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Impact of some hydrological factors on biodiversity of fish in Agaie/Lapai dam reservoir of Niger State, Nigeria

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Abstract:
The effects of some hydrological factors (rainfall, inflow and depth of water) on fish biodiversity in Lapai dam reservoir were studied by monthly samplings and measurements taken from May, 2013 to October, 2014. This reservoir is situated at 9° 39' N latitudes and 6° 33' E longitudes located near Bakaje at the confluence of the Jatau River. Samples of fishes were collected from the fishermen in two chosen landing sites where they catch fishes using cast nets, seine nets and hooks and lines in designated locations of the reservoir. Eleven (11) fish families were identified during the study belonging to *Brigridae* with 2 species, *Characidae* with 2 species, *Schilbeidae* with 2 species, *Cichlidae* with 5 species, *Claridae* with 2 species *Cyprinidae* with 3 species, while *Chanidae*, *Hepsetidae*, *Malapteruridae*, *Mochokidae* and *Mormyridae* had 1 specie each respectively. The highest level of impact of rainfall was felt by the fish from the month of March to November. *Cichlidae* recorded the highest respond to the inflow of water from tributaries while other fish families showed no any increase or decrease in abundance to the changes of the flow-rates of water. The family of *Mochokidae* responded to the fall of water level (depth) while other families of fish were not significantly impacted by the factor.

Keywords: Confluence, Impact, Inflow-rate, Water level, Rainfall, Landing site.

INTRODUCTION

Niger State is blessed with numerous large water bodies including reservoirs, floodplain of River Niger and Kaduna, and several streams. Large number of the population derives their livelihood from the water bodies through artisanal fishing. Agaie/ Lapai dam is one of the medium earthen dams constructed by the Upper Niger River Basin Development Authority with a reservoir of estimated 13.5sq. meters and a maximum storage capacity of 38 million cubic meters (UNRBDA, 1978).

The water systems are interconnected; they host plant and animal life and both influence and interact with weather patterns. The physico-chemical parameters induce both vertical and horizontal migration of aquatic organisms. It affects the organism distribution, diversity and feeding. (Imam and Balarebe, 2012).

Biodiversity constitute part of the stabilization of ecosystem and protection of overall environmental wellbeing of all species of organisms on the planet (Saliu and Eruteya, 2006). Fish biodiversity of reservoirs essentially represents the fish faunal diversity and their abundance (Lawson and Modupe, 2010). Nigeria has potential fish culture, although it is still lacking to be fully exploited compared to the developed countries (Ikomi and Anyanwu, 2010). Fishes are the largest part of the living vertebrates that constitute more than half of the approximately 48,170 known vertebrate species in the world although diversity of freshwater organisms are much narrower than on land or in the sea. (Ikomi and Anyanwu, 2010). Many small lakes and reservoirs may be regarded as parts of river or stream systems in which the inflow of water has been impeded (Singh and Laura, 2012).

The magnitude of the influence of the inflow of water through a lake reservoir depends on the volume, the extent of its catchment area and the amount of rainfall (Shukla *et al*., 2009). The effects of inflow on population and structures of fish has been the interest of ecologists in the past (Lashkar and Gupta, 2009; Roeike *et al.*, 2010; Eldridge and Roelke, 2010 Singh and Laura, 2012).

An increasing depth negatively affects mean light intensity and so specific production of primary producers is predicted to decrease with depth. Increasing depth also negatively affects alga sinking loss rate within the mixed layer and enrichment with the limiting nutrient positively affects phytoplankton production. (Richardson and Schoeman, 2004). Depth negatively affects light availability but positively affect nutrient availability in the water column (Kunz, 2005).

