

Full Length Research Paper

Impact of land use activities on Subin and Aboabo Rivers in Kumasi Metropolis

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Accepted 13 July, 2012

Water resources have come under a lot of threat in recent years from human activities especially in the urban environment as their protection seem to be neglected not only by the populace but also the responsible institutions as well. Within this context, study seeks to address the issues of compatibility of land uses with water bodies. Sample size of 90 activity units selected at 90% confidence level and a margin of error 0.1 was used for data collection. It was found that common threats emanate from land use activities carried out along the buffer zones of these vital resources. The study identifies the various factors such as land, land users and their desires that influence land use activities along water bodies and makes recommendations such as the adoption of buffer zone policy towards land use management along water bodies in an urban area in the case of Subin and Aboabo Rivers in the Kumasi Metropolitan Area. The study reveals that there has been a massive encroachment of the buffer zones of the Subin and the Aboabo Rivers leaving patches of vegetative cover thereby exposing the river bodies to direct sunshine. In addition, activities located along these rivers are as a result of proximity to market, cheaper lands, availability of water, and closer to work place. According to the 1963 Town Planning Scheme, all land close to the main streams should be green belt zone. These natural flood plains of streams, no buildings were supposed to be erected on them. With increase in population and urbanisation however, these green belts have been encroached upon. Therefore, creating community awareness of the need to protect water bodies, enforcement of water protection related laws and institutional strengthening are imperative.

Key words: Rivers bodies, land use change, water resource management.

INTRODUCTION

The extent and manner of co-existence between humanity and the water bodies in settlements has tended to be problematic in this era of modernisation and rapid urbanization especially in developing countries. Poor water resource management in the towns and cities is the primary contributory factor. Human beings have mismanaged their environment to such an extent that their actions and inactions have upset the ecological balance and exhausted the vital aspects of water as a resource by undermining its quality and quantity. The human impact is a result of the population growth, rapid physical development and incompatible land use

activities. Added to that resource for the conduct of widespread information and awareness programmes has been rather inadequate (Mtisi and Nicol, 2003). Currently, water bodies with little or no life are common all over the world.

A typical issue that has been of concern is human activities and land use appropriation that takes place along water bodies in growing towns and cities in developing nations. Significantly, water bodies are altered by both direct and indirect land uses which include agriculture, commerce, industry and residential structural constructions. There are also incidental impacts on water bodies from other human activities such as direct solid and liquid waste deposition, sand winning and bad farming practices involving indiscriminate waste disposal and chemical fertilizer use in agriculture (Meissner,

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2002).

The land use pattern of any particular locality is the outcome of natural and socio-economic factors. Necessarily, land use change must be a central component in current strategies for managing natural resources and monitoring environmental changes. Information on land use and possibilities for their optimal utilisation is essential for the selection, planning and implementation of land use schemes to meet the increasing demands for basic human needs and welfare.

In order to use river optimally, it is not only necessary to have the information on existing land uses but also the capability to monitor the dynamics of land use resulting out of both changing demands of increasing population and forces of nature acting to shape the landscape. It is against this background that, this paper has sought to assess the extent and impact of land use activities on Subin and Aboabo Rivers on their survival. The purpose of this paper is to examine nature of land use activities along water bodies in the Subin and Aboabo Rivers in the Kumasi Metropolitan Area and the attendant issues and implications that emanate. Strategic proposals to protect the water bodies for sustained access and utilization have subsequently been made.

Water resource management and land use issues

Water is inevitable for human existence and as such of prime importance to every government and the international community. The ultimate implication boils down to the proper management of water resources. Water resource management, in general, has a correlation with the land use and activities allotted to their immediate embankments. Many of rivers are at risk of losing their naturalness due to human activities leaving city dwellers with no or limited access to safe drinking water. This is attributable to the kind of land use and activities that are carried out along these water bodies. A related issue is the ever increasing drying up or reduction in water levels in rivers and their tributaries. There are various human activities impacting on water quality, these includes run-off from roads and pavements, mine source discharges, changed land use, intensified agricultural activities and poor urban storm water delivery. The quality of these water bodies becomes increasingly at risk as development of natural areas continue and forested lands are converted to commercial and residential parcels. As these and other land use changes continue to take place, the associated pollution impacts on lakes, streams and rivers increase.

Land use activities along water bodies have been a particular issue facing many governments in the world. This is because the activities tend to have a negative effect on such water bodies. The difficulty in making land use decisions arises from going through the process of evaluating each piece of land and deciding which of the

several competition uses to assign it. When land use decisions are made, the decision process involves the public, private landowners, developers, government and other interest groups. Each interest has special needs and tends to argue that its desires are most important.

Patterns and relationships of land use have a significant influence on the vitality, character and quality of a community. As cities continue to grow, they consume resources and evolve through development and redevelopment of land. Improper or conflicting patterns of land use activity can have long-range impact on the value of land, buildings and other improvements, and can place stress on water bodies. Amidst rapid rate of population growth and urbanization, the demand for land for various uses has become many and varied. With this, comes an increasing complexity of issues concerned with urban land use planning, coordination and control. Such complexities call for a more holistic and comprehensive approach to urban spatial development planning and control to ensure coordinated and harmonious development of our urban settlements so as to create environments that are health promoting, aesthetically pleasing, and yielding to economic efficiency of urban systems. According to Long et al. (2008), urban landscapes are represented by the large concentration of population, and fast expansion of urban zones which lead to alteration in the land use and land cover configuration that consequently impacts the landscape environment.

