Bima Journal of Science and Technology, Vol. 7 (1) Mar, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i01.389

IDENTIFICATION OF THE STATUS OF RIPARIAN VEGETATION ALONG DADIN KOWA RIVER, YAMATU DEBA LGA, GOMBE STATE, NIGERIA

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ABSTRACT

The study ascertained the true status of riparian vegetation along River Gongola basin Dadin-Kowa Dam Area. Both qualitative and quantitative data were used for the study. Remote sensing data was collected where Landsat 7 and 8 imageries (multi date - 1999 and 2019 data were sourced from www.usgs.nasa.gov at 30m resolution. Systematic sampling techniques was adopted for selection of quadrats while the respondents were selected using purposive sampling method. A line transects of 100m X 100m were laid systematically along the river course. On each transect quadrats of 30m X 30m were established for the survey. Microsoft excel, ERDAS software and ArcMap 10.4 GIS software were applied in the analysis. Result from the inventory of floristic composition within river Gongola around Dadin-Kowa Dam area revealed that, there are about 52 species of different genera. Azadirachta Indica was found to be more dominant specie with 790 stands (36.42%), followed by Mangifera indica with 403 stands (18.58%), then Anarcadium occidentale with 196 stands (9.04%). The year 2019 witnessed decline in the phenological characteristics of general vegetation, since 1999 dense vegetation has been decreasing. It has been discovered that, riparian vegetation has been altered by human activities such as farming, grazing, fuel wood collection, fire and establishment of settlements. The vegetation is reduced to isolated trees, leaving large open areas with buildings and open space. Plantation of economic tress such mango, guava, banana and cashew are found along the river bank which is a threat to native species. Species with high relative density (RD) are the most dominants. Anthropogenic disturbances course vegetation change negatively in the study area respectively, it has been concluded that riparian vegetation is decreasing due to impact of human activities around the area hence the need to halt the situation for future sustainability. The study recommended that afforestation programme should enforce and sustained.

Keywords: Riparian, Vegetation, Dadin Kowa, River, Status

INTRODUCTION

Riparian vegetation refers to the plant life and ecosystem that exist along a waterway. The surrounding areas of rivers, ponds, lakes, marshes, dams and streams are all considered riparian in nature. Riparian vegetation or landscape are among the most diverse and productive habitats which perform several critical ecological functions. They consist of infinite variety of plants such as herbs, grasses, trees and shrubs (Mubi, 2008). For most of the plants, running fresh water is the only habitat in which they can survive. Variation in water depth, morphology and slope, soil type among others, are among the factors that form an intricate pattern of the zones which type of plants may inhabit (Lecerf, Evangelista, Cucherousset and Boiché, 2016; Webb and Erskine, 2003).

Riparian vegetation's regulate the flow of energy and materials to forest floors and adjacent water bodies, filter nutrients and sediments in runoff, provide canopy to filter out UV radiation, and maintain cool water temperatures, deliver nutrient subsidies to receiving waters in support of aquatic food webs, and riparian derived woody debris can form critical structural elements of stream beds (Nisbet, Kreutzweiser, Sibley and Scarr*,* 2015). Riparian vegetation stabilizes and protects banks against erosion and interacts with hydraulic factors to shape channel morphology (Lecerf *et al.,* 2016). In spite of the variety of ecosystems services provided by well-preserved riparian vegetation, most riparian zones in highly populated regions have been deforested and/or deeply degraded. Since the ancient times, humans have competed with vegetation for occupying the fertile riparian soils, frequently reducing the riparian forest to a narrow hedge in the waterside Vidal, Gutiérrez and Alonso (2013).

Based on the obvious reasons of regional vegetation dynamics which has been influenced by global environmental change (Igbawua *et al.,* 2016), the natural vegetation of Nigeria has ever since been under considerable threat like those of most other parts of tropical Africa (Adekunle, *et al.,* 2013; FAO, 2012). Despite rich and abundant vegetation resources, the country is highly rated for unsustainable exploitations, deforestation and forest degradation among others (Momoh, 2014). Yet, the country lacks adequate monitoring framework (Erika *et al.,* 2015). However riparian zones in Nigeria provides different benefits, ecosystem services and support to well-being, ecosystem health, urban livelihoods and other advantages to the society at large. Riparian vegetation in River Gongola Dadin-Kowa Dam area Yamaltu-Deba has been negatively impacted largely by farming activities, expansion of human settlements as well as the invasion of alien plants with the former resulting in the clearing of riparian vegetation as well as livestock grazing and trampling along the river coast (Lazarus *et al.,* 2019). This area faces a lot of threats ranging from Fuelwood harvesting, overgrazing by livestock and agricultural practices that fail to conserve soil. Despite all these problems government and communities did not consider the possible ways of identifying the temporal changes in the riparian vegetation and the drivers of changes in order to take appropriate measures to minimize the damages or prevent the future destruction of the vegetation in the area. This study will help to provide information to forest management planning, policy and modeling efforts by quantifying and assessing the status of the riparian vegetation of the study area.

This research is aimed at assessing status and temporal changes of riparian vegetation in River Gongola Dadin-Kowa Dam area, Yamaltu-Deba with a view to providing information that will help in changing biodiversity management and conservation approaches in the area.

The Study Area

Dadin-Kowa Dam is on River Gongola a tributary of River Benue, it was constructed for the purpose of providing water for hydro-electricity generation and irrigation purposes. It also offers serious opportunities for fishing, recreation, grazing, construction and domestic and industrial water supply for residents of Gombe metropolis and environs.