MATERIALS AND METHODS

Study Area

Agaie/ Lapai dam is located adjacent to Bakajiba village at latitude 9^0 39'N and longitude 6^0 33'E southwest of Minna [Fig. 1]. It has a capacity of 38 million cubic meters and a crest length of 1.600 meters. Its average depth is about 10.8 meters and becomes progressively shallower towards the inflow part, where it measures less than 1.64 meters (Fig.2). The shore is not easily accessible during wet season. There are three tributaries and then one spillway on the side of the embankment of the dam. The northern end of the reservoir drains into a broad swampy area and gradually narrows to a small stream. The southern end is a small stream called Chemi River which flows directly into the reservoir. Other rivers are Jatau river coming from the eastern portion and river Jimada comes from the North-eastern part, bordered by fairly elevated flat land and covered by grasses and few scattered trees.

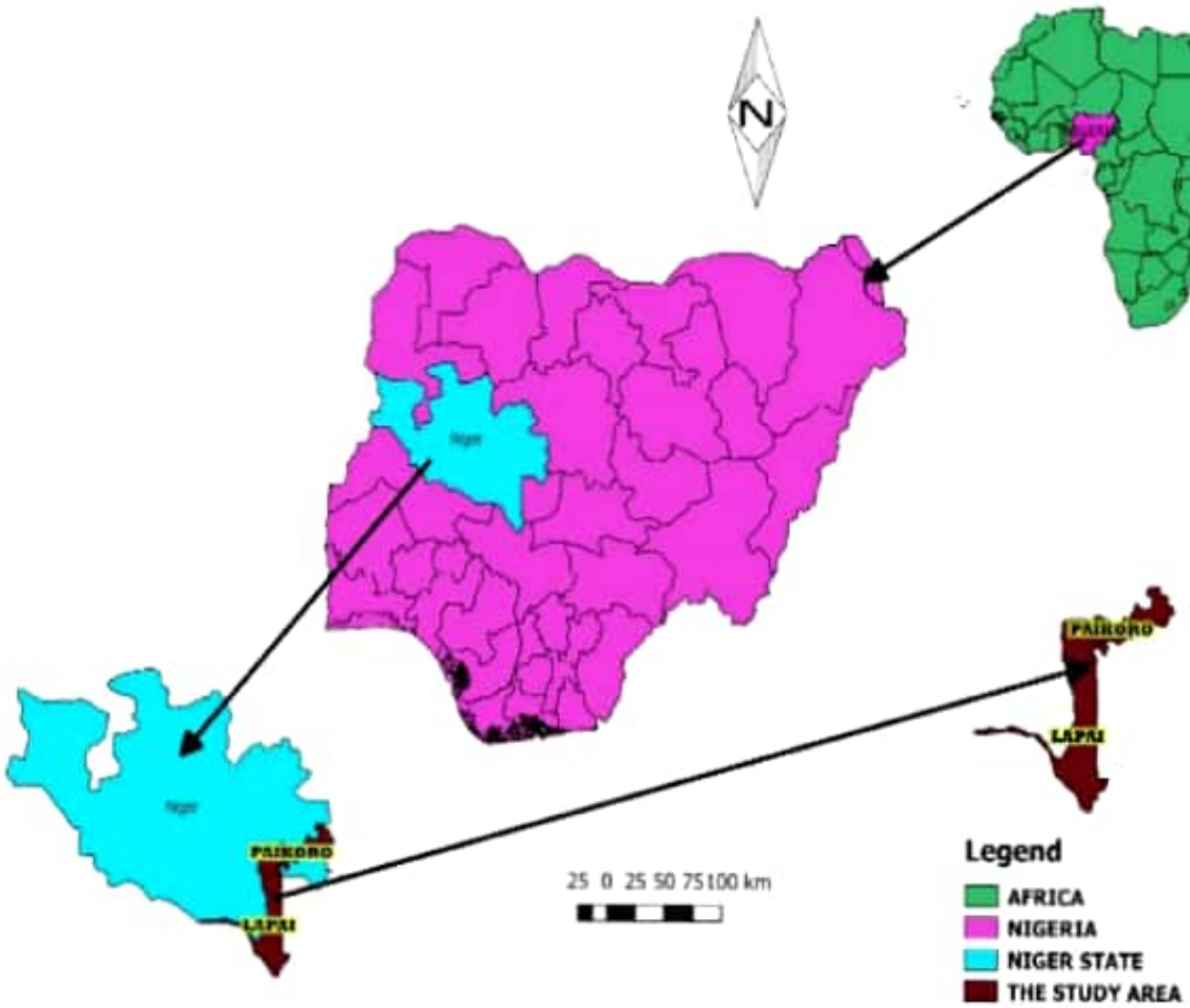

Figure 1: The location of Agaie-Lapai dam reservoir (inset map of Nigeria and Africa)

