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Effect of anthropogenic pressure on bird diversity of "Bird Island" in the commune of Karimama, Benin

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Abstract
Conservation of biodiversity is more than ever a topical concern. The Fifteenth Sustainable Development Goals (SDOs) underscores this. However, in recent years, it has suffered enormous effects that bear witness to regressive measures. This study carried out in a part of the Niger River valley known as the "Bird Islands" has made it possible to assess diversity and to list the pressures to which this diversity is subjected. The methodological approach used is simple stratified sampling (SSS) preceded by the memorization of bird songs carried out over 3 consecutive years. This was followed by the processing and analysis of the data collected in the riparian villages. About fifty species in 17 families were counted with the Shannon index (H') which varies from 1.6 to 3.8 depending on the localities. Following the surveys conducted among the populations, 42 % of our respondents think that agricultural practices are the major problems that do not contribute to the sustainability of the site, and 35 % think that it is rather the uncontrolled sampling. Moreover, the pressures identified are mainly linked to demographic growth, poverty and the inexistence of a firm local policy for the conservation and development of natural resources. Suggestions are made for the protection, safeguarding and integration of this site into the development policies of the commune.

Keywords: Diversity, pressures, avian, Bird Island, Karimama

1. Introduction

Animal and plant species are subject to various pressures from environmental and/or human sources that impact their distribution and assemblage (Revers *et al*, 2018) [15]. This is indeed the case of the "Bird Island" of the commune of Karimama, an impressive environment, which represents an original and fragile habitat hosting a remarkable biodiversity, of which the avifauna figures prominently. Birds are ubiquitous animals that frequent both terrestrial and aquatic ecosystems. They have fantastic ability to move and most species are found only in particular regions and habitats. The birds are widespread due to their adaptability and feasibility of movements (Rama Rao & Amaravathi, 2019) [14]. Although this environment remains relatively preserved, it is subject to anthropogenic pressures such as population explosion, which leads to inconvenient conservation practices. Agriculture and tourism are not very respectful of the living environment, one because of its intensive nature and the misuse of agrochemicals, and the other because of its unenvironmental nature. This site is invaluable for its role as a migration corridor through which it offers opportunities for genetic exchange between geographically isolated populations (Ouédraogo, 2008) [12].

Faced with the progress of scientific knowledge and the challenges of development, there is not only the problem of the perception of the importance and causes of biodiversity loss, but also of the possible measures to combat this scourge. To achieve this, knowledge and identification of the species that inhabit the planet is a preliminary step. This with the simple aim of envisaging appropriate conservation measures in the face of the factors of degradation of natural resources which are constantly multiplying.

The problem of biodiversity loss therefore appears today to be a malaise for States and United Nations organizations. In this logic, the Convention on Biological Diversity (2014) [5] indicates that whatever the scale (local or global), the causes of the loss of biological diversity are essentially due to human activities. Consequently, several authors have already agreed on the term "anthropocene", dedicated to our era to testify to the major effect of anthropogenic

actions on natural resources. Thus indicating that the human being is at the center of all processes of biodiversity erosion. Moreover, in tropical regions, forest destruction, fragmentation and degradation are threats to species' habitats (Gbankoto, 2011) [8].

However, birds are highly dependent on habitat factors and habitat variation. They are indicators of ecological change as meant by Lougbegnon *et al* (2010) [11]. In order to introduce measures to control biodiversity loss, International Union for conservation of Nature is proposing a global inventory of the conservation status of species, with the aim of populating the global red list of species. This will allow alarm bells to be sounded whenever necessary. It is in this logic that this research is being undertaken to take stock of this site, identifying the threats that are undermining its avian biodiversity in order to propose appropriate conservation measures for the sustainable management of this site.

