

## **An Assessment of the Impact of Livestock Grazing on Riparian Ecosystem along Gongola River, Dadin Kowa Yamaltu/Deba Local Government Area, Gombe State, Nigeria**

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### **Abstract**

Grazing of livestock is the most widespread land-use practice in Northern part of Nigeria, occupying about 60% of the land surface. These activities are usually carried out along river channels and therefore, impact to a considerable extent on the riparian ecosystem. This study assesses the effects of livestock grazing on riparian ecosystem along Gongola River at Dadin Kowa, Yamaltu Deba LGA, Gombe State, Nigeria. Water samples and laboratory test, field measurements and observation of vegetation species were employed in the study. Descriptive and inferential statistics i.e. T-test was used to analyze the data. The findings revealed that, shrubs are the dominant plant species with 23.17%, followed by neem (*Azadiractha indica*) 18.30%, Herbs dominating 17.07%, and Mango (*magnifera indica*) 13.41%. A t-test analysis reveals that there is significant difference in the height and diameter of trees with t-value of 9.087. Plant species that are palatable to animals have witnessed degradation through looping and trampling hence their survivals are at risks. While the largest livestock composition are mainly cows constituting about 52.72%, followed by sheep 40%. Apart from polluting the water, the livestock routes and riparian corridors are characterized by erosion thereby increasing to the siltation/sedimentation of the Gongola River valley. Also, result of water quality analysis revealed an uneven distribution in all the selected parameters. Mean pH value obtained was 8.22, while calcium, magnesium, chloride, turbidity, Biochemical Oxygen Demand were 10.88 mg/L, 0.23 mg/L, 21.26 mg/L, 564.00NTU and 11.29mg/L, respectively. This implies that the water quality is not safe for human consumption and to a larger extent the livestock. The study, therefore, recommends the need for creation of ranches in the area by the Federal or State Government to preserve the natural environment from biodiversity lost.

**Keywords:** Dadin Kowa, Ecosystem, Gongola, River, Livestock and Riparian.

### **Introduction**

Riparian ecosystem is said to be the plant life that exists along a water way. The surrounding areas of rivers, ponds, lakes, marshes and streams are all considered riparian in nature (Belsky and Blumenthal, 1997). Plants and trees along water margins and banks

are called riparian vegetation. Campbell and Franklin (1979) defined riparian vegetation as vegetation that is rooted at the edge of water (stream or lake). Often times, the stream influences vegetation well beyond the water line. Hence, riparian ecosystem can be defined as those areas associated with streams, lakes and wet areas where vegetative communities are predominantly influenced by their association with water (Carter 1978). Riparian vegetation provides shade, prevent adverse water temperature fluctuations (Meehan, Swanson, and Sedell, 1977). The roots of trees, shrubs and herbaceous vegetation stabilize streambanks providing cover in the form of overhanging banks (Marcuson 1977; Meehan *et al.*, 1977). Streamside vegetation acts as a "filter" to prevent sediment and debris from man's activities from entering the stream (Meehan, Swanson and Sedell, 1977). Riparian vegetation also directly controls the food chain of the ecosystem by shading the stream and providing organic detritus and insects for the stream organisms (Cummins, 1974 and Meehan *et al.*, 1977). Riparian ecosystem or landscape are among the most diverse and productive habitats and perform several critical ecological functions. The variety of plants such as hedges, grasses, trees, with other shrubs form the riparian ecosystem (Mubi, 2008). Riparian flora and fauna are often distinctly different from those found in adjacent communities because of the water and rich soils found in the riparian zones.

Livestock, particularly, cattle exhibit a strong preference for riparian ecosystem for a number of the same reasons other animals prefer and use these areas. The main attributes that attract and hold cattle to riparian areas are the availability of water, shade and thermal cover, and the quality and variety of forage (Ames 1977, Severson and Boldt 1978). However, livestock grazing affects watershed hydrology, stream channel morphology, soils, vegetation, wildlife, fish and other riparian-dependent species, and water quality at both local and landscape scales. Riparian zones provide key services for all ecosystems, but are especially important in dry regions, where they provide the main source of moisture for plants and wildlife, and the main source of water for downstream plant, animal, and human communities (Rob and Stephane, 2001; Armour, Duff and Elmore, 2008). These services are highly dependent on stream banks and flood plains, being a vegetated and relatively undisturbed land. Rooted stream side plants retard stream bank erosion, filter sediments out of the water, build up and stabilize stream banks and streambeds, and provide shade, food, and nutrients for aquatic and riparian organisms (Belsky, Matzke and Uselman, 1999). Riparian habitat is an ecosystem with extraordinary biodiversity richness. Riparian ecosystem is unique with continual disturbances related to inundation, transport of sediments, and the abrasive and erosive forces of water and ice movement that, in turn, create habitat complexity and variability, resulting in ecologically diverse communities' (Theresa and Saied, 2006). The rapid population explosion of the Third World countries has put the riparian ecosystem under stress of over exploitation and unsustainable use. Biodiversity resources of riparian ecosystem include vegetation community, which in most cases are hydrophilic.

