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ASSESSMENT OF THE IMPACT OF LAND USE CHANGES ALONG THE FLOODPLAINS OF RIVER LAMURDE, JALINGO LGA, NIGERIA

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ABSTRACT

Jalingo town has developed over the years from a simple linear settlement pattern dictated by the nature of its topography to a fast growing urban complex. The rapid growth of the town has necessitated the expansion of settlement and infrastructures to accommodate relative increases in population. River Lamurde and its tributary, River Mayo Gwoi which passes through the town and play very significant roles in the provision of water for domestic and agricultural uses also limits the growth of the town on the southern part for a long time. The construction of new roads and bridges along these rivers has in recent times opened up large areas for the construction of residential houses and intensification of agricultural activities along the river banks. These changes in land uses along the floodplain of the Lamurde river have resulted in large scale transformation of the landscape with telling consequences on the river and aquatic ecosystems. This study examines the causes and impact of land use changes along the floodplains of River Lamurde on the river system and how these impacts could be curtailed to safeguard the health and sustainability of the river system. Questionnaires were used to collect data for the study and were analyzed using simple descriptive statistics, particularly frequencies, percentages and ratios. Physical observation of the study area was undertaken to obtain first hand information on various uses along the floodplains of River Lamurde in the study area. The findings of this study shows that land use along the floodplain of river Lamurde has undergone substantial level of change from open fields and fallow lands to intensively cultivated irrigation and residential areas. The dominant land use types in the basins presently are rainfed agriculture and irrigation farming, grazing, development of residential, commercial and institutional buildings as well as indiscriminate waste disposal. The observed land use activities include, excessive water extraction, deforestation for fuel wood and other domestic uses, excessive use of chemical fertilizers and land degradation due to improper agricultural practices. These land use activities have impacted negatively on the river ecosystem. The study conclude that there is need to streamline land use activities, conserve vital ecosystems like watershed areas and maintain buffers along stream channels as a matter of policy to ensure adequate protection of aquatic fauna and sustainable water supply. The town planning authority should

enforce restriction of expansion of buildings on the floodplains of the river because of their vulnerability to flood disaster. Given the increasing intensity of irrigation and chemical fertilizer usage, this study recommends the need for further study on the impact of fertilizer and irrigation on the river ecosystem.

Keywords: Assessment, Buffer, Impact, Lamurde, Land use change, River banks.

Contribution/ Originality

This study is one of very few studies which have investigated the causes and impact of landuse changes along the flood plain of River Lamurde. The findings of the study will held in managing the incidence of flooding in the area. It will also help to conserve the riparian ecosystem.

1. INTRODUCTION

The increasing need for human development through rapid urbanization has led to a wide spread horizontal development especially in the developing countries [1]. As a result of this, river banks have been encroached, vegetal covers removed, soil properties modified and many micro to macro ecosystem have been driven into extinction. Where these changes are not met with complementing planning and management measures, challenges such as water pollution, high risk disaster (flood), and unstable food production are unavoidable, particularly along the river banks [1].

Human beings have been attracted to settle on floodplain and river banks since time immemorial. Before the advent of human settlement and development of the floodplains of rivers, rivers were unregulated, free of dams and levees among others. The flow of rivers then were determined by climate especially precipitation. Whenever there is flooding, the flood plains receive the extra water (buffer). The natural river and its floodplains sculpted the landscape and nourished the plants and wildlife that are dependent on the riparian ecosystem [2]. The floodplains are important natural biofilters, protecting aquatic environments from excessive sedimentation, polluted surface runoff and erosion. The floodplains also provide food and shelter to many aquatic animals and shade that is important for temperature regulation. The floodplain further protects water resources from nonpoint source of pollution and provides bank stabilization and aquatic and wildlife habitat.

However, with the advent of human settlement and development came the need for regulation. Regulation of the rivers allowed protection from the effects of floods, and improved use of the rivers for transportation and water supply for agriculture and urban uses [2]. Through regulation, many human services have been developed, but at the same time, countless ecological benefits have been reduced or lost. Some of the factors attracting people to the floodplain include the rich alluvial soils, access to water supplies and cheap sites in urban centres especially for low income families. Many of the land uses practiced on the floodplain along the river banks in recent

times have unwittingly increased the vulnerability of the area to flood risk and impacted on the aquatic ecosystem.

