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EFFECTS OF LANDUSE/LANDCOVER CHANGES ON KUSALLA RESERVOIR IN KANO STATE, NIGERIA

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Abstract

The aim of this study is to assess the effects of Landuse/landcover changes on Kusala Reservoir for the period of four decades. Satellite imageries including Landsat MSS 30m resolution for 1973, 1990, 1999 and 2009 were obtained and analysed using G.I.S procedures. The result revealed that the Reservoir has shrunk by 44.46 ha (70% decrease). Vegetation cover has reduced by 2955.87 ha (46% decrease). While built-up area has increased by 630.81 ha (98% increase). Cultivated area has increased by 5042.11 ha (84% increase). Bare land has reduced by 2683.98 ha (61% decrease) between 1970s and 2010s. The result also revealed that sedimentation and reduction in capacity of the reservoir are the major impacts of Landuse/ landcover changes over the years. Watershed management, dredging and proper project monitoring among others were recommended.

Key words*:* Landuse, Landcover,Reservoir, Built-up, Cultivated, Vegetation, Bare land.

1.0 Introduction

Land is the source of the materials needed for human development on the planet earth and the stage on which all human activity is conducted. Human use of land resources gives rise to "Land Use" which varies with the purpose it serves, which may include food production, provision of shelter, extraction and processing of materials among others.Understanding the role of land use in regional and global environmental changes requires a historical reconstruction of past change conversions and projection of future trends (Lambin, 1997).

Land use change is the result of the complex interactions between human and biophysical environment, which affect a wide range of temporal and spatial scales(Setiawan*et al*., 2015). Land use involves both the manner in which the biophysical attributes of the land are manipulated and the purpose for which the land is used (Briassoulis, 2000).The degree of Land use change differs with the time as well as the geographical area. The assessments of these changes depend on the source, the land use types, the spatial groupings, and the data sets used. Land use changes are driven by many diversified underlying processes (Geist & Lambin, 2001 and Turner *et al*., 2007). Anthropogenic drivers, example demographic and socio-economic conditions, and biophysical constraints such assoil, climate and topography, determine the spatial pattern of land use (Skole& Tucker, 1993 and Turner, *et al*., 1994), and their relationships are often used in the spatial models of deforestation and sedimentation in water bodies especial reservoir(Verburg *et al.,* 1999). The spatial integration of socio-economic and biophysical data, which provides a mechanism to explore the relationship between human activities, landscape conditions and forest cover changes, is an important step to improve understanding of the change in forestland and reservoir sedimentation and their future role (Prasetyo*et al*., 2009).

Land cover is the biophysical state of the earth's surface and immediate subsurface (Turner, 1995). In other words, land cover describes the physical state of the land surface. Human activities affected the land cover as a result of man's strive to meet the daily needs. Global assessment of percentage of land cover affected by human action varies from 20% to 100%, whereas, the human's appropriate earth's potential net primary biological production is 20% to 40% (Richards, 1990; Nemani &Running, 1995; Brown *et al.,* 1999; Small &Nicholls, 2003).According to Meyer & Turner, 1994 and Kalensky *et al.,* 2003, nearly 24% of the earth surface area has experienced decline in ecosystem function and productivity during the last two decades while the 43% of the earth surface area has experienced human-induced degradation(Daily, 1995).

A reservoir is a natural or an artificial lake where water is stored before it is taken to where it would be used. Reservoirs are built for agriculture, domestic, hydro-electric power generation and recreation (Ward,1975). However, sediment-laden rivers pose several challenges to reservoirs constructed across them. The resultant reservoir receives water and sediments from the catchment area of the river network. Erosion, sediment transport and sediment deposition are major environmental issues that affect the society, through the reduction of reservoir capacity and intensification of both water pollution and floods (Walling, 1983; Lane, 1992).

According to Ali and El-Magd (2016), the excessive increase in population, civilization and the accompanied developments during the last few decades accelerated the demand of water, land and forest resources and hence, land use land cover changes have increasingly assumed from significant to terrifying proportions. What is most important however is that with few exceptions, it is human and not nature's agency which brings about these changes and which is responsible for their magnitude and severity. Some of these environmental problems are desertification, eutrophication, siltation, among others (Lane 1992).

The predominant land use activities within Kusalla reservoir catchment area are farming, grazing and settlements while land covers are predominately shrubs, grasses and rocks outcrops. These land use activities contribute to accelerating erosion in the area which in turn increases the sedimentation problem of the reservoir and consequently reduction in its installed capacity. Hence this provides the impetus to study the contribution of Land use/Landcover to sediment generation through the following objectives: (i) to determine the trend of land use/land cover changes for the period of four decades in the area.(ii) to determine the degree of change for each of the land use/land cover attributes in the area.

