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Assessment of Water Quality, Ichthyofauna and Macroflora Diversity of Lower Ogun River Wetlands

[1]A.A. Hassan, [1]A. Jenyo-Oni and [2]A.B. Dauda

[1]Department of Aquaculture and Fisheries Management,
University of Ibadan, Ibadan, Nigeria
[2]Department of Fisheries and Aquacultural Technology,
Federal University Dutsin-Ma, P.M.B. 5001, Dutsin-ma, Katsina State

Abstract: The study investigated the water quality, Ichthyofauna and Macroflora diversity in view of knowing the pollution status of the wetlands around the estuaries of lower Ogun River and its environs in Kosofe/Ikorodu areas of Lagos State, Nigeria. The studied water quality indicators were; Temperature, Hydrogen ion concentration (pH), Salinity, Dissolved oxygen (DO) and Nutrient loads (Phosphate, Nitrate, Nitrite and Ammonia). Self-observation and structured interviews were conducted for 19 fishermen and 4 fishmongers to elicit information on the diversity and composition of fin and shell fish biota in the study area. Different species of Macroflora were sampled in all the study sites and samples of some closely related species were collected for identification. Water quality indicators at the sampled sites were found to range within acceptable limits for tropical water bodies except in Ogudu where the DO was slightly low and nitrite was above 0.5mg/L recommended for warm water fish species. In all, 21 fish species were reported while 10 of them were actually sighted. The dominant macroflora species include *Rhizophora racemosa, Avicennia africana, Elaeis guineensis, Panicum maximum* and *Eichhornia* spp. The study showed that anthropogenic activities influence the physicochemical parameters of lower Ogun River and this may in turn tend to affect the fauna and flora diversity of the area. However, the majority part of the wetland is still relatively healthy considering the high diversity of Ichthyofauna and Macroflora reported in the study as well as the water quality. Lastly, conservation and conscientious management of this and other wetlands in Nigeria are advocated in order to prevent their losses and corresponding forfeiture of a wide range of ecosystem services that humans derive from them.

Key words: Fish Diversity · Wetland Ecosystems · Pollution · Plant Diversity · Anthropogenic Activities

INTRODUCTION

Wetland has been used as a term since the beginning of the 20th century [1]. Mitsch and Gosselink [2], observed that sequel to continuous gradation of wetland characteristics from aquatic to terrestrial, any definition is to some extent arbitrary and as a result, there is no single, universally recognized definition of what a wetland is. Partly in response to the foregoing, the Committee on Characterization of Wetlands developed a 'reference definition', to stand outside any single agency, policy or regulation. The Committee reference definition states that a wetland is an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface and the presence of physical, chemical and biological features reflective of recurrent, sustained inundation or saturation at or near the surface of the substrate [3]. According to the above definition, there are some common features of wetlands like hydric soils and hydrophytic vegetation that are present except where they have been removed by specific physicochemical, biotic, or anthropogenic factors. Keddy [4] defined a wetland as an ecosystem that arises when inundation by water produces soils dominated by anaerobic processes

Corresponding Author: Hassan, A.A., Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Nigeria. Tel: +2348058482805.

and forces the biota, particularly rooted plants to exhibit adaptation to tolerate flooding. However, the most commonly adopted definition in Nigeria is that of Ramsar Convention Secretariat [5]. The Convention defines wetlands as "areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters". In summary, wetlands are the link between the land and the water. Wetlands are also referred to as nurseries of life [6] and are among the most productive ecosystems in the world. An immense variety of species of microbes, plants, insects, amphibians, reptiles, birds, fish, and mammals can be part of a wetland ecosystem. Globally, wetlands occur in a wide range of geographical locations and cover an estimated 6 % of the world's land surface [7]. This translates to about 5.6 million square kilometers of wetlands [8]. In Nigeria, wetlands are estimated to cover about 28,000 km^2 which is about 3 % of the 923,768 km^2 land surface area of the country [9]. According to Hughes *et al*. [10], Nigerian wetlands can be divided into five categories. The most extensive are the coastal wetlands found in the southern region bordering the Atlantic Ocean. These include the Lagos and Lekki lagoons wetlands, the Niger Delta wetlands, and wetlands of the Cross Rivers. Further inland and scattered across the country are the riverine wetlands under which the study area of this research falls. These include the floodplains of the Niger/Benue, Ogun/Osun, Anambra/Imo, Sokoto/Rima, Komadugu Yobe, Ngadda, Yedseram, and ElBeid Rivers, which are extensively used for livestock grazing, farming, and fishing. The importance of Lake Chad wetlands, which is in the third category, stems from their proximity to the edge of the Sahara Desert where they provide water for more than 20 million people living in Nigeria, Chad, Cameroon, and Niger [11]. Lake Chad wetlands are also important for fisheries [12]. The fourth category comprises of interior wetlands not associated with any major river system although seasonal, support a wide variety of livelihood activities including material collection, fishing and farming. The last category of wetlands in Nigeria is artificial impoundments and includes Lake Kainji, which is important for electricity generation, fisheries and irrigation. Wetlands contribute to the national and local economies by producing resources (fish, fibre and water), enabling recreational activities and providing other benefits, such as, climate regulation, water purification, pollution control and flood protection [13]. Wetlands provide an essential link in the life cycle of 75 percent of the fish and shellfish commercially harvested in the world [5]. Wetlands provide mammals, plants, amphibians, reptiles, birds and fish with food, habitat, breeding grounds and shelter. Wetlands have also played important roles in the development of Nigeria [14]. Human settlements concentrate in wetland areas in Lagos, Warri, Port Harcourt, and Nguru. Wetlands are equally the basis of popular Fadama projects, which are designd to increase the income of people using rural land and water resources on a sustainable basis. These projects support agricultural production, fisheries, livestock grazing, and forestry [15].