The effect of land-use change and pattern of change over the years on riverLamurde has not been investigated. Trends in population growth and urbanization in the area suggest that this land-use sequence will continue tointensify in the nearest future. Information about stream flow and how it is affected by land use along its floodplains can help communities reduce their current and future vulnerability to floods. It is also useful for devising sustainable urban growth and environmental planning. Therefore, understanding of the nature of urban land use changes on floodplains especially along the river banks is vital for flood and floodplain protection. Hence, it become very important to assess the pattern and type of land use changes in order to predict future changes in urban development in the study area. This study therefore examines the impact of land use changesalong the floodplains of River Lamurde in Jalingo Metropolis in the past two decades. The specific objectives of this study are to examine the causes and impacts of land use changes along the floodplains of river Lamurdeand how these impacts could be curtailed to protect and ensure the sustainability of the river ecosystem.

1.1. Study Area

Jalingo LGA is roughly located between latitudes 8°47' to 9°01'N and longitudes 11°09' to 11°30'E. It is bounded to the North by Lau Local Government Area, to the East by Yorro Local Government Area, to the South and West by Ardo Kola Local Government Area. Jalingo town was founded in 1893, as a convenient and suitable site for the relocation of the administrative capital of the Muri emirate. The town developed as a war camp established eight miles south of Kona village [3]. It was a military base for the operation of the Emir of Muri. It was renamed Jalingo following the successful relocation of the capital from the old Muri. A European, L.H. Moseley described Jalingo in 1895 as a settlement of about 1000 people built in a circle with four gates at the N.S.W.E. aspect respectively [4]. The name Jalingo means 'the victorious', following the nature of the struggle that led to the establishment of the town. Hamman [5] observed that since its establishment in 1895, Jalingo has continued to witness phenomenal growth as a result of its being the seat of the new Muri Emirate government and a trading centre. The present day Jalingo Local Government Council was an offshoot of the abolished native authority system. It was designated a Local Government headquarter in 1976 under the defunct Gongola state. Following the creation of Taraba State in 1991, it was made the state capital. It has a total land area of about 195km^2. Jalingo LGA has a population of 139,845 people according to the 2006 population census, with a projected growth rate of 3% [6]. Presently, it has a projected population of 165,774 in 2014 [3].

Jalingo town is located in a tropical continental climate area with distinct wet and dry seasons. The bedrock geology is predominantly metamorphic rocks of the basement complex

consisting of gneisses and older granites. The soils are typical of tropical ferruginous soils with vegetation comprising savannah woodland.

River Lamurdewhich drains the town is a third stream order which took its sources from the Yorro Mountain near Gangoro and flows downhill through Yorro, Tazarang, Alkali Gwa, Bassaand Jalingo. The river flows for over 96km westward before emptying into the Benue River system near Tau community. The Rivers Lamurde and Mayo Gwoi form a confluence in Jalingo town around Magami ward. River Lamurde has extensive flood plain on both sides of the river. The northern bank of the river is heavily occupied by residential settlements despite the increasing devastating effects of recent floods in the area, while the southern bank is intensively cultivated. The farmers in the area cultivate the land three times per year through irrigation [7]. With the construction of the new roads and bridges along these rivers and increasing urban population, the land uses along the floodplains of the river is fast changing.

River Lamurde is the major source of recharge for undergroundwater in the area with a typical minimum yield of 648,240m^3 per year from the boreholes located within the flood plain of the river [8]. The river has also over the years limited the growth of the town on the southern part for a long time. Hitherto, lands across the Lamurde river remained open fallow land and generally reserved for rainfed agricultural use only. The construction of new roads and bridges along these rivers that bordered the town on the southern part (Fig. 1) has in recent times opened up the areas (including the river banks) for urban growth [9]. These roads include the Jalingo byepass and the Nassarawa – Mile six roads, while the bridges include the second and third bridges along Mayo Goi River at Pantinapu and Nyabu Kaka (Nassarawa – Mile six road) and the new bridge across Lamurde river at Karofi (Jalingo byepass road). These are some of the recent developments that are encouraging and stimulating urban growth and land use changes in the study area. These changes in land uses along the banks of the Lamurderiver have resulted in large scale transformation of the landscape. The magnitude of this transformation of the landscapes resulting fromchanges in land uses along the floodplains of the river has been a matter of great concern because of the increase in the devastating effects of flooding in recent times in the area [10, 11].

