COMPARATIVE ASSESSMENT OF LANDUSE LANDCOVER CHANGES ON WATER QUALITY OF RIVER KADUNA FROM 2012-2020 AT WUYA, NIGER STATE, NIGERIA

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ABSTRACT

The study investigates the effects of land use land cover changes on water quality of River Kaduna from 2012-2020 at Wuya, Niger state, Nigeria using Landsat 7 imagery. Five classes of LULC types where selected and used as basis for classification. Also, five (5) sampling stations selected on the water body for water quality analysis which were collected once monthly for a period of six months from February 2020 to July 2020. The results of LULC classification depicts an increase in water body from 2.241km^2 in 2012 to 3.029km^2 in 2020 while Agricultural areas increased drastically from 4.718km^2 in 2012 to 22.862km^2 in 2020. Physical and Chemical parameters showed range values of Total dissolved solids varying from (15.54±18.00 - 61.00±21.38) in 2012 while (3.67±1.05 - 5.67±2.57) in 2020, Alkalinity was between (31.33±8.08 - 62.33±17.79) in 2012 whereas (21.33±11.55 - 29.33±6.11) in 2020, Hardness ranged from (38.67±4.16 - 51.33±10.26) in 2012 whereas (15.00±1.73 - 22.33±7.77) in 2020. The result showed no significant difference ($p > 0.05$) except Total dissolved solids, Alkalinity and Hardness which recorded higher values on both seasons across stations and months. In general, the study revealed increase in agricultural area drastically, so there is a need to constantly monitor and update the check list of land use land cover, Physical and Chemical parameters changes in and around the River to control anthropogenic pollution from residence, on the water and from nearby farmlands.

Keywords: Land Use Land Cover, Water Quality, River, Wuya, Physical and Chemical

INTRODUTION

Land use is simply human activities that explores the usage of land, and Land cover on the other hand can be seen as the amount of vegetation on land surfaces. Water quality could be referred to as a measure of water use for different purposes (drinking, industrial, agricultural, recreational and habitat) using various parameters such as physical, chemical and biological parameters which varies according to location, time, weather and sources of pollution (Giri and Qiu, 2016).

The impact of Land use is high on water quality of rivers and inland water bodies found in Nigeria due to the high rate of human interaction, this also result to change in land cover patterns within the watershed of rivers. As human activities increase in an area, there is change in Land use Land cover (LULC) hence affects the management of that area, the water quality of rivers and runoffs.
Remote sensing techniques have been recognized as a powerful means to obtain information on Earth's surface (Schneider, *et, al.* 2010). Through supervised classification, the relationship

between land use/land cover was analyzed using QGIS tool for change detections and how it relates to water quality around River Kaduna downstream at Wuya for the years 2012 and 2020.

MATERIALS AND METHODS

The Study Area

Wuya located in Niger State. It is just some few kilometres from Bida, at a latitude of 09°08'. 622" N and longitude of 05°50'. 258" E with an elevation of 75.1M. The prominent feature which can serve as a landmark in identifying the river is an MTN network mask mounted few meters to the river and an overhead bridge that connect both ends of the River together to allow for easy passage of travellers, cars, goods and services to and from across both ends of the river. The River is a major source of water for domestic activities for the community.

