up a new set of strategies to halt the decay in the rural water supply sector. The sector requires urgent structural reforms, wholesale restructuring and institutional strengthening for meaningful progress. This is necessary for improved, efficient and effective provision of water services in the area.

CONFLICT OF INTERESTS

The author has not declared any conflicts of interests.

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Full Length Research Paper

Assessing land use and land cover change using the participatory geographical information system (PGIS) approach in Nguruman Sub-catchment, Kajiado north Sub county, kenya

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Approaches that bridge the technology and knowledge gaps between policy makers and local communities towards natural resource management are required. This study employed participatory Geographical Information System (PGIS) to assess and identify drivers of land use and land cover changes in Nguruman Sub-catchment. Data were collected following a focus group discussion (FGDs) during which a resource mapping exercise was also carried out. FDGs consisting of 12 members were used to establish changes that had taken place between 1994 and 2004, and between 2004 and 2014. The ten year interval was purposively chosen in order to cater for temporal sensitivity in resource changes by local communities. The participants listed the land use in their respective villages for the years 1994, 2004 and 2014. The land uses listed included forestland, irrigated and rainfed cropland, woodlands and water bodies. This was later presented graphically on manila papers for the respective years to showcase land use and land cover changes as perceived by the local communities. Using a digital camera, photographs of these maps were then taken. Features that acted as boundaries and were also found within the areas drawn were mapped using Global Positioning System (GPS). These features were used for geo-referencing of the mental maps in order to analyze natural resource changes as perceived by the local communities. Results from the PGIS were further transferred and analyzed by the GIS in order to determine the extent and magnitude of changes, based on the local knowledge. Results indicate that local communities have knowledge about the causes and consequences of land use and land cover changes occurring in their areas. Significant ($p < 0.05$) changes were observed in irrigated cropland areas. The study provides an effective basis to describe and explain the patterns of land use and land cover change including their root causes and consequences based on the community perspective. PGIS is a suitable tool to involve local communities in planning, evaluating, monitoring and managing their own natural resources.

Key words: Land use, community, PGIS, natural resources, Nguruman.

INTRODUCTION

Land use and land cover changes (LULCC) is driven by various bio-physical (for example, temperature, rainfall,

slope, drainage) and socio-economic conditions for example, the growth of population, industrialization, infrastructure and technological growth (Campbell et al., 2000). Understanding the fundamental types of the driving forces and how they interact is one of the basic requirements to identify the most important change directions (Veldkamp and Lambin, 2001).

The complexity of the processes that determine LULCC requires the use of multiple methods of analysis and a critical interpretation of the social data in order to understand the drivers and impacts of spatial and temporal changes. Local knowledge is undoubtedly crucial to understand the human interactions with the environment. Local people are closely connected to the land for survival; hence, they possess the cumulative knowledge of generations, concerning real experiences (Berkes et al., 2000).

The recognition of a local expert knowledge in order to inform and guide into environmentally related decisions is becoming increasingly important (Millenium Ecosystem Assessment, 2005). The local community knowledge is embedded in their ecosystems, to which they can adapt and respond with an ecological feedback. Nevertheless, the acquisition of such an extensive knowledge and experiences affects their view and interpretation of those complex social-ecological systems. But this acquired knowledge is particularly valuable to collect information and guide towards an environmental management. In particular, the application of the local knowledge to a watershed management plan showed to be an essential element for an effective catchment restoration (Palmer et al., 2005).

Additionally, the participation of local communities is crucial in the early planning stages of the watershed management (Bernhardt and Palmer, 2007). The integration of the local people in order to identify their own needs is important because they enable an understanding of the underlying processes that will transform land use change. These include social and cultural, as well as economic and institutional processes, together with the responses of people to land use changes. Therefore, the interpretation of the local dynamics of resources access and use will be easier, providing better information for both policymakers and scientists (Troyer, 2002). Further, this enables planners to formulate policies to minimize the undesirable effects of future land use changes on catchments (Mustafa et al., 2005) and guide into an effective management of the natural resources. In the recent years, the separation between science and local knowledge has decreased, and researchers are attempting to understand the benefits that such an approach may bring to the research, government policy, and environmental and resource management (Briggs, 2005). Historically, modern knowledge systems have been criticized for marginalizing local knowledge either politically, socially or economically (Louis, 2007).

Conventional geographical information systems is currently a very popular mapping tool in geographic research. This system has many capabilities, including advanced geospatial analysis, computer mapping and digital display. It can be used to empower marginalized communities, but could conceivably alienate and isolate members who lack sufficient computer access (Chambers et al., 2004). In addition, GIS may not be compatible with local knowledge (McCall, 2004). It may also be inappropriate because of the cost of the technology, the need for specialized training, concerns over rights of information, access and use as well as the fundamental difficulties in understanding the Cartesian methods of spatial representation (Chambers et al., 2004).

Currently, emerging issues in Land use and management have prompted to the need to include local people in the decision making processes that may influence their lives. This need has brought about the evolution from GIS to the Participatory GIS (PGIS) concept as a tool for the social development and involvement. PGIS integrates participatory methodologies with geo-spatial technologies in order to better represent and empower marginalized communities and provide information to a wider range of people in various fields including: urban planning, landscape ecology, natural resources and conservation biology (Sieber, 2006).

Hence, Participatory GIS is a powerful tool for good governance, and this has led to an increased use of this initiative for the last 20 years throughout the world (IFAD, 2009). It is a useful means for communities to report land related information at present and future needs in order for the government to better understand the community and the environment (McCall, 2004). This exercise facilitates management of land and resources, and supports community advocacy on land related issues (Di Gessa, 2008). In a number of cases worldwide, communities have succeeded the demand for legal recognition resource rights through participatory mapping of land resource (McCall and Minang, 2005).

For instance; in Guyana, Amerindian people succeeded in claiming their ancestral land titles (Griffiths, 2002) as a result of participatory mapping of resources using PGIS). Moreover, the Ogiek, Sengwer and Yaiku indigenous communities in Kenya were able to initiate their own ancestral land and cultural rights, and natural land resource management projects after a participatory resource mapping exercise carried out in 2006 (Muchemi et al., 2009).

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In addition, Baaru and Gachene (2016) used PGIS to empower locals in their natural resource assessment and in identifying the problems faced by the community in Kathekakai - Machakos District, Kenya. Participatory approaches have also been useful in mapping areas that should be preserved (Bojorquez-Tapia et al., 2003; Brown et al., 2004; Kathumo and Gachene, 2012). As observed by Nabwire and Nyabenge (2006) and Kathumo and Gachene (2012), spatial inventories of natural resources, claiming land use rights and perceived problems can be documented through participatory GIS mapping, to enhance equitable and sustainable natural resource management. Sambalino et al. (2015) demonstrated that one of the most important activities for managing human-elephant conflicts is to bring stakeholders into a forum to share information, build collaboration and advocate for new policies.

Ngurman lies at the heart of Maasailand, a vast stretch of land that unfolds across Kenya and Tanzania (Homewood et al., 2009). Its inhabitants are predominantly nomad or semi-nomad Maasai shepherds. However, new groups are entering the area at a growing rate. Between 1962 and 1989, the Maasai population in Kajiado and Narok changed from 78 and 79% to 57 and 47%, respectively (Coast, 2002). This trend has continued until the recent years (Sambalino et al., 2015). Despite being predominately rooted in shepherding, Maasai are also adapting to the shifting context e.g changing from traditional pastroral sytems to agropastoral livelihood, As increased connectivity to the globalized market economy has brought new needs to the community.

Simultaneously, land privatization and fragmentation, recurrent climate shocks, the disintegration of collective natural resources management systems, as well as increasing livestock and human populations, have made natural resources increasingly scarce (Sambalino et al., 2015). Coupled with an influx of people interested in non-pastoral activities, this is causing land fragmentation and the disruption of traditional grazing patterns (Homewood et al., 2009). In Kajiado North County… perennial fresh water sources are rare and vital. The most important surface water body in the target area is the Ewaso N'Giro River. The amount of water flowing in the river has drastically decreased in the last years, mostly due to unregulated abstraction and degradation of the upper catchment coupled with insufficient rainfall (Gichuki and Macharia, 2006). Unfortunately, no ecologically sound plans have been made to sustain this critical area. In March 2015, the Ewaso N'Giro dried before reaching Lake Natron.

Therefore, the purposes of this study were i)to analyze resource changes with the local communities using PGIS; ii) to identify sustainable land use and management strategies to enhance the natural resource preservation; iii) and to identify policy options for a sustainable community management of land resources that can lead to a reduced land degradation and Human-wildlife conflicts.