Conserving riparian areas is one of the most effective ways of maintaining high quality aquatic habitats (Parkyn *et al.*, 2004; US Army, 2012). Although grasslands limit sediment, nutrient, and pathogen loading of surface water resources (Zoheir, 2001), cattle congregating near pastures around streams to meet their need for thirst, hunger, and thermoregulation reduce stream bank stability and increase soil erosion in pastures and rangelands. Additional pressure is also put on pasture resources by livestock from neighbouring countries, notably Republics of Cameroon, Chad and Niger respectively. The frontline states as well as the buffer zone are located along two of the pastoral corridors of Nigeria. The corridors are: the Northwest corridor, running from Niger/Benin Republics through Sokoto/Kebbi/Zamfara /Katsina, Niger and Kwara state axis, and terminating in Oyo State. The Northeast corridor emanating from Niger/Chad Republics and running through Adamawa, Borno, Jigawa, Kano, Plateau, Yobe and Gombe States and terminating in the Niger/Benue river basins. Both corridors form parts of Sahel eco-zone and run through Sudan Savannah zone, terminating at the Guinea savanna vegetation zone of the Middle-Belt and some Southern States. These corridors carry millions of heads of cattle annually (Lazarus *et al*, 2012). The main source or point where these livestock drink water and browsed plant are the few primal streams or rivers especially during the dry season. The river Gongola at Dadin Kowa Dam and lake area are among many rivers/streams in Nigeria that provide forage and water points to livestock's in the country. Thousands of cattle, sheep and goats depends daily on the water point in these area most especially during the dry season, for browsing and drinking water. This has led to trampling and overgrazing of stream banks, leading to soil erosion, loss of stream bank stability and declining water quality. Despite these impacts, not much has been done by way of research along the Gongola River in Dadin Kowa area to assess the effects of livestock grazing on the riparian ecosystem. It is against this background that this study sought to find out the effect of livestock grazing on the riparian ecosystem.

### **Aim and objectives**

The aim of this research is to assess the impact of livestock grazing on the riparian ecosystem along the Gongola River in Dadin Kowa area. This is to be achieved through the following specific objectives;

- i. To identify types of vegetation in the study area.
- ii. To identify the types and number of livestock in the study area
- iii. To assess the effect of grazing on the vegetation, soil structure and water quality in the study areas

## Materials and Methods

### Description of Study Area

River Gongola is a tributary of River Benue. The River Gongola takes its source from the Jos plateau area. The study area is located between latitude  $10^{\circ}18'N$  to  $10^{\circ}30'N$  and longitude  $11^{\circ}20'E$  to  $11^{\circ}40'E$  (Fig.1). It shares common boundaries with Gombe LGA in the West, Kwami LGA to the North, Akko LGA to the Southwest, Balanga LGA to the North and Borno State to the Northeast.

The climate of the study area is part of the tropical continental type of climate in Nigeria. 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. Rainfall usually begins in late April or early May and ends in early October. The rainfall last between five (5) to six (6) months. The maximum rainfall is usually experienced in the months of July and August. The annual rainfall amount ranges between 800 - 1000mm<sup>3</sup>. The dry season last between October to late May. The mean annual temperature of the study area is about 30°C, with highest temperature experienced in the month of April.



Source: GIS Lab Gombe State University

Figure1: Gongola River at Dadin Kowa dam (Study Area).

The vegetation of Dadin Kowa can be described as the Sudan savannah type. The natural vegetation cover consists of scattered trees, shrubs and grasses. These includes; *Adansonia digitata* (kuka), *Annona Senegalensis* (Gwandandaji), *Magnifera indica* (mango), *Ficusthonningii* (Baure), *Parkia biglobosa* (Doruwa), *Azadiractha indica* (Dogonyaro) and water lily among others.

The population of Yamaltu Deba LGA, according to 2006 National population census, was 255,726 which consist of 133,246 males and 122,480 females (NPC 2007). The major economic activity in the LGA is farming which is the mainly subsistence. Most of the people engage in irrigation farming along the Gongola River valley. Farm produce include maize, sorghum, groundnut, millet, vegetables and beans. Other activities include livestock grazing, poultry and fishing.