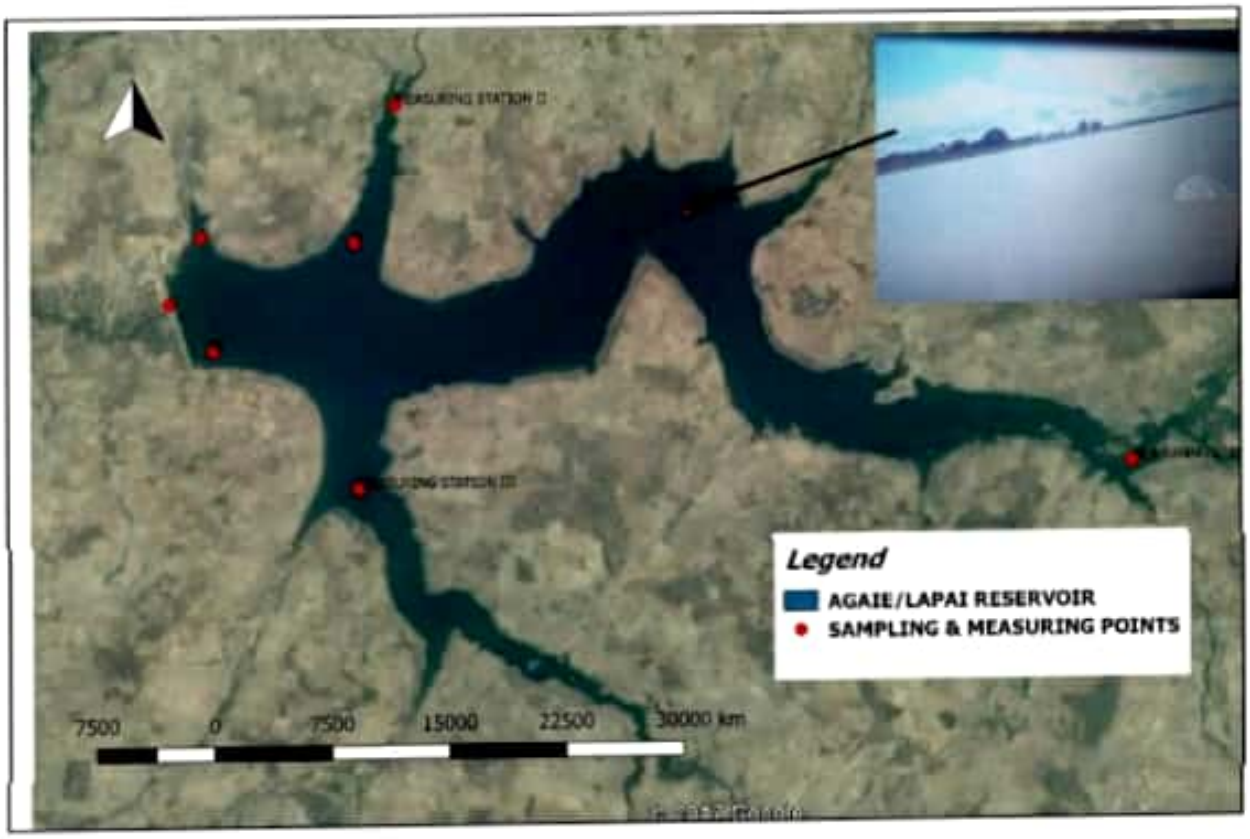

Figure 2 Agaie/Lapai Dam Reservoir showing the measuring and sampling points

Measurement of water level (depth) and rainfall

Depth of the water was measured by lowering a weighted, measuring tape to the bottom of the reservoir and then taking the value from the surface line of the water. Sample of physico-chemical parameters and plankton was taken from the surface of the water in all stations between 9.00am to11.30am. Daily rainfall measurement was taken using standard Rain gauge stationed at the dam site.

