

# Fishermen Local Knowledge and Aquatic Environmental Change: Impacts on Fishing and Adaptation Strategies in Volta Basin

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## Abstract

Climate researches predict that climate change will have an important impact on aquatic and terrestrial ecosystems. However, many fishermen do not have a lot of knowledge about climate change or how it might affect their fish catch yields and overall fishing operations in the future. The objective of this study was to assess local fishermen's perception of global change on the ichthyofauna of the Volta Basin in Burkina Faso. Focus group interviews were conducted between March 2019 and July 2020 in 19 reservoirs of the Volta Basin. A total of 242 fishermen divided into 34 groups participated in the interviews. The results showed that fishermen are aware of climatic and anthropogenic threats to fish fauna. According to them, these global changes lead to important modifications in the structure of the ichthyofauna ranging from seasonal mortality of fish (Mormyridae) to the extinction of certain species such as those of the genera *Lates*, *Hydrocynus* and *Heterotis*. These changes also lead to a loss of fish habitat through silting and lower water levels in the reservoirs. Statistical analysis of the collected data showed that the main factors threatening the structure and dynamics of fish are mainly agriculture and market gardening around the dam lakes, the temperature increase and the trend of decreasing rainfall. Thus, the main pressures responsible for the mortality and/or extinction of fish are market gardening pollution (100%), bad fishing practices (63.15%) and high temperatures (47.5%). As for adaptation measures and management strategies, the most important were training and sensitization of stakeholders (78.94% of citations) followed by fish stocking (21.05%). This endogenous knowledge is important for the development of climate

change adaptation programs.

## Keywords

Climate Variability, Perception, Fishing, Burkina Faso

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## 1. Introduction

Changes in climatic and environmental conditions today constitute threat to local populations in Burkina Faso [1] and to the survival of biodiversity [2] with a certain ecological impact [3]. According to the IPCC [4], these climate changes are likely to compromise ecosystems' sustainability and their services. Worldwide, fishery resources contribute more than 10% of the animal's protein ration for about 4 billion people [5]. In Africa, fish is the main source of animal protein for rural populations [6]. In Burkina Faso, it contributes to about 8% of the protein coverage of food needs and 3% of gross domestic product (GDP) [7]. In addition, we note that the landlocked position of Burkina Faso and the sources of its economy which are essentially based on agriculture make it even more vulnerable to climate change. Thus, activities such as fishing whose productivity is strongly influenced by climatic variables like rainfall and temperature are threatened by these global changes. An additional factor is the non-compliance with fishing regulations [8]. A reduction in fishery production risks jeopardizing the achievement of the Sustainable Development Goals (SDGs) by impacting its Goal2 which is to "...End hunger, achieve food security and improve nutrition, and promote sustainable agriculture". However, climatic hazards, in addition to population growth, may weigh more heavily on ecosystem services. Indeed, the modification of fish habitats due to climatic and environmental hazards such as irregular rainfall, rising temperature, anthropogenic activities, extreme weather conditions will have a negative impact on the size of fish and their geographic distribution [3] [9]. Several studies have already addressed the perception of environmental and climate change by local communities [10] [11] [12], but very few were interested in the way it is perceived by fishing communities. However, for a sustainable management of fisheries, it is important to better understand how fishermen perceive the effect of different pressures on fish and their habitat. In Burkina Faso, according to statistics from the Ministry in charge of Fisheries Resources, fish production has increased since the 2000s despite the decrease in fish catch per fisherman. This implicitly indicates an increase in the number of fishermen. According to some authors, this decline could be explained by the effect of anthropogenic pressures [13]. By the past, many studies have shown that local people possess endogenous knowledge and strategies to manage sustainably their natural resources [14]. For other authors, local actors often ignore the ecological problems generated by climate change [15]. In addition, insufficient knowledge of the fisheries creates uncertainties related to the quantity and qual-