As rural settlements grow and become urban centres, and urban centres do so and become large Municipal areas, there is always increased competition in the demand for land for different purposes. This requires adequate planning and control in these settlements to ensure harmonious development and functional efficiency. To achieve this fundamental activity, layouts of various land uses such as residential, commercial, industrial, open spaces and recreation, circulation and institutional uses among others are undertaken to standardise and control physical developments and ensure harmonious growth (Aribigbola, 2008). Land use has also been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type" (FAO/UNEP, 1999, 1997).

Barlowe (1986), in considering the use to which a land can be put, grouped the factors that affect land uses into three frameworks. Lands situated at various locations can be put to different uses by different categories of users according to their desires, hence the need to use zoning regulation and procedures to control and direct land use practices in the public interest. A careful observation of a city will reveal its subdivision within which the land uses are similar or functionally related. Hence all uses tend to be most advantageously located with respect to linked activities, creating neighborhoods of similar and interrelated land uses. Irrespective of the fact that land can be put to different uses, a clear distinction of the various categories of land use is often complicated by the

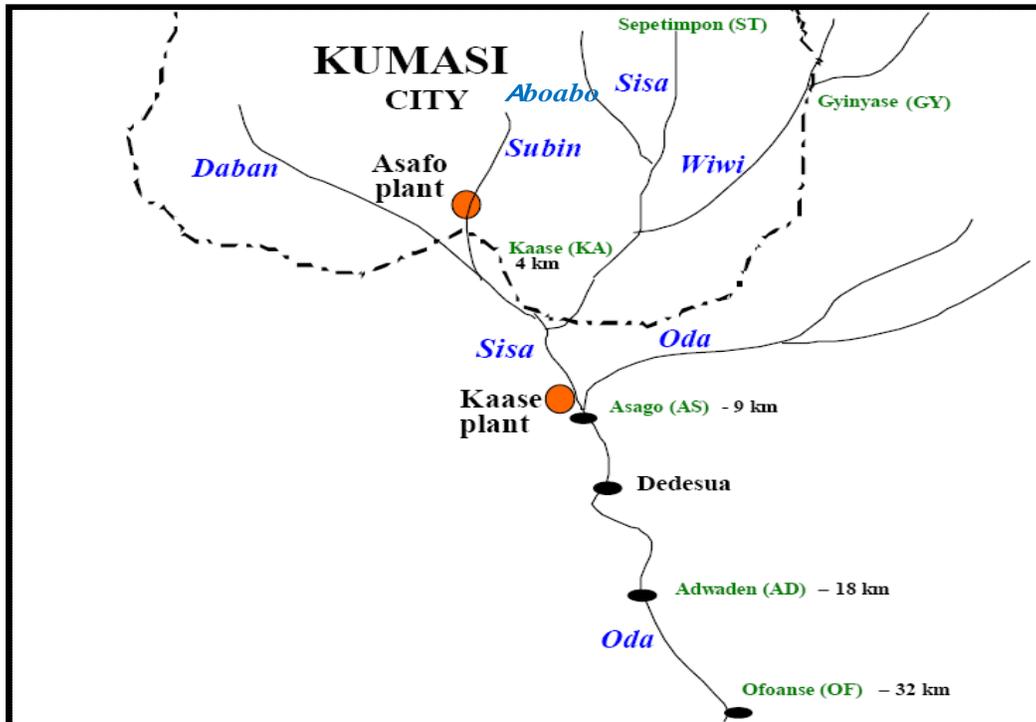


Figure 1. Map Showing Subin and Aboabo rivers in Kunasi, Ghana. Source: Friends of Rivers and Water Bodies (2008).

complementary nature of most types of land uses. This is as a result of combination of uses to be found in close proximity to each other.

It has been recognized that the quality of receiving waters is affected by human activities in a watershed via point sources, such as wastewater treatment facilities, and non-point sources, such as runoff from urban area and farm land (Wang, 2006). Although researchers have paid particular attention to the effect of land use on water quality, water-quality component often is missing in land-use plans. Land-use planning is rarely used in water-quality management (Wang, 2006). Land use development patterns (also called urban form, built environment, community design, spatial development, and urban geography) refers human use of the earth's surface, including the location, type and design of infrastructure such as roads and buildings. Land use patterns can have diverse economic, social and environmental impacts: some require less impervious surface (buildings and pavement) per capita and so preserve more (Litman, 2011).

Rivers and streams provide a great deal of benefits for people. Geographers and historians agree that a country's or region's livelihood, prosperity, and strength are directly related to their river systems. It would be difficult to imagine Europe without the Rhine or the Central United States without the Mississippi. Life would surely be different. People have modified their rivers and streams to gain even more benefits, but these benefits

have not come without costs.

The study area

Kumasi is the second largest and fastest growing city in Ghana, with a population growth rate of 5.47% and an estimated population of about two million (Obiri-Danso et al., 2005). This city is located in the transitional forest zone and is about 270 km north of the national capital, Accra. It is between latitude 6.35° to 6.40° and longitude 1.30° to 1.35°, an elevation which ranges between 250 to 300 m above sea level with an area of about 254 km². The Kumasi Metropolis lies within the plateau of the South-West physical region which ranges from 250 to 300 m above sea level. It is drained by a relatively dense network of streams. Its natural drainage runs generally from north to south, and some of which include the Daban, Subin, Aboabo, Wiwi and Santang streams. This exhibits some dendritic patterns and stems out of the Sisa, Oda, Sokoban and the Owabi rivers, whose valleys are flat-bottomed. These converge into the Sisa River, which flows into the Oda approximately 9 km south of Kumasi. Figure 1 shows some of the major water bodies in Kumasi.

The Subin River runs through the commercial centre of Kumasi. The River Subin rises out of a spring at an abandoned race course (6° 8' 450" N 18° 380' W) north of Kumasi and runs southwards through the city centre

Table 1. Land use activities and sample size selection according to field work, 2011.