METHODOLOGY

Land use and land cover change analysis

A combination of two approaches was applied: a consultation of expert knowledge, and opinions using Participatory approaches (PGIS) and focused group discussions (FGDs). To facilitate effective participation by local communities, participants were taken according to the tools to be used for the PGIS exercise. These included Geographical Position System (GPS), manila papers and symbology for the various land use and land cover types agreed upon. The objectives of the project and PGIS were discussed and roles assigned according to the various age groups and all sketching details explained to the participants.

Data were collected using the FGDs, consisting of 12 members. During the groups formation, a resource mapping exercise was also carried out.. Most of the studies on social economic dynamics as well as natural resources management employ FGDs (Odimegwu, 2000). Mapping involved sketching mental LULCC maps for 1994, 2004 and 2014: a period of 20 years divided in two periods with a 10-year interval was considered large enough to detect changes within locals. Mental maps graphically represent and conceptualise Local community perceptions and understanding of the LULCC that have taken place. The maps incorporate their knowledge and experience of their environment, accumulated over the years they have interacted with their environment. Further, Vernooy et al. (2000) observed that participatory mapping represent also graphically the community's perception on how they look at and use their environment.

Key participants involved the elderly, who showcased the land use as it was in their original state and how it changed over the years to the current state. Two PGIS sessions were conducted, in Pakasse and Entasopia sub-locations. Once the maps were drawn, discussions were carried out focusing on the accuracy of the mental maps for Pakasse and Entasopia and modifications were made until there was consensus among the participants. Similar procedures were followed by Aynekulu et al. (2006). The main land uses inserted in the maps included cropland, forestland, bareland, open water, swamps and grasslands and settlements.

Field surveys with representatives of the local groups were conduct to undertake ground truthing exercise in order to georeference the mental maps using GPS. These maps were then digitized using ArcGIS10.2 in order to convert different land use classes as mapped by the locals into either points, lines or polygons to visually display the changes detected. The area covered by each LULCC was calculated using spatial analyst tool in ArcGIS 10.2. this was later subjected to excel to calculate the extent and magnitude of change for the periods 1994-2004, 2004-2014 and overall change from 1994 to 2014.

The comparison of the land use land cover statistics assisted in identifying the percentage change between 1994 and 2014.In achieving this, the first task was to develop a table showing the area under each land use category and the percentage change for each year (1994, 2004 and 2014) measured against each land use land cover type. Percentage change to determine the change in land use was calculated by dividing observed change by the original area multiplied by 100.

Chi-square goodness of fit was used to determine if there were significant changes in land use and land cover (Zar, 1996). Prevailing issues on land and water resources were discussed and suggestions on the strategies for mitigating the negative impacts emerging from land use change was discussed by the various groups.

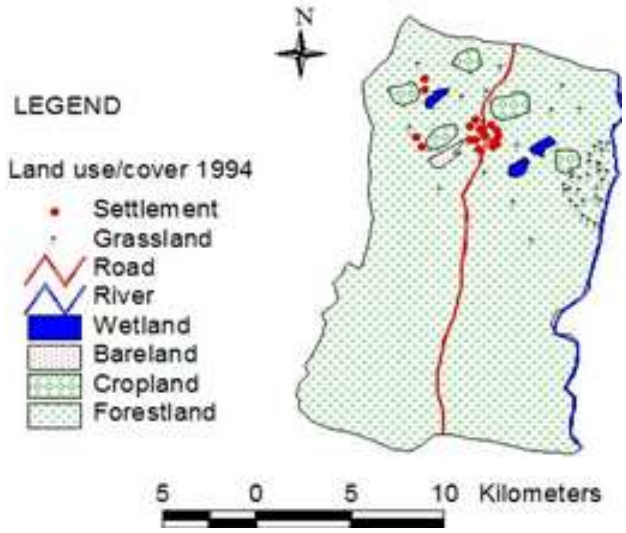

Figure 1. Entasopia land use land cover 1994.

Table 1. Land use and land cover changes in Pakasse between 1994 and 2014.

LULCC category	Area (km^2)			Change (%)		Overall change (%)
	1994	2004	2014	1994-2004	2004-2014	1994-2014
Forestland	28.18	26.96	33.02	-4.32	22.47	17.17
Cropland	15.74	22.14	8.03	40.66	-63.73	-48.98
Grassland	0.28	0.34	5.2	21.42	1429.41	1757.14
Wetland	12.65	3.11	0.27	-75.41	-91.31	-97.86
Settlement	17.65	20.16	13.97	14.22	-30.70	-20.84
Bare land	7.45	9.24	21.46	24.02	132.25	188.05
Conservancy	24.54	24.54	24.54	0	0	0
Total	106.49	106.49	106.49	-	-	-

RESULTS AND DISCUSSION

Trends in Land use and land cover change in Pakasse and Entasopia

Significant land use changes were recorded for all land use categories in Entasopia (Figure 1 and Tables 1 and 2). The area of each land use and land cover category for the three time periods and their percentage changes for both Entasopia and Pakasse were analysed as shown in Tables 1 and 2 and Figures 2 to 6, respectively.

In Pakasse (Table 1) between 1994 and 2001, major changes were observed mainly in cropland and wetland. In the subsequent period, 2004 and 2014 major changes occurred in Grassland, Bareland and wetlands again. While forest cover decreased by 4.3% by 2004 it increased by 22.47% by 2014. The overall change in forest cover for the three time periods was a 17.17 increase. The area under cropland increased by 40.66% in 2004 and decreased by 63.73% in 2014. The overall change in cropland was however a decrease by 48.98%. Areas occupied by grassland and bareland increased throughout the three time periods with an overall increase of 1757.1 and 188.05% respectively. Area occupied by wetland decreased steadily throughout the study period recording an overall reduction of 97.86%.

There was an increase in settlements in 2004 by 14.22% and a reduction of 30.07% by 2014. There was however an overall reduction by 20.84% over the three periods under investigation. Results indicate that cropland increased at the expense of forestland. Similarly as forestland increased cropland reduced. Settlements also showed a similarly trend as cropland that is, settlements increased as croplands increased. This is an indication that irrigated cropping attracted a lot of settlements in Pakasse sub-location and when the irrigation water could not sustain cropping the inhabitants moved out to other potential areas leading to a reduction in settlement area.

In Ethiopia (Table 2), major changes were observed in

Table 2. Land use and land cover changes in Entasopia between 1994 and 2014.

LULCC category	Area (km^2)			Change (%)		Overall change (%)
	1994	2004	2014	1994-2004	2004-2014	1994-2014
Forestland	234.48	198.97	54	-15.14	-72.86	-76.97
Cropland	10.75	25.65	80.7	138.60	214.61	650.69
Grassland	14.22	32.05	47.77	125.38	49.04	235.93
Wetland	4	1.5	0.4	-62.5	-73.33	-90
Settlement	7	12.2	43.5	74.28	256.55	521.42
Mathenge weed	0.59	0.08	38.03	-86.44	47437.5	6345.7
Bare land	0.48	1.07	7.12	122.91	565.42	1383.33
Total	271.52	271.52	271.52	-	-	-

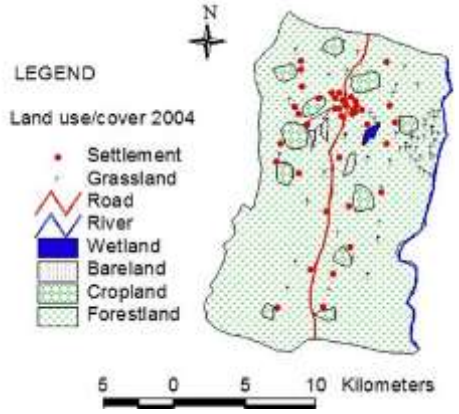

Figure 2. Entasopia land use land cover 2004.