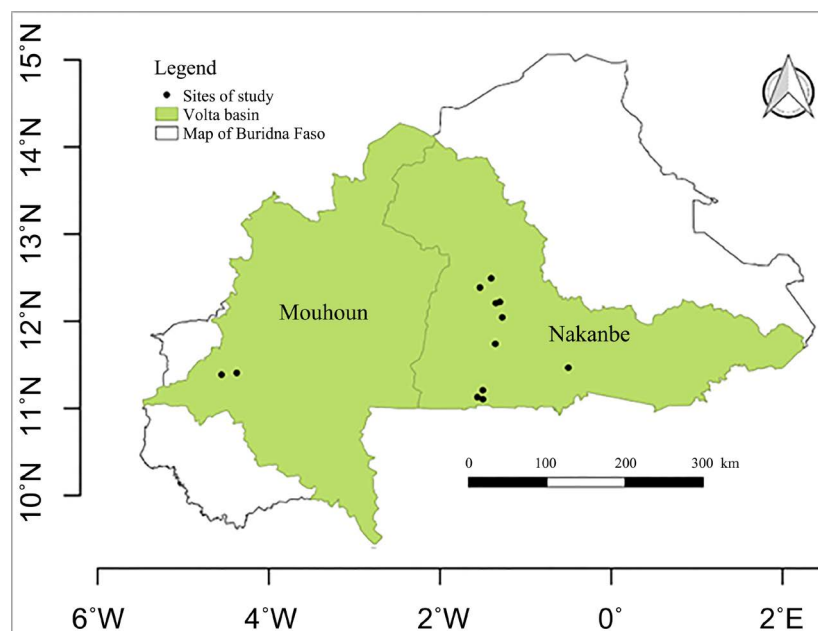
ity of the catches [5] and constitutes a factor limiting the sustainable management of the fishery [16]. This work answers the following research question: “What understanding do local fishermen have of anthropogenic and climatic pressures influence on fish fauna in Burkina Faso?” To answer this question, we hypothesized that fishermen, as the first direct actors of fishing, could have interesting information on the nature and intensity of environmental and climatic pressures affecting fish fauna, on the one hand, and could develop best strategies to adapt themselves to environmental change, on the other hand. This work’s general objective is to assess the perception of environmental and climatic changes by direct actors, namely local fishermen in the Volta basin fishery in Burkina Faso. To achieve this, specific objectives have been defined: 1) identify the different pressures likely to have an impact on fish diversity; 2), assess the occurrence of perception of these pressures by fishermen, 3) identify the groups or species of fish threatened by these anthropogenic and climatic pressures and 4) determine the local strategies adaptation.

## 2. Methodology

### 2.1. Sites of Study

This study was conducted in nineteen (19) sites of Volta basin in Burkina Faso. This basin is subdivided into two sub-basins (Mouhoun and Nakanbe). The choice of this basin is justified by the fact that it is the basin which has more reservoirs and also the most anthropized basin. This basin covers an area of 106,742 km<sup>2</sup> (Figure 1).

**Table 1** below presents the environmental characteristics of the 19 study sites. The description of the environment and the climate of the area are presented.



**Figure 1.** Map of Burkina Faso with study sites.

**Table 1.** Environmental characterization of the study sites.

Study sites	Sub-basins	Climate	Environment description
Naba Zana, Konioudou, Arzoum Baongo, Goanghin	Nakanbé	North Sudanian climate with annual rainfall between 350 mm and 900 mm. These sites have a low vegetation cover.	Located in the commune of Koubri, these sites are highly anthropized (agriculture, fishing, silting...).
Bazega			There is a strong pressure of fishing and pumping for fruit gardens
Loumbila, Tanghin			Experience a strong anthropization: fishing, pumping, market gardening, household activities, silting ...
Bankako			This site is located in the downstream part of the Bagré reservoir. Characterized by the cultivation of rice in irrigation.
Dirlakou, Zangoula Lengha, Koumbouré Béguédo, Niaogho	Nakanbé	Vegetation cover of the tree savannah type.	Located upstream of the Bagré reservoir, these sites are under strong agricultural pressure.
Nazinga (Kalieboulou, Bodjéro, Nakourou)			Protected area, controlled fishing.
Mare Hippo			Protected area, controlled fishing, presence of invasive plants.
Samandeni	Mouhoun	South Sudanese climate. Annual rainfall is between 900 mm and 1100 mm. Important vegetation cover with large trees all around.	Created in 2018, low agricultural pressure with increasing fishing pressure.

## 2.2. Data Collection

### 2.2.1. Socio-Environmental Data

The socio-environmental data collection was designed in two steps. The first step consisted of a pre-survey in March 2019. During this step, fishermen from 3 villages (Dirlakou, Dakopa and Zangoula) around the Bagré reservoir have been interviewed in order to test and refine the survey questionnaire. After these interviews a final questionnaire was developed. During the second step, we ran the survey based on the refined questionnaire following the focus group method. Thirty-four focus groups were constituted with 242 fishermen. The information collected were about the: 1) perception of environmental pressures by fishermen on fish fauna; 2) species sensitive to environmental pressures; 3) variables responsible for the variation in water column and 4) adaptation strategies.