Land use	Activity	Sample size
Residential	43	30
Agricultural	18	15
Commercial	11	10
Industrial	49	33
Civic and cultural	2	2
Green belt/Open space	0	0
Total	123	90

Source: Authors' Fieldwork (2011).

and merges with the River Oda at Asago (6° 8' 45" N 18° 360" W), which is the site of a rural farming community. The Subin River covers an area of about 230 km² and has a mean flow rate of 0.243 m³/s (Meteorological Services Department Kumasi Airport Weather Station, 2000; Obiri-Danso et al., 2005).

Aboabo stream is about 10.6 km long and has its source at the northern boundary of the city at Old Tafo. It flows south through New Tafo, Dichmeso and Aboabo Extension and join the Sisai stream near Asokwa. At varied points, the Aboabo River yields an average speed of 0.87 m/s (Omane, 2002). An important tributary is the Dichem, which has its source at Odumasi. Apart from few road culverts, this stream is undeveloped and overflows its banks at several points.

The Aboabo river basin has a very large percentage of the population of the metropolis. In 1984 and in 2000 the population of the basin was 95189 and 251510, respectively. By the year 2000, the population had more than doubled, about 2.6 times that of the population in 1984. It is estimated that about 449692 persons live in the basin approximating a quarter of the total population (23%) of the Kumasi metropolis (Danquah, 2010; Danquah et al., 2011).

RESEARCH METHODOLOGY

Primary data were collected using questionnaires, visual observations, institutional surveys and key informant interviews. The institutional surveys covered the Town and Country Planning Department, Environmental Protection Agency, and local Non Governmental Organisations. Secondary data were collected through the review of literature, which includes documents from the Kumasi Metropolitan Assembly and the internet. The questionnaires seeks to address the types and nature of land use activities, their implications on river bodies and the way forward for protecting these rivers such activities that have adverse effects.

A random sample was taken to ensure that the inference about population involved would be made valid and that the items in the population had the opportunity being chosen. Given one hundred and twenty three (123) activities classified under six (6) land uses, along the Aboabo and Subin rivers and a calculated sample size of 90 activity units selected at 90% confidence level and a margin of error 0.1. According to Rice (1995), in central limit theorem if a sample size of at least 30 is selected and properly distributed,

research findings are close to reality when dealing with small sample size. From this proposition the emphasis was on distribution of the sample size in order to give a true representation of current situation for the six land use activities to be assessed. Table 1 shows the systematic distribution of the sample size. Observation is one of the key techniques that was used in gathering qualitative data. This was done through monitoring by seeing the daily land use activities that takes place along the buffer zone of the rivers. Major data findings gathered was discussed with a group of interviewees for them to make further contributions as to whether or not the research finding were of true representation of the situation on ground. In all two focus group discussions were held comprising a team of seven each for preliminary, final findings and the compatibility of land uses with these rivers.

RESULTS AND DISCUSSION

The various land use activities along the Subin and Aboabo rivers are identified which includes residential, commercial, industrial, agricultural, nature reserve and civic and cultural land uses.

Residential land use

There are many buildings and structures very close to the rivers into which both solid and liquid wastes are directly discharged. Majority (67%) of the buildings are temporary structures such as kiosk and containers. Although the permanent buildings (33%) along the rivers have been earmarked for demolition by the Kumasi Metropolitan Assembly (KMA), people are still residing or working in these structures. In Kumasi, 38% of the residents use public toilets equipped with flush toilets, holding tanks or improved pit latrines. Most of the remainder of the population uses private facilities of which 12% use bucket or pan latrines, 10% pit latrines and 26% household water closets linked to septic tanks ("man-holes") and seepage pits. Only 8% of the population has toilets connected to a sewerage system, and the remainder has no toilet facilities at all (Keraita et al., 2003), hence waste disposal is a major problem in the metropolis. The study however shows that as much as 50% of residents along these river do not have toilet facilities in their houses, thus residents especially children defecate around (free range), into the river as well as on the dumpsite. The river Subin receives untreated waste from two breweries, a soft drink factory, a teaching hospital, an abattoir, wood processing plants, outfall pipes from run-down sewage works. Households along these rivers have an average household size of six per household. The waste generation, disposal and management from these households pose serious threat to Subin and Aboabo Rivers. As much as 90% of households earn below the minimum wage of Ghana, hence classified as urban poor. The rivers are often choked with refuse and stagnant water, posing a serious health threat. The lack of policies and legal instruments for regional and physical planning further contributes to the deterioration of living conditions

in the face of uncontrolled urban growth. Urban areas are obviously important if the residents' potential to access a significant share of the gross domestic product is to be realised. But instead many face a daily struggle with bad living conditions and despite their hard work, skills and innovative ideas they find it difficult to overcome their situation.

Notwithstanding the repugnant repercussions of building on and along waterways and encroachments of nature reserves and buffer zones within the Kumasi Metropolis, people still embark on this illegal pursuit with impunity. The most recent incidence is an encroachment in a buffer zone along the main Subin River at Kaase, a suburb of Kumasi. Kaase is one of the industrial hubs within the Metropolis and the Subin River meanders in the town as well as serving as a receptacle of most rainwater within the city. An increase in population growth leads to an increase in the demand for housing and an increase in the generation of wastes. A recent study of the Nworie and Otamiri rivers in Nigeria showed a strong relationship between nitrate concentration and urbanization. As urbanization increased, so did the nitrate concentration of the rivers. The increase in nitrate concentration was attributed to surface water flow from farm lands, recreational areas, industrial effluents and the indiscriminate disposal of solid waste into the rivers. Potential sources of these nitrates were identified as being the use of soaps, detergents and agricultural fertilizers (Ibe and Njemanze, 1998) for residents and agriculturalists. In Kumasi, urban wastewater is generated mostly from domestic sources. Population increase and lack of investment have overstretched the few available sanitation facilities, and large volumes of untreated or partially treated wastewater end up in nearby streams (Danquah, 2010; Keraita et al., 2003) like Subin and Aboabo rivers. Nsiah-Gyabaah (2001) maintains that inhabitants of the city pollute the rivers and streams used by inhabitants in the peri-urban interface by dumping night soil and waste tips close to sources of water supply. This has implications for the health and socio-economic well being of people living in the peri-urban areas of Kumasi where rivers and streams are the main sources of water supply. Thus due to rapid urbanization, inadequate supply of waste management facilities and poor waste management infrastructure, rivers in Ghana and Kumasi to be specific have not been spared of pollution.