2.0 Methodology

2.1 Study Area

The Kusala Reservoir is situated in Karaye local government area of Kano State, Nigeria. It liesbetween latitudes $11^{0}48'30''$–$11^{0}50'00''$ N and longitudes $8^{0}00'30''$–$8^{0}02'45''$E. The area is about 100 Km from the city of Kano and located to the south-western part of the state (Figure 1).

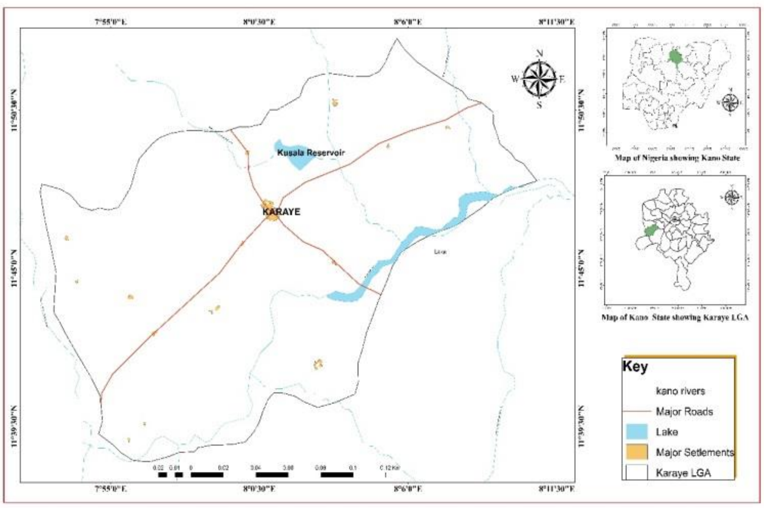


Figure 1:Map of the study Area

2.2 Landcover Data

To characterize land use/land cover changes of the catchment of Kusalla, Reservoir, satellite imageries covering the period 1970–2010 were obtained from the Global Land Cover Facility (GLCF) (http://glcfapp.glcf.umd.edu:8080/esdi/) and USGS Earth Explorer (http://earthexplorer.usgs.gov).These include; Landsat MSS 30m resolution for 1973, 1990, 1999 and 2009 covering the study area are.

The main method used in this study was supervised classification for land use and land cover identification. Land use and land cover that have been classified in this study are (1) Reservoir, (2) Vegetation, (3) Cultivated areas, (4) Built up area., (5) Bare land as demonstrated by Aroengbinang and Kaswantoa, (2015).

2.3 Land use Landcover Change Detection Analysis

The satellite imageries were analysed using Idrisi Selva version 17.02 and ArcGIS version 10.2.1 Geographic Information Systems (GIS) procedures: The Images were pre-processed by correcting and compensating systematic errors, they were also enhanced to improve the visual interpretation of the imageries. Geo reference was done to rectify geometric distortion. The imageries were classified in terms of their characteristics at the corresponding point on the earth surface followed by the production of colour composite image to provides background images for sampling and interpretation purposes. Finally, different symbols (colours) were assigned to the various land use land cover features. This was done following laid down conventional format. For instance, Blue was used to represent water body, Grey represent built-up area; Green represent forest among others.

According to Kaliraj*et al*., (2017), the combinationsof bands in Landsat MSS images are effectively suitable for extraction of various LULC features. For example, the band combination of band 1, band 4 and band 5 distinctly producedfeatures like water bodies, settlements, and salt marsh in the coastal area(Kaliraj*et al*., 2017). Similarly, the combined image of band 3 and band 4 are classified for cultivable lands, forest, scrub and other natural vegetative cover (Chen *et al*., 2003). In this analysis, the Landsat MSS images with the first five bands such as band 1 (0.45–0.52 lm), band 2 (0.52–0.60 lm), band 3 (0.63–0.69 lm), band 4 (0.76–0.90 lm) and band 5 (1.55–1.75 lm) were combined into multispectral image for extraction of land use and land cover feature for the periods of 1973, 1990, 1999 and 2009.