### 2.2.2. Fish Identification

In each site, the fish found dead were identified to species or genus level using identification keys [17]. Unidentified individuals were performed later by a professional taxonomist in the laboratory.

### 2.2.3. Statistical Data Analysis

The survey data was entered and processed using the Excel spreadsheet and the R Studio interface of the R 4.0.2 software. To define the size and perception of the population studied, frequency and percentage analyses were performed. A Redundancy Analysis (RDA) was carried out in order to identify the explanatory variables responsible for the extinction and mortality of the fish. The statistical test of Kruskal Wallis was carried out using the `kruskal.test ()` function to check

if there is statistically a significant difference between the pressure indicators expressed by the fishermen on the one hand, and on the other hand between the number of pressures expressed by the different groups of fishermen interviewed. The p-value was set at 5%.

### 3. Results

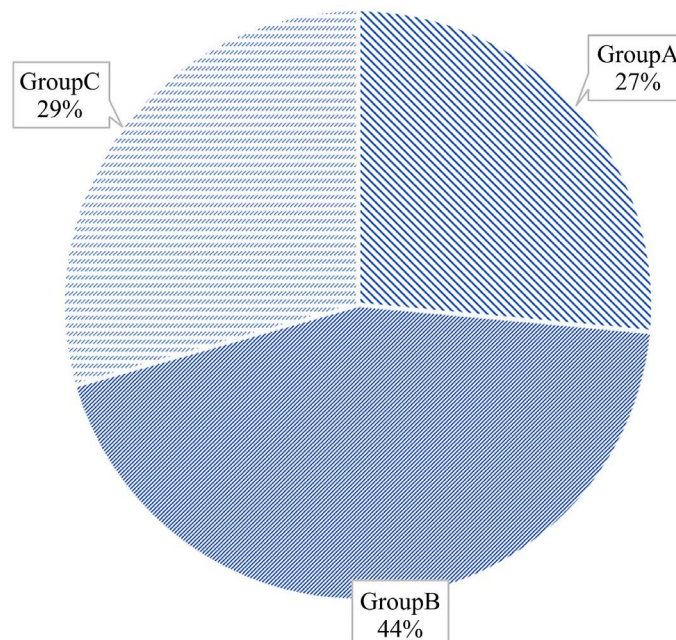
#### 3.1. Distribution of Fishermen Interviewed by Age Class

The fishermen surveyed are men with at least 5 years of fishing experience. **Figure 2** presents their distribution in the survey sample by age group. The analysis of this figure shows that the age group that includes the most fishermen questioned is the age group between 16 and 25 years which is represented by 44%.

#### 3.2. Pressures Perceived by Fishermen

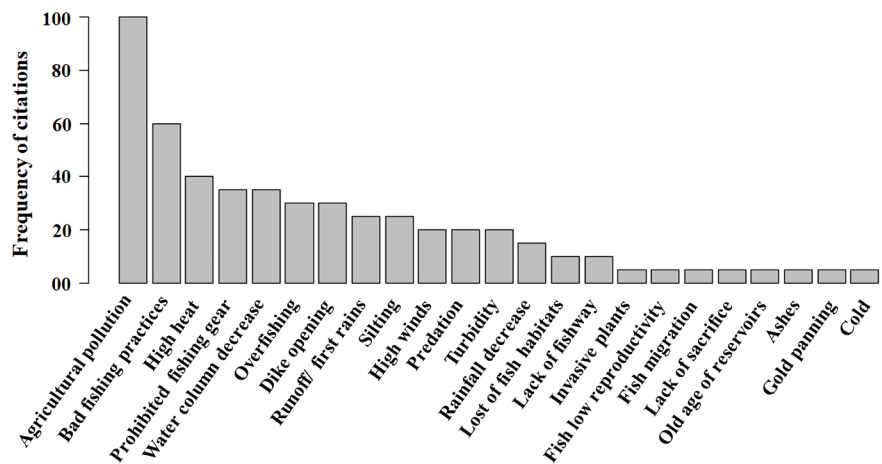
As a result of the interviews conducted, 23 pressures were cited by the fishermen as being able to cause fish mortality and/or disappearance (**Figure 3**). The statistical analysis showed that the difference between the frequencies of citations of the different pressures is statistically significant with a p.value = 0.0032. On the other hand, there was no significant difference between the number of pressures cited by each category of fishermen (p.value = 0.089). The different environmental and climatic pressures perceived by the fishermen of the different sites visited vary in number depending on the site. The highest number is found in the fisheries located in the Nakanbé basin and particularly in the Koubri area.