Dadin-kowa dam is in Dadin-Kowa village, Yamaltu Deba Local Government Area of Gombe State Nigeria. It lies between Latitude 10° 15' to 100 30'N and Longitude 11°15' to 110 30' E. The Dam is about 35 to 37km away from Gombe town and 5km north of Dadin-Kowa town. The Dam was constructed at the lower part of the Gongola River. Gongola River is in northern Nigeria which is

Bima Journal of Science and Technology, Vol. 7 (1) Mar, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i01.389

the principal tributary of the Benue River (UBRBDA Dadin-kowa area office 2016).

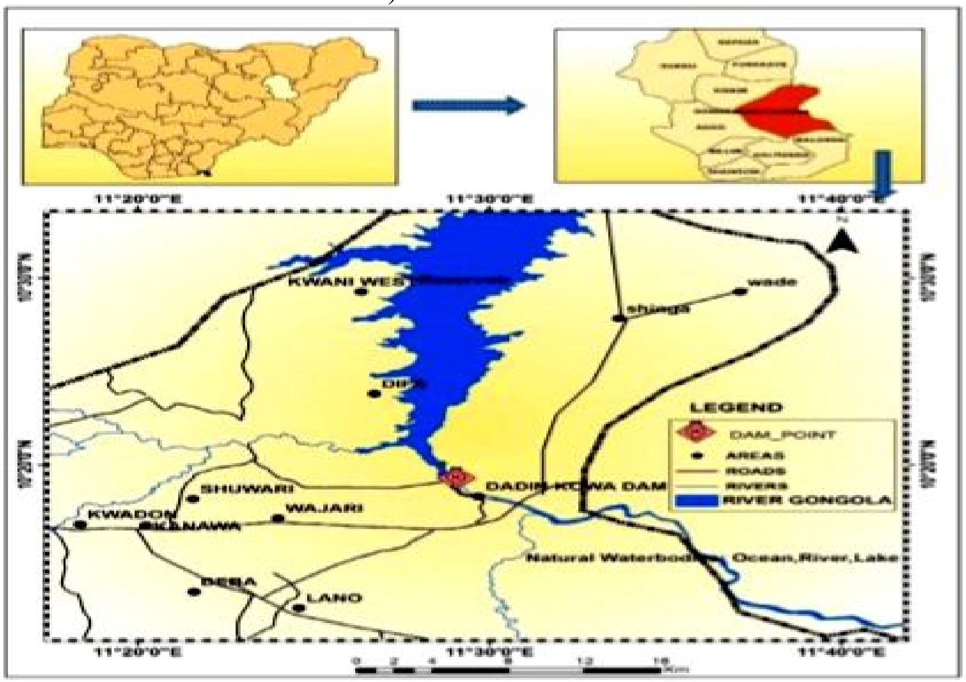

Figure 1: Study Area.

Source: Gombe State Shape file.

The climate of the area is part of the extreme tropical continental type. One of the basic characteristics of this climate zone is relatively short rainy season and a comparatively long dry season which fluctuates from year to year. The rainy season usually begins in late April and early May and ceases in late October. The rainy season lasts for (5) to Six (6) months, with a maximum rain fall in the month of July and August. The mean annual rainfall of the area ranges from 800-l000mm. The soil mostly found in Yamaltu-Deba local government is the vertisol, it is dark in colour and contain measurable amount of heavy clay. The vegetation of the study area is reflected by the climate of the region with scanty trees and grasses which are lush during the rainy season and dried off during the hot sunny (dry) season (Bello, 2015). The vegetation of Dadin-Kowa can be described as Sudan savannah, the natural vegetation cover consists of scattered trees, shrubs and species of grasses such as; *Adansonia digitata, Annona Senegalensis, Mangifera indica, Ficus thonningii, Parkia biglobosa, Azadirachta indica, Eucalyptus* and *water lilies*, are found within the study area (Bello, 2015).

MATERIALS AND METHOD

Type and Sources of Data

Both quantitative and qualitative data were collected to address the objectives of this study. Quantitative data inform of numerical values was sourced from vegetation inventory. Landsat 7 and 8 (multi date - 1999 and 2019) data was sourced from www.usgs.nasa.gov at 30m resolution. Qualitative data were obtained from the in-depth interview (IDI) with communities' members around the riparian vegetation zone.

DOI: 10.56892/bima.v7i01.389

Sample unit for this study was delineated in the field based on the morphology of the river channel. Systematic sampling was used to establish a transects and quadrats for the purpose of data collection following the river channel from the mouth of the dam down to Hinna Bridge in Dadin-kowa town for about a distance of 6km. Purposive sampling technique was used for the identification of respondents for the interview.

Transect walk was conducted with local guides where inventory of vegetation species of the study area was ascertained. The species were identified through their indigenous names; however, voucher sample of unidentified species was collected for further verification at the Federal College of horticulture Dadin-Kowa, Gombe State, Nigeria. The vegetation inventory was focused on the composition, density and frequency of the species in the study area. A line transect of 100m X 100m was laid systematically along the river course. On each transect, quadrats of 30m X 30m were established for the survey. Measuring tape 50m (for measurement of the distance between stations), ranging poles (for marking points), GPS global positioning system (Garmin *etrex* 10 Hand held type) for taking coordinates of the sampled points from each site, Microsoft excel software (was used for analysis of vegetation inventory data), ERDAS Imaging GIS software (was used for the classification of the land-sat imageries), Arc Map 10.4 GIS software (was used for the mapping and change detection), writing materials and digital camera were used in the collection of data.

Fig 2 shows the procedure for satellite image classification and change detection analysis. Geometric correction and radiometric correction were done on the imageries acquired. Layer stacking was done to stack the image bands together to form a single multi spectral image for both 1999 and 2019 imageries. These data sets were imported to ERDAS Imaging software to create a false color composite (FCC). Contingency error matrix was done before the classification to see the percentage accuracy of the training samples. Maximum likelihood algorithm (MLC) was used in Arc Map 10.4 software, to enhanced false color composite bands 6, 5, 4, 3, 2 and 1 of the different years depicting the vegetation image pixels were trained and categorized into appropriate classes. A total of six classes were discriminated, they are: 1, Bare land; 2, Buit-up areas; 3, Cropland; 4, Rockland; 5, Vegetation/Plantation and 6, Waterbodies. The accuracy assessment of this study was done through ground truthing. The Kappa coefficient for 1999 and 2019 were calculated respectively. The accuracy of the vegetation cover layers was analyzed each for 1999 and 2019 respectively.