Commercial land use

A number of commercial activities are undertaken along the Subin and the Aboabo Rivers which causes pollution of the rivers. Such activities include animal skin dressing which generates a lot of wastewater into the Subin River. In the same vain vigorous commercial activities along the Subin River also generate both liquid and solid wastes

which are directly dumped into the river obstructing flow and causing pollution. Thus, by observation at Moshie Zongo, people have highly encroached on the Aboabo River, siting in their car washing bays extracting several liters of water for their activities and connecting their gutters straight to the Aboabo River without any initial treatment. According to Water Use Register of Water Resource Commission, 176 commercial and industrial activities draw water from various rivers in Ghana and the number of unregistered users is even more.

Commerce include the activities of street vendors (80%) along the Kumasi-Accra highway generating thousands of tones of waste an insignificant proportion of which is collected with the rest entering into the Aboabo River during rainfall. Of all the commercial activities along these rivers, 80% are street vendors and hawkers who throw waste directly into the rivers. The location of lorry parks and petrol filling station (10%) in close proximity to the Aboabo River also poses a threat of chemical pollution due to likely seepage of petroleum products into the water bodies. Indiscriminate dumping of refuse especially plastics into the Subin drain stretching from the Kumasi Central Market area to Kaase, in the metropolis, is seriously impeding the free flow of the already heavily polluted river. So serious is the situation that a pile of refuse and silt has completely blocked four of the five channels of the concrete bridge on the Asolwa Police Station and Ahodwo roundabout road. Unless immediate steps are taken to remove the heap of rubbish and silt, a massive flooding of the area with disastrous consequences cannot be ruled out during the coming rains.

Industrial activities

The industrial activities located along the Subin especially at Kaase industrial area which comprises the breweries, the abattoir and other Small Scale Industrial (SSIs) activities comprising mechanic workshops, wood processing and water packaging. Small scale industries constitute 60% of industrial activities along the rivers. The categories of people engaged in these SSIs are the urban poor and rural-urban migrants. As much as 60% of SSIs workers are migrants seeking livelihoods in informal settlements and slums along these rivers. Although, these land uses are located outside the flood plains of the river, the activities impact negatively by way of their manner of waste disposal. Despite the contribution of industry to local economic development by employing, industrial activities along river bodies pose serious implications emanating from waste discharge and water usage. The Aboabo River has become more or less a refuse dump and a waste drainage system in Kumasi and therefore very debatable to be regarded as a river. A Kumasi-based firm located in Asokwa, A.J Fanji/Halaby is claiming portion of the buffer zone as their legally

acquired land in addition to their land. This assertion by the Company's owner has led him to instruct his workers to fill the portion of the buffer zone with mud sand and industrial waste. According to UNESCO (2003), some 2 million tons of waste per day are disposed off within receiving waters, including industrial wastes and chemicals, human waste and agricultural wastes such as fertilizers, pesticides and pesticide residues. The waste management and sanitation situation in Subin and Aboabo is quite precarious. Rivers in the Kumasi metropolis are noted to be polluted through human activity (Danquah et al., 2011; CEDAR, 1999; Cornish et al., 1999; McGregor et al., 2003). Recent research evidence showed that the Aboabo River was the most polluted river in Kumasi whilst the least polluted was the Wiwi (Omane, 2002; Danquah et al., 2011) mainly resulting from industrial activities such as wood processing.

Agricultural land use

Urban agricultural activities are now a lucrative source of income generation in the urban environment. Vegetables are the predominant crops grown since it has a ready market and a short gestation period. Along the Subin and the Aboabo Rivers, the crops grown include cabbage, carrots, green pepper and tomatoes of which all require massive water consumption. Out total of 15 farmers constituting 17% of sample, 33% of them grow only cabbage, and 67% grow a variety of vegetables. Due to the use of chemical fertilizers and pesticides seepage and run-off from the farms during rainfall, urban agriculture poses as a threat of pollution to the water bodies. The survey revealed that 80% of the farmers along these two river bodies use chemicals on their farms with quantities used based on crude farming practices, thus without any consultation of extension officers. The quality of rivers at any point on a landscape reflects the combined effects of many processes along water pathways and both quantity and quality of water are affected by human activity on all spatial scales (Peters and Meybeck, 2000). Agriculturalists along these rivers use chemicals that lead to the release of toxins as Nitrogen (N) and Phosphorus (P). Apart from fertilizer application, sewage disposal from urban areas contribute significantly to nitrogen loadings in river systems leading to eutrophication (Hayakawa et al., 2006). Anthropogenic factors play a major role in contributing to the pollution of rivers (UNEP, 2006). Anthropogenic factors such as agricultural development, population growth, urbanization, and industrialization as well as market policy failures have been identified as the root causes of water pollution (UNEP, 2006) in Aboabo and Subin Rivers. Also farming practices such as slash and burn was common among farmers which micro-organisms within the buffer zone and also has impact on rate of

evaporation since 80% of farmers do slash and burning.