The results of **Figure 4** show the threats to fish based on the experience of the fishermen surveyed. The analysis of this figure shows that fishermen with more

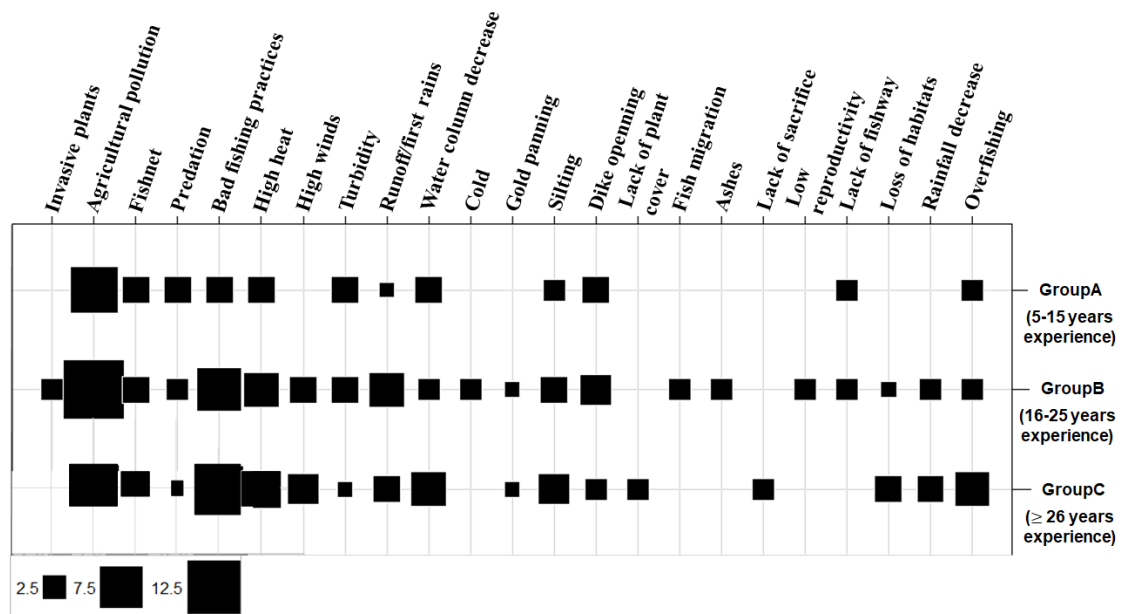


Legend: GroupA: 5-15 years experience; GroupB: 16-25 years; GroupC: ≥26 years

**Figure 2.** Distribution of respondents by age group.



**Figure 3.** Global pressures perceived by fishermen.



**Figure 4.** Indicators of pressures perception' according to the experience of the fishermen.

years of experience (at least 16 years or more) tend to perceive more threats, and are the ones indicating more perception indicators.

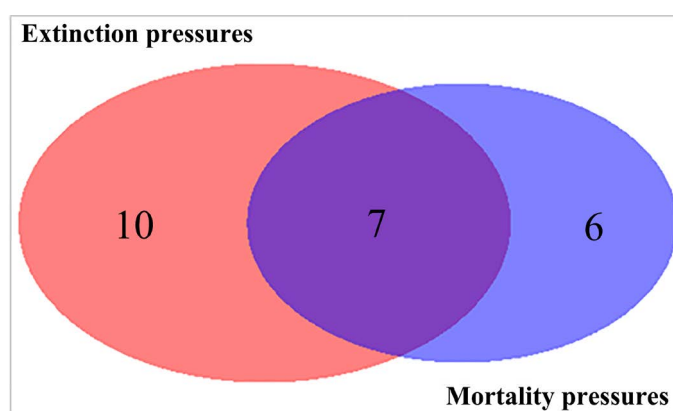
**Figure 5** is showing some pressures observed in the field during the sampling period.