2. Materials and methods

2.1 Geographical location of the "Bird Island" in the commune of Karimama

Bird Island, is located in the commune of Karimama, which lies between 11°40' and 12°23' North and 2°2' and 3°2' East, is located in the Alibori department about 750 km from Cotonou. It is bounded to the north by the Niger River, to the south by the commune of Banikoara, to the east by the Alibori River and the communes of Kandi and Malanville, and to the west by the Mekrou River. It covers an area of 6041 km² of which 80% of Protected Areas are 6% arable land and less than 5% pasture land. The subject of this study is located between the districts of Karimama centre and Birni Lafia. It is bordered by villages and hamlets commonly called "Tounga" in Dendi. To the north of the island are Natougou and Monboye-Tounga. It is limited to the South by Toundikoara, Boyizéra, to the South-East by Djamia-Tounga, to the East by Faram-Tounga and to the West by Dogo-Tounga in Niger and Bello-Tounga in Benin. It consists of a floodplain fed by the major bed of the Niger River, thus serving as a natural boundary in this border area between Niger and Benin. This "bird island" is surrounded by two arms of the Niger River, the large arm being on the Republic of Niger side and the small arm on the Benin side. It is distant from the summer island by about 01 km on the west side. The surface of the island is about 13 km^2 with a circumference of 15280 km. As shown in Figure 1.

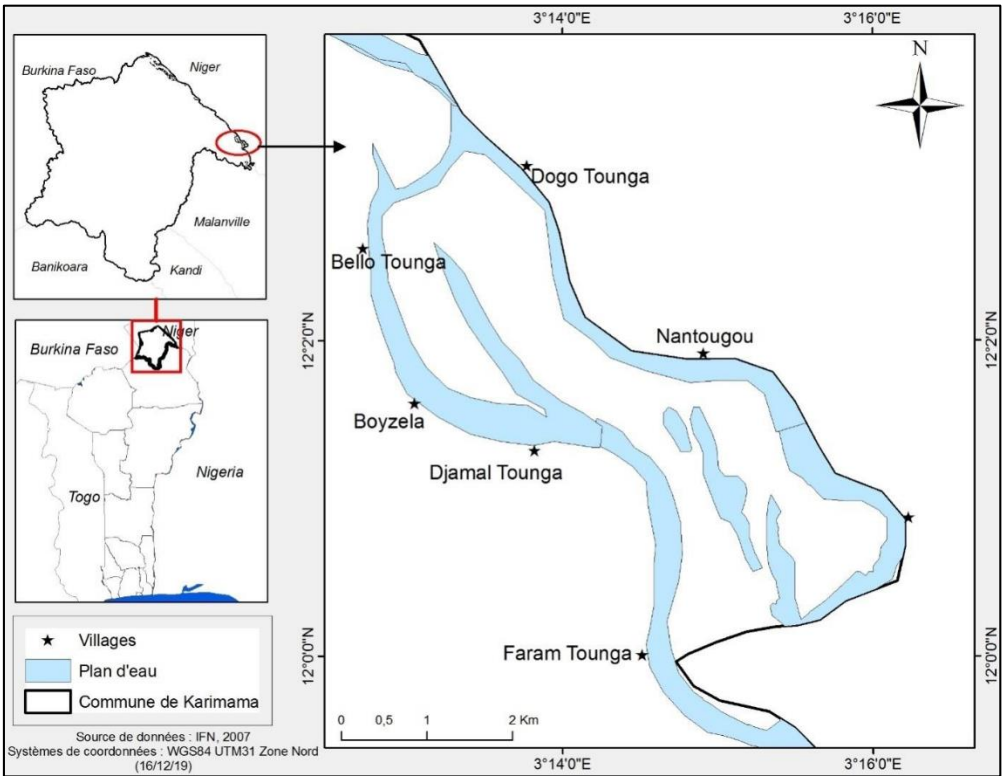


Fig 1: Geographical location of the "bird island" in the commune of Karimama

2.2 Materials

The field equipment consists of a pair of binoculars, a Borrow & Demey (2015) [4] bird identification guide and the African Bird Song Record Series (Chappuis, 2000) [3], a camera, a Global Positioning System (GPS) and a canoe for prospecting. To survey the riparian populations, the main equipment we used during this study is an Android phone on which the kobocollect application containing the survey questionnaire form is installed. The questionnaire is essentially made up of two sections. The first is an inventory of the different pressures on the site and the proposed solutions.

2.3 Bird inventory method

Bird communities were counted on the site using the listening point method and in several phases of implementation spread over 3 consecutive years. The listening point method consists of standing still at certain points in the study area in order to record all the species seen and heard from these points (Bibby *et al.*, 2000) [1]. Three passes were made at each point, at least two weeks apart. The passages (surveys) were carried out throughout the year in order to detect as many breeding species as possible. Eleven listening points were thus drawn on the four sites prospected during this study. The duration of

the listening points was set at 20 min to maximize the detection of the most discrete species and for a better estimation of the species richness (Bonthoux & Balent, 2012) [2]. The listening points were conducted during the 3-hour period before and after sunrise and sunset and under favourable weather conditions: no precipitation, no or little wind (Bibby *et al.*, 2000) [1]. The choice of the centre of the listening area (the point where the observer is positioned) was made rationally. This made it possible to detect all species regardless of their position and also without being disturbed by parasitic noise. Water birds, raptors, insectivores and birds in active migration, considered as non-breeding in the study area and all other birds, seen or heard, were counted. The species lists from the four site visits were merged.