### Material and Methods

Both primary and secondary sources of data were employed in this study. Primary data were sourced through field measurement and reconnaissance survey, where measurement and observations of the types of vegetation, quality of vegetation, status of soil erosion through the roots, number of animals that graze in the study area were made. Water quality analyses were also carried out to determine the pH level, faecal contamination and other physio – chemical parameters. The water quality analysis was conducted in the Federal Ministry of water resources' laboratory in Gombe town. The secondary data was sourced from relevant published and unpublished materials such as text books, journals and past projects and thesis.

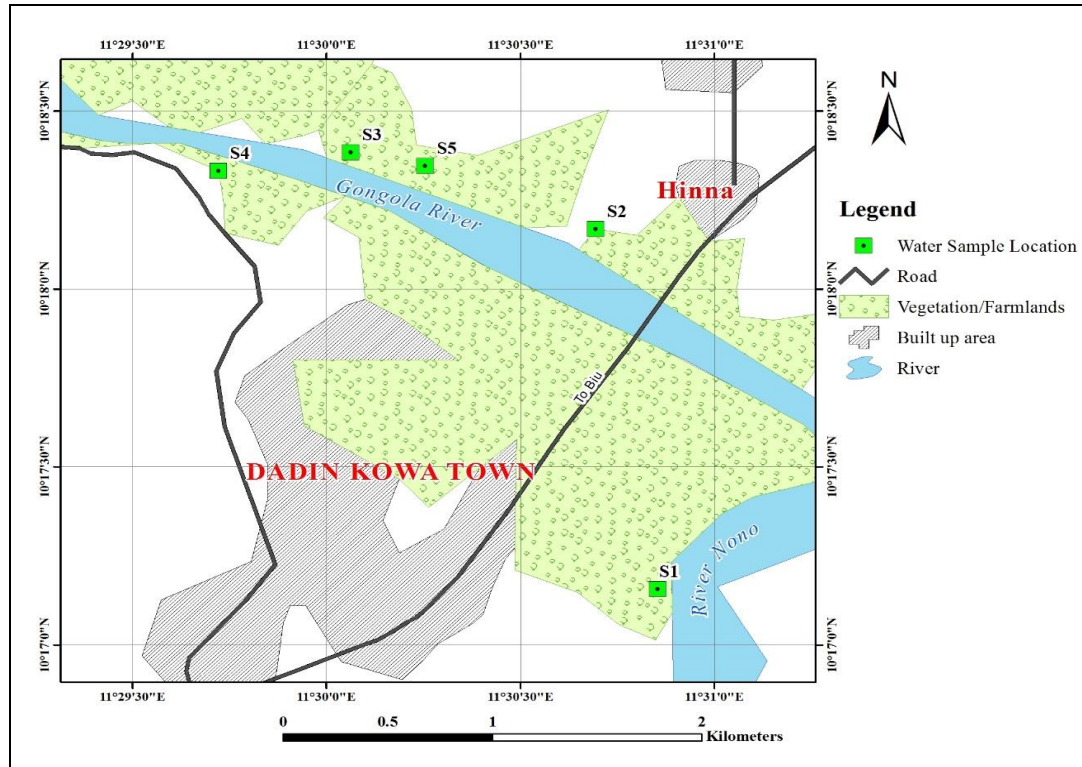
Sampling techniques includes:

- I. Livestock grazing sites were identified through field observation using the GPS.
- II. Soil degradation were identified and measured using measuring tapes and ranging poles, field book, abney level and GPS.
- III. Five samples of water were collected and analyzed in order to determine the amount of faecal contamination, *E coli*, coliform, odour, pH, electrical conductance, turbidity, chloride, iron, temperature, oxygen demand, chemical and biological, total and suspended solid, total dissolved solid, calcium and magnesium. Five samples of water at different points where livestock drink water were collected in 1 litre measuring container, labeled and then taken to the laboratory for analysis according to WHO standard.
- IV. Vegetation compositions were sampled via water points where livestock browse and drink water. Five areas along the river were sampled and available plants species frequency, dominance and height were determined.

This was achieved through the following hypothesis:

$H_0$ = There is a significant difference in the height and diameter of vegetation between the sampled areas.

$H_1$ = There is no significant difference in the height and diameter of vegetation between the sampled areas.