Measurement of Flow-rate (Cross Section Method).

The cross-section method was used to measure the flow-rate of the major rivers entering into the reservoir. It was done by choosing a point in the stream that acted as the cross-section of the river. The depth of the river was measured at equal intervals along the width of the river using a measuring tape. As the data was gathered, each depth was multiplied by the interval it was taken and the entire values were added. Then, a length of the river was decided typically longer than the width of the river. A floating object (an Orange) was released down the reservoir repeatedly. Using a stop watch the time it takes for the float to travel down the length of the stream was taken. This step was repeated four times and the mean value was calculated as the average velocity. The velocity obtained was multiplied by a friction correction factor in this case by 0.85 because of the rocky nature of the river beds. The corrected velocity was multiplied by the crosssectional areas to yield the flow rate in volume/ time (m^3/sec), (Graftman,2006).

Water Physical and Chemical parameters

Water physical and chemical parameters were measured following the methods described by the America Public Health Association (APHA, 2005).

Patterns of the hydrological factors in Agaie/ Lapai dam reservoir.

The pattern of local rainfall regimes in Lapai dam reservoir revealed the month of September with the high record value of 558.8mm of rainfall and at the end of November the value recorded dropped to 48.2mm signifying the close of the raining period of the season. In September the following year, the trend of local rainfall regimes changed where

the record high of the rainfall value dropped to 508mm and the lowest value of 38.7mm was recorded at the beginning of the season in May (Figure 3). The water level (depth) of the reservoir had the record high value of 10.6m in the month of October and the lowest value of 6.2m in the month of April (Figure 3). The highest record value of 10.7 m water level (depth) of the two seasons was obtained in the month September. The flow-rate of water from the three major tributaries into the reservoir water showed the month of August had the highest flow-rate value of 234.4 m^3/cm dropped to 48.2m^3/sec in November. In the following season 2014, the flow-rate record was first obtained in May with low value of 38.7 m^3/sec and the highest value of 241.2 m^3/sec in the month of August (Figure3)