Despite this enormous importance and value, wetlands have been misunderstood for many years, often viewed as wastelands to be drained and converted to other uses. As a result, there have been exceptional losses of wetlands during the last two centuries. Estimates of wetland loss exceed 50% for the conterminous United States and for Europe [16]. In Nigeria, Lagos State recorded colossal wetland loss of more than 96 per cent between 1965 and 2012 [17].

However, the several essential ecosystem services that wetlands perform will, no doubt be lost when wetlands disappeared, water will not be as clean, fish and bird populations will suffer, and the frequency and severity of floods will increase, there will be losses of recreational opportunities and aesthetic benefits as well as sites for scientific research and education. This study therefore assessed the water quality, Ichthyofauna and Macroflora diversity in view of knowing the physical and biological health status of the wetlands around the estuaries of lower Ogun River and its environs in Kosofe/Ikorodu areas of Lagos State.

MATERIALS AND METHODS

Study Area: The study area covers a region referred to as the Lower Ogun River Basin Wetlands and it is a major wetland region in Nigeria [18]. Ogun River took its source from Igaran Hills at an elevation of about 530m above the mean sea level and flows directly southwards over a distance of about 480km before it discharges into the Lagos Lagoon at Oworonsoki and Ikorodu ends (Fig. 1). The two major vegetation zones that can be identified on the watershed are the high forest vegetation in the north and central part and the swamp/mangrove forests that cover the southern coastal and floodplains, next to the lagoon. The following Local Government Areas (LGAs) fall completely or partly within the study area: Kosofe, Somolu and Ikorodu Local Government Areas (LGAs) of

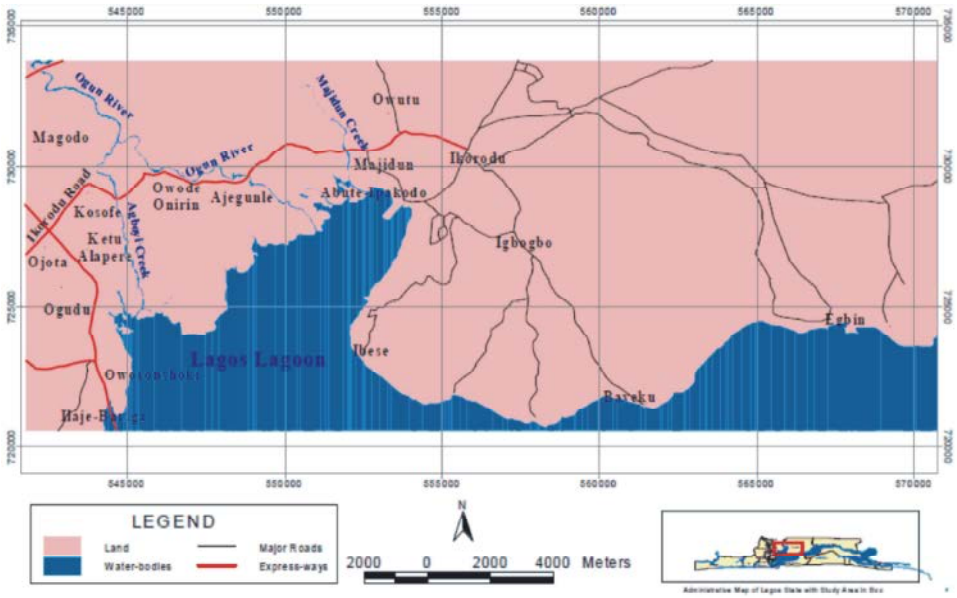

Fig. 1: Map of the study area Source: [19]