3.0 Result and Discussion

Figure 2 presents the imageries for Land use/Land cover, while Table 1 presents the result of Land use/Landcover changes in hectares of the study area for 1973, 1990, 1999 and 2009. The Land use/Land cover of the study area in the 1973 shows abundant vegetation cover of about 3670.38 ha and bare land of about 3272.94 ha. The built-up and cultivated areas are very scarce with 23.85 ha and 5662.94 ha respectively (Table 1). The Reservoir is at its full capacity covering an area of 132.48 ha of land mass. Around the Reservoir, there are lots of vegetation cover and bare land, an indication that the Reservoir is newly constructed at the time. The nature of the Land use land cover distribution for the study area in the 1973image, indicates scarce human population and hence less socio-economic activities. In the1990, built-up and cultivated areas sprang up in different sections of the study area to cover up to 214.2 ha and 8440.56 ha respectively. The bare land still in abundance, the vegetated area diminishes while the reservoir shrinks. The shrinking of the Reservoir may be attributed to the emergence of built-up areas within the Reservoir as it attracts human population at the time. In the 1999, built-up and cultivated areas continue to sprang up as new roads are constructed while bare land is overtaken by cultivation of crops to feed the ever growing population. Vegetation diminishes as a result of clearing of bushes for cultivation and the cutting down of trees for fuel wood. The capacity of the Reservoir reduces as a result of human activities mainly the construction of infrastructures which in turn increases the sedimentation loads in the Reservoir and consequently reduces its water holding capacity. The year 1999 shows more built-up and cultivated areas an indication of very rapid increase in human population. The bare land, vegetation and Reservoir diminish an indication of high pressure exerted upon the environmental components by the human population in the area. As indicated by Ifatimehin and Ufuah(2006) that man's dependence on the physical environment for his basic needs has generated a lot of impact on the environment especially in terms of population increase with its associated consequences including shrivelling water bodies due to human induced sediment yield.

The trend on Land use/Landcover changes in the study area is presented in Figure 3. There are three Land uses and two Landcovers. The built-up area, cultivated area and reservoir constitute the Land uses areas while the vegetation and the bare land areas constitute the land covers in the study area.

Table 1. Land Use Land Cover Change

LULC	**1973**	**1990**	**1999**	**2009**	**% Change**
Reservoir	132.48	113.4	109.98	88.02	70 ⬇
Vegetation	3670.38	1614.51	714.51	725.67	46 ⬇
Cultivated Area	5662.94	8440.56	9595.62	10705.05	84 ⬆
Built-up Area	23.85	214.2	267.75	654.66	98 ⬆
Bare Land	3272.94	2379.69	2074.5	588.96	61 ⬇

The arrows indicating increase (⬆ and decrease (⬇)