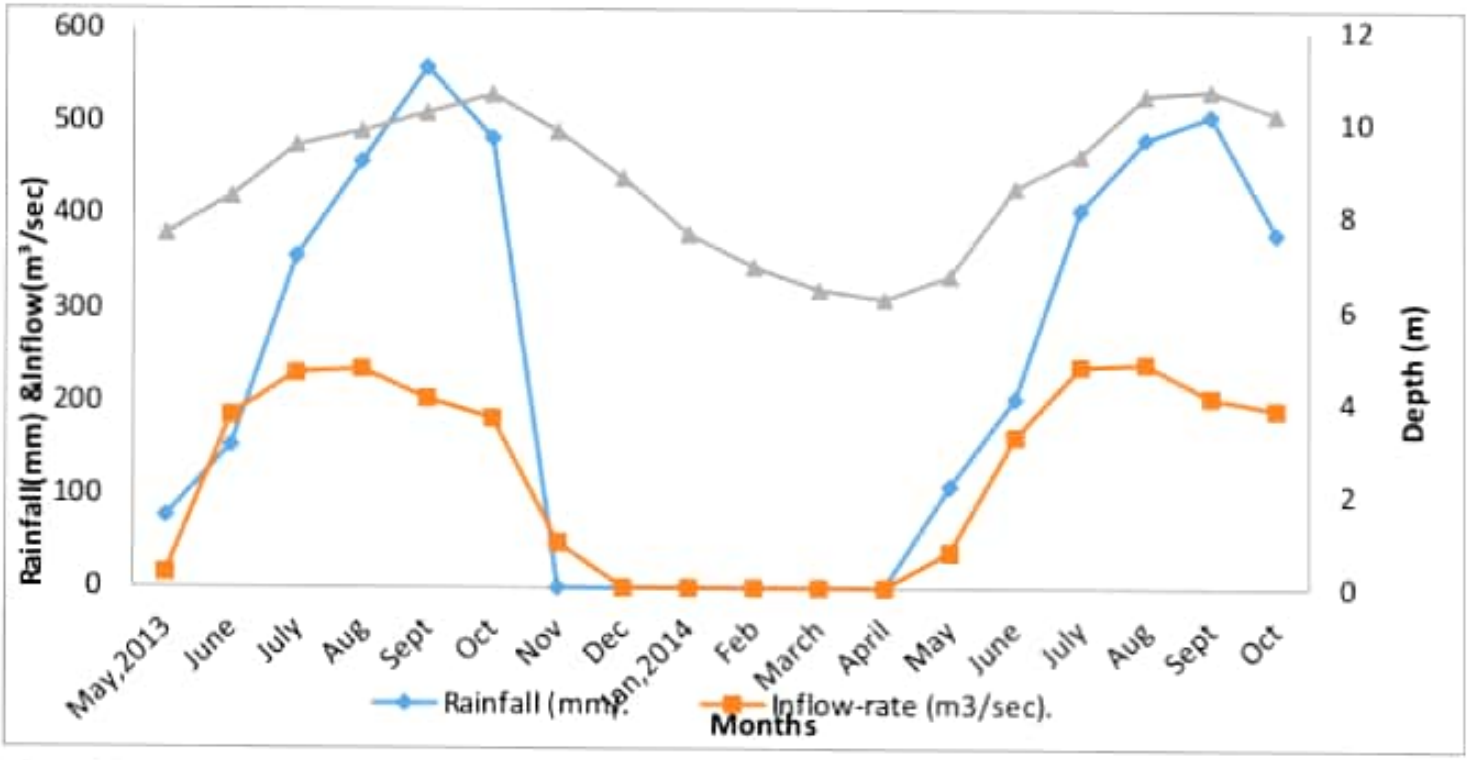

Figure 3: Patterns of the hydrological factors of Agaie/Lapai dam reservoir.

The impact of rainfall on the phytoplankton biodiversity and abundance of the dam reservoir

The impact of rainfall on the phytoplankton in the dam reservoir affected the abundance of phytoplankton (Figure 4.15). The highest values of 18 and 13cell/ml of Chlorophyta and Chrysophyta respectively were recorded when there was no rainfall within locality between the month of November and April. Other phytoplankton groups that were affected by the rainfall were the Bacillariophyta and Euglenophyta with lower values of 9 and 8 individuals' cell/ml respectively.