2. MATERIAL AND METHODS

This work was based largely on data collected from direct fieldwork exercises and questionnaire administration. This includes site visits for physical inspection of the various land uses along the floodplains of River Lamurde; interviews of inhabitants of the floodplain and analyses of land use data collected during the investigations. Measurement of houses and farmland distances away from river channels on both flanks of the river in the study area was carried out.During the fieldwork component of the investigation, the team visited some of the areas affected by flood in the past to determinedthe depths of flooding. This floodplain observation in the field was complemented with topographical map of the area obtained from the

Land Bureau. This study was carried out in 2014 to determine the degree of human encroachment on the floodplains (buffer zone) in the past two decades. The specific issues considered in this paper are the nature of changes in land uses, causes of the land use changes and its impact on the river system. Questionnaire was drawn and randomly administered to residents and farmers along the floodplains of River Lamurde in the study area. In all, 84 questionnaires were administered in the study area. The questionnaires were analyzed using descriptive statistics, particularly frequencies and percentages. Additional data was derived from the existing literature on land use, landuse changeand related subjects.

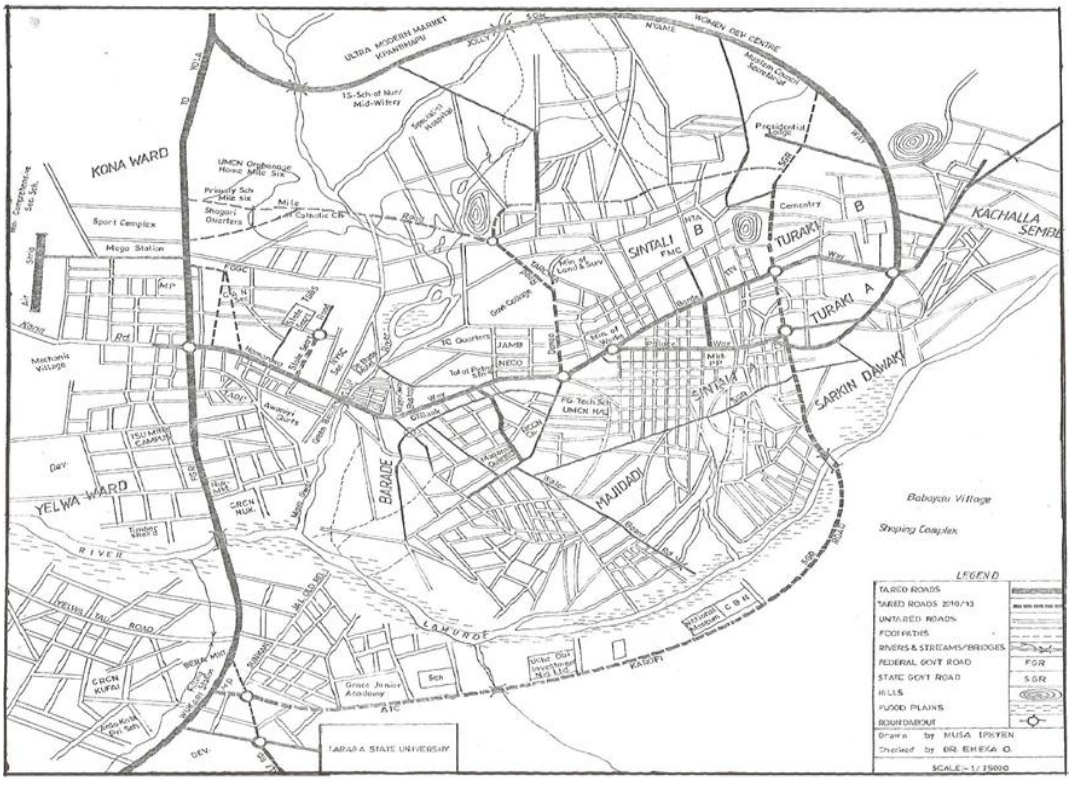

Fig-1. Map of Jalingo Metropolis

3. RESULTS

3.1. Land Use Changes in the Study Area

The findings of the study show that the existing land use along the floodplains of River Lamurde was predominantly agricultural farmlands. Movement to the lands across the river to the southern banks was hitherto limited by the River Lamurde that traversed the area in east – west direction and lack of bridge across the river. Following the construction of the bye-pass road and Karofibridge on River Lamurde and other road network extension, people begin to move into these areas, resulting into the conversion of prime agricultural lands into commercial and residential uses. The continuous infiltration of residential and commercial uses over the past

twodecades has gradually changed the landscape. The road construction was necessitated by the increasing population of Jalingo metropolis from about 68,000 inhabitants in 1991 [12] to about 160,000 people today (2013 projection) [9]. Thus, the new road construction facilitated the outward expansion of the town and resulted in changes in land use whereby the residents buy up prime agricultural land for commercial and residential purposes. New residential houses are fast springing up all over the areas in the northern and southern banks of Rivers Lamurde and its tributary.