Classified image pairs of two different years' data were compared using cross-tabulation to determine quantitative aspects of the changes for the periods 1999 and 2019. Change map was produced with a matrix of changes by overlaying the classification results for time t_1 (pre-event image) and t_2 (post-event image) with the help of Arc Map 10.4 software. Quantitative data of the overall in vegetation changes as well as gains and losses in each category between 1999 and 2019 were compiled. The various classified imageries were imported to Arc Map 10.4 software environment, adding Neat-lines, True-North arrows, Scale bars and Legends for final map output.

The vegetation inventory data was analyzed using three indices to get a clear picture of the composition, density and frequency of the species in the study area. The results were presented in tables, narration and pictures. The indices are as follow:

- Species Composition

DOI: 10.56892/bima.v7i01.389

%Composition Spp A = (Number of Spp A/ Total Number of Individuals) X 100

- Species Density (SD)
  SD = (Total number of species in the quadrat/ Area of the quadrat) X 100
- Relative Density (RD)
  RD = (Species density of individual species/ Total density for all species) X 100
- Frequency (F)
  F = Number of quadrats in which the specie occurs/ Total number of quadrats in the area X 100
- Relative Frequency (RF)
  RF = Species frequency or individual species/ Total frequency value of all species X 100

RESULTS AND DISCUSSION

Composition entails the proportion of different plant forms in an area (Zakariya, *et al.,* 2020). The composition of different species of trees of the study area was evaluated and presented in Table 1.

The result of the inventory of floristic composition within river Gongola Dadin kowa Dam Area shows that, there are about 52 species of different genera in the area with a total of 2,169 stands respectively. Table 1 entails variation in terms of composition of species where exotic species more dominant than native species in the study area. The finding (Table 1) also reveals that, *Azadirachta indica* is the dominant specie in the area, it constitutes about 36.42%, the reason for its dominance could be as a result of habitat adaptation and favorable environmental conditions. This is in line with the work of Zakariya, *et al.,* (2020) where they reported that, *Azadirachta indica* is the most dominant speciein all segments which represented the highest number of individuals stand in the riparian vegetation in the area. *Azadirachta indica* leaves and seeds are used as medicines by rural dwellers in the area. Less frequently the root, flower and fruit are also used. Some people in Dadin-kowa village apply neem seeds oil directly to their skin to cure skin diseases. Furthermore, *Mangifera indica* constitutes about 18.58%, followed by *Anacardium occidentale* with 9.04%, the next in the ranking is *Carica papaya* with 3.18%, *Moringa oleifera* constitute about 6.27%, *Phoenix dactylifera* 2.95% and *Psidium guajava* constitute 1.98% of the study area respectively. Their dominance could be as a result of anthropogenic activities (plantation by man). Exotic species are competing with indigenous species so much so that if care is not taken by stakeholders and forest managers in the next coming year's exotic species will take over indigenous species which is of a great threat to the riparian ecosystem of the study area.

However, indigenous tree species are the least dominant species and, they include: *Bombax brevicuspe* 0.05%, *Ceiba pentandra* 0.05%, *Combretum glutinosum* 0.41%, *Commiphora Africana* 0.51%, *Crossopteryx febrifuga* 0.14%, *Daniellia oliveri* 0.23%, *Detarium microcarpum* 0.23%, *Parkia biglobosa* 0.0v5%, *Poupartia birrea* 0.05%, *Ziziphus spina-christi* 0.28% and *Zornia glochidiata* 0.05% respectiely. The low number of these tree species in the area could be attributed to anthropogenic activities and fuel wood collection which affected species growth and production. Farming is the dominant anthropogenic activities along the stream, the natural vegetation is cleared for farming which increased bank erosion and landslide. The species with asterisk in the table are exotics species. Similar instances were reported by Meragiaw *et al.,* (2018) where they found that, livestock grazing and anthropogenic disturbances are factors that cause riparian vegetation disappearance in the area.

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Table 1: Composition of Trees of Different Species of the Study Area