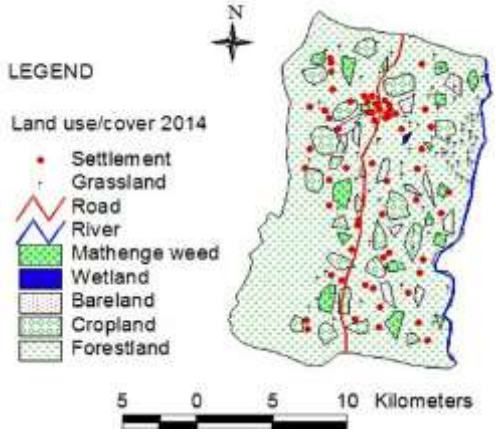

Figure 3. Entasopia land use land cover 2014.

almost all the land use and land cover categories except for Forestland and Wetland and areas covered by the Mathenge bush, *Prosopis juliflora*. In 2004, results showed increases in Cropland, grassland, settlements and bareland by 138.60, 125.38, 74.28 and 122.91, respectively. However in 2014, the same increased by 214.62, 49.05, 256.55 and 565.42 respectively. Areas occupied by Forestland and Wetland decreased in 2004 by 15.14 and 62.5% and in 2014 decreased by 72.86 and 73.33%, respectively. Mathenge bush, *P. juliflora* showed

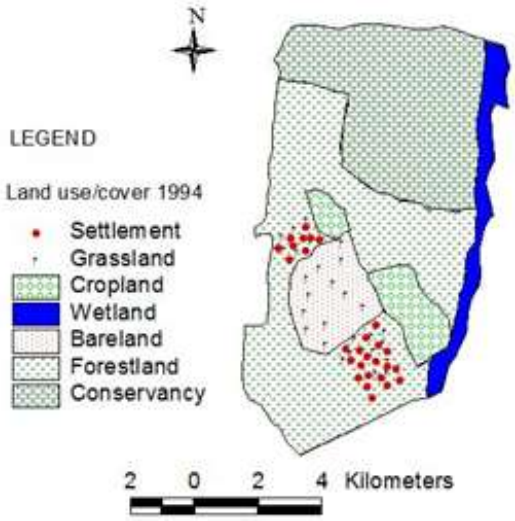

Figure 4. Pakasse land use land cover 1994

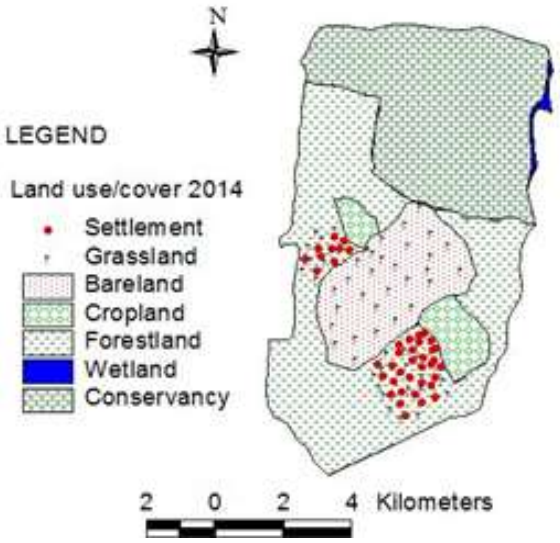

Figure 6. Pakasse land use land cover 2014.

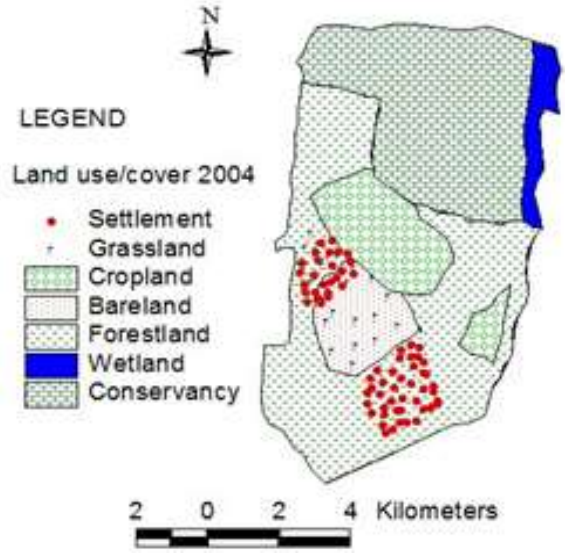

Figure 5. Pakasse land use land cover 2004.

decline in 2004 by 86.44% and in 2014 the area had increased by 565.4%.

To determine whether the observed land use land cover changes were significant, results of chi square goodness of fit test are shown in Tables 3 and 4 for both Entasopia and Pakasse sub-locations. For Pakasse (Table 3) the most significant changes ($p<0.01$) were observed in Forestland, grassland and bareland. The changes in cropland, wetland, and settlement were not significant. Even though wetlands indicated the highest percentage reduction this was not significant. In Entasopia (Table 4) significant changes ($p<0.01$) occurred for all land use and land cover changes except for areas occupied by wetland. Wetlands however showed the highest decline over the three time period with highest expansion recorded for grassland areas.

In the PGIS assisted analysis, the greatest land use change was observed in the conversion of Forestland to Cropland in Entasopia. Results showed that as cropland increased forestland decreased. This implies that there was more land being cleared for cropping. This study is supported by the decreasing trend in volume of wetland was also reported. The reduction in volume of wetland and river flows is attributable to water abstraction from the only source of wetlands for irrigation purposes in water scarce region. The decrease in volume of wetlands could also be attributed to clearing of vegetation. The original vegetation is slowly being overtaken by invasive species which has increase over the years. Mathenge (*P. juliflora*) is a very hardy bush originally from Central America. It was introduced in arid and semi-arid areas of the Horn of Africa in order to control erosion and contrast desertification. This plant has overtaken and replaced the original vegetation. The invasion of most parts of Pakasseby “Mathenge” weed is posing great challenge on the grazing land since 2014. The situation is aggravated by due to movement of herds from Tanzania to Shompole Market. Mathenge has covered almost all the grazing land leaving the people with no place to graze their livestock. The invasion of land by *P. juliflora* is perceived to expand as the crop is drought resistant.

Overall, water shortages are a major challenge in the Landscape, while measures to improve water availability are limited. Throughout the rest of the Landscape, water availability is severely limited, especially during the dry season. There is also tremendous increase of sprinkler irrigation in Entasopia and Nguruman sub-locations funded by African Development Bank under the project

Table 3. Chi-Square goodness of fit test for the various land use and land cover change in Pakasse sub-location.

LULCC category	Area (km^2)			Change (%)	Chi-square test		
	1994	2004	2014	(1994-2014)	χ^2	df	p-value
Forestland	28.18	26.96	33.02	17.17	10.97	2	0.004
Cropland	15.74	22.14	8.03	-48.98	3.58	2	0.167
Grassland	0.28	0.34	5.2	1757.14	891.7	2	0.0001
Wetland	12.65	3.11	0.27	-97.86	1.6968	2	0.428
Settlement	17.65	20.16	13.97	-20.84	5.2674	2	0.0712
Bare land	7.45	9.24	21.46	188.05	76.65	2	0.0001
Conservancy	24.54	24.54	24.54	0	0.019	2	0.990

Table 4. Chi-square goodness of fit test for the various Land use and land cover change in Entasopia sub-location.

LULCC category	Area (km^2)			Change (%)	Chi-square test		
	1994	2004	2014	(1994-2014)	χ^2	df	p-value
Forestland	234.48	198.97	54	-76.97	39.052	2	0.0001
Cropland	10.75	25.65	80.7	650.69	187.96	2	0.0001
Grassland	14.22	32.05	47.77	235.93	86.12	2	0.0001
Wetland	4	1.5	0.4	-90	3.97	2	0.1374
Settlement	7	12.2	43.5	521.42	190.92	2	0.0001
Mathenge weed	0.59	0.08	38.03	6345.76	14099	2	0.0001
Bare land	0.48	1.07	7.12	1383.33	442.79	2	0.0001
Total	**271.52**	**271.52**	**271.52**	-	-	-	-

called Small Holder Horticulture Development Project (SHDP) which started in 2011 and is monitored by the Kenyan Ministry of Agriculture. Irrigation and domestic water for Nguruman sub-location comes from Oloibortoto Stream which drains into River Ewaso Ngiro. This stream also serves the entire Magadi soda company (TATA company). The locals perceive that in the next 10-20 years there will be more water scarcity resulting from increased droughts and water abstraction from the streams. This would also contribute to decline in cropping/farming and forests and increase the extent of bareland due to perceived abandonment of farming that could emerge from water scarcity.

However the trends in various land uses took a different trend in Pakasse Location as shown in. There were fluctuations reported in the extent of land use change with a reduction of forest land in 2004 and increasing by in 2014. These observations coincided with the same period cropland increased in 2004 and reduction in cropland in 2014 followed by increase in forestland. This is a clear indication that that there is a direct link between cropland and forestland. Increased as revealed by the PGIS study. Settlements showed similar trend with cropland, this implies that cropping attracted settlements. However bare land for the whole period of investigation this was similar to observations in Entasopia.

In Pakasse, the change in river courses was a major concern mention by locals especially for lower Pakasse stream and Ewaso Ngiro river. This is due to increased sedimentation carried to the streams that eventually blocks their courses. This has had impacts on the farming community causing them to move towards the upper part of pakasse to continue with irrigation farming using water from pakasse stream. Perhaps this could also explain the reason for fluctuating changes that occurred in forestland , cropland and settlement between 2004 and 2014 since the available supplies of water are not able to sustain irrigation forcing locals at one point to abandon farming leaving land fallow thus increasing the area of bareland and reverting to other livelihood options. This change in livelihood from farming to original pastoral livelihood could have contributed to some level of restoration of forested areas. Private conservancy which was unique land use observed in Pakasse maintained status quo. The latter implies that the type of land ownership has implications on land use change. The overall change observed in both sub-locations Pakasse sublocation clearly indicate a direct link between forestland, cropland, and settlement.