Lagos State as well as Isheri Olofin and the OPIC Estate areas of Ogun State [19]. The sampling sites for the study were Isheri-Olofin/Magodo, Ogudu/Agboyi and Majidun/Ikorodu areas of lower course of Ogun River. The entire study area lies between latitudes 6° 33'- 6° 38' N and longitudes 3° 21'-3° 28'E. The area is characterized by a typical rainforest climatic condition of rainy season from April to November and dry season from December through March.

Field Measurements and Laboratory Analyses: This work was carried out between February and May 2013, reconnaissance survey was first carried out to collect information about the study area; locations of landing sites, access roads, boat/canoe piers and so on to corroborate and confirm the remotely sensed data earlier collected from Google Earth (a mapping and satellite software). A Global Positioning System (GPS) receiver (Garmin eTrex 10) was used for locating the sampled sites and a digital camera (Kodak M530) was used for necessary picture photographs. The water quality indicators investigated were surface water temperature, hydrogen ion concentration (pH), salinity, dissolved oxygen (DO) and nutrient loads following the guidelines of U.S. EPA [20] and Kentula and Cline [21].

Surface Water Temperature: A mercury-in-glass thermometer, graduated in degree centigrade (°C) was used to determine the surface water temperature. The thermometer was placed at a minimum of 20cm below the surface of water and temperature was read after the mercury had stabilized. The water temperature of the wetland was taken as the mean temperature of the three sampled sites.

Hydrogen ion Concentration (pH): The pH of the water samples was determined using a standard laboratory pH meter Griffin model 40 (cell battery operated) at room temperature and standardizing with two buffers (6.9 and 9.2). The mean of the pH values at the three sites were taken as the mean pH of the wetland.

Collection of Water Samples: Surface water samples were collected for the survey for chemical parameters analysis using 75cl plastic containers with screw caps. Collection of samples from the sites was done early in the morning before 11.00 AM in line with the procedure of U.S. EPA [20] in all the three sampled sites. Water samples were collected just a few centimeters below the water surface. The plastic containers were labeled appropriately and transported to the laboratory and stored in refrigerator prior to further laboratory analysis.

Dissolved Oxygen: The dissolved oxygen (DO) content of the water from the wetland was determined using the Rideal-Stewart modification of the Winkler method as described by Wetzel and Likens [22]. The mean of the dissolved oxygen concentration at all the sampled sites was taken as DO of the wetlands.

Salinity: The salinity of the water from the wetlands was determined by the Silver Nitrate ($AgNO_3$) titration method using Potassium Dichromate as indicated [23]. The mean salinity of samples sites was taken as the salinity for the wetland.

Nutrient Load Determination: Nutrients are essential elements for biochemical and growth maintenance of biomass, with nitrogen and phosphorus being the most important and commonly determined nutrients in aquatic ecosystems [24]. As a result, amounts of nitrogen and phosphorus were determined.

Nitrogen Determination: Ion chromatography was used for simultaneous determinations of nitrogen anions (NO_2^- and NO_3^-) and cation (NH_4^+) as described by Jackson [25].

Phosphorus Determination: Phosphorus determination was based on the reaction of phosphate with acidified molybdate reagent to yield phosphomolybdate heteropolyacid, which is then reduced to an intensely coloured blue compound and determined spectrophotometrically at 840nm [26].

Fish Diversity and Relative Abundance: Personal interviews and self-observations of the fishermen landings were conducted to elicit information on the diversity and composition of finfish and shellfish biota in the study area. This was done with the aid of fish identification guides [27]. The target respondents were fishermen and fishmongers at the sampled landing sites within the study area. The monitoring of relative abundance was carried out employing three indices; "High" "Medium" and "Low" in line with Arowomole [23].

Plant Species Composition: Photographs of different species of plants were taken at the three sampled sites within the study area. Samples of some closely related species were also collected. The species identification was carried out with the aid of a manual of West African Weeds [28] alongside with the help of a wetland ecologist in the department of Crop Protection and Environmental Biology using the Departmental herbarium in the University of Ibadan, Ibadan, Nigeria.

RESULTS

Water Quality Parameters of Sampled Sites within the Study Area: The results of water chemistry analysis and physiographic field measurements of sampled sites within the study area are presented below in Table 1.