Source: Fieldwork, 2018

Fig. 2: Location of water sample collection Points

Descriptive and inferential statistics were used to analyze the data collected. Descriptive statistics used include tabulations, pie chart, bar chart, and histogram. It was used to present data on the percentage of dominance and frequency of plant species observed in the study area. In terms of inferential statistics, the t-test was used to test the hypothesis on the differences in the height and diameter of vegetation between the sampled areas.

## Result of Findings

### Vegetation Composition of the Study Area

Table 1, presents the distribution of plant species along the Gongola River at Dadin Kowa dam area. Nine (9) dominant species were identified during the study and they include; *Acacia nilotica*, *Zizphus spina-christi*, *Azadirachta indica* (Neem tree),

*Psidiumguajava* (guava), *Musa acuminata* (banana), *Carica papaya* (Pawpaw) and other shrubs and herbs. The findings (Table 1) revealed that, shrubs are the dominant plant species and make up 23.17% composition of the riparian vegetation in the Dadin-kowa dam area. *Azadiractha indica* constitute about 18.30% as a result of man's activities (afforestation). Herbs constitutes 17.07%, *magnifera indica* constitute 13.41%, *Carica papaya* (Pawpaw) 7.31%, *Acacia nilotica* (Gum Arabic) and *musa acuminata* (banana) constitutes 6.17% respectively; shrubs have 3.46%, herbs have 17.28% and *Zizphus spina-christi* and *Psidiumguajava* (guava) constitutes 3.70% respectively.

**Table 1:** Composition of Riparian Vegetation in the Study Area

| S/no. | Plant species                  | Families      | Frequency | Percentage  |
|-------|--------------------------------|---------------|-----------|-------------|
| 1     | Acacia nilotica (Gum Arabic)   | Fabicere      | 5         | 6.17        |
| 2     | Zizphus spina-chisti (magarya) | Rhemnaceal    | 3         | 3.70        |
| 3     | Azadirachta indica (Neem tree) | Meliaceare    | 15        | 18.52       |
| 4     | Magnifera indica (mango)       | Anacardiacear | 11        | 13.58       |
| 5     | Psidiumguajava (guava)         | Myrfacear     | 3         | 3.70        |
| 6     | Musa acuminata (banana         | Musacear      | 5         | 6.17        |
| 7     | Shrubs Fatsia,                 |               | 19        | 23.46       |
| 8     | Herbs                          |               | 14        | 17.28       |
| 9     | Pawpaw Carica papaya           | Caricacear    | 6         | 7.41        |
|       | <b>Total</b>                   |               | <b>81</b> | <b>100%</b> |

Source: Fieldwork, 2018

### Distribution of Livestock along Gongola River at Dadin Kowa

Figure 3 present the analysis on the distribution of livestock along the Gongola River. Result indicated that about 1227 (57.38%) of the livestock that graze along the river channel are cows, followed by Sheep's 317 (25.84%) and goats 206 (16.79%). This result is obvious given the complexity of areas by which majority of the rural dwellers are farmers and therefore take advantage of the River and Dadin kowa dam in order to graze their animals. The all year round flow of the channel is a contributing factors that attract animals along the channel because of the presence of pasture all years round. The month of April and May has the highest frequency of animal grazing along the Gongola tributary. This result is evident because of early rain expectancy that marked the end of dry season and beginning of rainy seasons.