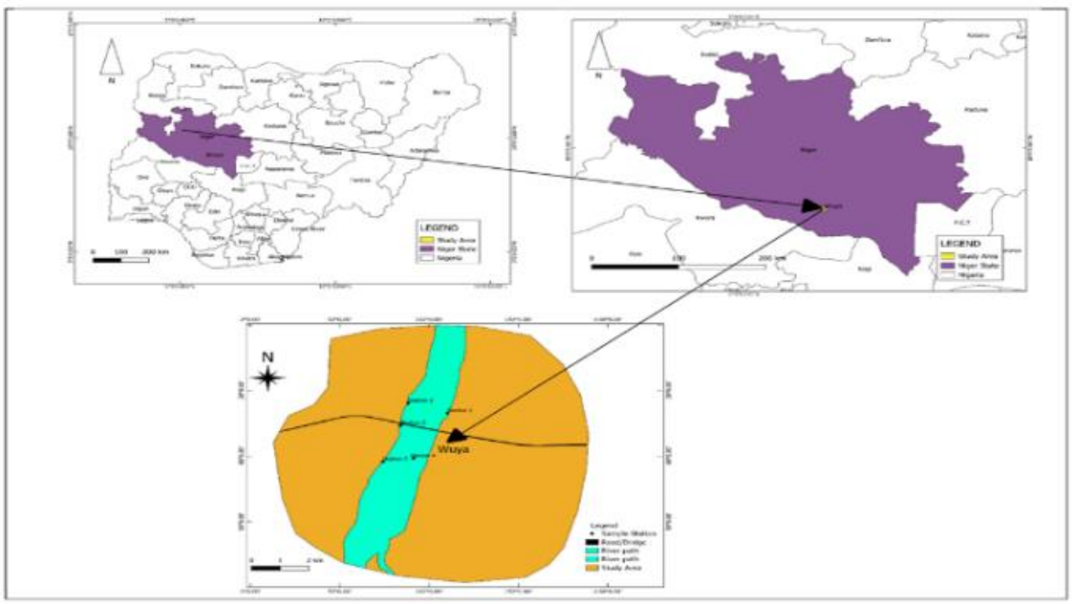

Figure 1. Nigeria indicating Niger state and the study area.

The study was carried out in six month (6) from February and July 2020.Water samples were collected once monthly for the period from 5 sampling stations. Five classes of LULC types where selected (Water bodies, Agricultural areas, bare surfaces, Natural vegetation, Settlements) and used as basis for classification of the LULC around the River using QGIS tool.

Site Selection

Station 1 had its land use classification as natural vegetation. This area consists of naturally growing plants with little interference with human activities, (where pipes for irrigation purpose were mounted). On coordinates point of 09°08'.061" N, 05°49'.858" E, and elevation as 71.1m.

Station 2 had its land use classification as agricultural area. This consists of where farming activities and irrigation take place on coordinates 09°08'.141"N, 05°50'094"E and elevation as 70.6m.

Station 3 had its land use classification as settlements on coordinates as 09º08’.686” N, 05º50’.070” E and elevation as 69.0m.

Station 4 had its land use classification as water body. This area consists of a large volume of water towards the middle of the river. The area recorded coordinates as 09o08’.853”N, 05o50’109” E and elevation as 67.0m.

Station 5 had its land use classification as bare surface. This area is a plain ground with sharp sand around and no grasses growing. The area recorded coordinates as 09º08’.784” N, 05º50’.302” E and elevation as 65.9m.

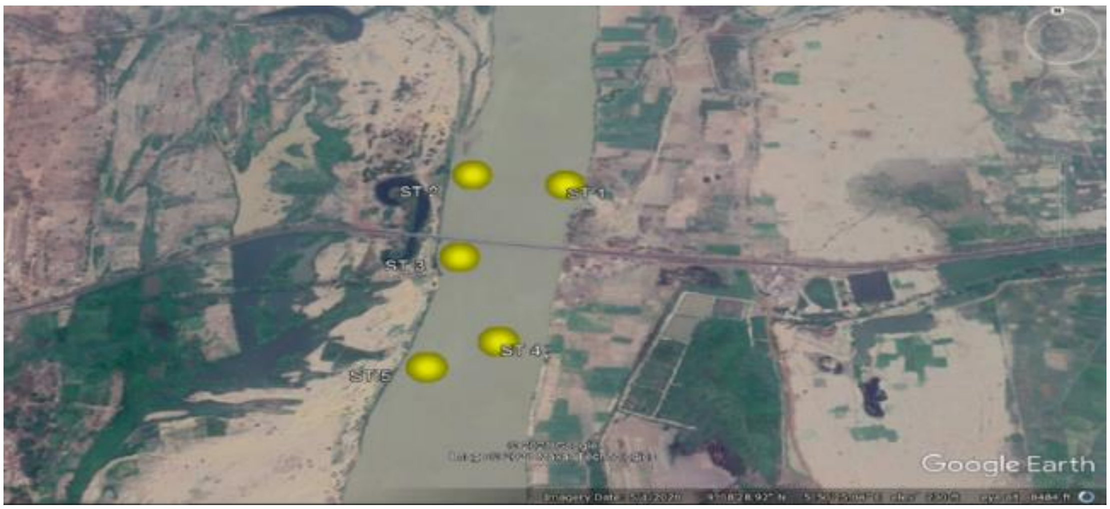

Figure 2. Google Earth Image of River Wuya showing selected sites.