S/N	Botanical Name	Local Name	Family	Total (N)	%
1	*Acacia albida*	*Gawo*	*Fabaceae*	5	0.23
2	*Acacia nilotica*	*Gabaruwa*	*Fabaceae*	3	0.14
3	*Acacia sieberiana*	*Fárár ƙáyà*	*Fabaceae*	66	3.04
4	*Adansonia digitata*	*Kuka*	*Fabaceae*	11	0.51
5	*Anacardium occidentale**	*Yazawa*	*Anacardiaceae*	196	9.04
6	*Anogeissus leiocarpus*	*Márkéé*	*Combretaceae*	7	0.32
7	*Azadirachta indica**	*Darbejiya*	*Meliaceae*	790	36.42
8	*Balanites aegyptiaca*	*Aduwa*	*Zygophyllaceae*	15	0.69
9	*Bauhinia rufescens*	*Tsáttsààgíí*	*Fabaceae*	48	2.21
10	*Bombax brevicuspe*	*Kúryáá*	*Malvaceae*	1	0.05
11	*Calotropis procera*	*Tunfafiya*	*Apocynaceae*	11	0.51
12	*Carica papaya**	*Gwanda*	*Caricaceae*	69	3.18
13	*Cassia singueana*	*Rúnfúú*	*Fabaceae*	9	0.41
14	*Ceiba pentandra*	*Rimi*	*Malvaceae*	1	0.05
15	*Celtis integrifolia; C. spp.*	*Zùùwóó*	*Cannabaceae*	14	0.65
16	*Combretum glutinosum*	*Káttákàràá*	*Combretaceae*	9	0.41
17	*Combretum lamprocarpum*	*Zindi*	*Combretaceae*	27	1.24
18	*Commiphora africana*	*Dààshíí*	*Burseraceae*	11	0.51
19	*Crossopteryx febrifuga*	*Gíyàyyátá mátá*	*Rubiaceae*	3	0.14
20	*Daniellia oliveri*	*Maje*	*Fabaceae*	5	0.23
21	*Detarium microcarpum*	*Taura*	*Fabaceae*	5	0.23
22	*Diospyros mespiliformis*	*Kanya*	*Ebenaceae*	25	1.15
23	*Eucalyptus camaldulensis**	*Zaiti*	*Myrtaceae*	34	1.57
24	*Ficus platyphylla*	*Gamji*	*Moraceae*	1	0.05
25	*Ficus thonningii*	*Shediya*	*Moraceae*	10	0.46
26	*Gardenia aqualla*	*Gáuɗè*	*Rubiaceae*	1	0.05
27	*Guiera senegalensis*	*Sabara*	*Combretaceae*	4	0.18
28	*Hyphaene thebaica*	*Goruba*	*Arecaceae*	25	1.15
29	*Isoberlinia doka*	*Doka*	*Fabaceae*	3	0.14
30	*Jatropha curcas L.*	*Binidazugu*	*Euphorbiaceae*	16	0.74
31	*Lannea acida*	*Faru*	*Anacardiaceae*	6	0.28
32	*Mangifera indica**	*Mangwaro*	*Anacardiaceae*	403	18.58
33	*Moringa oleifera**	*Zogale*	*Asclepiadaceae*	136	6.27
34	*Musa sapientum**	*Ayaba*	*Musaceae*	11	0.51
35	*Myrianthus serratus*	*Farin ganye*	*Cecropiaceae*	13	0.6
36	*Parkia biglobosa*	*Dóòráwà*	*Fabaceae*	1	0.05
37	*Phoenix dactylifera**	*Dabino*	*Arecaceae*	64	2.95

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38	*Piliostigma reticulatum*	*Kargo*	*Fabaceae*	1	0.05
39	*Poupartia birrea*	*Dinya*	*Verbenaceae*	1	0.05
40	*Prosofis Africana*	*Kirya*	*Fabaceae*	8	0.37
41	*Psidium guajava**	*Gwaiba*	*Myrtaceae*	43	1.98
42	*Pterocarpus erinaceus*	*Madobiya*	*Fabaceae*	3	0.14
43	*Sterculia setgera*	*Kukkuki*	*Malvaceae*	1	0.05
44	*Stereospermum kunthianum*	*Sánsámíí*	*Bignoniaceae*	13	0.6
45	*Tamarindus indica*	*Tsamiya*	*Fabaceae*	11	0.51
46	*Terminalia macroptera*	*Baushe*	*Combretaceae*	1	0.05
47	*Vitellaria paradoxa*	*Kadanya*	*Sapotaceae*	6	0.28
48	*Vitex doniana*	*Ɗínyáá*	*Verbenaceae*	2	0.09
49	*Ximenia Americana*	*Tsada*	*Olacaceae*	7	0.32
50	*Ziziphus abyssinica*	*Magarya*	*Rhamnaceae*	6	0.28
51	*Ziziphus spina-christi*	*kurna*	*Rhamnaceae*	6	0.28
52	*Zornia glochidiata*	*Sàbúlùn yán Mátá*	*Papilionoideae*	1	0.05
	Total			**2,169**	**100**

*=Exotics species **(N)** =Number of plants encountered **(%)** = Percentage

Source: Fieldwork, 2019

Table 2: Density and Frequency of Trees of Different Species of the Study Area

S/N	Species	Total (N)	(RD%)	Total (N)	(RF%)
1	*Acacia albida*	5	0.23	1	0.34
2	*Acacia nilotica*	3	0.14	2	0.67
3	*Acacia sieberiana*	66	3.03	17	5.7
4	*Adansonia digitata*	11	0.5	8	2.68
5	*Anacardium occidentale*	196	8.99	6	2.01
6	*Anogeissus leiocarpus*	7	0.32	3	1.01
7	*Azadirachta indica*	790	36.22	88	29.53
8	*Balanites aegyptiaca*	15	0.69	9	3.02
9	*Bauhinia rufescens*	48	2.2	5	1.68
10	*Bombax brevicuspe*	1	0.05	1	0.34
11	*Calotropis procera*	11	0.5	3	1.01
12	*Carica papaya*	69	3.16	4	1.34
13	*Cassia singueana*	9	0.41	2	0.67
14	*Ceiba pentandra*	1	0.05	1	0.34
15	*Celtis integrifolia; C. spp.*	14	0.64	3	1.01
16	*Combretum glutinosum*	7	0.32	2	0.67
17	*Combretum lamprocarpum*	27	1.24	6	2.01
18	*Commiphora africana*	11	0.5	4	1.34
19	*Crossopteryx febrifuga*	3	0.14	1	0.34
20	*Daniellia oliveri*	5	0.23	2	0.67
21	*Detarium microcarpum*	5	0.23	2	0.67
22	*Diospyros mespiliformis*	25	1.15	5	1.68
23	*Ecalyptus camaldulensis*	34	1.56	5	1.68
24	*Ficus platyphylla*	1	0.05	4	1.34
25	*Ficus thonningii*	10	0.46	1	0.34
26	*Gardenia aqualla*	1	0.05	1	0.34
27	*Guiera senegalensis*	4	0.18	1	0.34