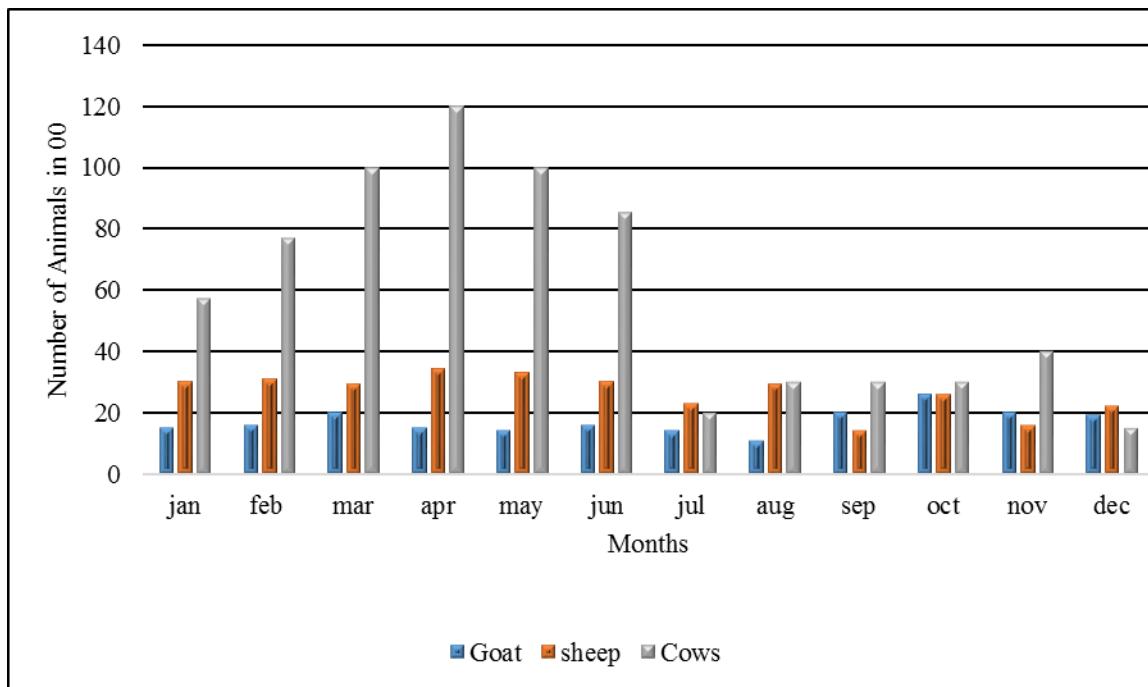


Fig. 3: Mean monthly distribution of Livestock Grazing along Gongola River

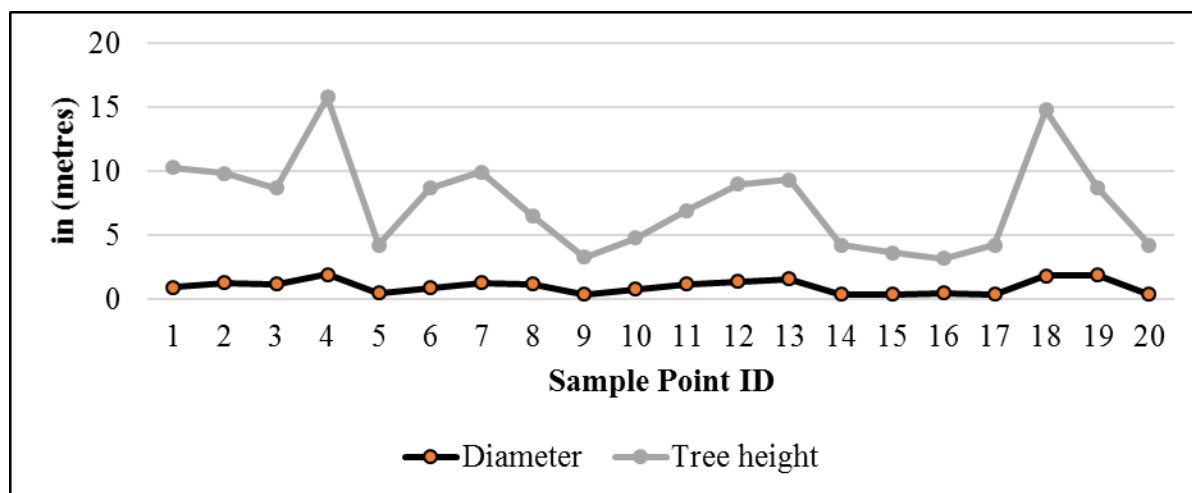
### **Riparian Vegetation condition**

Fig.4 shows that the maximum height of tree was 15.8metres, minimum height 3.2metre, given an average height of 7.84metres and a standard deviation value of 3.65metres. Also, diameter at breast height measurement of the vegetation revealed that maximum diameter is 1.97metres, minimum value of 0.4metres and mean of 1.08metres and a standard deviation value of 0.55metres. This is attributed to continuous grazing of livestock more especially during the long period of dry season. Through seasonal pruning, trampling and other forms of destruction might have contributed to current vegetation heights and diameter at breast height.

Grazing pressure by unregulated livestock has contributed to the current vegetation degradation along the river. The remains of native vegetation are under continuous browsing and trampling by livestock and this affects the vegetation growth and reduce regeneration of plants. These plants are often in poor condition owing to microclimate exposure. Browsing by cattle is probably more damaging to trees and shrubs than that by sheep and goats possibly due to their number and feeding system.