2.4 Bird census and population survey procedures
The sampling used was reasoned. The investigations took into account 4 villages bordering the study site (Bello Tounga, Dogo Tounga, Nantougou and Boyzéla). These investigations were based on observation and interviews with certain social strata (local elected officials, farmers, fishermen and herders). Surveys took place at the sites in 2017, 2018 and
2019. Within the installed listening points, birds are observed or detected by singing, shouting or flying. Thus, in each of the 11 listening points with a radius of 150 m, bird manifestations (contacts and singing) are recorded. All birds seen posing (on the ground or in trees) are counted. Songs and calls that are far from the listening circle are not taken into account. The surveys mention both the species (systematic inventory) and their frequency. The distance between two listening points varies between 1.5 km and 2 km in order to avoid double counting of individuals during sampling for better results (Delahaye, 2006) [6]. Most of the survey sessions are carried out during the day during periods of intense bird activity. Observations begin at 6 am and end in the morning at 12 noon. In the evening, they resume at 4 pm and end at 7 pm.

2.5 Data processing
The information collected has first undergone manual processing and is coded before being integrated into the computer for processing by means of software and computer programs. A table for recording the data thus coded is produced using the Excel spreadsheet that is used to produce the graphs. The parameters of determined diversities are:

2.5.1 Diversity of bird communities
To appreciate the avifaunistic diversity of the study site, all the birds species recorded during the present study were tabulated giving their family, scientific name and common name. The alpha diversity indices of the bird communities recorded were then calculated: these included Shannon's (1949) [16] diversity index and Pielou's (1969) [13] equitability.

2.5.2 The Shannon-Weaner Diversity Index (1949)
Shannon's (1949) [16] diversity index measures the entropy of the data by the number of individuals of the bird species in its community, calculated on the basis of the proportions of species observed. It represents the sum of the information given by the frequency of the various bird species collected along the surveyed site. Its formula is as follows:

$$H' = -\sum_1^s Pi \log_2 Pi$$

Where P_1= ni/n where ni is the number of individuals of bird species at each census station
and n is the total number of individuals of bird species inventoried at the site level. Generally the Shannon diversity index value ranges from 0 to 5 bits but sometimes a little more than 5 bits;
H' ϵ [0; 2.5] then Shannon's diversity index can be assumed to be low
H' ϵ [2.6; 3.9] then Shannon's diversity index can be assumed to be medium
H' ϵ [4; 6] then Shannon's diversity index can be assumed to be high.
A Shannon's diversity index is high when the station presents conditions suitable for the installation of many bird species, but the number of individuals per species is low. This is a sign of a very stable environment. This therefore suggests that station conditions are unfavourable and lead to a high specialisation of species, so we have a very low number of species with many individuals, hence a dominance phenomenon.

2.5.3 The Equitability of Pielou (1969) [13]
It is often calculated to reflect the degree of diversity achieved relative to the maximum possible. It varies from 0 to 1.
His expression is:

$$H' = -\sum_1^s Pi \log_2 Pi$$

E = H'/Log2(S) where S is the total number of species at the station level and H' is the
Shannon - Weaner diversity index at the station level.
Pielou's equitability index tends towards 0 if almost all of the birds at the station correspond to a single species and tends towards 1 when each species is almost represented by the same number of individuals in the station. High Pielou equitability may then be a sign of a balanced stand, a stable environment. Low Pielou equitability corresponds to highly selective stations with dominant species.