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28	*Hyphaene thebaica*	25	1.15	7	2.35
29	*Isoberlinia doka*	3	0.14	3	1.01
30	*Jatropha curcas L.*	16	0.73	2	0.67
31	*Lannea acida*	6	0.28	1	0.34
32	*Mangifera indica*	403	18.48	28	9.4
33	*Moringa oleifera*	136	6.24	9	3.02
34	*Musa sapientum*	11	0.5	1	0.34
35	*Myrianthus serratus*	27	1.24	8	2.68
36	*Parkia biglobosa*	1	0.05	1	0.34
37	*Phoenix dactylifera*	64	2.93	5	1.68
38	*Piliostigma reticulatum*	1	0.05	1	0.34
39	*Poupartia birrea*	1	0.05	1	0.34
40	*Prosopis africana*	8	0.37	3	1.01
41	*Psidium guajava*	43	1.97	12	4.03
42	*Pterocarpus erinaceus*	3	0.14	3	1.01
43	*Sterculia setgera*	1	0.05	1	0.34
44	*Stereospermum kunthianum*	13	0.6	1	0.34
45	*Tamarindus indica*	11	0.5	7	2.35
46	*Terminalia macroptera*	1	0.05	1	0.34
47	*Vitellaria paradoxa*	6	0.28	3	1.01
48	*Vitex doniana*	2	0.09	2	0.67
49	*Ximenia Americana*	7	0.32	4	1.34
50	*Ziziphus abyssinica*	6	0.28	3	1.01
51	*Ziziphus spina-christi*	6	0.28	3	1.01
52	*Zornia glochidiata*	1	0.05	1	0.34
Total		**2181**	**100**	**298**	**100**

(RD) Relative Density **(RF)** = Relative Frequency **(N)** =Number of Plants Encountered
Source: Fieldwork, 2019

The findings revealed that the plant species found along the river Gongola are mostly trees and plantations of (Cashew, Guava and Mango) respectively as contained in Table 2. The result also revealed that species with high relative density (RD) value are the most dominant species along Dadin Kowa Dam area, this include: *Azadirachta indica* (36.22%), *Mangifera indica* (18.48%), and *Anacardium occidentale* (8.99%) while the least specie are *Parkia biglobosa* (0.05%) and *Zornia glochidiata* (0.05%) see Table 2. These species suffer from exploitation by local people due to their high demand and economic values as confirmed by the respondents of Hina and Dadin-kowa communities. These tree species are cut down and used as source of fuel wood, local tent, local huts by rural dwellers in the area. It has been established that *Azadirachta indica* is the most dominant plant species in the area due to its high regeneration capacity and the seeds are easily dispersing due to its usage by birds, animals and humans being (Nisbet, 2015). Furthermore, the climatic condition and the soil types favours the growth of such kind of plants species. Some of the tree's species like *Moringa oleifera* is use for curing hypertension and *Tamarindus indica* is use for busting appetite by rural dwellers in the study location, these contribute to their disappearance respectively. These species suffer from exploitation by local people of Hina and Dadin-Kowa communities, they cut down and use as a source of firewood as confirmed by the rural dwellers during data collection respectively.

Bima Journal of Science and Technology, Vol. 7 (1) Mar, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i01.389

Species frequency indicates the rate at which species occurred in the sampled plots. The result from Table 7 showed that *Azadirachta indica* is the most dominant tree species with 88 appearances and 29.53% relative frequency respectively. It is followed by *Mangifera indica* with 28 appearances and 9.40%, *Acacia sieberiana* with 17 appearances 5.70% and *Psidium guajava* with 12 occurrences with 4.03%. These tree species are the most represented species with highest relative frequency percentages respectively.

Moreover, *Acacia albida, Bombax brevicuspe, Ceiba pentandra, Gardenia aqualla, Guiera senegalensis, Lannea acida, Parkia biglobosa, Sterculia setgera, Piliostigma reticulatum* and *Zornia glochidiata* are the species with the lowest appearances in the study area with 0.34% each.

These species were the most vulnerable species and are under threat of endangerment in the area which may be as a result of over exploitation, climatic and edaphic factors. Tree species with high relative frequency are the most densely distributed species in the area respectively. Farming at the North and South banks of the River Gongola along Dadin Kowa Dam, involves the removal of native vegetation and the introduction of new vegetal covers (exotics specie). This is pure indication of habitat alteration which is in line with the report of Millennium Ecosystem Assessment (2005) that affirmed that, the degradation and loss of inland wetlands and species are driven by human activities such as infrastructure development, land reclamation/conversion, irrigation farming, pollution, overharvesting, and the introduction of invasive alien species.

Vegetation Cover Dynamics of the Area Between 1999 and 2019

The classified maps obtained after processing and supervised classification which shows the various Land use/Land cover characteristics of the study area are given in Figure 3 and 4. These imageries provide the information about the land cover pattern of the area. The yellow colour represents the cropland, red colour represents the built-up area, dark green depicts the vegetation cover, dark brown shows Rockland, light brown represents bare land and the blue colour shows the water bodies (Fig 3). The data interpretation and analysis are based on comparison of land cover classes for two different years during the 20 years period (1999-2019)

Accuracy Assessment

Each of the land use and land cover map was compared to the reference data to assess the accuracy of the classification. The reference data was prepared by considering random sample points, the field knowledge and Google earth. During the field visits a hand-held GPS (Global Positioning System) is used to identify the exact position of the place under consideration with Latitude and Longitude and its type by visual observation. The ground truth data so obtained was used to verify the classification accuracy. Overall classification accuracy for 1999 and 2019 are (83.75% and 86.25%) respectively. The kappa coefficient for 1999 and 2019 imageries are 80.50% and 83.50% respectively. The result of the accuracy assessment as well as error of commission and omission as presented in Table 3.