One of the most damaging results of the destruction of remnant vegetation and pasture in the riparian zone is severe microclimatic exposure of the stream and its banks. This microclimate exposure combined with dense growth of light tolerant, often alien, species

(such as grasses) discourages regeneration of forest plants, resulting in further increases in number and dominance of alien species. This has the potential of impacting negatively on terrestrial wildlife habitat causing a subsequent decrease in wildlife species and numbers (Ames 1977 and Tubbs 1980) and decline of various species of birds (Townsend and Smith 1977).



**Source:** Fieldwork, 2018

**Fig. 4:** Diameter and Height of Vegetation along Gongola River

The result of the t-test analysis (Table 2) shows a t-value of 9.240 for vegetation height and 8.449 for vegetation diameter. This is more than the expected value of 2.093. The result shows that there is statistically significant difference in the height and diameter of vegetation between sampled points. The study therefore rejects the Null hypothesis that “there is no significant difference in the height and diameter of vegetation between the sampled points”, and accept the alternative that “there is significant difference in the height and diameter of vegetation between the sampled points”. This is justifiable given the result in Table 2 with range values of 1.57m and 12.58m for diameter and tree height respectively.

**Table 2.** Result of student t-test analysis

**One-Sample Test**

|             | Test Value = 0 |    |                 |                 |                                           |        |
|-------------|----------------|----|-----------------|-----------------|-------------------------------------------|--------|
|             | T              | Df | Sig. (2-tailed) | Mean Difference | 95% Confidence Interval of the Difference |        |
|             |                |    |                 |                 | Lower                                     | Upper  |
| Diameter    | 8.449          | 19 | .000            | 1.03050         | .7752                                     | 1.2858 |
| Tree height | 9.240          | 19 | .000            | 7.53950         | 5.8317                                    | 9.2473 |

**Source:** SPSS Analysis v.23, 2018

$H_1$ = There is a significant difference in the height and diameter of vegetation between the sampled points.

$H_0$ = There is no significant difference in the height and diameter of vegetation between the sampled points.

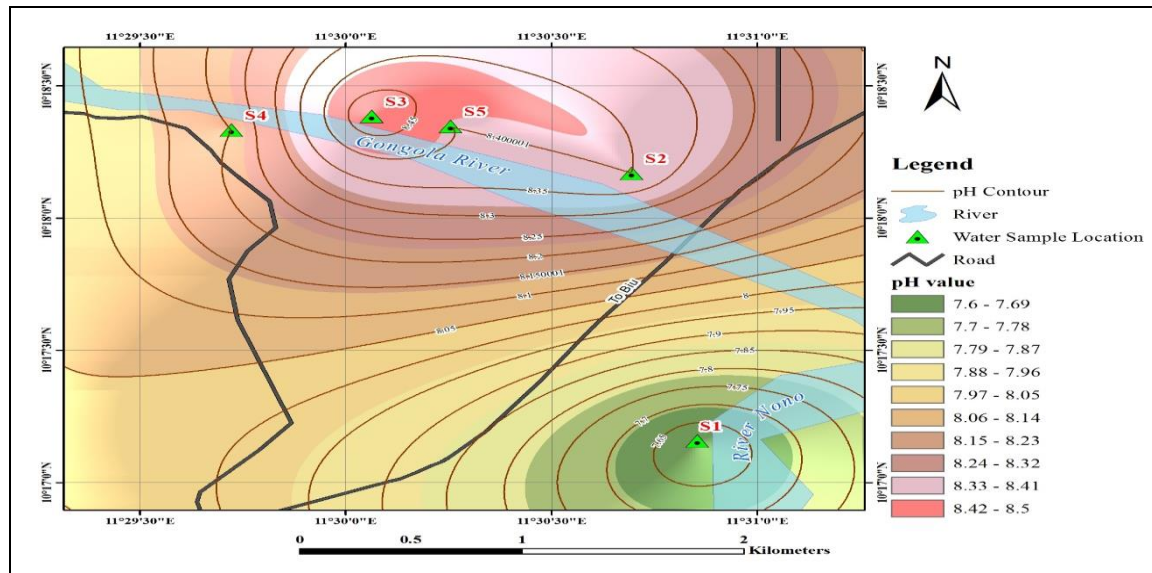
**Water Quality Analyzed**

Livestock damage to riparian vegetation and soils, destabilizes the banks and leads to mobilization of fine sediment that in turn causes sedimentation in the channel and turbidity. In addition, more runoff of sediment occurs from soils disturbed and compacted by livestock trampling. The resulting increased sediment load and accompanying particulate nutrients may contribute to eutrophication and sedimentation. Fig. 5 and 6 shows results of water quality analysis. The results revealed that it poses some perceived odour. The occurrence of odour might probably be associated with the presence of inorganic or organic contaminants in the water. Related to taste, a strong odour from water for consumption will obviously cause rejection which causes offensive taste. The mean odour value as obtained from the water quality test result ranges from 21.62 to 16.70 and 32.30 mg/l respectively. The total suspended solid content depends on the amount of suspended particles, soil and silt directly associated with water turbidity. The total suspended solids (TSS) content of the sampled water ranges between 4.01, 6.03mg/L, 6.31mg/L, 7.80mg/L and 11.2mg/L respectively.