3. Results
3.1 Birding composition of Karimama Bird Island
The inventory reveals that there are more than 50 species of birds divided into 17 families. A host of bird species from the "Bird Island" were therefore inventoried during the various surveys. As far as their typology is concerned, a distinction is made between migratory birds (Abdim's storks migrate between East Africa and the Sahel) and sedentary birds. Beyond the consideration of migratory status, this area serves as a nesting and mating site for several species of migratory waterbirds. Figure 2 shows the different species observed at the site and their
Families

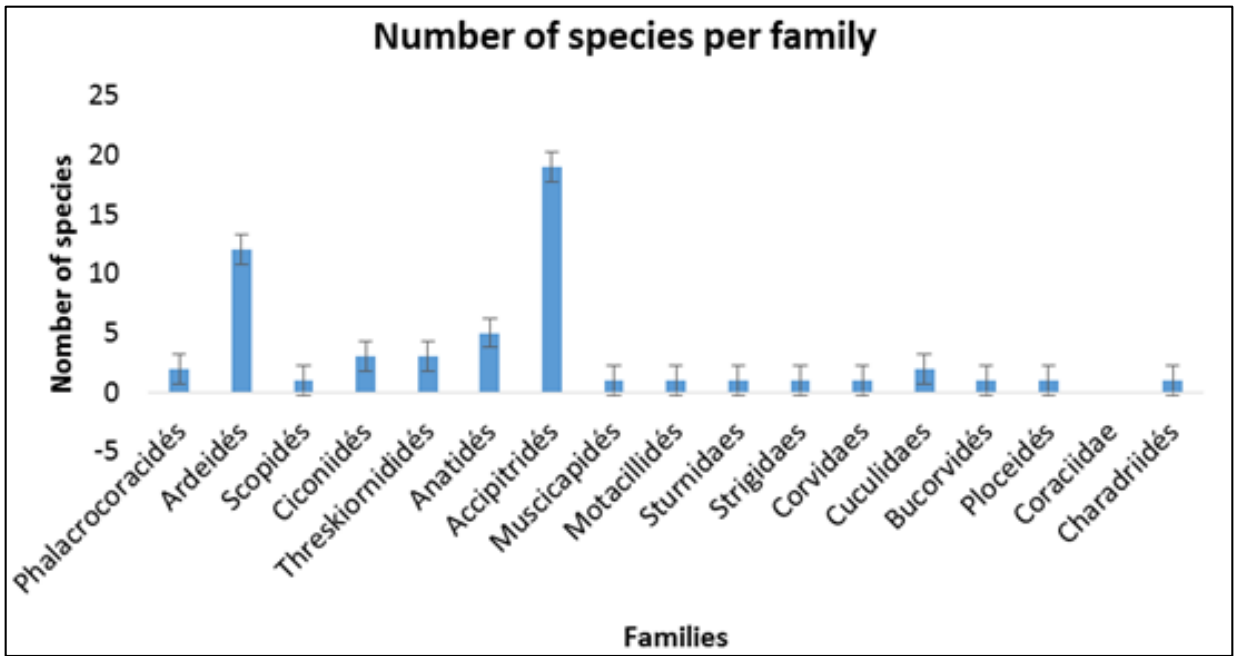


Fig 2: Distribution of bird species by family

The most represented families from a specific point of view are accipitridae (33.92 %) followed by ardeidae (21.42 %).

The most represented families are listed in Table 1.

Table 1: Bird species observed at surveyed sites and their surroundings.

Nº	Common name	Scientific name	Familly
1	Booted eagle	*Hieraaetus pennatus*	Accipitridae
2	African fish eagle	*Haliaeetus vocifer*	Accipitridae
3	Western osprey	*Pandion haliaetus*	Accipitridae
4	African gymnogene	*Polyboroides typus*	Accipitridae
5	Bataleur eagle	*Terathopius ecaudatus*	Accipitridae
6	Hooded vulture	*Necrosyrtes monachus*	Accipitridae
7	White-headed vulture	*Trigonoceps occipitalis*	Accipitridae
8	White-backed vulture	*Gyps africanus*	Accipitridae
9	Black kite	*Milvus migrans*	Accipitridae
10	Brown snake eagle	*Circaetus cinereus*	Accipitridae
11	western banded snake eagle	*Circaetus cinerascens*	Accipitridae
12	western marsh harrier	*Circus aeruginosus*	Accipitridae
13	black-winged kite	*Elanus caeruleus*	Accipitridae
14	Ovambo sparrowhawk	*Accipiter ovampensis*	Accipitridae
15	Dark chanting-goshawk	*Melierax metabates*	Accipitridae
16	Lizard buzard	*Kaupifalco monogrammicus*	Accipitridae
17	shikra	*Accipiter badius*	Accipitridae
18	African hawk-eagle	*Aquila spilogaster*	Accipitridae
19	Grey heron	*ardea cinera*	Ardeidae
20	Great Blue Heron	*ardéa mélanocéphala*	Ardeidae
21	Purple heron	*ardea purpurea*	Ardeidae
22	Black-crowned Night Heron	*nycticorax nycticorax*	Ardeidae
23	Crab heron	*Ardéola ralloides*	Ardeidae
24	cattle egret	*Bubulcus ibis*	Ardeidae
25	black heron	*Egretta ardesiaca*	Ardeidae
26	Little egret	*Egretta garzetta*	Ardeidae
27	median egret	*Ardea intermedia*	Ardeidae
28	Great egret	*Ardea alba*	Ardeidae
29	Striated Heron	*Butorides striata*	Ardeidae
30	Dwarf bittern	*Ixobrychus sturmii*	Ardeidae