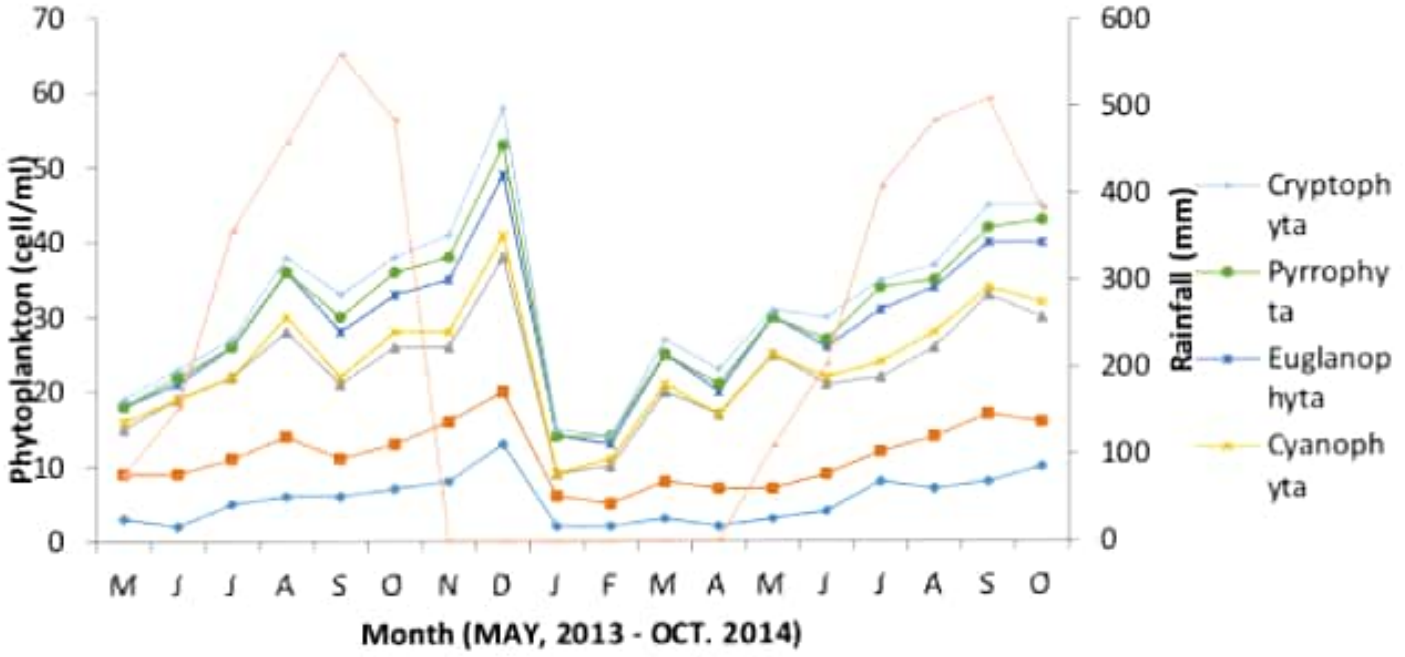

Figure 4: Impact of rainfall on the biodiversity and abundance of phytoplankton in the dam reservoir

The impact of inflow of water on phytoplankton biodiversity and abundance of the dam reservoir

The impact of flow-rates of water into the dam reservoir was pronounced on the phytoplankton groups. During two raining periods of the study, Chrysophyta and Bacillariophyta were not affected by the inflow-rates and the groups had 14 and 8 individuals cell/ml respectively at 234.4m^3/s (Figure 4.18). Similarly, the same groups of phytoplankton had 16 and 9 individuals cell/ml respectively at 204.7m^3/s. The Cryptophyta and Pyrrophyta were impacted by the inflow of water and they had 18 individuals and latter had 13 individuals at the peak of flow-rates.