The quality and distribution of these newly built houses have often times resulted to various levels of development violations in some places especially in terms of quality [3]. The study findings show that 73.8% of the houses on the floodplain were permanent structures made of brick walls while 26.2% of the structures were also permanent structures made of mud houses. It is a common sight to see land use conversions which does not allow for access road.All the respondents interviewed (100%) agreed that there have been drastic changes in land use in the last decade.

The findings of the study show that Jalingo metropolis has experienced significant spatial growth in built-up extents over the years.This growth has been accompanied with simultaneous encroachment on the River Lamurde floodplain, in an increasing trend. The study findings show that more than half of the floodplain of the metropolis segment of River Lamurde has been encroached upon by built-up. The 30m statutory standard setback by government for river buffer zone was not observed in the study area. The fastest encroachment was observed in the 1990s which corresponds with the period of rapid urbanization in Jalingo metropolis following the creation of the state and designation of the town as the state capital. Urbanization has thus proceeded at a gradual rate since then to date. In order to get an idea of the period of time the residents moved to the area (floodplain), the people were asked how long they have been living in their houses and the age of the buildings. Their responses are presented in Table 1 and 2.

Table-1. Duration of occupation of Floodplain by Residents

S/No	Duration of Floodplain residents (years)	Frequency	Percentage
1	Less than 5years	27	14.3
2	6 – 10 years	28	16.7
3	11 – 15 years	14	32.1
4	16 – 20 years	12	33.3
5	Above 20 years	03	3.6
6	Total	84	100

The findings of the study show that 33% of the respondents have been living on the floodplain between 16 – 20 years, while 32% between 11 – 15 years as shown in Table 1. From Table 2, 25% of the respondents are of the view that the buildings are between 11 – 15 years old,

22.6% between 16 – 20 years old, 20.2% 6 – 10 years old and 16.7% above 20 years as shown in Table 2.

Table-2. The age of the buildings on the Floodplain

S/No	Age of the buildings on the Floodplain (years)	Frequency	Percentage
1	Less than 5years	13	15.5
2	6 – 10 years	19	20.2
3	11 – 15 years	21	25
4	16 – 20 years	17	22.6
5	Above 20 years	14	16.7
6	Total	84	100

The increasing rate of commercial activities in and around Jalingo town has resulted in the growing proportion of residential areas within the town limits by transforming the remaining portion of agricultural and undeveloped lands. The rise of land value in Jalingo town also affects the land use pattern. Highly valued land in central business district (CBD) area is used by high income group. Considering land value some residences are converted into commercial uses. Different categories of land uses including residential have been greatly developed on the fringes of the town because of the high value of land in the central area. A large number of people from different parts of the north eastern Nigeria have migrated to Jalingo town for several pull factors, especially the relative peace in the area in the face of increasing threat from insurgent activities in the region. New residential area has developed using agricultural land, fallow land and open spaces for providing housing facilities to the increasing population. This led to emergence of new residential areas along the banks of the river, replacing the agricultural and fallow lands on the flood plain.

The increase density of settlement on the flood plain along the river bank has increased the amount of runoff generation as a result of impermeable surfaces to absorb rainfall and channel its flow into sewers and drainage ways. Findings of this study show that substantial part of the floodplains in the study area has been encroached by residential buildings.

Table-3. Reasons for building on Floodplains

S/No	Reasons for building on Floodplain	Frequency	Percentage
1	Low cost of land (land values) affordability	29	34.5
2	Less interference by town planning agents	11	13.1
3	Proximity to city centre/place of work/irrigation farmlands	25	29.8
4	Low income of residents	08	9.5
5	Security and safety of lives	02	2.4
6	Easy access to unregulated building	09	10.7
7	Total	84	100

About 25% of the houses sampled are located within less than 20 metres distance from the river channels (buffer zone). Most of the alluvial plains previously used for irrigation are now been gradually converted to residential houses. Reasons given for inhabiting the flood plain are presented in Table 3.