Source: Survey 2017, 2018 and 2019

Several other families are inferior to this environment but less represented during our visits.

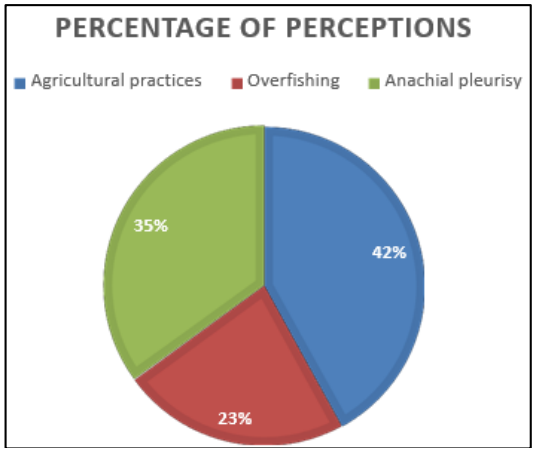
Table 2: Least represented bird species at surveyed sites and their surroundings.

Nº	Common name	Scientific name	Familly
1	White-faced whistling duck	*Dendrocygna viduata*	Anatidae
2	African pygmy goose	*Nettapus auritus*	Anatidae
3	Knob-billed duck	*Sarkidiornis melanotos*	Anatidae
4	Goose armed with gambia	*Plectroptérus gambiensis*	Anatidae
5	Garganey	*Anas querquedula*	Anatidae
6	Abyssinian ground hornbill	*Bucorvus abyssinicus*	Bucorvidae
7	spur-winged lapwing	*Vanellus spinosus*	Charadriidae
8	White Stork	*Ciconia ciconia*	Ciconiidae
9	Abdim's Stork	*Ciconia abdimii*	Ciconiidae
10	Saddle-billed stork	*Ephippiorhynchus senegalensis*	Ciconiidae
11	Abyssinian Roller	*Coracias abyssinicus*	Coraciidae
12	pied crow	*Corvus albus*	Corvidae
13	Senegal Coucal	*Centropus senegalensis*	Cuculidaes
14	Black Coucal	*Centropus grillii*	Cuculidae
15	rufous-tailed scrub robin	*Cercotrichas galactotes*	Muscicapidae
16	western yellow wagtail	*Motacilla flava*	Motacillidae
17	Long-tailed cormorant	*phalacrocorax africanus*	Phalacrocoracidae
18	Great cormorant	*phalacrocorax carbo*	Phalacrocoracidae
19	village weaver	*Ploceus cucullatus*	Ploceidae
20	hamerkop	*Scopus umbretta*	Scopidae
21	Long-tailed glossy starling	*Lamprotornis caudatus*	Sturnidae
22	African wood-owl	*Strix woodfordii*	Strigidae
23	glossy ibis	*Plegadis falcinellus*	Threskiornididae
24	Hadada ibis	*Bostrychia hagedash*	Threskiornididae
25	African sacred ibis	*Threskiornis aethioppicus*	Threskiornididae
26	Black Bee-eaters	Merops gularis	Meropidae

Source: Survey 2017, 2018, 2019

3.2 People's perceptions of the types and extent of pressures

Three main types of pressure have been released from the site, essentially cultural practices, fishing practices that do not conform to the standards in force and anarchic sampling orchestrated by the populations. Our surveys show that cultural practices have an impact on this site to the extent of 42 % followed by anarchic sampling (35 %), then a percentage of 23 % for overfishing closes the margin. In reality, none of the threats mentioned are negligible as they all generate drastic consequences in terms of conservation.