Nature reserve/green belt

The nature reserve or green belt areas along water bodies are significant in protecting the water shed and the subsequent prevention of drying up of water bodies. This significant land use is also located along the Subin River at some stretch at Kaase and at dotted places along the middle course of the Aboabo at Alonga and Moshie Zongo. Through observations many trees are not found within this zone, plantain and banana plants are dominant with few grass lands. According to Natural England and Campaign to Protect Rural England (2010), the purposes of green belt are to check the unrestricted sprawl of large built up areas; prevent neighbouring towns from merging with one another; assist in safeguarding the countryside from encroachment; preserve the setting and special character of historic towns; and to assist with urban regeneration, by encouraging the recycling of derelict and other urban land. It is how ever punitive to note that along Subin and Aboabo Rivers planning has not been done through the Regional Spatial Strategies with detailed boundaries fixed by Local Development Frameworks. The purpose of using green belt as mechanism for effective planning in Ghana has not been able to support sustainability by encouraging urban regeneration and concentration of homes, services and employment opportunities. Not until recent times in 2011, Ghana no to buffer zone policy. The current riparian buffer zone policy is yet to be passed as an act of parliament. Riparian vegetation extends along the catchment landscapes of the water bodies in Ghana and provides a wide range of socio-economic, biophysical and ecological functions. Human induced activities such as uncontrolled logging and mining activities, human settlements, urbanization, livestock populations, and poor agricultural practices have degraded the vegetative cover at headwaters and along the banks. Development within Green Belts is not strictly controlled and there is a general presumption against inappropriate development. Development considered appropriate includes development strictly required in connection with agriculture, forestry and outdoor sport and recreation. The existing belts along Subin and Aboabo rivers do not only encourages regeneration both within the urban areas it contains and in areas in need of regeneration outside the principal urban areas, but also reduces energy consumption, thereby helping to tackle climate change. The Urban Task Force (1999) noted a proven link between urban residential housing densities and energy consumption, calling for higher density, more compact development on previously developed land as a means of reducing consumption. Elson (1994) argues that Green Belts are not originally envisaged as merely stopping development, but guiding it to particular

locations, in order to shape the expansion of a city on a regional scale. However unsustainable management practices are jeopardizing the physical quality of the environment, the hydrological and ecological support systems and the livelihoods of local inhabitants around these water bodies. The policy statement for Ghana's buffer zone policy aims at ensuring that all designated buffer zones along rivers, streams, lakes, reservoirs and other water bodies shall be sustainably managed for all (Ministry of Water Resources, Works and Housing, 2011). At local and regional levels, there are not clear designated dimensions for buffer zones as every department uses its conventional units that suits its organizational objectives. Town and Country Planning for instance uses 50 ft while Environmental Protection Agency uses 50 m. The policy in terms of dimension for buffer zones uses various widths for varied types of water bodies with the minimum of 10 m and the maximum of 90 m.

Civic and cultural land use

Churches are located just along and even sometimes within the river basin. An example is the Global Evangelical Church which is also located just along the Aboabo River. Though the surroundings have been landscaped, their toilet facilities are being channeled into the river. A section of the church area is being defecated on causing a lot of stench around. This usually happens at night when there is no one around the church. The location of the church has thus exposed the river banks to direct sun rays, thus causing the river to dry up. The laws prohibiting the indiscriminate dumping of refuse or pollution of rivers in Ghana in particular exist but the enforcement of these laws proves difficult. Omani (2002) asserts that water pollution still persists perhaps due to the fact that these laws were varied and each narrowed towards particular purposes other than pollution prevention. In addition, these laws were fragmented under so many governmental departments and they were too many, too weak. In the case of Kumasi, Obuobie et al. (2006) indicate that many people attribute the increasing water pollution in the Kumasi metropolis to the failure of KMA to collect, treat and dispose of waste water efficiently. Cultural land use along these rivers is historically rooted emanating from the belief and use of shrines along Subin River.

Locational factors

The location of activities in the urban environment tends to be dictated by certain factors. These are pull and push factors that underpin their location at particular places. Land under market conditions should go for the highest and best use otherwise the economic potential would be

underutilized. Farmers have farms along the water bodies, as much as 35% located there due to the rich loamy soil. For 45% of them, the location was due to availability of water and 20% located there due to access to market. The farmers indicated that the absence of good agricultural lands and irrigation facilities to support the growth of urban agriculture in the metropolis accounted for their location along the Aboabo and Subin Rivers. With regard to the commercial activities, availability of land around the water bodies and a large market recorded 70 and 30% respectively with factors like proximity to the Central Business District, social ties, land ownership and accessibility. Also 60% indicated that land around these areas were quite cheaper as compared to other areas. Moreover, 15% of the respondents mentioned proximity to workplace as the factor accounting for their location in the area. Other residents complained of high cost in acquiring a place for business and residence, as a result they have been encroaching on these rivers gradually and have not decided to move to any other place. According to Rockson (2009) the use to which urban land is engaged in is always undergoing changes because of the dynamism of human settlements, emanating from the improvement in urban economies, stable political climate and the increase in urban population. These changes provide different frameworks within which competition between the existing and potential land users decide the pattern of land use in urban areas. Urban land use along rivers is grounded on the concept of bid rents whereby the land user seeks closer locations to rivers for various reasons, but is willing to accept a location further from the river bodies if rents are lower in compensation. According to Harvey (1999) there are wide differences in the land use patterns of urban areas. Varying topographical features have an effect on land use locations; so do climatic conditions, past and present social and religious agglomerations, legislation and legal decisions, demand for goods and services including varying consumer preferences and the policy of local and central government in the supply of public utilities and social services. From his understanding, these variations provide different frameworks within which competition between the existing and potential land users decide the pattern of land use in along any river, and within these frameworks and subject to the imperfections of the market, the forces of demand and supply provide the means by which land is developed up to its highest and best use.