The findings of this study show that underlying drivers of LULCC are specific to a location as was revealed by other similar studies elsewhere (Geist and Lambin 2002; Leper et al., 2004). The key drivers of land use change in

Entasopia and Pakasse fall into two categories mentioned by Framer et al. (2006) namely mega drivers and environmental factors. The mega driver in this case is crop agriculture while environmental factors include prevailing climatic e.g. rainfall and temperature and demographic factors that is, population increase (Tables 5 and 6). These findings are supported by Mbaaru and Gachene (2015). The prevailing climatic conditions have brought about changes in livelihood from pastoralism to agro-pastoralism. Unpredictable climatic conditions certainly have an impact on pasture production and sustainability for pastoral livelihoods. This explains the gradual change from pastoralism to agro-pastoral systems to meet basic livelihood requirements. The change to agro-pastoralism has also contributed to impact of water resources due to the practice of commercial agriculture using irrigation water from the streams and rivers in the already water scarce catchment.

In addition, increased irrigation farming is driven by both climatic factors and economic factors. There is an increasing demand for horticultural crops from the region and these have been identified as key determinants of land use change in the area. In both Entasopia and Pakasse, there has been a huge influx of immigrants mainly aiming at purchasing or leasing land for farming under irrigation. This has subsequently affected land cover especially clearing of forestland for settlement and farming.

PGIS practice as used in this study provided a good opportunity for addressing participatory problems. Compared to other similar studies (Mbau et al., 2013; Aynekulu et al., 2006) the approach can facilitate the bottom transmission of information thus influencing the process of decision making using bottom up approach including gender representation by involving both men and women sketching the mental maps. This application of PGIS attempts to reduce the implementation of imposed solutions that do not represent or reflect public concerns. Wang *et al* 2008 indicated that PGIS is designed to reflect the local peoples spatial knowledge that can be integrated with modern technologies to empower local communities.

CONCLUSION AND RECOMMENDATION

The PGIS study also revealed that the main driver of land use change in the study area is irrigated crop agriculture. This has led to increased pressure on wetland ecosystems due to increased water abstraction for the rivers leading to reduced river flows over the years. Similarly expansion in cropland has led to clearing of more land to support agriculture. This has also contributed to reduction in river flow due to erosion and increased sedimentation.

The methods involved, in this chapter is a clear indication that the locals have good knowledge of changes occurring on their environments. The PGIS and forum discussions revealed that the locals in both Pakasse and Entasopia have observed changes in weather pattern e.g. drastic reduction in rainfall amounts and changing patterns and on the contrary there has been an increase in temperature. PGIS-based approaches provide residents with an opportunity to discuss and map their priority land use issues and to identify land use hotspots in a way that is not typically possible in a general public meeting. The participatory method provides not only the most recent LULC data but also provides data that could be verified by direct observation, and the possibility of meeting the land users, and exploring the nature of LULCC change, and its drivers and consequences. The locals through the PGIS forums recommend that there is need for tree planting campaigns and advocacy on the importance of forests, need for rainwater harvesting technologies including dam constructions to reduce pressure on streams and rivers at large.

Nguruman offers a good example of livelihood diversification within the landscape. There is good potential for livelihood differentiation through agriculture, but its expansion is limited by the amount of water available and by conflicting land uses. Water abstraction is not only for irrigation and domestic use. Magadi Chemicals uses the water from the same stream to support its workers and its industrial processes. The demand will increase in the coming years, which calls for better management of the catchment and especially sustainable use of water resource Locals also perceived that in the next 10-20 years as the population increase grazing and forest land would reduce significantly. Most of the land would be used for settlement due to continuous population increase. Crop production would significantly increase because more people are changing from pastoralism to agro-pastoralism. The current change of livelihood has negative impacts on the natural resource base. This calls for a multi-stake holder forum in formulating sustainable natural resource management strategies in the study area to innovation and social change.

The current PGIS study has promoted community understanding of the implications of resource use changes thus facilitating their participation in strategy setting and ownership of their contribution to environmental degradation. PGIS can be used for enhancing community awareness on the implications of the changing scenarios of land use and land cover and hence facilitates planning. Such knowledge increases local community capacity to participate in implementing strategies proposed. PGIS can be used to campaign for sustainable use of land resources and convince local communities to participate and uptake strategies implemented. It offers communities the opportunity to learn about resource use change, participate in their

Table 5. Land use and land cover change in Entasopia from PGIS maps.

Entasopia land use/cover category	1994	2004	2014	Percent change	Percent change	Percent change	Chi-square Test		
	Area (km^2)	Area (km^2)	Area (km^2)	1994-2004	2004-2014	1994-2014	χ^2	df	p-value
Forestland	234.48	198.97	54	-15.14414875	-72.86023019	-76.9703	39.052	2	0.0001
Cropland	10.75	25.65	80.7	138.6046512	214.619883	650.6977	187.96	2	0.0001
Grassland	14.22	32.05	47.77	125.3867792	49.04836193	235.9353	86.12	2	0.0001
Wetland	4	1.5	0.4	-62.5	-73.33333333	-90	3.97	2	0.1374
Settlement	7	12.2	43.5	74.28571429	256.557377	521.4286	190.92	2	0.0001
Mathenge weed	0.59	0.08	38.03	-86.44067797	47437.5	6345.763	14099	2	0.0001
Bare land	0.48	1.07	7.12	122.9166667	565.4205607	1383.333	442.79	2	0.0001
Total	271.52	271.52	271.52	-	-	-	-	-	-

Table 6. Land use and land cover change in Pakasse from PGIS Maps.

Pakasse Land use/cover category	1994	2004	2014	Percent change	Percent change	Percent change	Chi-square Test		
	Area (km^2)	Area (km^2)	Area (km^2)	1994-2004	(2004-2014)	(1994-2014)	χ^2	df	p-value
Forestland	28.18	26.96	33.02	-4.329311568	22.47774481	17.1753	10.97	2	0.004
Cropland	15.74	22.14	8.03	40.66073698	-63.73080397	-48.9835	3.58	2	0.1667
Grassland	0.28	0.34	5.2	21.42857143	1429.411765	1757.143	891.7	2	0.0001
Wetland	12.65	3.11	0.27	-75.41501976	-91.31832797	-97.8656	1.6968	2	0.428
Settlement	17.65	20.16	13.97	14.22096317	-30.70436508	-20.8499	5.2674	2	0.0718
Bare land	7.45	9.24	21.46	24.02684564	132.2510823	188.0537	76.65	2	0.0001
Conservancy	24.54	24.54	24.54	0	0	0	0.019	2	0.990
Total	106.49	106.49	106.49	-	-	-	-	-	-

conservation and own problems irrespective of their age and level of education.

Participatory resource mapping is an approach that can be adopted by local governments to make access of information and transparency in local governance a reality. Furthermore, the process of making the maps, the questions raised and features chosen to be included on the maps through direct interaction with the community provide vital information that can in incorporated in management of land and water resources.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Full Length Research Paper

Urban renewal strategies in developing nations: A focus on Makoko, Lagos State, Nigeria

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One of the greatest changes that have occurred in the last century in developing countries is the urban growths which have produced more slums in our cities. The study examines the physical conditions in Makoko, an urban slum in Lagos, Nigeria. Geographical information system (GIS) and remote sensing (RS) technologies were used, in a post classification, to model possible land use changes in the area overtime. It also uses questionnaires to elicit information on infrastructural and socio-economic characteristics to determine the factors responsible for the physical conditions of Makoko. Findings revealed that the rate of infrastructural provisions are lacking behind and suffer from overstress and dilapidation The residents lack good environmental sanitation as the lagoon emits a pungent smell. It is recommended that the area is entirely restructured so as to create a habitable abode for sustainable residential living.

Key words: Slum, urban growth, physical condition, environmental sanitation, GIS/RS and Makoko.

INTRODUCTION

One of the most remarkable developments in the world especially since the 1980s is rapid urbanization. Today, according to UNDESA (2015), “fifty-four percent (54%) of the world’s population lives in urban areas, a proportion that is expected to increase to 66% by 2050”. Projections show that urbanization combined with the overall growth of the world’s population could add another 2.5 billion people to urban populations by 2050, with close to 90% of the increase concentrated in Asia and Africa (UNDESA, 2015).