Thirteen (13) pressures were underlined as causes of fish mortality against 17 pressures recognized as factors of fish extinction (**Figure 6**). Seven threats were cited by fishermen interviewed as causing both mortality and extirpation of fish in water bodies. These were agricultural pollution, poor fishing/water harvesting practices, increased temperature, decreased water volume, high winds, and predation. This high number of common pressures as well as those that may cause fish extinction could be explained by the fact that mortality pressures lead to long-term extinction.





**Figure 5.** Images of some pressures observed in the field. (a) Deposition of organic matter and detergent observed at Arzoum Baongo; (b) Pumping water for irrigation in Konioudou reservoir; (c) Dewatered reservoir in Koubri area; (d) Pumping water in Naba Zana for construction.



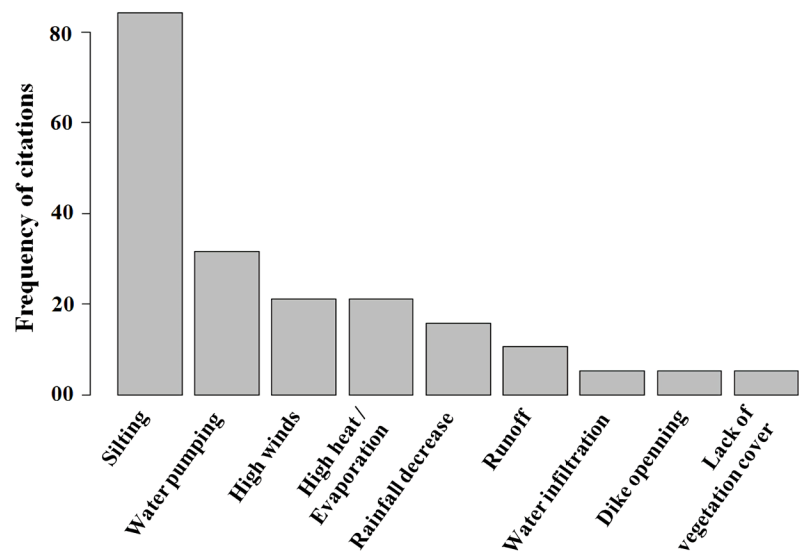
**Figure 6.** Venn diagram showing mortality and extinction pressures according to fishermen interviewed.

### 3.3. Causes of the Drop in Water Level

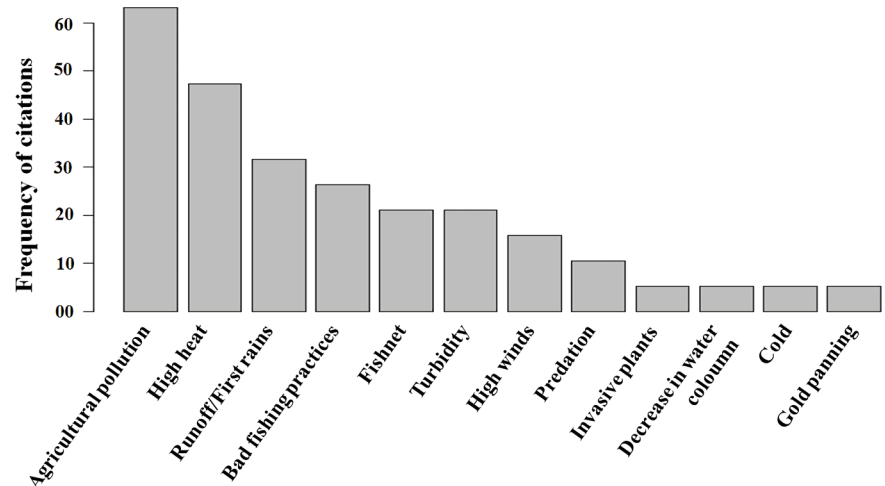
Of the 19 sites visited, only fishermen in Samandeni Reservoir did not experience a decrease in water level. According to fishermen from other fisheries interviewed, nine pressures were listed as potentially causing the decrease in water column (**Figure 7**). The main causes of this decrease in water level in the reservoirs would be silting (84.21%), pumping for irrigation, buildings and public works (31.58%), strong winds (21.05%) as well as strong heat with its corollary of water evaporation (21.05%).