3.3 Diversity of bird communities

3.3.1 The Shannon - Weaner Diversity Index (1949)

Table 3 shows the values of the Shannon diversity index and the Pielou equitability index at the various stations that were surveyed.

Table 3: Summary of Shannon diversity and Pielou equitability index values by station

Stations	*H'*	*E*
Bello Tounga	1,6	0,01
Boyzela	2.02	0.012
Nantoungou	2.17	0.013
DogoTounga	3.8	0.023

Analysis of this table reveals that the Pielou Equitability Index varies from one village to another. As one moves further away from the shoreline, the index increases, which is indicative of the pressure on the study site. The majority of birds tend to take refuge in the Niger zone where they enjoy more peace and quiet. While Pielou's equitability values almost all tend towards 0, a sign that the environment is almost unstable.

3.4 Ecological Importance of "Bird Island's" Avian Fauna

In and around Bird Island, there are several categories of birds, including agricultural landscapes and sacred birds available in all seasons. Weavers, Abyssinian Roller bill (*Ploceus cucullatus*, *Coracias abyssinicus*) come to nest in the rainy season (July-August) and other species that migrate in the warmth during the dry season (December-February). All these species contribute to the ecological balance of this ecosystem. Consuming the most numerous grasses that are harmful to the agricultural production system. These birds are involved in the dissemination of seeds for reforestation and plant pollination. Several piscivorous species (species that consume fish) have the art of accommodating fish and thus participate in the balance of the food web. Bee-eaters (*Merops apiaster)* nesting in the clay cliffs owe their presence to the insects of the environment. They are in fact attracted by bush fires that put the insects on the run in the valley of "Birds

Island". The turtle doves often take advantage of the threshing areas to peck millet grains. The birds of this "island" therefore regulate the overall functioning of this ecosystem. In addition, the agricultural production sites located near the island benefit from the ecosystem services of these birds. Karimama populations have sown rice production areas (*Sativa oriza) in the* vicinity, in the interior of the island and around the bird island. Each year, the need for arable land increases, increasing the pressure on the bird island under study. These birds control dominant species such as predatory insects. They also help to regulate the level of weed presence on production sites, allowing farmers to make less effort to eliminate weeds. These are just a few striking facts that demonstrate the ecological value of these birds.

3.5 Population pressure and its corollaries on the bird fauna of the "bird island".

The General Population and Habitat Census of 2002 and 2013, (RGPH3 and RGPH4) and the rate of increase, allowed comparisons to be made between the Karimama populations in its two periods. The population size as well as the growth rate are important factors indicating the level of pressure on natural resources in general and on the bird island's bird population in particular. Populations show growth from one census to the next. This situation is explained by the fact that this site is not only subject to the influence of population growth, which generates the problems of searching for agricultural land, for which the island's soils are often highly prized by the riparian populations. This belief is also dependent on the need for fishing resources, hence the elements of overfishing with the use of prohibited gear. Out of 82 surveyed,

73 acknowledged using unsuitable nets as an advisor by supervisory officers. They justify their choice by the progressive scarcity of fishery resources. Table 4 shows the Karimama population figures for 2002 and 2013.

Table 4: Evolution of the population of Karimama from 2002 to 2013

Years	Population size	Rate of increase
1992-2002	(RGPH3, 2002) 19787	3,13
2002-2013	(RGPH4, 2013) 66,353	4,72

3.6 Threats to "Bird Island" Diversity

Some human activities practiced on the island have been identified with a direct or indirect effect on bird diversity. These include:

- **Intensive agriculture:** the riparian population (village of Dogo tounga; Bello tounga; Faram tounga; Djamal tounga; Nantougou and Boyzela), in order to satisfy their food needs, exploits the riparian areas of the island for agricultural purposes with the increased use of inputs such as :
- chemical fertilizers which, after leaching, pollute the surrounding wetlands. This pollution leads to the loss of certain aquatic insects that are sensitive to pollution, hence the lack of food resources for certain insectivorous birds that feed on the insects.
- Phytosanitary products (insecticides, herbicides, etc.): some sensitive granivorous birds are found poisoned by feeding on seeds from crops treated with phytosanitary products.
- **Anarchic removal of avian species:** apart from agricultural activities, local residents also hunt. This activity for the most part is carried out without control. This has repercussions on bird diversity: disappearance of certain species from the island over time.
- **Overfishing with prohibited gear:** some fish-eating birds feed on insects and fish.