-The effect of the concentration of iron can be evident also from the colour of the water (plate 2). The result for iron test is observed to range between 0.00mg/l to 0.40mg/l. This might be as a result of deposition of nutrients directly to streams and riparian areas in form of dung and urine.

Naturally water bodies' shows changes in temperature daily and seasonally due to different activities that can contribute to change in the surface water temperature. The temperature of sampled water in the study area is steady with mean of 29°C. Livestock damage to riparian vegetation leads to reduced shade and, consequently, increased solar heating of the stream water surface.

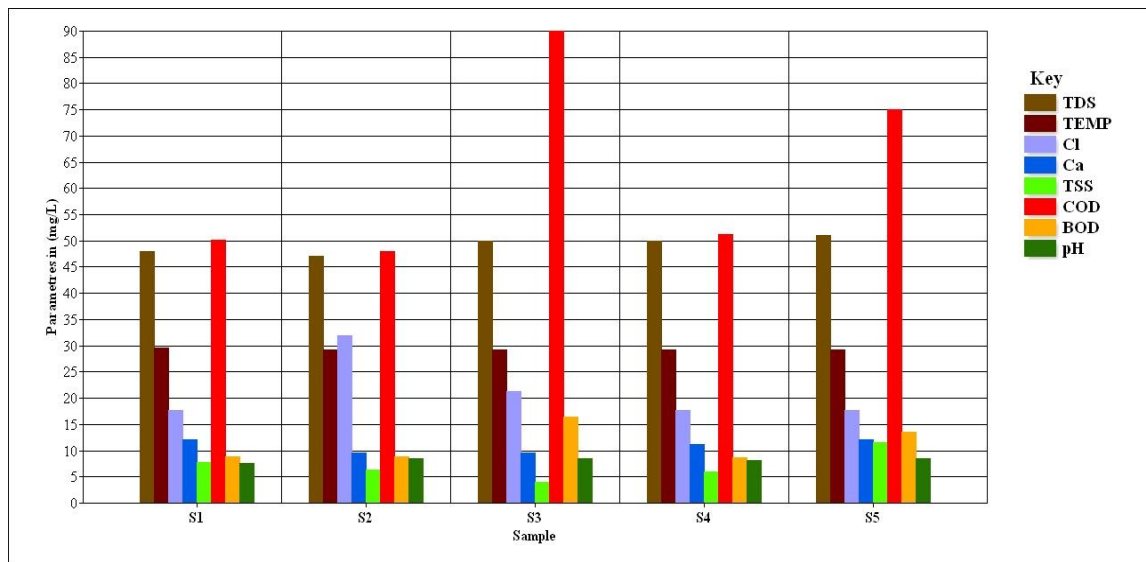
Analysis of pH concentration along the Gongola river channel in the riparian vegetation reveals that there is a significantly high concentration of alkalinity ranges between pH 7.6 – 8.5 (Fig. 5). The degree of Alkalinity can be observed having an uneven distribution pattern though increased in the Gongola river channel. This result can be attributed to the grazing activities in the area.



Source: Fieldwork, 2018

Fig. 5: Distribution of pH values in Study Area.

Turbidity means water hardness. The variation in water hardness is high and ranges between 200mg/L to 960mg/L. The significant difference in the occurrence of this parameter is high with mean value of 564 NTU. Chloride exists in all natural waters and its concentration varying- widely and reaching a maximum in sea levels, chloride does not pose a health hazard to humans and the principal consideration is in relation to palatability. This parameter is found to be high in regions closer to the sea. The Chloride content of the water samples analyzed ranges between 31.90mg/L to 17.70 mg/L. The mean value for this parameter is 21.26 mg/L. Calcium and Magnesium are among the most common ingredients found in natural water and their salts are an important contributor to the hardness of water. For calcium, the mean concentration is 10.88mg/L and 0.29mg/L.