Landsat 7 data was gotten for the study area of 2012 and 2020 from earth explorer which collected a panchromatic (black and white) imagery and multispectral imagery which was then imported into remote sensing image processing software (QGIS tool) for analysis.

RESULTS AND DISCUSSION

The result in Figure 3 depicts changes in classified land use land cover imagery of 2012 and 2020 with a rise in agricultural areas, lesser bare surfaces and natural vegetation in 2020 while Figure 4 compares the percentage changes in land use land cover around the study area.

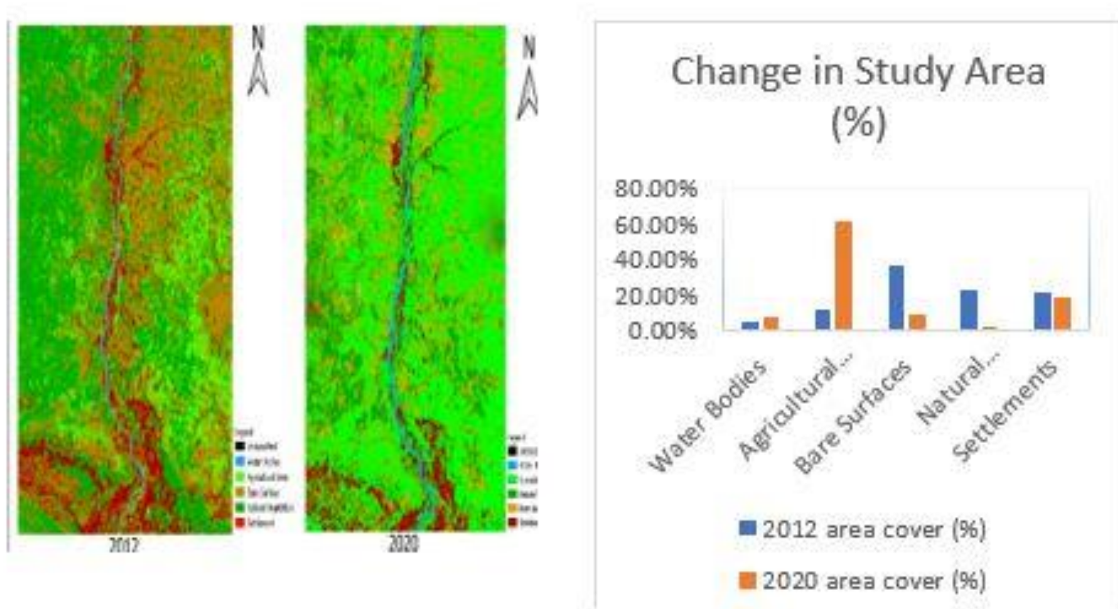

Figure 3. Classified Land sat image of the Land Use Land Cover around the study area in (2012 and 2020) with Comparison of their Percentage changes.