### 3.4. Causes of Fish Mortality

The fishermen interviewed in the 19 reservoirs admitted to seeing dead fish in the reservoir at a certain time of year. In terms of the causes of this fish mortality, twelve pressures (**Figure 8**) were cited by the fishermen, the most recurrent



**Figure 7.** Main pressures affecting water column decrease.



**Figure 8.** Main causes of fish mortality according to fishermen.

of which are Agricultural pollution (70.15%), high temperatures (48%), the first rains (32.12%) and poor fishing practices (25%). At none of the sites was natural mortality mentioned.

During the survey, dead fish carcasses were observed in the field (**Figure 9**).

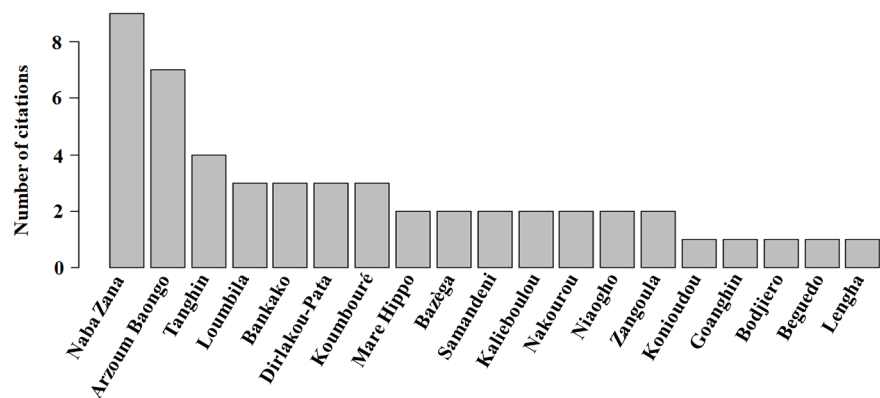
The analysis of pressures by site shows that the Koubri reservoirs are the most affected by the maximum pressures. These include the Naba Zana and Arzoum Baongo reservoirs, which each recorded 69% and 54% of mortality pressures respectively (**Figure 10**).

The main groups of fish affected by this mortality are Cichlidae and Mormyridae. According to the fishermen, the factors influencing fish mortality vary depending on the group of fish considered. **Figure 11** shows that the death of Mormyridae could be explained by several variables such as bad fishing practices, high winds, high heat, deposition of pots, turbidity and cold. On the other

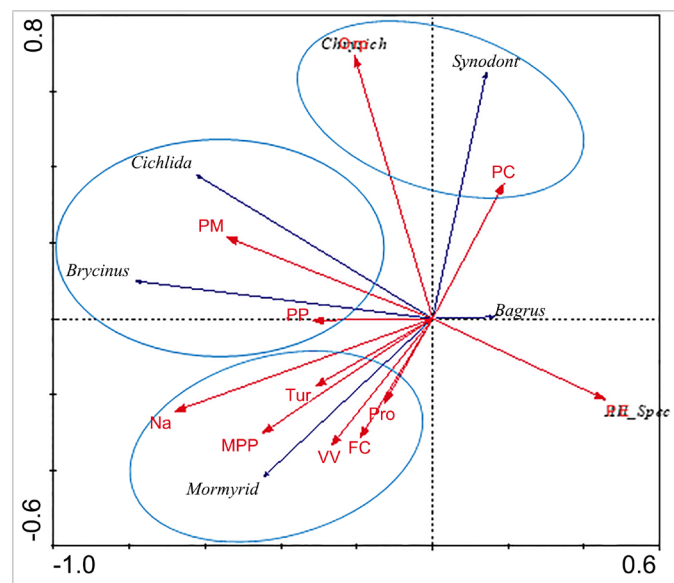




**Figure 9.** Images of some dead fish observed in the field. (a) *Chrysichthys*, (b) *Clarias*, (c) *Mormyrus rume*, (d) *Oreochromis niloticus*.



**Figure 10.** Number of pressures cited by site.



**Figure 11.** RDA showing the correlation between fish communities and environmental variables. Legend: PM. Agricultural pollution; Tur. Turbidity; Fro. Cold; FC. High heat; PE. Invasive plants; Na. Fishnet; MPP. Bad fishing practices; VV. High winds; Orp. Gold panning; PC. Predation; PP. First rains.

hand, the Cichlidae as well as the fish of the genus *Brycinus* are mainly threatened by marsh pollution and drainage from the first rains. Gold mining residues would cause the death of fish of the genus *Chrysichthys* while the genus *Synodontis* would be victim of predation pressures. In addition, the presence of invasive plants could cause the death of any fish species.