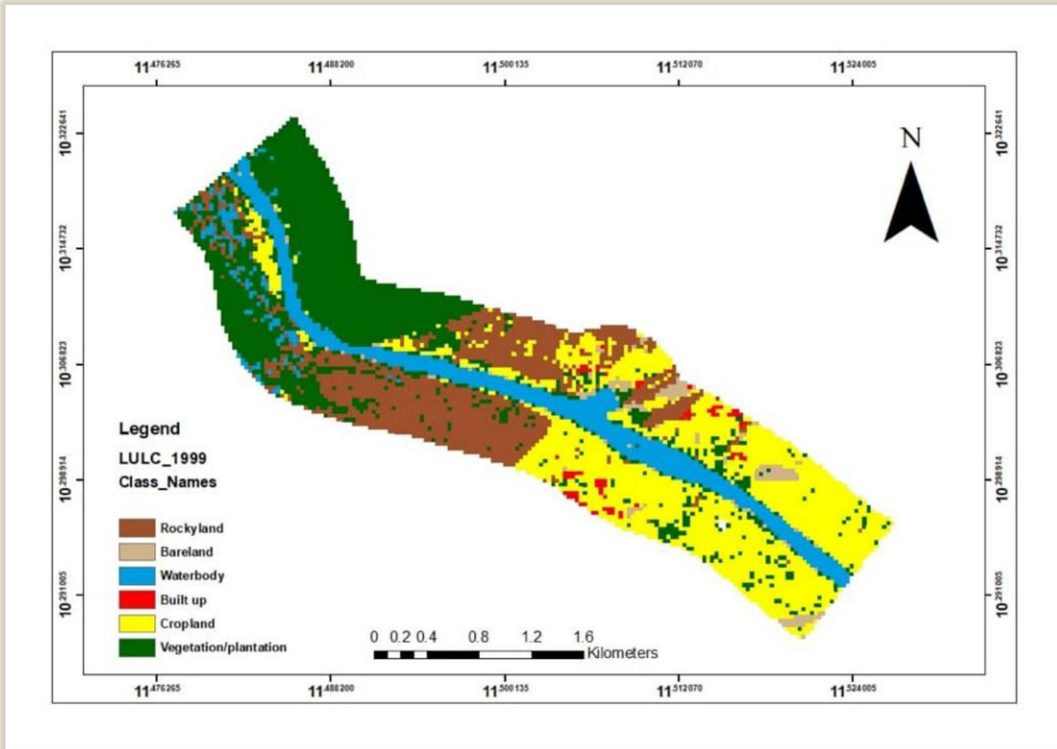

Figure 3: Classified Image of the Study Area for 1999

Source: GIS Laboratory Bayero University, Kano 2020

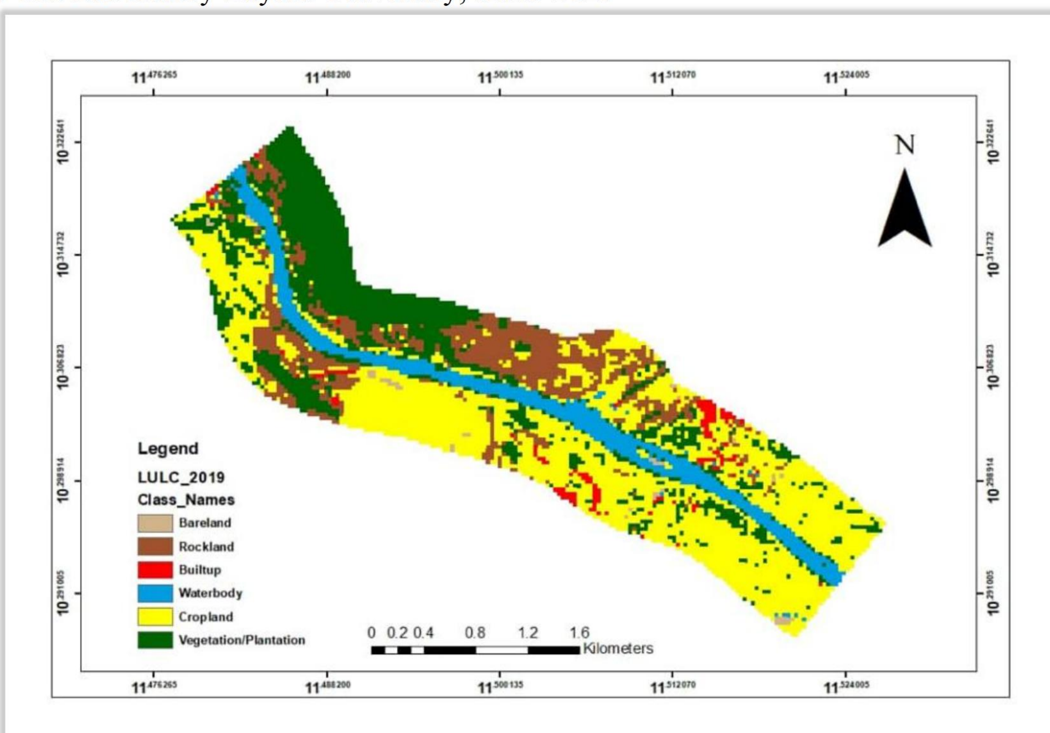

Figure 4: Classified Image of the Study Area for 2019

Source: GIS Laboratory Bayero University, Kano 2020

DOI: 10.56892/bima.v7i01.389

Table 3: Accuracy Assessment Report

Land Cover Class	Accuracy for 1999		Accuracy for 2019		Error of C&O for 1999 and 2019			
	Producer's	User's	Producer's	User's	(C 99)	(O 99)	(C 19)	(O 19)
Bareland	70.00%	93.33%	62.50%	96.15%	6.67%	30.00%	3.85%	37.50%
Built-up	87.50%	97.22%	92.50%	100%	2.78%	12.50%	0.00%	7.50%
Cropland	85.00%	73.91%	80.00%	60.38%	26.09%	15.00%	39.62%	20.00%
Rockland	77.50%	68.89%	95.00%	97.44%	31.11%	22.50%	2.56%	5.00%
Vegetation	85.00%	82.93%	87.50%	77.78%	17.07%	15.00%	22.22%	12.50%
Waterbodies	97.50%	92.86%	100%	100%	7.14%	2.50%	0.00%	0.00%
Overall Accuracy					**83.75%**		**86.25%**	
Kappa's Statistics					**80.50%**		**83.50%**	