Towns and cities in developing countries have been expanding rapidly, and the total number of urban dwellers in the region is now roughly doubling every ten years (Otoo, 1982). Urbanization in Nigeria is characterized of economic growth without development. According to George (2002), “an average of 6,000 people move to Lagos everyday and the United Nation has estimated that the city of Lagos will swell to 25 million by 2016”. The consequence of this is unabated gross degradation and decay of all the constituent fabrics of the city.

Makoko is an integral part of the Lagos community in terms of its population, and its importance to the economy of Lagos state, Nigeria. Makoko is one of the many water and shoreline settlements. Their economic activity includes salt making, sand dredging, sawmills, firewood, and fishing. According to Habitat (2007), Makoko is one of the 43 large blighted slums identified in Lagos, and has been classified as one of the 9 largest

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slums in the city. Makoko is characterized by adverse environmental conditions otherwise known as urban slum. The total area of space covered by this settlement cannot be easily estimated as residents continue to build and encroach on the water body as population increases.

According to Kilani (2012), Makoko, “village in the city” shows a community long abandoned by government, and with inadequate basic social amenities. The residents lack sufficient sanitation – ‘communal latrines are shared by about 15 households and wastewater, excreta, kitchen waste and polythene bags go straight into the water’, the oily black water is no longer suitable for fishing; it emits a pungent smell, and a thick layer of white scum gathers around the shack stilts, when it rains, conditions turn particularly nasty (Udoma, 2013).

Despite the poor environmental conditions found in the settlement, Makoko continues to grow in both population size and physical boundary. More housing units can be seen sprawling into the Lagoon and road side. The aim of this study, therefore, is to examine the urban renewal activities and their effectiveness in Makoko with a view to modeling possible changes overtime, using remote sensing (RS) and Geographic Information System (GIS) techniques.

LITERATURE REVIEW

Urban renewal started as the concept of urban re-development. According to Buissink (1985), the concept has an America origin in the Housing Act of 1949, and was originally designed to clear, and restructure land use in the inner city which have developed into slums, and to develop in their place, a comprehensive programme of new residential and nonresidential development.

In America, urban renewal refers to the redevelopment and/ or rehabitation of older parts of towns and cities. In Britain, urban renewal is highly associated with the desire for housing upgrading and reform, especially in the interest of the urban poor (Onokerhoraye and Omuta, 1994). Urban renewal according to Roberts (2000) “is a normative concept and rooted in British urban policy. It leads to the resolution of urban problems and seeks to bring about a lasting improvement in the economic, physical, social and environmental conditions of an area that has been subjected to change”. Although the main aim is to eliminate substandard and inadequate housing, urban renewal has become a catch-all for other strategies such as the revitalization of downtown, promotion of University or hospital centres, industrial redevelopment and the creation of new-towns-town (Zuckerman, 1991). In summary, urban renewal aims at improving the physical, social-economic and ecological aspects of urban areas through various actions including redevelopment, rehabilitation, and heritage preservation.

Urban renewal is often presented as a natural process through which the urban environment viewed as a living entity undergoes transformation. Miller and Marshall (1995) pointed out that "as the years pass, transformations take place, allowing the city to constantly rejuvenate itself in a natural and organic way". He further stated that ‘the purpose of urban renewal is to deliberately change the urban environment and to inject new vitality through planned adjustment of existing areas to respond to present and future requirements for urban living and working.

Urban renewal involves the relocation of businesses, the demolition of structures, the relocation of people, and the use of eminent domain (government purchase of property for public purpose) as a legal instrument to take private property for city-initiated development projects (Chigbu,2012). Urban renewal has been seen by proponents as an economic engine and a reform mechanism and by critics as a mechanism for control. It may enhance existing communities, and in some cases result in the demolition of neighborhoods. Many cities link the revitalization of the central business district and gentrification of residential neighborhoods to earlier urban renewal programs. Over time, urban renewal evolved into a policy based less on destruction and more on renovation and investment, and today is an integral part of many local governments, often combined with small and big business incentives (Lobbia, 1999).

According to Gbadegesin and Aluko (2010), Urban renewal involves overhaul the congestion in the city centres. It comprises a number of strategies which include: filtration; social planning; the boot-strap strategy; replacement; and guiding urban growth through investment and conservation and heritage preservation.

Therefore, the main objectives of urban renewal are: re-structuring and re-planning of concerned urban areas; designing more effective and environmentally-friendly local transport and road networks within the concerned urban areas; promoting the timely maintenance and rehabilitation of buildings in need of repair; preserving buildings, sites and structures of historical, cultural or architectural value; providing purpose-built housing for groups with special needs, such as the elderly and the disabled; and providing more open space and community/welfare facilities among others (URS 2011).
Figure 1 shows the concept of urban regeneration as depicted by Couch and Fraser (2003). Couch and Fraser (2003) explained that “urban regeneration is concerned with the re-growth of economic activity where it has been lost; the restoration of social function where there has been dysfunction, or social inclusion where there has been exclusion; and the restoration of environmental quality or ecological balance where it has been lost". This approach goes well beyond efforts to put vacant land and buildings to new use.

Urban regeneration is about implementing policies in existing urban areas rather than developing new

Figure 1. The concept of urban regeneration (Source: Adapted from Couch and Fraser, 2003).

urbanization. It aims to build upon the triangle of sustainability, with its commitment to economic, social and environmental problems and developments. Urban renewal is used to describe actions on a quarter-level that address neighborhoods and housing estates as a reaction on deprivation, regeneration addresses inner city areas, areas facing imbalance and decline as well as rural areas.

Roberts (2000) illustrates that "the history of urban problems and opportunities shows five continuous and enduring themes, that represent the nature of urban change plus a new one" These themes are:

(1) The relationship between physical conditions and social response
(2) The continued need for the physical replacement of many elements of the urban fabric
(3) The importance of economic success as a foundation for urban prosperity and quality of life
(4) The need to make the best possible use of urban land and to avoid unnecessary sprawl; and
(5) The importance of recognizing that urban policy mirrors the dominant social conventions and political forces of the day; plus the new theme of sustainable development.

MATERIALS AND METHODS

Research locale

Lagos State lies between longitude 3°21'24"E and latitude 6°35'8"N. It is located at the South-Western of Nigeria (Figure 2). Lagos State consists of twenty local governments. Ikeja currently serves as an administrative seat of the State and of a local government (Figure 3).

The study area is Makoko, located in Lagos Mainland Local Government Area of Lagos State. Makoko is one of the many water and shoreline settlements in Lagos State. Is geographically located within Longitude 3°23'31.085"E, Latitude 6°30'9.154"N; and Longitude 3°22'57.467"E, Latitude 6°29'28.887"N. Figure 4 shows the location of Makoko within the Lagos Mainland Local Government.

Makoko is a shanty settlement located in the centre of Lagos city, along the banks of the Lagos lagoon. It was established in the 18th century as a fishing village (Udoma, 2013). Makoko lies within the south-eastern part of Lagos metropolis. It is bounded on the North by Iwaya and University of Lagos; at the West, by Ebute-Meta; South, by the Third Mainland Bridge; and East by the Lagos lagoon (Udoma, 2013). The vegetation is majorly wild swamp trees. The community is dominated by the Ilajes and Eguns; there are also Yorubas with few Igbos and other ethnic groups (Oduwaye and Lawanson, 2010).

The population of Makoko according to the Baale (chief of the village) is estimated to be 400,000 people. The area was not officially counted as part of the 2006 census, because the settlement is considered non- existent and illegal. The World Bank estimates that the population on land is just over 85,840 with each dwelling unit usually housing between six to ten people and a high percentage are rental properties (Udoma, 2013).

The houses on water are built from hardwood, supported by wood stilts driven deep into the waterbed. Each house usually houses between six to ten people. The water is five feet deep. Water meanders through the water settlement like streets in between houses, which act as a road system, with canoes as means of transportation. Canoes are used for fishing and act as points of sale; where women sell food, water and household goods.

The main economic activities are salt making, sand dredging, sawmills, firewood, and fishing. Plate 1 and Figure 5 show the aerial photograph and digitized building map of Makoko respectively.

Data base

Data was collected through structured questionnaire which was administered on household heads in Makoko community. The questionnaire contained close-ended questions with pre-coded alternatives meant to ascertain: the socio-economic characteristics of respondents; building and environmental condition in the community; as well as sustainable residential living. The authors administered the questionnaires through face-to-face contact with residents of the community in March 2016.