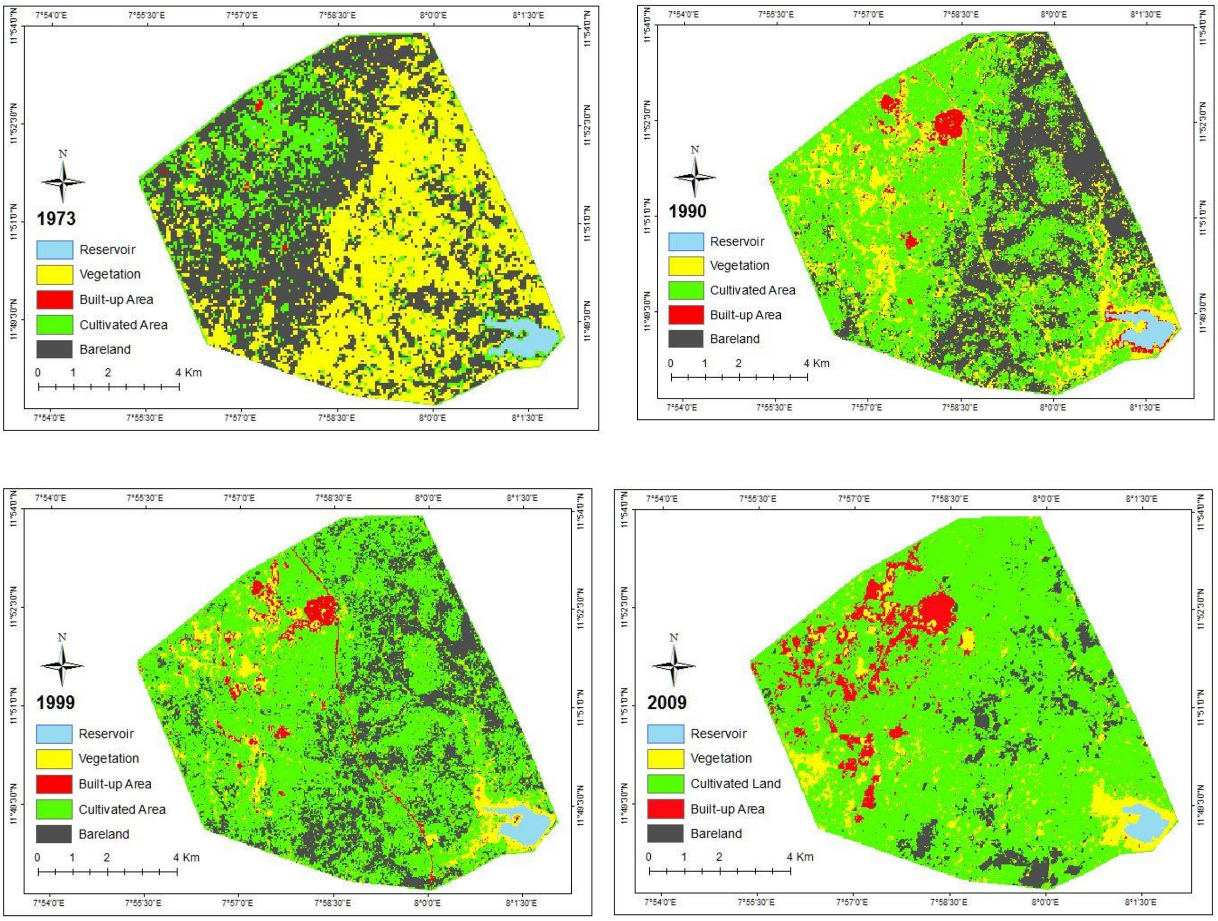


Figure 2: Satellite imageries of the study area for 1973, 1990, 1999 and 2009

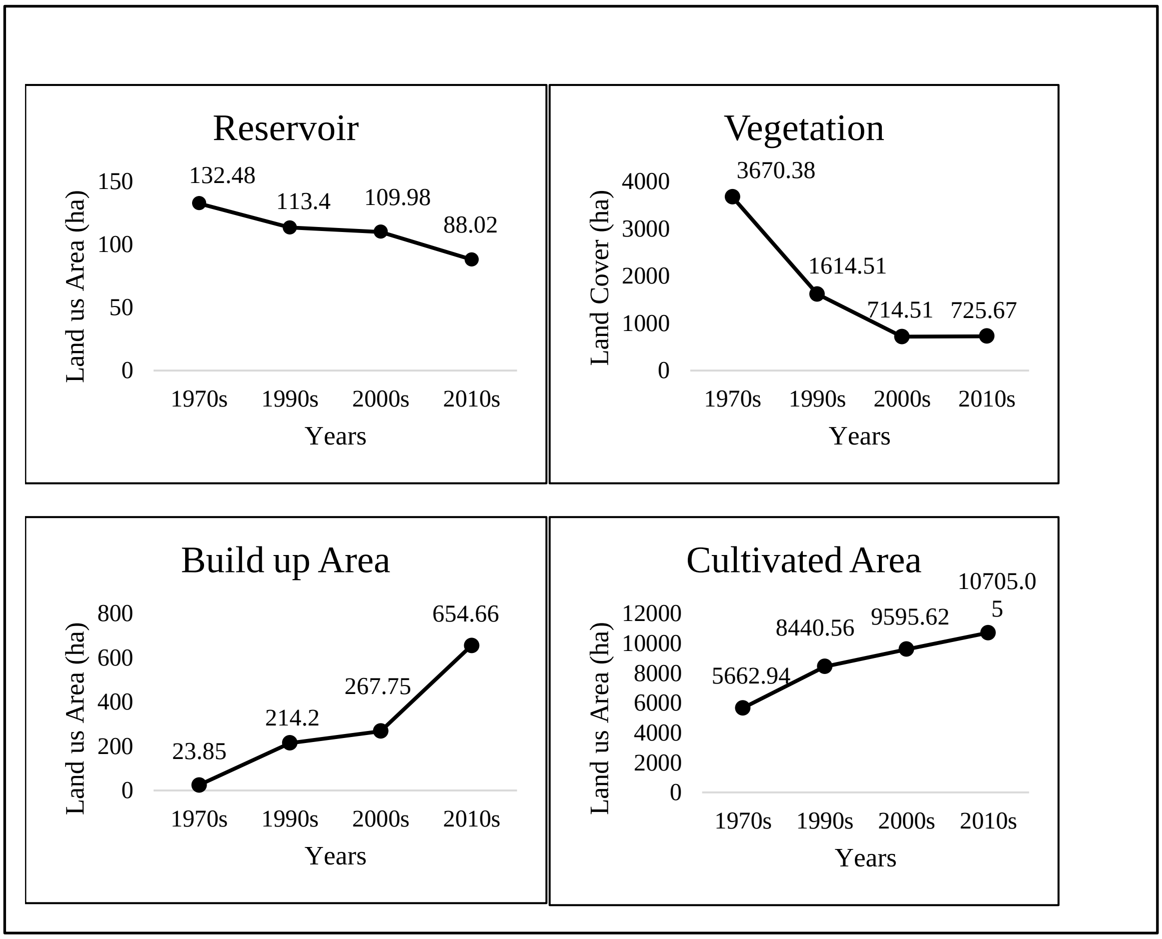
The reservoir decreases from 132.48 ha in 1973 to 112.4 ha in 1990 and further decreases to 109.98 ha in year 1999. The decease continues to about 88.02 ha in the year 2009. This implies that the Reservoir has reduced by 44.46 ha about 70% decrease from 1973 – 1999 in the study area. The decrease in the water body may be attributed to high rate of sedimentation resulting from erosion of surrounding agricultural land in rainy season due to intensive agricultural activities around the reservoir and also from upstream via river corrosion.

