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Lake Guidimouni: Diversity of Vertebrate Fauna and its Threats

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Lakes provide many services to humanity. However human activities affect negatively the function of the lakes to deliver their values to society. It is in this sense, this study tried to assess the effects of human activities on the dryland lake (Lake Guidimouni) mostly, the effects of the human activities on the vertebrate fauna. This study will close the paucity of data about the diversity of vertebrate fauna in the West African Sahel Lake. Therefore, this study assessed the diversity of vertebrate fauna and its menaces in Lake Guidimouni, Niger. We used Field investigations and questionnaires for the data collection. While we used descriptive statistics and the number of species, the number of families of the different classes of vertebrates recorded in the lake. The study recorded 21 vertebrate fauna species across the four vertebrate classes (Fish species = 7; Bird species = 7; Amphibian species = 2 and reptile species = 5) in the lake Guidimouni based on the field

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observation and questionnaire. More specifically the study recorded six fish species belonging to the six families in the lake with as Cichlidae dominant family. While we recorded seven bird species with Ardeidae having the high species richness (3 species) belonging to three families. Furthermore, five species of reptile were recorded belonging five families in the lake Guidimouni. Lastly, two amphibian species were identified belonging to two families. Secondly, the study documented the many threats to Lake Guidimouni biodiversity mainly illegal poaching, salinity, the use of the chemicals, overexploitation such as overfishing, invasion by species such as *Typha australis* and *Prosopis juliflora,* destruction of the lake by unsustainable farming practices such as cutting down of trees and drying up of the lake. This study constitutes the baseline reference about the impacts of human activities on the dryland lake (lake Guidimouni) in Zinder region, in Niger. The study recommends some ecological restoration activities of lake Guidimouni such as the removal of the invasive species, enforcement of law and regulation about the use of chemicals in the lake. It also recommends further study which look at socio-economic and ecological benefits of the lake Guidimouni in the context of changing climate.

Keywords: Dryland; Lake Guidimouni; invasive species; aquatic biodiversity.

1. INTRODUCTION

Lakes play a major role in biodiversity conservation. For instance, 15% of the world biodiversity lives in lakes [1]. Particularly, the lakes play a major role in vertebrate fauna conservation [2–5]. In addition to that, lakes are known as an area with high levels of unique animal and plant biodiversity [2,4–7]. Lakes are natural brakes on climate change due to their high carbon sequestration potential and their ability to keep carbon for long-tern conservation [8,9]. Lakes are great source of livelihood such as source of food, forage, medicines, and materials for human needs, which help to reduce poverty, food insecurity, and malnutrition in the world for climate change adaptation [10–12]. The world's lakes are also important for understanding the trend of climate change as reported by [13–15] that lakes are sentinels of climate change.

However the lakes provide a wide range of ecosystem services to society, and the human activities constitute a major threat to the lake ecosystems such as the conversion of the lake to farmlands, overfishing, and poor fishing practices as reported by [16–18] which destroys many animal species in the Lake Victoria Basin. In addition to that, the use of chemicals for fishing or farming and invasive species are the agent of the destruction of freshwater. For instance, the use of pesticides and fertilizers in farming is a great source of water pollution in wetlands in West Africa [5,19], Apart from these threats, climate change has various and great effects on the lake ecosystems [14,20].

Despite their importance, West African Sahel lakes continue to be fairly ignored in the global and regional conservation efforts. In addition to that, there is a paucity of data about the vertebrate fauna in a wetland of West African Sahel region. For instance, biodiversity data from lakes in the Sahel region as Niger are seriously underrepresented in the conservation literature. Therefore, this study tries to close this gap by determining the vertebrate fauna and threats of lake Guidimouni, Niger. This completes the international and national efforts to identify lake biodiversity for its sustainable management.

2. MATERIALS AND METHODS

2.1 Study Area

Lake Guidimouni (13°42'N 09°31'E) has been the site study site which is located in the rural commune of Damagaram-Takaya in the Zinder Region (Fig. 1), with a total population of 84 649 inhabitants [21]. Lake Guidimouni runs along the National Route in the vicinity of 500 m on its right bank with a land area of 338.4 hectares. Lake Guidimouni is of the Ramsar sites in the Niger republic. The main activities of the people in the commune of Guidimouni are agriculture with a predominance of market gardening, livestock, trade, and fishing practiced. Lake Guidimouni is located in the Sahel agro-climatical zone of Niger which receives 300-500 mm of rain annually [22].