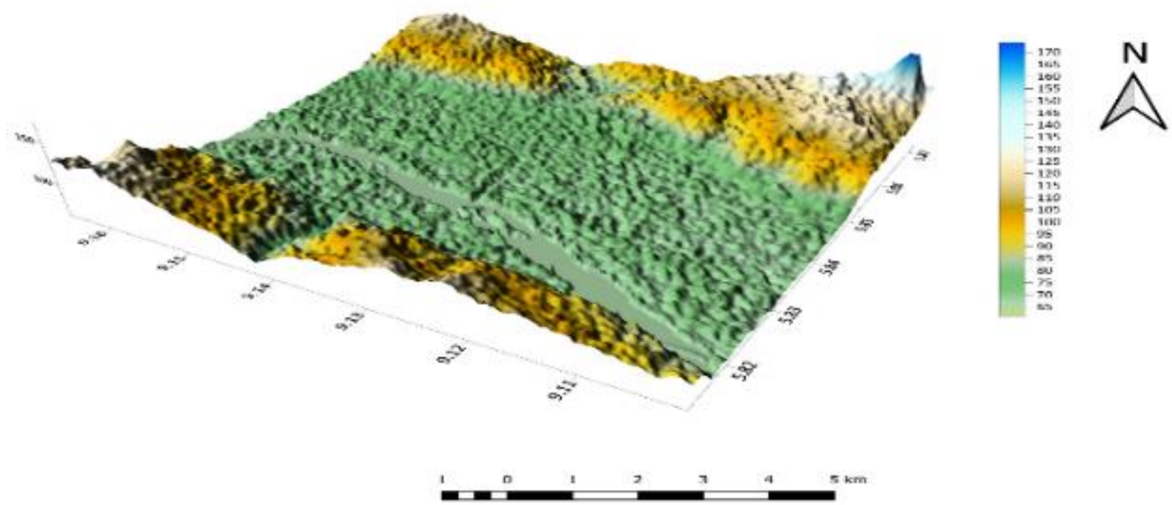

Figure 4. Digital Elevation Model of the Study Area.

Table 2. Magnitudes, percentage and average rates of change in Land Use Land Cover around study area (2012 and 2020).

LULC Types	2012 Area (Km^2)	2020 Area (Km^2)	Magnitude of Change (km^2)	% Change	Average Rate of Change (Km^2)	Remark
Water Bodies	2.241	3.0285	0.7875	2.24	0.3514	Increase
Agricultural Area	4.7178	22.8618	18.144	48.42	3.8458	Increase
Bare Surfaces	13.6728	3.5532	-10.1196	27.07	-0.7401	Decrease
Natural Vegetation	8.7471	1.0098	-7.1937	19.27	-0.8845	Decrease
Settlements	8.2035	7.1289	-1.0746	3.0	-0.1309	Decrease
Total	**37.5822**	**37.5822**	**0.5436**	**100**	**2.4417**	Increase

Table 2 above depicts that there was a decrease in the area covered by bare surfaces from 13.673km^2 in 2012 to 3.553km^2 in 2020 which relates directly with natural vegetation which also decreased in area covered from 8.747km^2 in 2012 to 1.010km^2 in 2020 due to anthropogenic activities. An increase in water body of the area was recorded from 2.241km^2 in 2012 to 3.029km^2 in 2020 this could be attributed to the change in vegetation type as part of land preparation, increase in runoff, uncontrolled human activities, demand for firewood and so on. There was a decrease in Settlements of the area from 8.204km^2 in 2012 to 7.129km^2 in 2020 which could be related to the increase in water body of the area that may have caused flooding in settlements along the water shed and made settlers relocate. A drastic increase in agricultural areas was recorded from 4.718km^2 in 2012 to 22.862km^2 in 2020. The highest increase maybe because of conversion bare surfaces into farmlands as agriculture is one of the main sources of income for the riparian communities and it is practiced all year round such irrigation. With these changes in land use land cover effects, water quality is highly affected and needs to be controlled. Relationships between land use land cover and surface water quality are relevant topics for discussion as human activities increase in a watershed (Ding, *et al.* 2015).

The physico-chemical parameters results vary across the sampling stations in both seasons (Table 3 and 4 below).

Hydrogen ion Concentration: pH recorded its highest value across stations for 2012 in the dry season (7.22 ± 0.18^a) at station 1 with its lowest value in the wet season (6.86 ± 0.77^a) at station 2.While 2020 had its highest recorded value across stations in the wet season (6.83 ± 0.02^a) at station 4 with its lowest value in the dry season (6.20 ± 0.43^a) at station 5.There was no significant difference ($p > 0.05$) for pH across means. Ideal range for pH 6.5 – 7.5 (Ding *et al.*, 2015). pH recorded negative correlation with Phosphate and positive correlation with total suspended solids, alkalinity, hardness and nitrate.