A total of 205 respondents were randomly selected for interview representing 5% of the total number of people due to homogeneity characterizing the population. Other relevant data were gathered from texts, seminars, reports, internet and observation made at the study site in terms of nature of the environment, transportation and general living condition in the study area. Aerial photograph and Google-Earth imagery of the study site was acquired and digitized to produce the composite map of Makoko which was used for further analysis using the Geographic Information System (GIS) technology. Photographs of scenic sites were captured and presented. Data from questionnaire administration was processed by computer using Statistical Package for Social Sciences (SPSS). Univariate analysis of data was utilized for easy description of the phenomenon investigated.

RESULTS AND DISCUSSION

Socio-economic characteristics of residents

The socio-economic characteristics of the people show

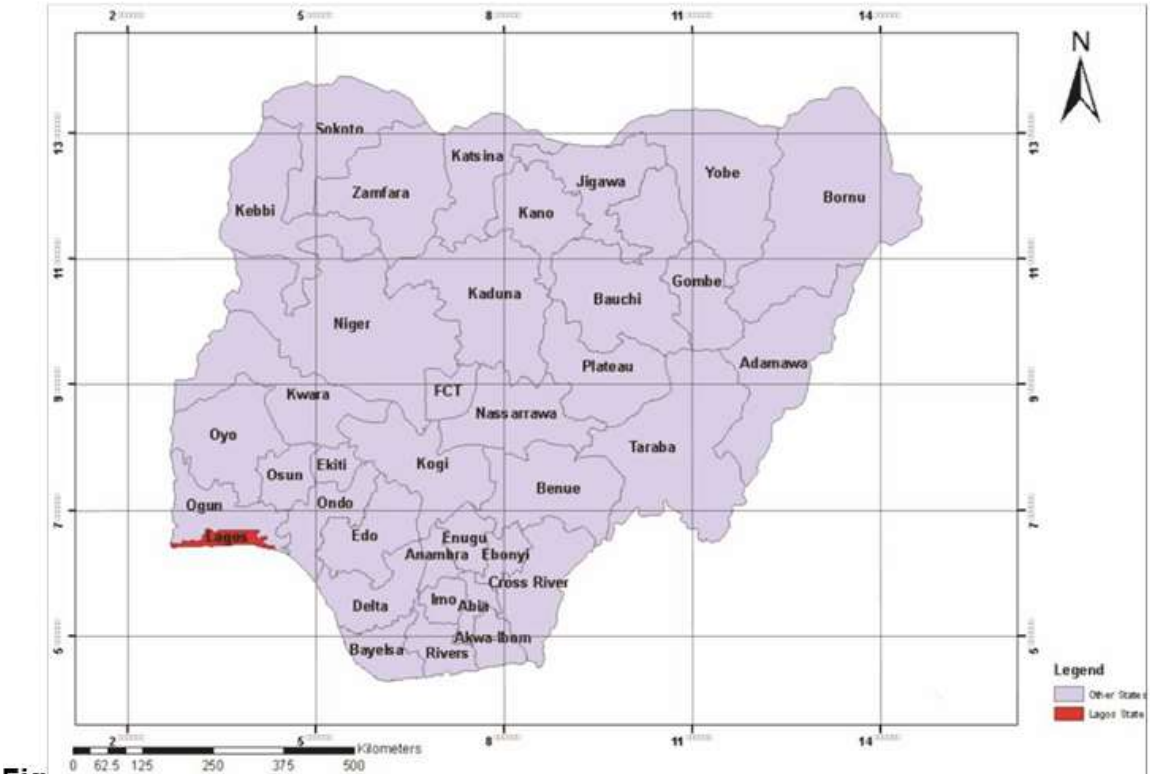

Figure 2. Map of Nigeria showing Lagos State (Source: Google Satellite Imagery, digitized by Authors using ArcGIS (2016).

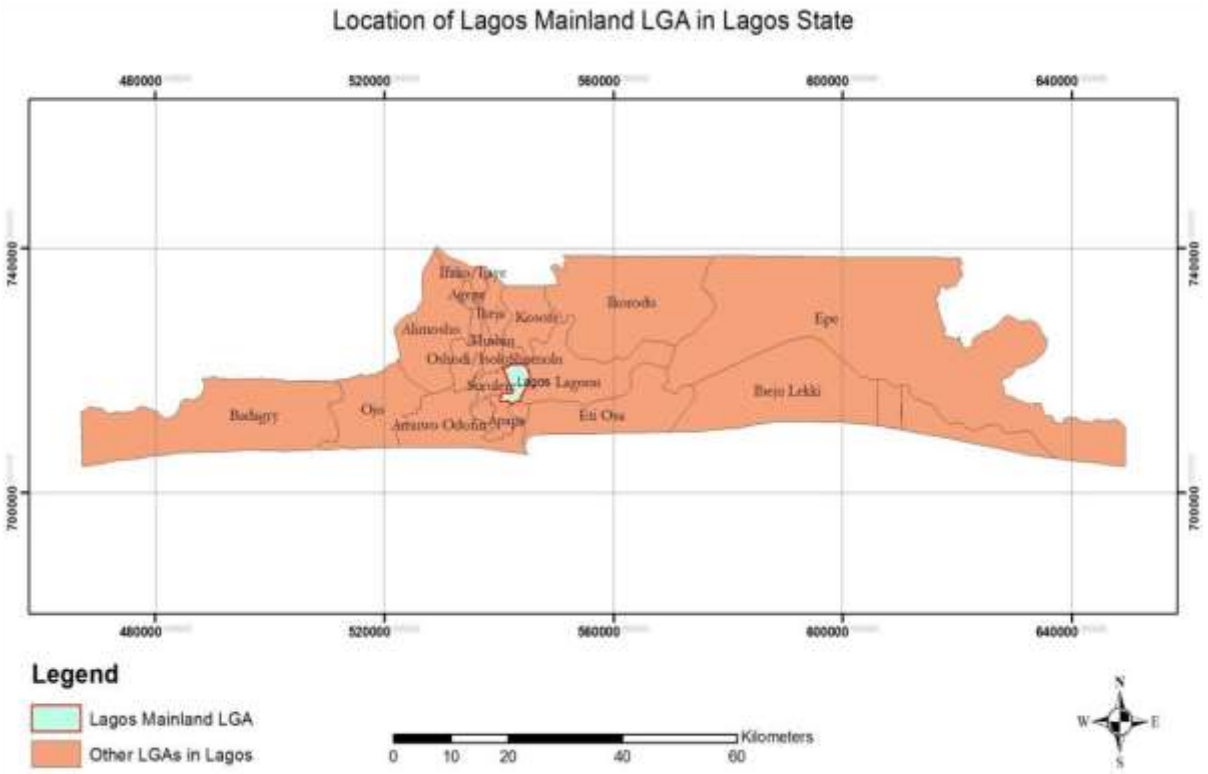

Figure 3. Location of Lagos Mainland LGA within Lagos State (Source: Adapted from: Kelani, 2012).

Figure 4. Map of Lagos showing Makoko and the Lagos Lagoon (Source: Daily mail, 2016).

Plate 1. An aerial photograph of Makoko (Source: Authors' fieldwork, 2016).

that about 73.7% of Makoko residents were females while 26.3% were males. The modal age of respondents falls between 46 and 55 years, which constitutes about 49.0% of the population. The median age is between 25 and 35 years, representing approximately 25.0% of the respondents.

The age grade comprises mostly the educated but employed people who have lived in the area for more than 10 years, and were able to give required information on the subject matter based on experience. There is high proportion of married people as over 77% of respondents are married as against 21% that are not

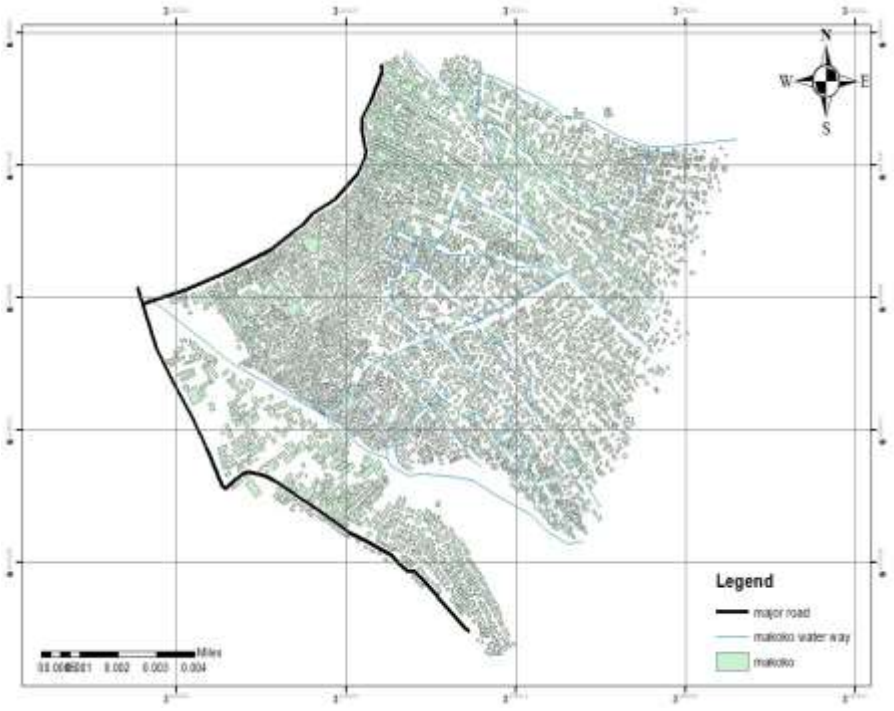

Figure 5. Digitized building map of Makoko (Source: Authors' fieldwork, 2016).