Source: Author Image Analysis 2020

Classified Image of the Study Area for 1999

Fig 3 represents the classified image of the study area for 1999. However, Table 4 showed that, image of the area for 1999 was classified in to six land use land cover classes with their areal coverage in square meters.

Table 4: Landuse/Landcover Classes and Areal Coverage of Classified Image of the Area for 1999

S/N	Land Cover	Area_SQM	(%)
1	Bareland	168221	2.49
2	Built-up Areas	66781	0.99
3	Cropland	2196780	32.47
4	Rockland	1430120	21.14
5	Vegetation/Plantation	1981630	29.29
6	Waterbodies	922647	13.64
Total		**6766179**	**100.00**

Source: Author Image Analysis 2020 SQM=Square Meters

In 1999, cropland occupies the highest class of land cover with a total areal coverage of 2196780 Sqm. (about 32.47%), followed by the vegetation/plantation occupying about 1981630 Sqm accounting for (29.29%) of the total land cover under study, the rockland, water bodies and bareland areas accounted for 1430120 Sqm (21.14%), 922647 Sqm (13.64%) and 168221 Sqm (2.49%) respectively. The built-up areas recorded leethan a percentage 66781 Sqm (0.99%) of the total area under study as seen in Table 4.

Classified Image of the Study Area for 2019

Fig 4 represents the classified image of the study area for 2019. However, Table 5 showed that, 2019 satellite image of the study area was classified in to six land use land cover classes with their areal coverage in square meters.

However, the land use land cover classes for the year 2019 from landsat 8 satellite image (Table 5), further showed that cropland still remain the most dominant cover type, accounting for 45.59% (3086550Sqm) of the total land cover of the study area, Like the previous result, the 2019 classification map shows a reduction in fragments of dense vegetation on one hand, and on the other hand increased fragments of sparse vegetation, built-up and congested areas. Indeed, the 2019 classification result is a near-perfect representation of the current vegetation status in the study area as observed during data collection exercise. The vegetation/plantation had 25.63% (1735150 Sqm), while rockland represents a total of 15.64% (1058870Sqm), the water bodies and built-up areas accounted for about 10.76% (728256 Sqm) and 1.86% (126082 Sqm) respectively (see Table 5). The bareland showed total area coverage of 35760 Sqm (0.53%), it decreases compared to that of 1999 class.

Table 5: Landuse Landcover Classes and Areal Coverage of Classified Image of the Area for 2019

S/N	Land Cover	Area SQM	(%)
1	Bareland	35760	0.53
2	Built-up Areas	126082	1.86
3	Cropland	3086550	45.59
4	Rockland	1058870	15.64
5	Vegetation/Plantation	1735150	25.63
6	Waterbodies	728256	10.76
	Total	**6770668**	**100**

Source: Author Image Analysis 2020 SQM=Square Meters

Table 6: Change Detection Difference of Vegetation Cover (%) of River Gongola Dadin-Kowa Dam Area between 1999 and 2019

S/N	Landcover Classes	Year 1999	Year 2019	Change Difference
1	**Bareland**	2.49	0.53	-1.96
2	**Built-up Areas**	0.99	1.86	+0.87
3	**Cropland**	32.47	45.59	+13.12
4	**Rockland**	21.14	15.64	-5.5
5	**Vegetation/Plantation**	29.29	25.63	-3.66
6	**Waterbodies**	13.64	10.76	-2.88

Source: Author Image Analysis 2020

The result shows that, the study area was classified in to six landuse and landcover classes namely: Bareland, Buit-up areas, Cropland, Rockland, Vegetation/plantation and Water bodies respectively. It can be seen that, there was an increased in cropland from 32.47% in 1999 to 45.59% in 2019 with a change difference of (+13.12) respectively (see Table 6); this is an evidence that the vegetation was cleared and the area had been converted to farm lands. This could be attributed to the extraction of firewood by local people from Hina and Dadin-Kowa. Furthermore, there is decrease in vegetation/plantation from 29.29% in 1999 to 25.63% in 2019 with a change difference of (-3.66) respectively. The 2019 image classification analysis indicates a serious decline in general vegetation of the area, judging from the spatial dominance of the sparse vegetation in the area. Since 1999, dense vegetation has been decreasing, while other land cover types gain from these losses (Table 6). This could be attributed to serious encroachment by farmers and Fulani cattle rearers of the area. Rocky land and water bodies decrease form 21.14% and 13.64% in 1999 to 15.64% and 10.76% in 2019 with change difference of (-5.5 and -2.88) respectively.

Similarly, bareland decreases from 2.49% in 1999 to 0.53% in 2019 respectively. This may be as a result of the increase in population of Hina and Dadin-Kowa communities which put pressure on the vegetation of the study area. However, built-up areas increase from 0.99% in 1999 to 1.86% in 2019 with (+0.87) level of increase. Built-up and urbanization have grown to sustain a steady growth pattern, especially because of the rising population and increasing quest to satisfy human need for urban occupancy in Hina and Dadin-Kowa communities.