3.2. Causes of Land Use Changes in the Study Area

The floodplain settlements constitute the urban informal settlements which are usually regarded as unsuitable for development and as such present a comparatively lower risk of eviction Derek and Adrienne [13]. Anunobi [14] alluded to this by describing floodplain settlements as informal and illegal settlements that falls outside the development control or regulation and are not accounted for in the economy of the area. This has thus, resulted to inadequate land-use planning on the flood plain and uncontrolled development of residential buildings which further add to the consequences of water challenges and security in the study area. Oyinloye, et al. [15] observed that urban informal settlements are usually characterized by lack of or absence of waste disposal facilities and lack of development control mechanism.

The desire for cheap landed property and residential accommodation had thus led to the extension of housing into the flood plains along the river banks. The findings from this study show that most of the inhabitants of the floodplain were people who moved to the area because of the cheap land and low rent of the residential accommodation, while others were strangers (migrants) who bought the land without prior knowledge of its vulnerability to flooding. Since the flood is not an annual event, many of those who bought the land comfortably built their houses uninterrupted. It was later that they discovered that the area is vulnerable to flooding. In the last decade, there has been about two major flood disaster in Jalingo town (i.e 2005 and 2011). The result of this study shows that 59.5 percent of the respondents owned the houses they were living in, while 40.5 percent were tenants.

3.3. Nature of Land Use Changes along the Floodplain

Most of the lands across the River Lamurde to the southern bank were hitherto used for rainfed agriculture and the major crops cultivated were cassava, maize, guinea corn and rice but with increased urbanization, the lands were cleared of their vegetative cover and replaced with irrigation farming. The crops cultivated changed to potato and vegetable for urban consumption. According to some of the residents interviewed, the changes in land cover accelerate the effects of flooding along the river banks and floodplain. The lands are intensively cultivated and the farmers plant 3 times a year. The intensification of irrigation farming on the banks is facilitated by high usage of chemical fertilizer and animal waste (faeces). Findings from field observations show that residential settlements are also fast expanding from the newly constructed roads towards the river valley in the southern banks.

3.4. Effects of Land use Changes along the Floodplain

Land use is a complicated term, which natural scientists define in terms of patterns of human activities such as agriculture, forestry and building construction that alter land surface processes including biogeo-chemistry, hydrology and biodiversity [16]. Land use has also been defined as "the total arrangements, activities, and inputs that people undertake in a certain land cover type" [17]. According to Ayivor and Gordon [16], land use types are always influenced by local livelihood demands. Irrespective of the causes of land use change, their impacts could be very devastating on river catchments, and could result in loss of biodiversity through habitat loss, habitat fragmentation, and edge effect, which has the potential to affect interior species' viability [18]. As urban centresgrow and become large Municipal areas, there is always increased competition in the demand for land for different purposes. 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 [19]. The urban growth in the area has led to intensification of irrigation activities along the banks of the rivers to produce vegetable for the increasing urban population resulting in changes in land uses. This is further worsened by the increase in the construction of residential buildings along the banks of River Lamurde and its tributaries. Some of the observed effects of land use changes in the study area include;

i. Building on floodplains along the river banks block the right way of water and reduce the channel capacity to carry load, thereby forcing the river to deposit their excess load on the beds of their channel. This gradually raises the river beds and quickly initiate floods even with moderate rainfall event as observed by Jimoh and Iroye [20] in their study in Ilorin, Kwara state. All the respondents insist that there were no drainage network in the area to channel excess surface flow. Also, during the field observations, drainage network were not found in most places in the floodplain. The only drainage network that lined up the road entering the area was small and incapable of containing the overland flow generated from rainfall.

ii. The flood plains of the river systems in the study area are often cultivated without any planning or management practices. Chemicals from the farms are washed into the rivers, hence making them to become health threat to residents using them for domestic consumptions. The adjacent cultivated soil (Plate 1) are loosened thereby causing massive silt-washing into the river system. Wastes and refuse were being disposed into the river by the adjoining settlements, thereby turning them into sewers of waste (Plate 3).

iii. Most of these areas that were newly built have become densely settled with buildings of different type and quality. These areas are highly vulnerable to seasonal flood hazard, including inundation and erosion, as new development continues. The flood plain is among the high population density areas in the town. These areas include parts of Magami, Sarkin Dawaki and Majidadi wards.