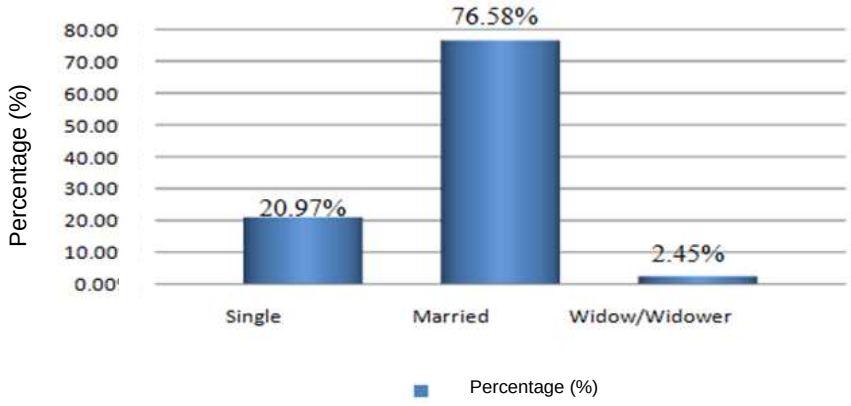

Figure 6. Marital status of respondents (Source: Authors' fieldwork, 2016).

married, while the remaining 2.0% are widowed (Figure 6).

This explains the high population of children in Makoko with average household size of 8 which is higher than the estimated National average number of household (7) as reported by Fasakin (2000) and Olajuyigbe (2008) in similar studies. The settlement is however dominated by tenants who constitute about 58.0% of respondents while the remaining 42.0% are landlords. The implication of this is that most residents in Makoko are poor, illegal migrants (seeking greener pastures) who could not afford the high cost of accommodation in Lagos mainland, hence sought alternative and cheaper accommodation in Makoko.

Table 1 shows the occupation of respondents in Makoko. From the table, it is evident that majority of respondents are fishermen, traders and artisans. Only about 10.7 and 6.3% are civil servants, and in allied professions respectively. This implies that Makoko residents are majorly peasant farmers and traders with low income. Plate 2 shows traders displaying their wares in canoes on water.

Table 1. Occupation of respondents.

Occupation	Frequency	Percentage (%)
Fisherman	47	23.0
Trader	69	33.7
Civil servant	22	10.7
Artisans	54	26.3
Others	13	6.3
Total	205	100.00

Source: Authors' fieldwork (2016).

Plate 2. Trading activities on water at Makoko (Source: Authors' fieldwork, 2016).

Of the type of materials used in building construction coupled with the age of the buildings, over 75.0% of building walls are in poor condition, while a paltry 12.20% and 11.71% were adjudges good and fair respectively (Plate 4). However, most buildings in Makoko enjoyed good roofing materials such as aluminum (65.37%); corrugated iron sheet (22.93%); and asbestos (11.70%). No building with thatched roof.

Housing condition in Makoko

From Table 2, analysis on age of buildings shows that over 75.0% of respondents affirmed that buildings in Makoko have existed for more than 20 years. A meager 9.76% of them were between 1 to 10 years old. This shows that slum condition had persisted for over two decades in the area. The building types were mostly Wings and the Brazilian (face-to-face) category. Bungalows and duplexes constituted about 1.0 and 5.0%, respectively. The materials of construction were chiefly wood (64.88%), sandcrete block (32.68%), and corrugated iron sheet (2.44%) (Plate 3).

Environmental condition in Makoko

Apart from the application of GIS to analyze the environmental situation in Makoko, other variables such as the toilet system, refuse disposal method, location of kitchen and the drainage system were examined. First, over 70.0% of respondents defecate directly into open Lagoon, while the others made use of pit latrines. This trend was responsible for dirty and stinking environment in the area. Plate 5 shows the location and condition of a typical toilet system in Makoko.

The refuse disposal method is another environmental concern in Makoko. Over 80.0% of respondents affirmed the use of refuse dump to dispose solid waste (Plate 6). Observation shows that the residents dump their waste directly into the Lagoon as they use this to reclaim land portions from it. The implication of this is flooding hazard during raining season.

Social amenities in Makoko

The social and public amenities in the study area is in a

Table 2. Housing condition in Makoko (N=205).

Variable	Frequency	Percentage (%)
Age (in years)		
1-10	20	9.76
11-20	31	15.12
21-30	45	21.95
31-40	84	40.97
41 years and above	25	12.20
Types of building		
Bungalow	2	0.98
Duplex	11	5.37
Wing	89	43.41
Brazilian type	48	23.41
others	55	26.83
Materials of building construction		
Wood	133	64.88
Block	67	32.68
Corrugated sheet	5	2.44
Walling condition		
Good	25	12.20
Fair	24	11.71
Poor	68	33.17
Very poor	88	42.92
Roofing materials		
Aluminum sheet	134	65.37
Corrugated iron sheet	47	22.93
Asbestos	24	11.70
Thatched	0	0.00

Source: Authors' fieldwork (2016).

Plate 3. Building wall materials in Makoko (Source: Authors' fieldwork, 2016).

Plate 4. A typical building wall condition in Makoko (Source: Authors' fieldwork, 2016).

Plate 5. A typical toilet system in Makoko.

Plate 6. A typical refuse dump in Appolo Street, Makoko (Source: Authors' fieldwork, 2016; Date of plate: 2/7/2016).

Plate 7. Women and children in search of drinking water (Source: Authors' fieldwork, 2016).

state of pity as the available drainage have been blocked by refuse; public electricity distribution is in a condemnable state as residents prefer other means of generating electricity for themselves. Generator sets are mostly used and this adds to the smell exuding from the water body due to large deposit of waste. The source of water coupled with its distance for the residents living on water is strenuous as residents who don't have water for consumption during the night would wait till its morning to get water.

Plates 7 and 8 show the search for water and state of water facility in Makoko. There is no public health facility in this settlement as majority of the facilities are privately owned and not well equipped. There is a missionary public primary school, other primary schools are privately owned. There is no secondary or tertiary institution in the study area. The settlement is generally susceptible to flooding during heavy downpour of rain causing the ground to be soggy and waterlogged. Also, during the raining season, there is always an occurrence of sea level rise causing water to rise above its normal level thereby affecting commuters who walk on the wood bridges made to connect houses.

GIS analysis

The acquired Google-earth imagery of Makoko was processed in the GIS environment using the ArcView software. The overlay operation was performed on two map data sets, namely: buildings and pollution maps. The pollution map is as shown in Figure 7, while the overlay of the pollution map and the building map is as depicted in Figure 8. From Figure 7, the GIS analysis shows that about 16.7% of Makoko was fairly polluted; 33.3% highly polluted; while about 50.0% was very polluted. Generally, all the buildings are located in polluted areas (Figure 8) but the majority is located in highly polluted areas. The highly polluted area is characterized by offensive and pungent smell due to poor waste disposal practices (Figure 7 and 8). Observation shows that the rate of pollution reduces as one goes farther into the Lagoon. This shows that pollution of the Lagoon water was from the land. This can also be explained on the premise that the Lagoon cleanses itself by pushing the pollutants to the shore.

CONCLUSION AND RECOMMENDATION

Urban Renewal Strategies in developing nations spans through rehabilitation, redevelopment and total clearance. The situation in Makoko calls for partly rehabilitation and partly total clearance depending on the level of decadence from street to street as depicted in this paper.

However, this study has been able to establish that majority of the residents in Makoko are immigrants who are seeking for greener pastures. Many of them live in make-shift building on water. They dump wastes in nearby bushes, lagoon and drainages which make the environment repugnant. They are poor with majority of them being peasant traders, fishermen and artisans with low level of education and income. The housing condition is poor, built mainly with wood and without toilet facilities.