According to the fishermen interviewed, the period of fish mortality is generally at the beginning of the rainy season. A total of 65% of the fishermen stated that fish die just after the first rains of the winter season, while 23% of the fishermen explain this mortality by the impact of the heat waves of the warm period of the year (March, April, May).

### 3.5. Causes of the Fish Extinction

According to the fishermen interviewed, there are different types of pressures that are causing the extinction of certain groups of fish. Among the pressures most cited by the fishermen are agricultural pollution (48.12%), the drop in water levels in the reservoirs (38.72%), as well as overfishing, the opening of the dike and silting up with 32.15% frequency of citations (Figure 12). Next to these, we note the rare pressures that were cited only once with a frequency of 5.26%. These are predation, low reproductivity, lack of sacrifice, increase of water temperature, loss of habitat and high winds. The water temperature increase, although recognized as one of the main factors that can lead to the death of fish, is considered by few fishermen as being the cause of the fish extinction.

The main species affected by this loss are *Lates niloticus*, *Heterotis niloticus* and fish of the genus *Hydrocynus*. These fish were cited respectively by 65%, 20% and 45% of the focus groups as being endangered in the reservoirs.

The analysis of pressures by site shows pressure numbers ranging from 0 (Samandeni and Nakourou) to 5 for some sites in Bagre such as Bankako and Dirlakou (Figure 13).

The redundancy analysis (Figure 14) allowed the categorization of endangered

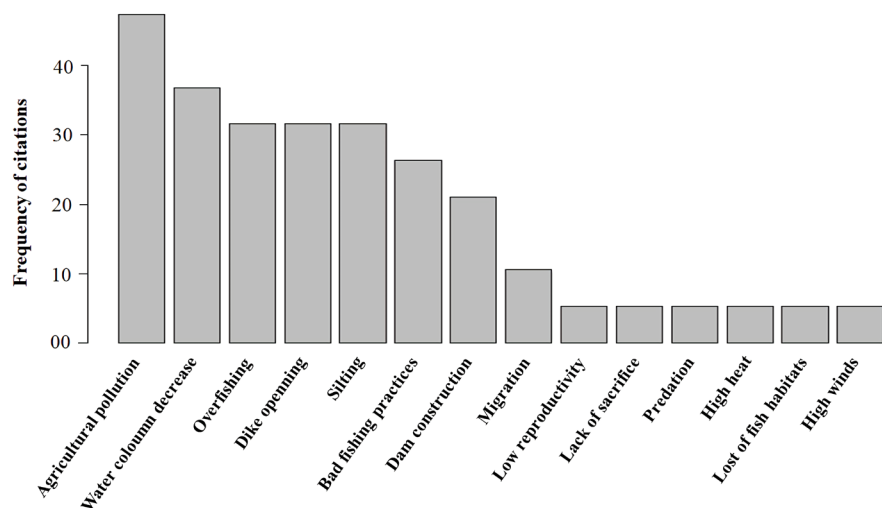
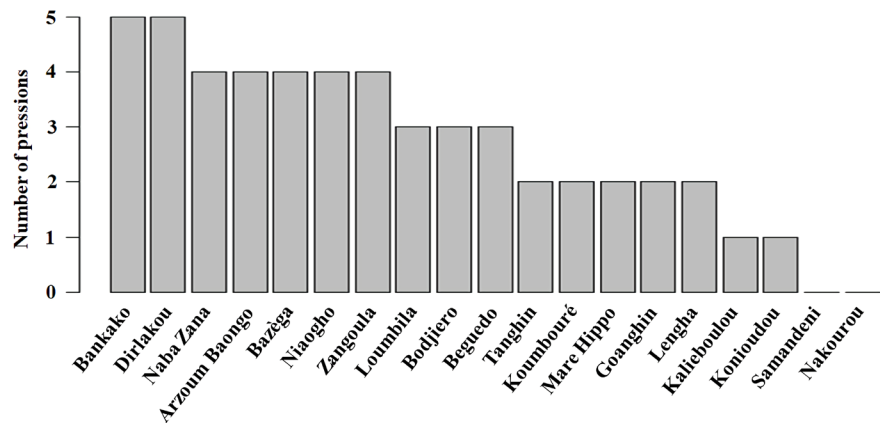
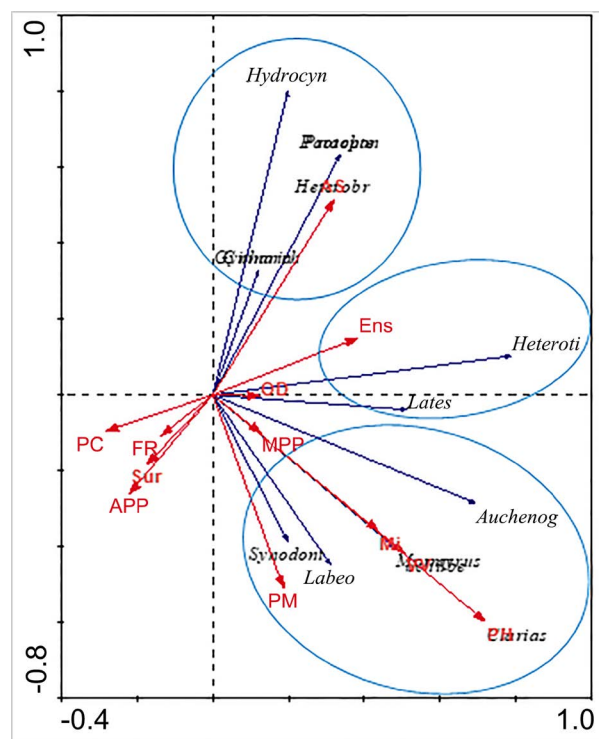