Compatibility analysis

The following matrix explains how compatible the land uses and activities are to the Aboabo and Subin Rivers. The results of the analysis are shown in Table 2. In Table 2, the compatibility of major land use and activities along

Table 2. Compatibility analysis matrix activities and land uses along Aboabo and Subin rivers.

River \ Activity	Residential	Commercial	Industrial	Civic and culture	Nature reserve	Agricultural
Aboabo	-1	-1	-1	-1	1	-1
Subin	-1	-1	-1	-1	1	1
Total	-2	-2	-2	0	2	0

Source: Authors Construct (2011).

the Subin and Aboabo Rivers is shown by using a Linkert scale with ranks based on the following reasons:

Compatible = score 1

Reason: Where the impact of the activity poses no threat and protects the water bodies

Neutral = score 0

Reason: Where the impact of the activity poses no

Incompatible = score -1

Reason: Where a particular activity impacts negatively by destroying the water bodies or when a particular activity pollutes and poses threat of extinction to the water bodies and inhabitants.

The articulation of the compatibility matrix reveals that the nature reserve and green belt along the Subin and the Aboabo had the highest rating of (+2) indicating its compatibility. Conversely, the industrial activities which recorded (-2) signifies its incompatibility with the Subin and Aboabo Rivers. Commercial, civic and culture, agricultural, and residential land uses with (-2) implies that these land uses and activities could be carried out along the rivers only when regulated.

The survey revealed that residential buildings are built within the buffer zones and in extreme cases, on the banks of the Subin and the Aboabo rivers. As a result there is the difficulty of free flow of the rivers. It was realized from the survey that 80% of the buildings located 20 m away from the banks of the rivers are always flooded whenever there is a heavy downpour. The lack of proper drainage systems in the area makes it difficult for surface water to drain off whenever it rains.

A typical case of a house located along the Aboabo River which gets flooded whenever there is a heavy down pour. The compound of the house has been turned into a waterlog area which serves as a breeding place for mosquitoes and other insects. Stalls of saw millers and a church (Global Evangelical church) are located very close to the river. As a result, the sawmills around Aboabo community use the river bank as a place for keeping and dumping their sawn dusts and other waste materials. The Global Evangelical church also contributes to the pollution as their drainage is channeled directly into the river. The saw millers activities are gradually reducing size of the Aboabo River which if not appropriately addressed will dry up.

Dumping of refuse into the stream basin has reduced its capacity in terms of volume therefore causing the stream to overflow its bank, since it cannot contain the volume of runoff it receives. The flood, being a recurrent problem leads to huge economic and social loses and has a negative impact on the society. This has resulted in the occurrence of damages in terms of life and property.

The deplorable nature of the vegetative cover of the width of a 100 m stretch along the Subin River has been cleared exposing the water basin to the direct exposure of the sun rays. Also untreated liquid waste from nearby residential buildings has been directed in the river causing pollution and as such extinction of aquatic life.

Summary of findings

Residential land use

Though there is a land use scheme to guide the development of the communities along the rivers, land has been encroached upon, as a result of such lands being sold away at a cheaper price to developers by the traditional authorities and public officials. These activities have contributed to the ill health of the water bodies as due to the channeling of storm drains and pipelines disposing of untreated liquid wastes. As much as 50% of the houses have no toilet facilities compelling the residents and owners of activities around the water bodies to defecate either at the edge or within the rivers. There is a refuse disposal site close to the Aboabo River which spills over and litters the surrounding areas when there is a heavy down pour or wind, thus polluting the rivers. The apparent dumping of night soil and direct disposal of domestic and other kinds of wastes from the urban areas has contributed to the current state of the water bodies. However, there are plans to locate a suitable dump site for the residents and owners of activities along the water bodies along the Subin River. Currently, malaria and cholera are chronic diseases that the people living close to the river are battling in addition to the bad odour from the river.

Industrial activity

Small scale industries are the dominant industrial

activities for most migrants and poor urban indigenes. Most of these industrial activities require large volumes of water especially palm oil extraction. Subin River has turned to be a dumping place for garbage for the people living and doing business along the river. This is because, sawmills and other industries dispose of their waste products through pipes into the Subin River. The Aboabo River is not in a different situation as the Anloga wood workers dump sawn dust into the river. This has resulted in the degrading of the Subin and Aboabo Rivers, therefore becoming a mighty gutter and a hydrant of wastes in Kumasi.

Commercial land use

A number of commercial activities are undertaken along the Subin and the Aboabo Rivers. In the same way vigorous commercial activities along the Subin River also generate both liquid and solid wastes which are directly dumped into the river obstructing flow and causing pollution. Other commercial activities are the selling and buying along the Kumasi- Accra highway by street vendors and their customers generating thousands of tones of waste of which an insignificant proportion is collected with the rest entering into the Aboabo River during rainfall. Several attempts by KMA to manage waste along these rivers have failed. Refuse containers along these rivers are always full without regular emptying.

Agricultural land use

Agricultural activities which include piggery act, crops and vegetable farming along the Subin and the Aboabo Rivers cause chemical pollution through seepage of chemical fertilizers and run-off after rains. Urban farming according to the study is mostly vegetable farming characterized by fertilizer applications within small portions of open lands and gardens along river bodies. Due to the scarcity of urban land, agricultural developments are on small basis for crops such as carrots, cabbage and tomatoes mostly for subsistence.

Nature reserve

Nature reserve which should have been a major land use along the Subin and the Aboabo Rivers has given way to other land use activities. However, there are patches of vegetative cover which consist of about 15 and 20% for Aboabo and Subin rivers flood plains respectively. There are several residential buildings along the buffer zones that have been earmarked for demolition by KMA since 2009 but are currently habited by people. How to obtain public acceptance of the concept of using vegetation to buffer valuable aquatic resources from the impact of

adjacent human use of the land is difficult.