2.2 Data Collection

Field investigations and questionnaires were carried out in 2016 in order to collect data on Lake Guidimouni. The study was mainly based on a field survey of vertebrates at the lake and in its surrounding areas. The lake Guidimouni users

administered the questionnaires (individuals or focus group discussion). Pictures of the vertebrate fauna of the lake were taken. For the fish species inventory, we followed the legal anglers (those who have a permit of fishing) during the collection of their fish trap early in the morning for 10 days. We took only the pictures, and local names of the fish from the fish trap every day. For the bird inventory, we took only pictures of the birds that we found in the water and near the lake. We collected also some vertebrate fauna indicators such as faeces.

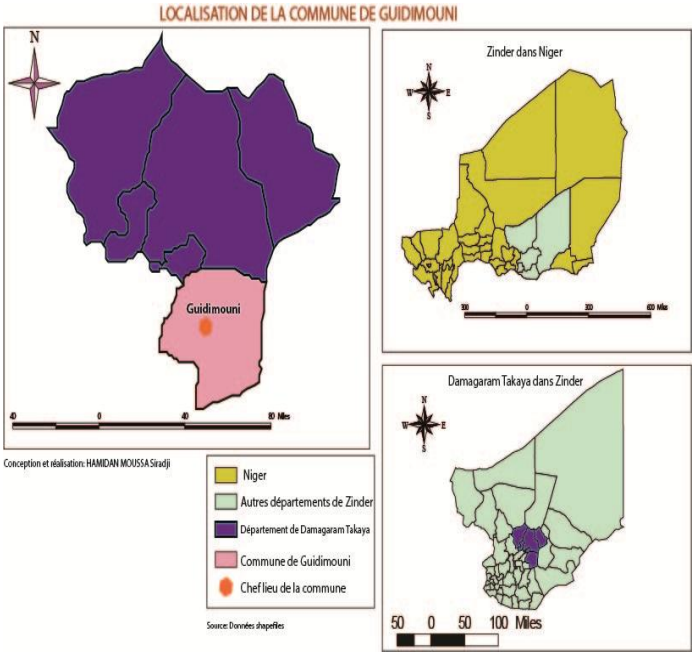


Fig. 1. Map of the Commune of Guidimouni

Table 1. Diversity of vertebrate fauna of the Lake Guidimouni

Fish species and richness (S = 7)	**Families (F = 6)**
Coptodon zillii Gervais	Cichlidae
Oreochromis niloticus Linnaeus	Cichlidae
Clarias gariepinus Burchell	Clariidae
Protopterus annectens Owen	Protopteridae
Lates niloticus Linnaeus	Latidae
Bagrus bajad Forsskål	Bagridae
Auchenoglanis occidentalis Valenciennes	Claroteidae
Bird species and richness (S = 7)	**Families (F = 3)**
Ardea cinerea Linnaeus	Ardeidae
Bubulcus ibis Linnaeus	Ardeidae
Egretta garzetta Linnaeus	Ardeidae
Ephippiorhynchus senegalensis Shaw	Ciconiidae
Ciconia nigra Linnaeus	Ciconiidae
Plectropterus gambensis Linnaeus	Anatidae
Sarkidiornis melanotos Pennant	Anatidae
Amphibian species and richness (S = 2)	**Families (F = 2)**
Rhinella marina Linnaeus	Bufonidae
Pelophylax lessonae Camerano	Ranidae
Reptile species and richness (S = 5)	**Families (F = 5)**
Crocodylus niloticus Laurenti	Crocodylidae
Bungarus niger Wall	Elapidae
Aparallactus niger Boulenger	Lamprophiidae
Pelusios niger Duméril & Bibron	Pelomedusidae
Varanus niloticus Linnaeus	Varanidae

2.3 Data Analysis

Vertebrate species were recorded then species richness (S) was assessed for each class as the total number of species occurring along a given number of class. To be able to determine the different families of species of fish encountered: the key to identifying families of freshwater fish: case of the lake of Ayamé, which we were taught in the systematic module of fish was used, (Manual practice of identifying fish from Lake Ayamé (Rivière Bia, Côte d'Ivoire). Nevertheless, we used recent binomial name by putting the name of species.