Status of Riparian Vegetation in River Gongola Dadin-Kowa Dam Area

An interview conducted with the respondents along the river bank revealed that the riparian corridor in River Gongola Dadin-Kowa Dam Area had significantly been fragmented or cleared by human activities. The zone is reduced to isolated trees, leaving large open areas with buildings (see Plate 1) or land-uses that severely compromise corridor and filtering functions respectively. Although, some parts of the zone are dark because of the tree leaves forming canopy; this area is usually silent, cool and ideal for abundant food and animal rest in the area. Plantations of economic trees such as mango, cashew, guava and banana are found along the stream, as a result of this, must of the native species have been cleared to pave way for plantations agriculture as explained by a respondent. He further stated that the riparian vegetation in the area is disappearing due to deforestation for timber and other forest produce or total conversion to other uses.

Plate 1: Status of Reparation Vegetation along River Gongola
Source: Fieldwork 2021

The Effects of Ecosystem Disturbance in the Area

The people around River Gongola Dadin-Kowa Dam riparian habitats cut trees at will and indiscriminately and these have seriously affected the natural vegetation of the area. According to the respondents, these tree species have interconnected values hence their removal infers damage to the river banks ecosystem. The attendant results are habitat destruction, nest removal, breeding ground obliteration and threatened amphibians and reptiles inhabiting the area.

"According to the respondents, farming activities is the dominant activity along the river; the natural vegetation is cleared for farming/irrigation activities which increase bank erosion, land slide and sedimentation".

Irrigation and rainfed farming are pronounced at the river banks, this also contributed immensely to the reduction of vegetation cover in the area. According Mallam Musa

DOI: 10.56892/bima.v7i01.389

Ibrahim, majority of the sheds serves as point of smoking Indian hemp drinking solution and cigarette sales, while some were used for transient resting place during hunting expedition and finally, some serve as a temporary place for concluding negotiations during purchase of firewood, fish and hunting successes respectively. All forms of encroachment are inimical to the natural ecosystem of the area. Negligence and ignorance by local people from Dadin-kowa and Hina about the sensitivity of the area has been a major factor encouraging higher frequency of visit by the people into the river banks, thereby narrowing and damaging the riparian ecosystem drastically.

The participant also reveals that, riparian zone of River Gongola Dadin-Kowa Dam and the organism inhabiting them have been substantially altered as a result of clearing of native riparian vegetation. Amphibians and reptiles inhabiting the area had migrated to other communities while some of them have died due to pressure by anthropogenic disturbances, this include *Kada*, *Guza, Damo, Kazan ruwa, Babba da jaka, Kirin-jijiya, Agwagwan ruwa* and *Zabuwan daji* respectively. While animal include *Jan biri*, *Bakin biri* and *Kura*, all have been migrated to other communities because the entire ecosystem has been affected. The only semiaquatic animal remain in the area is Hippopotamus which were four in number (two males and two females).

"According to the participants, the elimination of riparian vegetation in the area has also affected the river ecosystem by reducing shading and thus increasing the stream temperature and light penetration which affect many species of fish and frogs that depend on the riparian ecosystem for habitat like *Karfasa, Rajiya* and *Kurungu".*

The participant also reveals that, removal of riparian vegetation of the area decrease bank stability, input of organic litter and wood, reduce sediment trapping and increase bank and channel erosion respectively. Riparian vegetation degradation and transformation to agricultural uses in the area often lead to invasion by alien plants such as *Mangifera indica*, *Psidium guajava*, *Anacardium occidentale*, *Eucalyptus camaldulensis* and *Azadirachta indica* which are of a great threat to the ecosystem of the area. Subsequently, sand deposit is found in the stream at areas that are used as grazing routes and farming activities, deforested areas also have large amount of sand deposit and this contribute to the damages of seedling species of the study area.

The study also reveals that; the width of the stream is not uniform because of the intense irrigation activities taking place along the river. Cattle route along the river also contribute to sedimentation at various points of the river which is why the river is very wide due to the lack of vegetal cover. The interaction also reveals that, in areas with less vegetal cover along the river, the depth is shallow and this is due to the fact that the water flowing is getting wider space to expand its banks thereby increasing the rate of erosion and landslide of the river respectively. In areas that are densely vegetated, the river grows thin due to the resistance capacity provided by plants' roots in the area. But in the areas where vegetation is removed for agricultural activities, the river increases in width because there is no obstacle to prevent bank expansion due to the absence of vegetation cover. In areas devoid of vegetation cover, the water flows with turbidity and contain sediments, eroded particles and dirt which give dull colour due to turbidity. The increase in width of the river is greatly enhanced by anthropogenic activities such as the intensive irrigation activities and the clearing of vegetation for firewood and other domestic activities along

DOI: 10.56892/bima.v7i01.389

the river. The width of the river increased towards the end of each transects respectively.

CONCLUSION

The riparian vegetation is decreasing on daily basis due to increase in population and attendant energy needs by the neighborhood of the river bank. Fuelwood exploitation, fire, landslide, erosion and agricultural activities in the study area which have been taking place for quite a long time and this will result to severe damage to the remnants of riparian vegetation along Dadin-Kowa corridor of Gongola River, these disturbances are the major drivers of change which causes vegetation depletion in the area. With current dependence of people on the natural vegetation for fuelwood and other activities and with the existing environmental challenges, this situation will be worsening unless measures are taken to improve forest resource management.

Recommendation

I. Legislation should be strongly enforced to restrict resources users from cutting down trees and shrubs indiscriminately without replacement. Resource users particularly fuelwood cutters and local resources managers should be carried along in aspects of management of the riparian vegetation.

II. Afforestation programme should be emphasized by the stakeholders. The policy that mandates people who cut one tree must plant two should be enforced on individuals, and government should provide enough seedlings free of charge to facilitate the program.

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