GIS analysis shows that every household in Makoko suffers pollution of both land and water due to indiscriminate dumping of refuse and open defecation. A meager 16.7% of Makoko area is fairly polluted; 33.3%, highly polluted; while about 50.0% was much polluted. The highly polluted area is characterized by offensive

Plate 8. A dilapidated borehole tank (Source: Authors' fieldwork, 2016).

Plate 9. Children on queue for water (Source: Authors' fieldwork, 2016).

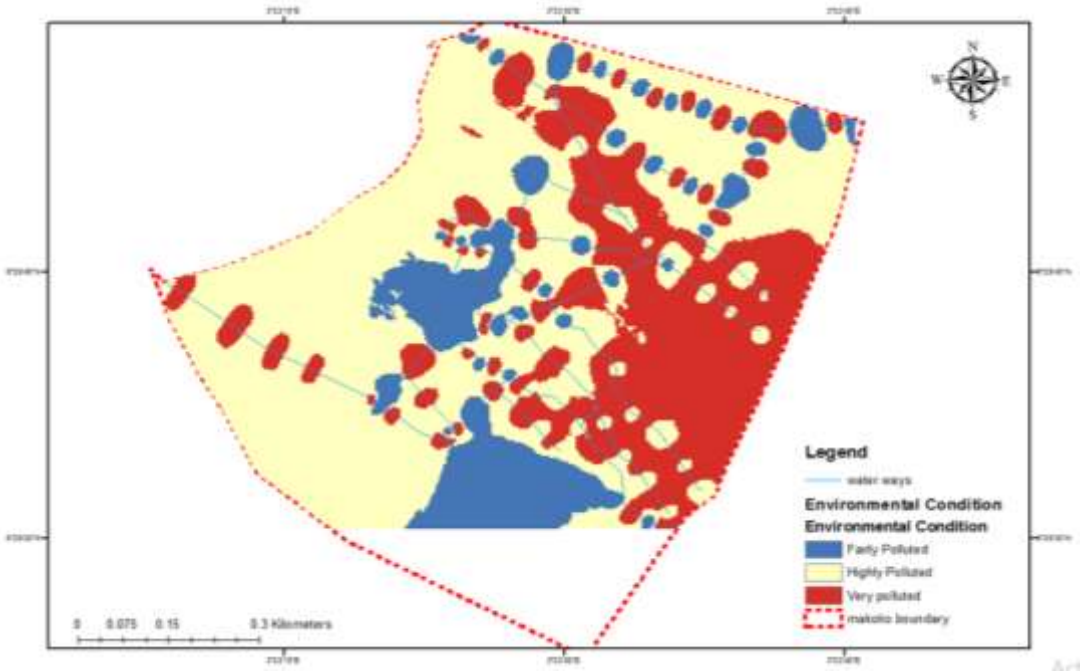

Figure 7. Pollution Map of Makoko (Source: Authors' fieldwork, 2016).

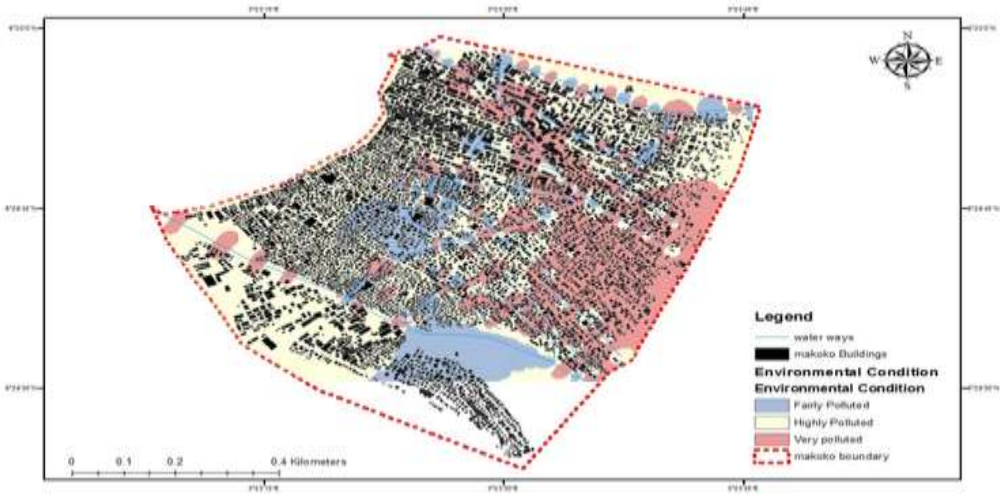

Figure 8. Overlay pollution map of Makoko (Source: Authors' fieldwork, 2016).

and pungent smell due to poor waste disposal practices.

In order to eliminate substandard condition in Makoko and get rid of dilapidated and derelict buildings, the redevelopment and rehabilitation option of urban renewal strategy is canvassed. This would help to create new housing opportunities; redevelop vacant, deteriorated and underutilized properties; improve public safety/community facilities and enhance the general aesthetics and image of Makoko.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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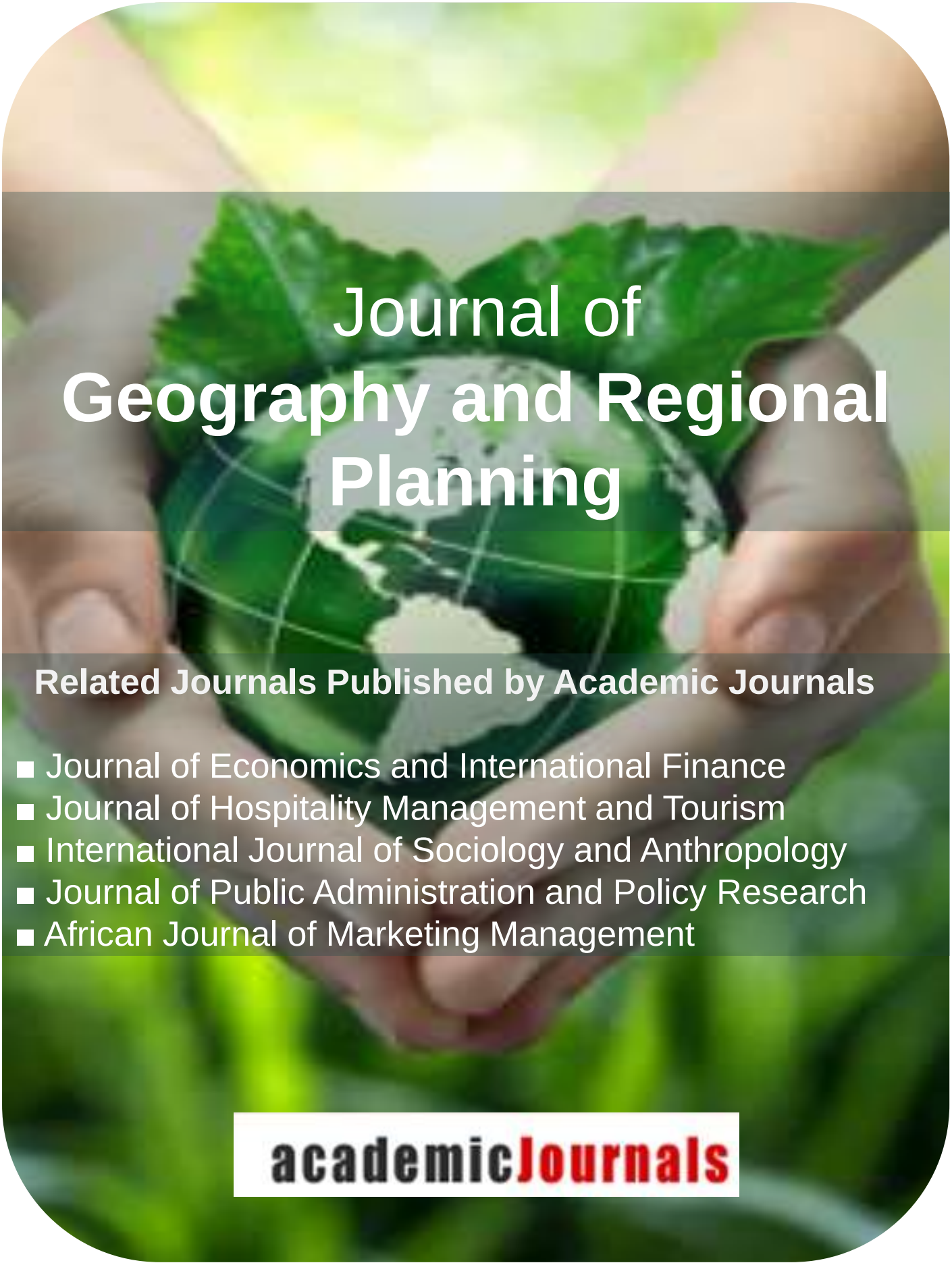

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