Source: Laboratory Analysis

Fig. 6 Distribution of Water Quality Test

**Table 3: Physico – Chemical properties of water analyze**

| Name         | Odour<br>pt-t | EC     | TDS<br>mg/l | TEMP  | TURB<br>NTU | PH   | Fe<br>mg/L | Cl<br>mg/L | CaH<br>mg/L | MgH<br>mg/L | COD<br>mg/L | BOD<br>mg/L |
|--------------|---------------|--------|-------------|-------|-------------|------|------------|------------|-------------|-------------|-------------|-------------|
| S1           | 19.30         | 96.00  | 48.00       | 29.60 | 640.00      | 7.60 | 0.40       | 17.70      | 12.00       | 0.00        | 50.10       | 8.90        |
| S2           | 20.00         | 94.00  | 47.00       | 29.20 | 500.00      | 8.40 | 0.35       | 31.90      | 9.60        | 0.49        | 48.00       | 8.80        |
| S3           | 16.70         | 100.00 | 50.00       | 29.20 | 200.00      | 8.50 | 0.00       | 21.30      | 9.60        | 0.97        | 90.00       | 16.45       |
| S4           | 19.80         | 99.00  | 50.00       | 29.20 | 520.00      | 8.20 | 0.15       | 17.70      | 11.20       | 0.00        | 51.20       | 8.70        |
| S5           | 32.30         | 102.00 | 51.00       | 29.20 | 960.00      | 8.40 | 0.25       | 17.70      | 12.00       | 0.00        | 75.00       | 13.60       |
| mean         | 21.62         | 98.20  | 49.20       | 29.28 | 564.00      | 8.22 | 0.23       | 21.26      | 10.88       | 0.29        | 62.86       | 11.29       |
| Std          | 6.12          | 3.19   | 1.64        | 0.18  | 274.37      | 0.36 | 0.16       | 6.15       | 1.21        | 0.43        | 18.73       | 3.56        |
| Varian<br>ce | 37.40         | 10.20  | 2.70        | 0.03  | 75280.00    | 0.13 | 0.03       | 37.81      | 1.47        | 0.19        | 350.89      | 12.65       |

Key: Iron (Fe), Chlorine (Cl), Calcium (Ca), Magnesium (Mg), Turbidity (TURB), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Total Dissolved Solid(TDS)

Source: Federal Ministry of water resources, Gombe Office



**Plate 3a: Brownish Colour of surface water in the study Area Plate 3b Soil degradation by livestock**

## **Soil Degradation**

Livestock damage the underlying riparian soils by trampling hence compaction and break-down of soil aggregates that has resulted to reduced infiltration and increased contaminant runoff. In addition, soil erosion is wide spread and rapid as a result of

livestock pressure in the riparian zones more especially along their routes and hence becoming a source of sediment and other pollutants.

Degradation of riparian soils and bank slumping through livestock grazing increased siltation of the sediment bed of the river by fine sediment (clay, silt, sand). This results in increased suspended sediment in the substrate and increased concentration of coarse grains, sediment yield and turbidity of the waters.

### **Stream life**

The degree of catchment development to pastoral land use, water temperature and level of nutrient enrichment were identified as the most important factors affecting invertebrate community. Direct impacts on biota of livestock entering streams are difficult to separate from those of general pastoral land use such as deforestation and nutrient inputs from overland flow. For instance, increased light levels from tree removal can facilitate the growth of algae, but nutrients found in animal wastes also stimulate algal and aquatic plant growth, and these may be deposited directly by animals or washed in from overland flow of grazed zones. The main potential impacts of livestock trampling of stream banks or browsing of streamside vegetation includes benthic invertebrate biodiversity and fishes among others.

### **Conclusion**

This study has examined the impact of livestock grazing on riparian ecosystem in Dadin Kowa dam area along the Gongola river. From the findings of the study, it can be deduced that livestock grazing has significantly affected the growth of vegetation, increased land degradation and contaminated the surface water in the study area, thereby negatively affecting the stream organisms and possibly human lives that use the water.

### **Recommendation**

Based on findings of this study the following suggestions are made;

- i. Ranching method of cattle rearing should be encouraged by the Federal Government of Nigerian especially in settlements living along river channels so as to reduce the level of water population as well as preserve the soil and water quality of the environment.
- ii. Modern varieties of tree/vegetation species suitable for alkaline soils should be introduced and planted along river channel by the state ministry of agriculture and water resources so that to encourage afforestation/climate change control.
- iii. Community leaders, state ministry of agriculture and water resources should mobilize and sensitize its people on the importance of preserving the natural vegetation especially those living along river channels for it minimizes the threat of flood as well as absorb carbon dioxides and releases good oxygen.

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