Overfishing therefore limits the food resources for this category of birds

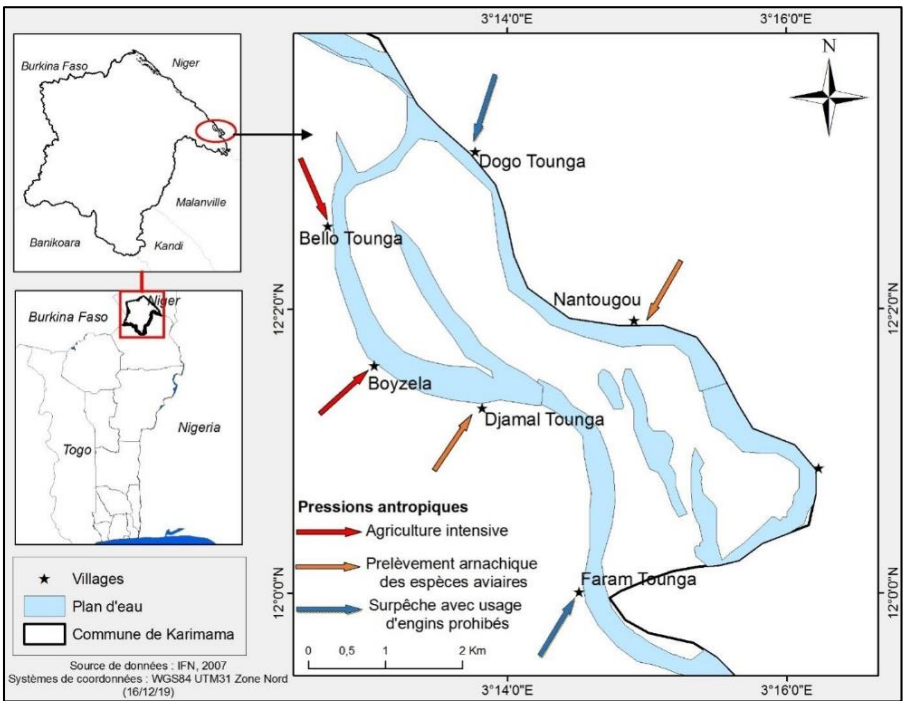


Fig 3: representation of anthropic pressures on Bird Island

4. Discussion

Bird research carried out in the Niger Valley (Benin part)

reveals a progressive decrease in the bird population at the site. This appears to be a generalized observation for most of the islands that are known by humans. This is the case of the studies carried out on the birds of the island by amateur ornithologists on guided visits to the site which proved that in 2004, 107 species live in this environment. In 2006, the work report of an ecotourism team revealed only that sixty-seven (67) species of birds divided into (18) eighteen families inhabit the island.

In the same way, the report of the study of the viability of the bird island carried out in June

2006 by the regional program ECOPAS (2008) [7] in the Niger Valley, presents 49 species of birds divided into 14 wetland families that are home to the island only. These different research works show a considerable decrease in the number of birds. Between 2004 and 2006, the bird population fell from 107 species to 67, i.e. a loss of about 40 species in two years. During the same period, 18% of bird species have left because of threats that were constantly increasing (ECOPAS, 2008) [7]. The main factors behind the pressing threats to the avian fauna in Karimama commune are agriculture, animal husbandry and fishing, which occupy a predominant place and are practiced in forms that are not very respectful of the environment. It can therefore be postulated that the species listed in this study and especially their location far from the shore and human settlements are very indicative of the pressure that reigns in these places and the destruction of the environment that is increasing in scale.

Maintaining such an ecosystem is of paramount importance, especially in the context of climate change. Finally, water species and palearctic migrants are dependent on this habitat because their temporal presence is a reality and continuous. It is therefore important to carry out an in- depth study of the effect of anthropic pressures on the avifaunistic potential of this site.

5. Conclusion

This study has identified the diversity of the species it hosts and the diversity of the species it harbours. But this richness is threatened by a series of pressures governed by demographic pressure and poverty. This site undoubtedly constitutes a habitat that can be beautifully recolonised by the avifauna. It therefore constitutes one of the environments whose progressive destruction will go hand in hand with the flight or disappearance of several species. It is therefore urgent to establish a fairly strict and promising conservation plan in common agreement with the authorities and local populations for its enhancement.

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