Table 1: Water quality parameters of the study area

	Location		
Parameters	Isheri	Ogudu	Majidun
Temperature (oc)	25.60±1.22	27.50±1.27	26.30±1.03
Dissolved Oxygen(mg/L)	8.00±1.00	4.80±0.46	7.10±0.17
pH	7.60±0.20	8.50±0.30	6.90±0.26
Salinity (ppt)	0.65±0.05	4.55±0.48	12.90±1.20
Phosphate (mg/L)	0.02±0.00	0.34±0.07	0.04±0.01
Nitrate (mg/L)	0.40±0.01	0.88±0.10	0.22±0.01
Nitrite (mg/L)	0.24±0.04	0.53±0.01	0.13±0.01
Ammonia (mg/L)	0.08±0.02	0.18±0.02	0.04±0.00

Table 2: Species Diversity and Relative Abundance of Finfish and Shellfish in the Study Area

		Relative Abundance In Sampled Locations		
S/N	Species	Isheri	Ogudu	Majidun
1.	*Chrysichthys nigrodigitatus*	High	High	High
2.	*Gymnarchus niloticus*	Medium	Low	Low
3.	*Tilapia niloticus*	High	High	High
4	*Synodontis nigrita*	High	Medium	Low
5.	*Penaeus notialis*	High	Low	High
6.	*Acathurus monroviae*	Medium	Low	Medium
7.	*Pomadasys jubelini*	Low	Low	Medium
8.	*Liza grandisquamis*	Medium	Low	Low
9.	*Sardinella eba*	Low	Low	Medium
10.	*Polydactylus quadrifilis*	Low	Low	Medium
11.	*Pellonula afeluisi*	High	High	High
12.	*Ilisha Africana*	Medium	Low	Medium
13.	*Epinepheleus aeneus*	Low	Low	Medium
14.	*Clarias gariepinus*	Medium	Low	Medium
15.	*Heterobranchus bidorsalis*	Medium	Low	Medium
16.	*Lutjanus goreensis*	Medium	Low	Medium
17.	*Shilbe mystus*	Medium	Low	Medium
18.	*Cynoglossus canariensis*	Medium	Low	Medium
19.	*Hemichromis bimachulatus*	Medium	Low	Medium
20.	*Littorina littorea*	Low	Low	High
21	*Metarcarinus magister*	Medium	High	High

Table 3: Plant Species Composition of the Study Area

		ISHERI	OGUDU	MAJIDUN
1.	*Rhizophora racemosa*	X	X	X
2.	*Avicennia Africana*	X	X	X
3.	*Paspatum vaginatum*	X	X	X
4	*Raphia* spp.	X		X
5.	*Elaeis guineensis*	X		X
6.	*Musa* spp.	X	X	X
7.	*Mangifera indica*	X	X	X
8.	*Panicum maximum*	X	X	X
9.	*Heliotropium indicum*	X	X	X
10.	*Acanthus* spp.	X	X	
11.	*Oncosperm filamentosa*	X		X
12.	*Nyah fruticans*	X	X	X
13.	*Cyperus* spp.	X		X
14.	*Oryza barthii*	X	X	X
15.	*Panicum laxum*	X	X	X
16.	*Ipomoea aquatic*	X	X	X
17.	*Azolla pinnata*	X	X	X
18.	*Eichhornia* spp.	X	X	X
19.	*Shrankia leptocarpa*	X	X	X

"X" indicates the species is present at the sampled site

Fish Diversity and Relative Abundance: The results of fishermen landing and personal interviews to elicit species diversity and relative abundance of finfish and shellfish in the study area are presented in the Table 2.

Plant Species Composition in the Study Area: The diversity of common wetland plant species and invasive species encountered at the different sampled sites within the study area during the study is shown in Table 3.

DISCUSSION

According to Table 1, the temperature in all the sites were normal for a tropical water body and this is in line with values (26.5 and 32.8°C) recorded by [29] for tropical rivers, Yakubu and Ugwumba [30] and Akin-Oriola [31] also have similar observation. However the temperature is within the recommended level (24-31°c) for warm water fish [32]. A low DO was recorded in Ogudu compared with other sites but all the DO were still within (>4mg/L) recommended for warm water fish [33] and [34]. This report agreed with that of Fakayode [35], who noted low DO in a station with high temperature and therefore established that temperature is inversely related to DO and this can be associated with high level of organic decomposition going on due to domestic and industrial effluents. The pH recorded in all the stations tend towards alkalinity and this is similar to the results of some previous researchers on tropical water bodies [29, 30, 36, 37]. The pH fell within the recommended range of 6.5-8.5 [32] for tropical fishes. Ammonia, Nitrate and Nitrite in all the stations were within the recommended ranges [33] except for nitrite in Ogudu which is slightly above 0.5mg/L recommended for warm water fishes. Though phosphate recorded is relatively higher in Ogudu than the two other stations but they are all still within limit for water bodies, the value recorded in Ogudu is still within 0.01-3,0mg/L recommended by USAID Markets [38]. Therefore based on the water quality Lower Ogun River basin wetland can't be said to be under pollutional stress even when there is slight traces in one of the stations (Ogudu). This report is in line with that of Fagade *et al.* [39] and Atobatele *et al.* [36]. The water sampled collected from Ogudu actually hinted of a degraded quality for its black colour and bad odour and this can be associated with discharge of industrial and domestic effluent that constitute threats to the integrity of the coastal wetlands [40]. This observation is supported by the report of BNRCC [17].