Reasons for locating along water bodies

Different reasons were assigned for locating the various activities along the Subin and the Aboabo Rivers but the general factors of cheaper lands and proximity to market in the case of commercial activities ranked high. Location factors are predominantly not based on the use of the water bodies except for agricultural activities.

Compatibility of land uses

The industrial, residential, commercial and agriculture activities located within the buffer zones of the Aboabo and the Subin create waste into these rivers that pollutes and has contributed to the current state of the water bodies. The only land use discovered to be compatible with the water bodies is the nature reserve.

Institutional co-ordination

There is weak co-ordination among the institutions responsible for the management of these areas comprising the Kumasi Metropolitan Assembly; the Town and Country Planning Department, the Lands Commission and the Traditional Authorities. The responsibility gap of the related institutions and resource inadequacy has contributed to the inability of responsible institutions to live up to expectation.

Conclusion

The security of adequate supply of safe water requires the understanding of the driving forces behind the water pollution and depletion of the water bodies. Issues here are related to poverty mitigation and livelihood strategies, the impact of human activities such as industrial, residential, and commercial need to be analysed to develop effective measures that can be put in place to plan, manage, conserve and protect the water bodies. The study revealed that individual residents and workers residing along the Aboabo and Subin Rivers have not been involved in the management of the water bodies and as a result has adversely affected the sustainable management of these rivers. Community participation in the Subin and Aboabo areas has not been considerable and most implementation problems stem from lack of involvement and social equity. Impediments to community participation have been the scarcity of knowledge and experience of the local communities; and a prejudice for technical rather than social considerations in natural resource management efforts.

The existing state of the rivers in the Aboabo and Subin areas is very alarming, hence the need for a concerted effort towards curbing the problem so as to preserve these water resources and derive the maximum benefits from their use. As the population within the watershed continues to grow, the impact of human activities on the quality of water will become increasingly noticeable. Residential and commercial development along with increased recreational activities may stress water bodies, threaten some designated uses and degrade the status of others. The protection of rivers and streams especially dealing with issues concerning encroachment and pollution is complex and only a concerted effort among the sector institutions can yield results in safeguarding the rivers and streams.

RECOMMENDATIONS

There is the need to facilitate the implementation of a comprehensive water policy and riparian buffer zone policy to enhance the livelihood of people who live along the water bodies. This would help improve the management practices, ensure institutional co-operation and coordination, protect water bodies, improve quality and supply and promote water conservation as enshrined in the policy. The buffer zone policy should be passed as a law. Local government should do massive stakeholder engagements, discussions and strengthen the enforcement of by-laws for people who pollute these rivers. Unauthorized structures within the buffer zones should be demolished by KMA and rezone the rivers embankments as green belts.

There is a need to increase public understanding of the impacts of land use on water quality and the desirability of improving degraded water quality as much as possible at the source of contaminants. The current lack of public awareness of the link between land use and water quality problems makes it difficult for those who have to make the 'hard' political decisions required to effectively address water quality issues through controls on land use. There is therefore the need to intensify education on impacts of land uses and water quality to increase awareness. This should be done through media announcements, posters, flyers and instituting community durbars to educate the public.

Authorities in charge of protecting water bodies should rejuvenate their duties to preserve the water bodies in the country. The Kumasi Metropolitan Assembly is to enforce its by-laws on construction along waterways. Chiefs and land related public officers should be sensitized on the effects and dangers of selling lands along water bodies. The law must also take its course against anyone who flouts it. Water management authorities such as Water Resource Commission, Environmental Protection Agency (EPA), have to deal with existing land use in the catchment and must define restrictions or even ban land use from targeted spaces to achieve defined legal and

societal objectives. The Law enforcers can introduce a Polluter Pay Principle for the residents and owners of activities.

There is the need for the Private Sector and NGO's like the Friends of Rivers interested in the conservation of water bodies to be given the mandate to effectively participate in the protection and solution of the current problems. Some of the primary difficulties for developing countries include limited physical and financial resources and this is why non-governmental institutions as well as other organizations are expected to play an important role such as the provision of finances, awareness creation, participation, and monitoring of water and sanitation issues. They are to serve as facilitators in forging alliances and networks to enhance exchange of information and experiences among different actors as well as to mediate among the state, local communities, and external support agencies.

In order to ensure sustainability in every society, it is important to understand the significant role of community participation in the sustainable development of water bodies and there is the need to involve the people who are directly involved. Local participation helps educate the people on how to manage and take responsibility on the management and protection of the water bodies.

Since the traditional leaders are accorded maximum respect by their people, there are wide opportunities for them to be able to organize and motivate the people to contribute both physical and economic resources towards managing their own water bodies. This can be done with their wide knowledge, power and other resources.

Institutions are vital in every society especially in policy making. It was identified that there is weak co-ordination among the various actors of environmental management and development of the City. To address this, there is the need for institutional strengthening, whereby the institutions involved should collaborate to develop a mechanism that would help hasten the permit approval process. This would help developers obtain permit before developing. Also offenders who violate the development permit process should be prosecuted to help serve as a deterrent to others.