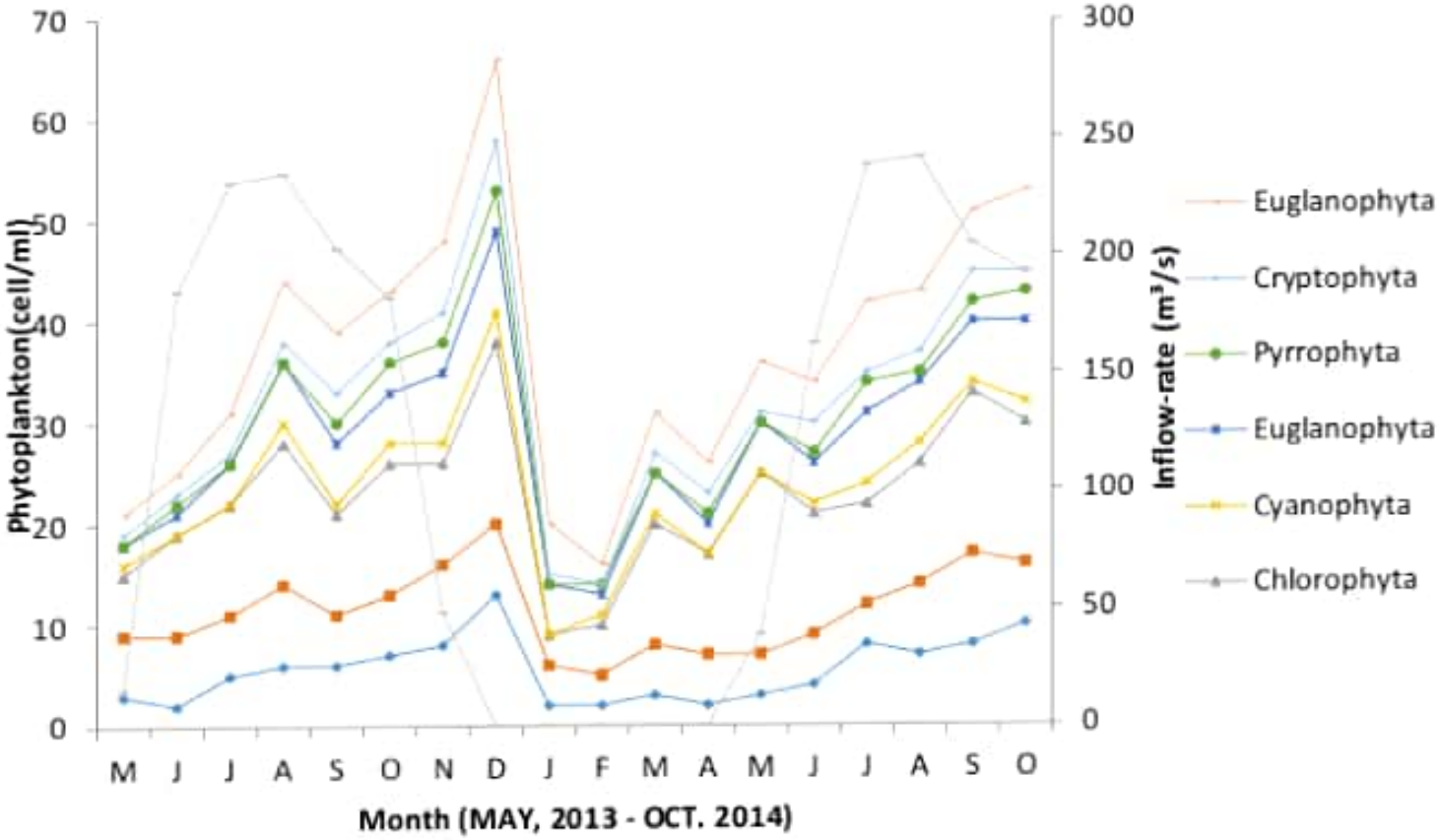

Figure 5: Impact of inflow-rate of water on biodiversity and abundance of phytoplankton in the dam reservoir

The water level (depth) on the biodiversity and abundance of phytoplankton of the dam reservoir.

The changes of water level (depth) of the dam reservoir showed the abundance of phytoplankton taxa of Chlorophyta and Chrysophyta were much affected when the water level was at the verge of falling (Figure 4.21). All of the groups fell sharply between the driest month of January and February. At the highest peak, Chlorophyta had 14 individuals cell/ml in August and Chrysophyta had 13 individuals cell/ml in December at the depth of 10.6m. The trend of variations continued in the proceeding season where Chlorophyta had 16 individuals cell/ml in September when the water level was 10.7m and Chrysophyta had 10 individuals cell/ml in October