Temperature: Biological and chemical changes of water are greatly influenced by temperature, with the ideal range being 26^{o}C – 32^{o}C (Ding *et al.*, 2015). Highest value across stations was recorded for 2012 in the dry season (34.77±4.13^{o}C) at station 2 with its lowest value in the wet season (27.67±1.15^{o}C) at station 4. highest recorded value across stations in the dry season (31.66±0.75^{o}C) at station 3 with its lowest value in the wet season (27.63±1.66^{o}C) at station 4. There was no significant difference ($p > 0.05$) across means. A slightly negative correlation was recorded against dissolve oxygen.

Table 3. Dry Season Stations Variation (February - April 2012 and 2020).

Parameters	Years	SAMPLE STATIONS 1	2	3	4	5
pH	2012	7.03±0.70[a]	6.86±0.77[a]	6.90±0.56[a]	7.00±0.64[a]	7.00±0.45[a]
	2020	6.82±0.04[a]	6.82±0.04[a]	6.81±0.02[a]	6.83±0.02[a]	6.83±0.05[a]
T(^{0}C)	2012	29.33±0.57[a]	29.00±1.00[a]	28.00±0.00[a]	27.67±1.15[a]	28.00±1.73[a]
	2020	27.67±1.50[a]	27.80±1.65[a]	27.77±1.55[a]	27.63±1.66[a]	27.77±1.66[a]
EC	2012	92.33±30.62[a]	83.00±64.86[a]	67.33±33.32[a]	69.67±42.19[a]	67.00±44.44[a]
	2020	76.67±18.90[a]	65.67±5.86[a]	64.33±5.51[a]	67.33±5.51[a]	58.00±16.82[a]
DO (Mg/l)	2012	12.67±3.06[a]	12.00±2.00[a]	10.67±4.16[a]	11.33±5.03[a]	14.00±5.29[a]
	2020	10.67±3.06[a]	9.33±1.16[a]	10.67±2.31[a]	13.33±3.05[a]	10.00±3.46[a]
TDS (Mg/l)	2012	61.00±21.38[a]	55.00±44.23[a]	44.33±22.81[a]	45.67±28.68[a]	44.33±29.87[a]
	2020	4.91±1.21[a]	4.20±0.37[a]	4.12±0.35[a]	4.30±0.34[a]	3.67±1.05[a]
Alkalinity (Mg/l)	2012	62.33±17.79[a]	56.66±5.77[a]	57.00±18.36[a]	51.66±7.64[a]	53.00± 28.05[a]
	2020	28.00±4.00[a]	28.00±10.58[a]	29.33±6.11[a]	29.33±2.31[a]	30.67±6.11[a]
Hardness (Mg/l)	2012	38.67±4.16[a]	42.00±15.87[a]	37.33±8.08[a]	51.33±10.26[a]	39.33±18.58[a]
	2020	15.00±1.73[a]	18.00±5.29[a]	20.67±3.06[a]	21.00±2.00[a]	17.33±5.03[a]
PO_4 (Mg/l)	2012	0.70±0.47[a]	0.62±0.48[a]	0.66±0.50[a]	0.66±0.47[a]	0.80±0.63[a]
	2020	2.94±0.51[a]	2.40±0.37[a]	2.96±0.49[a]	2.49±0.21[a]	2.81±0.18[a]
NO_3 (Mg/l)	2012	2.88±0.93[a]	2.90±0.76[a]	2.84±.89[a]	3.04±0.72[a]	2.95±0.86[a]
	2020	0.22±0.02[a]	0.33±0.19[a]	0.24±0.04[a]	0.24±0.04[a]	0.24±0.03[a]

Means in the same row having the same superscript are not significantly different from other means (p>0.05)

Table 4. Wet Season Stations Variation (May - July 2012 and 2020).