3. Results

3.1 Diversity of Vertebrate Fauna of the Lake Guidimouni Based

The study recorded 20 vertebrate fauna species across the three vertebrate classes in the lake Guidimouni (Table 1) based on the field observation and questionnaire. More specifically the study recorded six fish species belonging to the six families in the lake with as Cichlidae dominant family (Table 1). While we recorded seven bird species with Ardeidae having the high species richness (3 species) belonging to three families (Table 1). Furthermore, five species of reptile were recorded belonging five families in the lake Guidimouni (Table 1). Lastly, two amphibian species were identified belonging to two families (Table 1).

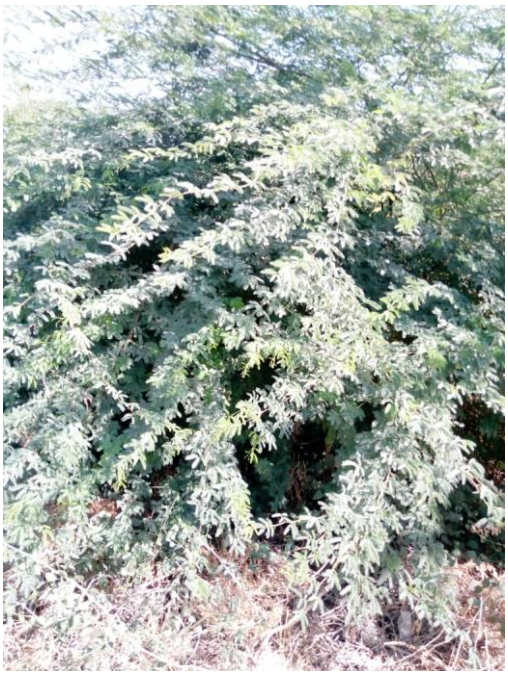
3.2 Different Threats to the Vertebrate Fauna of Lake Guidimouni

The study documents based on the focus group discussion the following emerging menaces to the Lake Guidimouni which are: (i) overexploitation; (ii) microplastic pollution (Presence of the plastic waste in the lake); (iii) illegal poaching as documented by the Photo (a) which shows the black stork (*Ciconia nigra*) and frog in the trap of illegal poacher as reported to us by the people we met during the field observation. (iii) salinization; (iv) chemical pollution caused by the use of chemicals (pesticide and chemical fertilizers) which come from irrigated farming activities near the lake (Photo b); (v) climate change represented by drought as reported by the respondents; (vi) plant invasion (*Typha australis* Schum et thonn and *Prosopis juliflora* (Sw.) DC. (Photo c), (vii) deforestation which leads to silting up of the lake as illustrated in the Photo (d).

Photos A. Ciconia *nigra* and frog trapped by a poacher by the lake. (Source: Hamidan, August 2017)

Photo B. Pesticides and fertilizer used by crop producers irrigate around Lake Guidimouni (Source Hamidan, 2017)

Photo C. *Typha australis* in the Lake Guidimouni



***Prosopis juliflora* in the lake basin**

Photo d. Shows deforestation near the lake which leads to the silting

4. DISCUSSION

The Lake Guidimouni fishery is dominated by Cichlidae. The dominance of this fish family in Lake Guidimouni may be due to the presence of the species such as *Clarias gariepinus, Oreochromis niloticus* which play a major role in combating malnutrition and poverty [23,24]. This dominance is key for the aquaculture and fisheries production in the lake as the fish recorded in this family in the Lake Guidimouni. This confirms the finding of [25] who reported such dominance in Lake Malombe. Our study provides the diversity of vertebrates in Lake Guidimouni which demonstrates also the role of the lake in biodiversity conservation as highlighted by [3,5,6].