The vegetation cover has sharply decrease from 3670.38 ha in 1973 to 1614.51 ha in 1990. It further decreases to 714.51 ha in year 1999. The implication is that the vegetation cover has reduced by 2955.87 ha about 46% decrease between 1973 – 1999. This decrease in vegetation cover may also be attributed to clearing of bushes for cultivation, grazing by animals and cutting down of threes by the local populace for fuel wood.

The built-up area increases from 23.85 ha in 1973 to 214.2 ha in 1990. The increase continues to 267.75 ha in 1999 and further sharp increase to 654.66 ha was attained in 2009. This suggests that built-up area has increased by 630.81 ha about 98% increase from 1973 – 2009.The increase in built-up area is associated with the increase in human population. This is due to relevance of shelter and other infrastructures to man. The Progressive increase in built up area from 1973 to 2009 agreed with the fact that rapid increase of settlement with its attendant population growth have serious impact on land. By creating impervious surfaces due to buildings, runoff is generated consequently high level of sediment generation which are emptied in stagnant water.

Cultivated area increases from 5662.94 ha in 1973 to 8440.56 ha in 1990. It further increases to 9595.62 ha in 1999. The increase continues to 10705.05 ha in 2009. This implies that cultivated area has increased by 5042.11 ha; about 84% increase between 1973 and 2009. The increase in the cultivated area is attributed to the growing population which ultimately cultivate the land for food production.

The bare land in the study area experience decrease from 3272.94 ha in 1973 to 2379.69 ha in 1990. The decrease continues for a decade to 2074.5 ha in year 1999 and finally, a sharp decrease to 588.96 ha in 2009 has been attained. It implies that bare land has reduced by 2683.98 ha; about 61% decrease from 1973 – 2009. This decrease in bare land within the study area is associated with cultivation of food crop to cater for the growing human population in the study area.



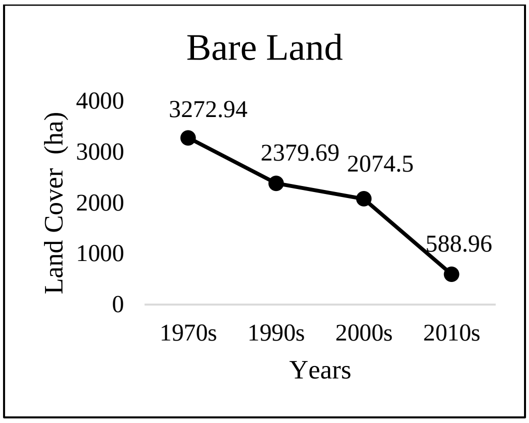


Figure 3: Trends of Land us changes in the study area from 1970s – 2010s

4.0 Conclusion

The paper assessed the Land use/landcover changes for the period of forty (40) years within the catchment of Kusala Reservoir in Karaye area. The Land use/landcover in the study area was characterized into reservoir, built-up area, cultivated area, vegetation and bare land. The results obtained supported the conclusion that the decrease in vegetation cover and the bare land coupled with the increase in built-up and cultivated areas over the years have consequently caused the shrinkage of the reservoir through rapid sedimentation as impervious surfaces were created as result of increase in build-up areas. Run-off was generated as a result of decrease in vegetation cover. Erosions were formed as a result of increase in land cultivation during wet season. River sedimentations were created due to decrease in bare land within the reservoir. Based on the conclusion the authors recommended that the reservoir should be monitored regularly to ascertain level of sedimentation. Embankment should be put in place in order to prevent the collapsing of the reservoir as it may result to flooding the areas downstream of the reservoir. The reservoir should be dredged regularly.

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