Table 2 shows that 21 different fish species (19 finfish and 2 shellfish) were noted to be present by the interviewers but 12 of them were actually seen and identified during the study period. Species that were actually sampled were *Chrichthys nigrodigitatus, Gymnarchus niloticus, Tilapia niloticus, Synodontis nigrita, Penaeus notialis, Acathurus monroviae, Pomadasys jubelini, Liza grandisquamis, Sardinella madarensis, Shilbe mystus, Metarcarinus magister and Littorina littorea.* The fish diversity is not very poor, though lower than 37 species reported by Adeosun *et al*. [41] in Ikeere gorge reservoir in Oyo State, Nigeria, but higher than 10 species reported by Bala *et al*. [42] in Daberam reservoir Katsina State, Nigeria. However, the variation in the total number of fish species (21) that identified through interviews with fishermen and fishmongers and those encountered during sampling may probably due to temporal differences as the study was carried out during the late dry season to early rainy season (February to May). Yakubu and Ugwumba [30] recorded significant higher macro-invertebrate (a major group of fish food organisms) abundant in the rainy season than dry season in the area. This is suggesting that the fish abundance and diversity may be higher during rainy season due to increase availability of fish food organisms. Ikenweiwe *et al*. [43] also reported three of the species among nine different ones they found in upper course of the same study area. It was noted that human activities (such as sand-filling, sand mining, waste disposal and so on) might upset the wetland ecosystems for especially fish species and other biotic components within the study area. The reclamation of the wetlands for bridges, residential houses and industrial buildings, has virtually destroyed the breeding grounds, nursery and schooling areas for mullets, tilapia species, shrimps and many other species of fin and shellfish. This deduction is in line with the submission of Ekanem [44], that environmental degradations, including oil spillages, pollution and destruction of mangrove swamps have had considerable impacts on the breeding and nursery coastal habitat of the fish, particularly in Nigeria. According to U.S.EPA [13], wetlands provide a consistent food supply, shelter and nursery grounds for many marine and freshwater species which are dependent on wetlands for at least part of their life cycles.

The floral composition of the wetland shows a high level of diversity. Bruce *et al.* [45], noted that inland wetlands include marshes and wet meadows dominated

by herbaceous plants, swamps dominated by shrubs, and wooded swamps dominated by trees. The dominant species in the study area include *Rhizophora racemosa, Avicennia Africana, Elaeis guineensis Panicum maximum* and *Eichhornia* spp. (Table 3). This really shows similarity with the findings of Hughes *et al.* [10], with the exception of *Eichhornia* spp. (water hyacinth) which is an invasive species. Water hyacinth was observed to have invaded these wetlands probably due to high level of nutrient (phosphate) especially in Ogudu station and this is a signal of development of pollutional stress.

CONCLUSION

The study revealed that the lower Ogun River wetland ecosystems are influenced by anthropogenic activities which is gradually influencing the physicochemical parameters and may in turn affect the fauna and flora diversity of the area. It was also revealed that anthropogenic activities in the area though have not significantly harmed the wetland ecosystems but if continue have a tendency of growing to the stage of severe harm. This makes it imperative that we must always be conscious of the fragile nature of wetland ecosystems when we engage in any developmental projects. However, the wetland is still relatively healthy considering the high diversity of ichthyofauna and macroflora reported in the study as well as the water quality indicators. However, it is strongly recommended that anthropogenic activities in the area should be checked because the more domestic waste, sewage and industrial wastes are emptying directly into the wetland the higher will be the disappearance of the ecological integrity of the lower Ogun River wetlands. Lastly, conservation and conscientious management of these and other wetlands in Nigeria are advocated in order to prevent their losses and corresponding forfeiture of a wide range of ecosystem services that humans derive from them.

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