iv. Construction of residential buildings along the river banks have the ability to alter the capacity of the channel to convey water and can increase the height of the water surface (also known as stage) corresponding to a given discharge. Sediments and debris carried by flood waters can further constrict a channel and increase flooding. This hazard is greatest upstream of culverts, bridges or other places where debris collects. Small stream channels can be filled with sediments or become clogged with debris, because of undersized culverts as observed around the roundabout on the new road and Palace road close to the Karofi bridge. Land use and other human activities along the banks of the river and floodplain can influence the peak discharge of flood by modifying how rainfall water run off the land surface into streams.

v. The main environmental concerns are organic and bacteriological contamination caused by improper agricultural practices (use of fertilizers and pesticides runoff), urban waste (Plate 4) (solid waste, sewage discharge and effluents from the abattoir). All the effluent generated from the abattoir is directly discharged into the stream. The effluents and solid waste such as blood, manure and faeces generated from the abattoir and discharged into river Lamurde contains a lot of bacteria, virus and chemical elements that are harmful to human health [21]. By accumulating metals in above ground tissue, plants can transfer heavy metal pollution from soils into the food chain, and this accumulation is one of the most serious environmental concerns of the present day, not only because of the phytotoxicity of many of these metals to the crops themselves, but also because of the potentially harmful effects toxic metals could have on animal and human health. Even at low concentration, these chemical elements can be toxic and low toxicity can be harmful as a result of bioaccumulation [21].

vi. In growing urban centres like Jalingo Metropolis, one of the primary factors that cause changes in water resources is the constant evolution and changes in land uses especially on river banks and floodplains. Inappropriate water abstraction for domestic use (Plate 2 and 3) and for irrigation within the catchment is also a great source of worry. All these impacts invariably have telling consequences on river systems and aquatic environment.

Plate-1. Farmlands along River Lamurde

Plate-2. Water abstraction along River Lamurde

Plate-3. Refuse heaps along River Lamurd

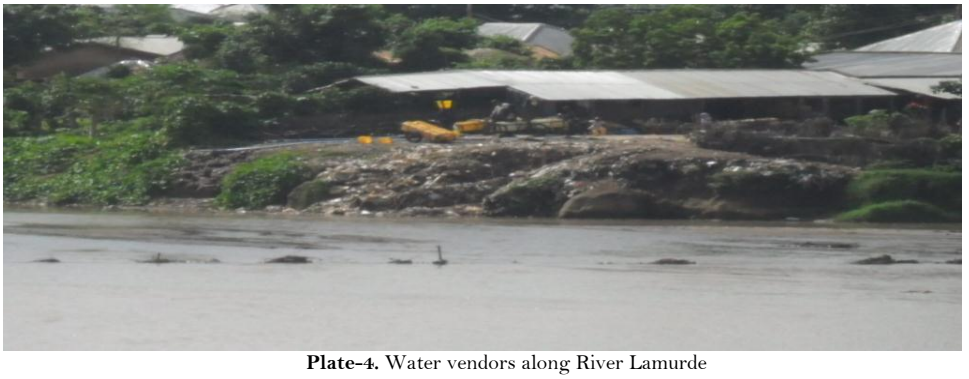

Plate-4. Water vendors along River Lamurde

4. CONCLUSION

This study has examined the causes and impact of land use changes along the banks of River Lamurde. The findings of this study shows that land use along the banks of the river Lamurde has undergone a substantial level of change from open fields and fallow lands to intensively cultivated irrigation farmlands and residential areas. The dominant land use types in the basins presently are rainfed agriculture and irrigation farming, grazing and development of residential buildings as well as indiscriminate waste disposal. The observed land use activities include, excessive water extraction, deforestation for fuel wood and other domestic uses, excessive use of chemical fertilizers and land degradation due to improper agricultural practices. These land use activities

have impacted negatively on the river systems. The study conclude that there is the need to streamline land use activities, conserve vital ecosystems like watershed areas and maintain buffers along stream channels as a matter of policy to ensure adequate protection of aquatic fauna and to ensure sustainable water supply. The town planning authority should enforce restriction of expansion of buildings on the river banks because of their vulnerability to flood disaster. Given the increasing intensity of irrigation and chemical fertilizer usage, this study recommends the need for further study on the impact of fertilizer and irrigation on the river ecosystem.

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