REFERENCES

- Aribigbola A (2008). Improving Urban Land Use Planning and Management in Nigeria: The Case of Akure, Theoretical and Empirical Researches in Urban Management, Year 3, Number 9, 2008", ISSN 1842-5712.
- Barlowe R (1986). Land resource economics , The Economics of Real Estate,. Fourth Edition, Prentice-Hall, Englewood Cliffs, NJ. Barnett, 1-1.
- CEDAR (1999). Peri-urban natural resources management at the watershed level, Kumasi, Ghana. Peri-urban interface production systems research, Centre for Developing Areas Research (CEDAR), Department of Geography, Royal Holloway, University of London UK, Inception report.
- Cornish GA, Mensah E, Ghesquire P (1999). Water quality and peri-urban irrigation: An assessment of surface water quality for irrigation and its implications for human health in the peri-urban zone of

- Kumasi, Ghana. Report OD/TN 95, HR Wallingford, UK.
- Danquah L (2010). The causes and health effects of river pollution: A case study of the Aboabo River, Kumasi (Unpublished master's thesis). Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Danquah L, Abass K, Nikoi AA (2011). Anthropogenic Pollution of Inland Waters: the Case of the Aboabo River in Kumasi, Ghana. December. *J. Sustain. Dev.* 4:6.
- Elson M (1994). *The Effectiveness of Green Belts*, HMSO.
- FAO/UNEP (1997). *Negotiating a sustainable future for land - Structural and institutional guidelines for land resources management in the 21st century*, Dordrecht, Kluwer Academic
- FAO/UNEP (1999). *The future of our land: facing the challenge, guidelines for integrated planning for sustainable management of land resources*, Rome, Food and Agric Organisation of the United Nations.
- Friends of Rivers and Water Bodies (FRWB) (2008). *A paper on field survey on water bodies in Kumasi. Unpublished baseline study by Friends of Rivers and Water Bodies.*
- Harvey J (1999). *Urban and Economics*. 3 Edition. London, Macmillan Education Press. Pp. 23-24.
- Hayakawa A, Shimizu M, Woli P, Kuramochi K, Hatano R (2006). "Evaluating Stream Water Quality Through Land-use Analysis in Two Grassland Catchments: Impact of Wetlands on Stream Nitrogen Concentration", *J. Environ. Qual.* 35:617-627.
- Ibe KM, Njemanze GN (1998). "The Impact of Urbanization and Protection of Water Resources, Oweri, Nigeria". *J. Environ. Hydrol.* 6:9.
- Keraita B, Drechsel P, Amoah P (2003). "Influence of Urban Wastewater on Stream Water Quality and Agriculture in and around Kumasi, Ghana". *Environ. Urban.* 15(2):171-178.
- Litman T (2011). *Evaluating transportation land use impacts considering the impacts, benefits and costs of different land use development patterns*, Victoria, Victoria Transport Policy Institute.
- Long H, Wu X, Wang W, Dong G (2008). *Analysis of urban-rural land use change during 1995-2006 and its policy dimensional driving forces in Chongqing, China*, Sensors. p. 8.
- McGregor D, Thompson DA, Simon D, Kotei NO, Poku KO (2003). *The influence of Kumasi on peri-urban water quality: a problem of community health and floodplain agriculture?* In Cornish, G. (Ed.). *Informal peri-urban irrigated agriculture: opportunities and constraints* (pp. 65-76). Wallingford, England: HR Wallingford Ltd.
- Meissner R (2002). *The impact of demography on global and regional water resources*, UNESCO Encyclopedia on life support systems-EOLSS, UNESCO.
- Meteorological Services Department Kumasi (2000). *Airport Weather Station Annual Report 2000*, Ghana Publishing Corporation, Accra, Ghana.
- Ministry of Water Resources, Works and Housing (2011). *Riparian Buffer Policy of Ghana*, Government of Ghana.
- Mtisi S, Nicol A (2003). *Representation and Participation in decentralised water management: 29th WEDC International Conference*, Abuja, Nigeria.
- Natural England and Campaign to Protect Rural England (CPRE) (2010). *Green Belt: a green future, A report by Natural England and the Campaign to Protect Rural England on green belt debate*. ISBN 978-1-84754-160-4, www.naturalengland.org.uk/publications.
- Nsiah-Gyabaah K (2001). "Population Growth, Urbanization and Water Supply: A Growing Challenge to Human and Environmental Security in the Peri-urban Interface in Ghana", *Journal of the Kwame Nkrumah University of Science and Technology, Kumasi* 21(1, 2, 3):71-81.
- Obiri-Danso K, Weobong CAA, Jones K (2005). *Aspects of health-related microbiology of the Subin, an urban river in Kumasi, Ghana. J. Water Health | 03.1 | 2005.(provide page number)*
- Obuobie E, Keraita B, Danso G, Amoah P, Cofie OO, Raschid-Sally L, Drechsel P (2006). *Irrigated urban vegetable production in Ghana: Characteristics, benefits and risks*. Accra: International Water Management Institute.
- Omane OK (2002). *Peri-urban water quality monitoring in the Sisa-Oda catchment of Kumasi* (Unpublished master's thesis). Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
- Peters NE, Meybeck M (2000). *'Water Quality Degradation Effects on Freshwater Availability: Impacts of Human Activities'*. *Water Int.* 25(2):185-193.
- Rice J (1995). *Mathematical Statistics and data analysis* (Second Edition.), Duxbury Press, ISBN 0-534-20934-3. p. 2-6.
- Rockson NY (2009). *The Relationship between the Changing Land Use Patterns and Land Values along Major Roads in Kumasi*, Unpublished Special study submitted to the Department of Planning, Kwame Nkrumah University of Science and Technology Kumasi.
- UNEP (2006). *Challenges to International Waters – Regional Assesments in a Global Perspective*, United Nations Environment Programme, Nairobi, Kenya.
- UNESCO (2003). *Water for people, water for life: UN world water development report, executive summary*. Paris: United Nations Educational, Scientific and Cultural Organization.
- Urban Task Force (1999). *Towards an Urban Renaissance*, Spon Press.
- Wang X (2006). *Integrating water-quality management and land-use Planning in: A watershed context*, (2001). *J. Environ. Manage.* 61:25–36.