This study reported the presence of two invasive species *Prosopis juliflora* and *Typha australis*. The presence of *Prosopis juliflora* as a threat in lake Guidimouni confirms the finding of this who [26] reported the spread of *Prosopis juliflora* in the Baringo basin, Kenya which has led to severe changes in the ecosystem with negative socio-economic impacts. The presence of *Prosopis juliflora* in Lake Guidimouni could lead to negative socio-economic and ecological effects. For instance, *Prosopis juliflora* in Lake Guidimouni restricts the physical assess to the Lake and blocks socio-economic activities such as fishing and gardening. This physical barrier may affect the domestic and wild animals to access the surface water of the lake. The presence of *Prosopis juliflora* has been reported to inhibit the growth of other species such as lowing the diversity of plant species [27]. This may affect the diversity of the cropping systems within and near the lake such as gardening, date palm cultivation and even the water resources of Lake Guidimouni as *Prosopis* species have been reported to be the most water-consuming plant species [28]. Moreover, this affects water availability for the native woody and herbaceous species which leads to a degradation of the ecosystems and its delivery of services [28,29]. There is a need to develop management options for the two invasive species (*Prosopis juliflora* and *Typha australis*). For instance, logging and pruning of the *Prosopis juliflora* may serve for firewood production as an income generating activity for poverty alleviation in the Guidimouni district in Niger. *Typha australis* blocks the waterway which hinders cropping and fishing activities [30]. *Typha australis* affects also the water quality by modifying the calcium and causing the high bicarbonate rate and pH as reported by [31] in the urban wetland in Niamey city. This could be the case of the Lake Guidimouni which is under *Typha australis* invasion. As far as *Typha australis* is concerned, it can be used as means of biofuel production and charcoal. This reduces the pressure on indigenous tree species which are major source of wood energy in Guidimouni.

Our study reported also the presence of plastic waste in Lake Guidimouni. This may lead to plastic pollution in the Lake which has been reported to affect negatively the lake biodiversity and ecosystem services delivery [32]. In addition to that, it has been reported that freshwater biodiversity such as birds [33], fish species [34,35], reptiles, and amphibians consumed the microplastic. The presence of microplastic in Lake Guidimouni may affect also negatively the aforementioned biodiversity. This may lead to Lake Guidimouni microplastic pollution as it has been reported to be a major worldwide environmental problem threatening the world lakes [36]. So, there is a need for sustainable management of Lake Guidimouni to educate and sensitize the lake users about the effects of plastic waste on biodiversity conservation and their socio-economic livelihood that they get from the lake. In addition to that, there is a need to respect the legislation of Niger that interdicts the use of microplastics.

In addition to that, our study reported the illegal hunting activities in Lake Guidimouni as shown the Photo A where a bird and reptile species are caught. This may lead to aquatic biodiversity loss as of the birds (Photo A) trapped by the illegal hunter. This could reduce the aquatic vertebrate fauna such as migratory birds as Lake Guidimouni is a Ramsar site, there is a need to more surveillance of the site in order to protect its biodiversity. There is also a need to take the Lake Guidimouni as Ramsar site in the local policy of the Commune of Guidimouni for the sustainability of the Lake.

Furthermore, our study reported the use of chemical products such as pesticides, fertilizers, and phytosanitary products shown in Photo B by the Lake Guidimouni users for gardening and other farmers. This activity may lead to the Lake Guidimouni pollution as the agricultural use of pesticides has been reported to be the source of surface water contamination [37]. The use of the pesticides by farmers in Lake Guidimouni may cause many perturbations in the lake such as biodiversity destruction and aquatic ecosystem disturbances [38,39].

5. CONCLUSIONS

This study described the vertebrate fauna diversity of Lake Guidimouni and its threats through field observation and questionnaires. The study recorded 21 vertebrate fauna species across the four vertebrate classes which are under threat due to human activities such as the use of chemical products for farming purposes, illegal poaching, plastic waste, and the invasion of the Lake by two species. This study provides data about Lake Guidimouni related to the vertebrate fauna and its different threats. But our study recommends a further study that will look at the Lake Guidimouni biodiversity entirely and the effects of the agricultural chemicals on the water and biodiversity by using some sophisticated analysis tools. However, our study recommends that the Commune of Guidimouni elaborates on the Lake management plan in order to integrate this Ramsar site into its development policy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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