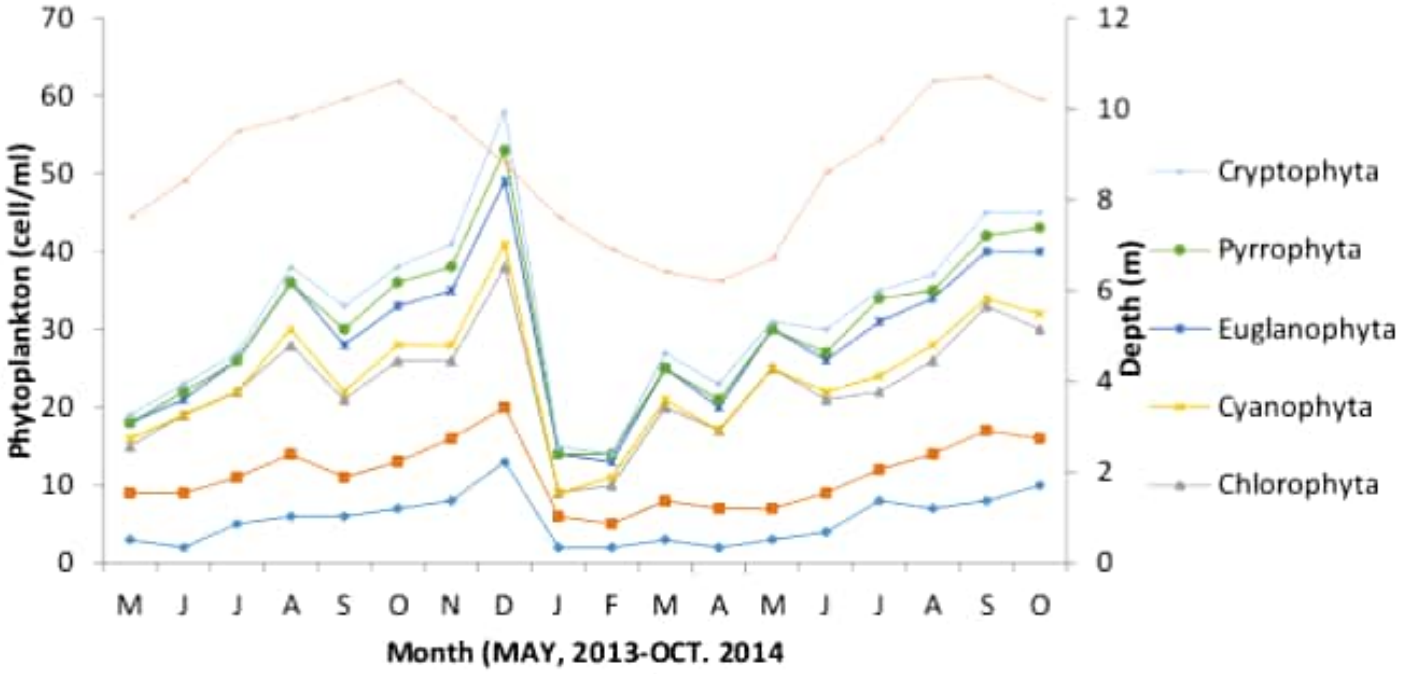

Figure 6: Impact of the water level on biodiversity and abundance of phytoplankton in the dam reservoir.

Discussion

In relation to the influence of the environmental variables, the peak of the total fish was between November and May. Magami, *et al,* (2015), reported October to concise with the raining season that the total number and abundance of the most species. Rainfall showed positive impact on the abundance of fish and reached its peak when the rain was about to stop (Lawson and Modupe 2010). Zarate-Hernandez, *et al.* (2012), supported the observation in the report that high occurrence of *Brevoortia gunteri* and *Menidia beryllina* species of fish showed positive correlation during dry season to trophic response associated with the proliferation of plankton. Rainfall increase tributaries discharge and freshwater runoff and, carries along large amount of allochthonous organic matter and dissolved nutrients into the aquatic system (Castillo-Rivera Manuel, 2013)

Conclusion

The environmental variable was found to influence the proliferation and abundance of the fish when the factors were at their peak about to decline or fall. Their multiplications and consequent abundance were brought to zero when the rainfall record stopped, the beginning of the dry season as the nutrients in the reservoir declined.

There are rich diverse culturable species of fish in Agaie/Lapai dam reservoir hence urgent need to protect the existing indigenous fish stocks and enhance their quality. These species are in numerous small other reservoirs across the state which should be incorporated into the value system of the society.

Recommendations

i. Fish stock assessment should be measured regularly.
ii. Conservation plan should be identified for effective monitoring.
iii. Preservation of the rich fish diversity of the reservoir should be intensified by regular restocking.

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