Parameters	Years	SAMPLE STATIONS 1	2	3	4	5
pH	2012	7.22±0.18[a]	7.11±0.07[a]	7.04±0.19[a]	7.11±0.19[a]	7.07±0.15[a]
	2020	6.51±0.76[a]	6.41±0.41[a]	6.27±0.54[a]	6.21±0.53[a]	6.20±0.43[a]
T(^{0}C)	2012	32.17±4.65[a]	34.77±4.13[a]	32.87±5.22[a]	29.33±1.15[a]	30.17±0.28[a]
	2020	31.46±0.71[a]	31.50±0.75[a]	31.66±0.75[a]	31.43±0.80[a]	31.43±0.77[a]
EC	2012	76.00±27.84[a]	72.67±25.42[a]	78.00±27.06[a]	83.00±36.01[a]	79.67±32.87[a]
	2020	87.00±37.32[a]	77.00±24.27[a]	78.33±27.47[a]	85.00±39.00[a]	93.67±28.75[a]
DO (Mg/l)	2012	8.00±3.46[a]	7.83±0.29[a]	6.33±0.58[a]	8.00±2.00[a]	8.47±1.50[a]
	2020	11.33±2.31[a]	11.33±4.16[a]	12.67±1.16[a]	11.33±3.05[a]	10.00±0.00[a]
TDS (Mg/l)	2012	48.88±16.92[a]	46.60±15.54[a]	15.54±18.00[a]	52.70±23.40[a]	50.53±21.17[a]
	2020	5.67±2.57[a]	5.24±2.08[a]	5.19±2.06[a]	4.79±1.37[a]	5.45±1.23[a]
Alkalinity (Mg/l)	2012	33.33±11.55[a]	39.33±13.61[a]	41.33±18.90[a]	31.33±8.08[a]	34.67±12.86[a]
	2020	21.33±11.55[a]	24.00±12.00[a]	26.67±2.31[a]	26.67±6.11[a]	32.67±6.43[a]
Hardness (Mg/l)	2012	38.00±7.21[a]	45.33±9.87[a]	46.67±10.07[a]	41.33±6.11[a]	43.33±3.06[a]
	2020	23.67±14.15[a]	19.33±8.08[a]	22.33±7.77[a]	31.00±12.29[a]	28.67±4.16[a]
PO_4 (Mg/l)	2012	0.80±0.14[a]	0.88±0.23[a]	0.94±0.16[a]	0.77±0.06[a]	0.88±0.10[a]
	2020	3.15±0.29[a]	2.68±0.14[a]	3.16±1.28[a]	2.70±0.32[a]	2.54±0.24[a]
NO_3 (Mg/l)	2012	2.59±0.94[a]	2.64±1.25[a]	3.27±1.75[a]	2.57±1.48[a]	2.65±1.57[a]
	2020	0.21±0.05[a]	0.22±0.04[a]	0.21±0.04[a]	0.24±0.07[a]	0.23±0.09[a]

Means in the same row having the same superscript are not significantly different from other means (p>0.05).

CONCLUSION

The study on the comparative analysis of land use and land cover changes on water quality of River Wuya using QGIS, exposed causes of the land use and variation in physicochemical parameters. The use of QGIS allowed a more graphical representation on the study area to see trends and how land use land cover changed over time. The variations of land use land cover changes & physico-chemical parameters may be due to climate change, land use types, human activities, change in vegetation types, erosion due to the cut down of trees and more land rendered plain and open.

REFERENCES

Ding J, Jiang Y, Fu L, Liu Q, Peng Q, Kang M. 2015. Impacts of land use on surface water quality in a subtropical river basin: a case study of the Dongjiang River Basin, Southeastern China. Water, 7(8), 4427-4445.

Giri C, Zhu Z, Reed B (2005) A comparative analysis of the global land cover2000 and MODIS land cover data sets. Remote Sens Environ 94:123–132

Schneider, A.; Friedl, M.A.; Potere, D. Mapping global urban areas using MODIS 500-m data: New methods and datasets based on ‘urban ecoregions’. Remote Sens. Environ. **2010**, 114, 1733–1746.