Figure 12. Pressures of fish extinction according to interviewed fishermen.



**Figure 13.** Number of pressures cited by site.



**Figure 14.** RDA showing correlation between causes of fish extinction and fish communities. Legend: Ens. Silting; OD. Dike opening; Mi. Migration; PM. Agricultural pollution; Sur. Overfishing; FR. Low reproductive; MPP. Bad fishing practices; VV. High winds; PH. Loss of habitats; APP. Lack of fish pass; PC. Predation; AS. Absence of sacrifice.

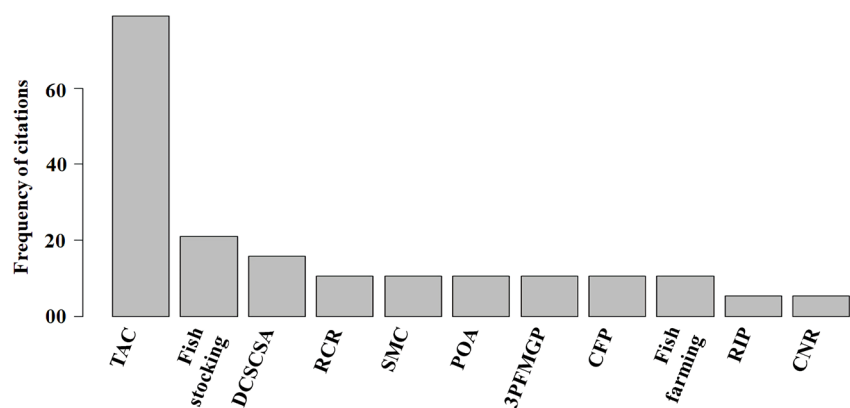
fishes according to the different pressures cited by the fishermen. Thus, fish of the genus *Synodontis*, *Auchenoglanus*, *Clarias*, *Labeo* and *Mormyrus* would be endangered at some sites due to pressures such as loss of habitats (PH), high winds (VV), Agricultural pollution (PM) and migration (Mi). Sites where *Heterotis niloticus* and *Lates niloticus* are extirpated are mainly due to silting (Ens). Other species of the genus *Hydrocynus*, *Protopterus* and *Heterobranchus* are also believed to be endangered in some reservoirs due to pressures such as Absence of sacrifice (AS).

### 3.6. Adaptation and Management Strategies

When asked about the adaptation measures of fishermen in the face of various environmental changes, 11 measures including suggestions were cited by them (Figure 15). The main adaptation measure according to them remains the Training, Awareness and Compliance (TAC).

## 4. Discussion

Fish resources in Burkina Faso are impacted by climate change and anthropic pressures and fishermen are aware of this situation. Some studies have already mentioned same perception by local farmers in Burkina Faso [18] [19]. This study is a contribution to monitoring the effects of global change at the local level and the related adaptation strategies by fishermen in Burkina Faso particularly in Volta basin. The perception indicators were correlated with the professional experience of the fishermen surveyed. Then, although the number of threats perceived does not seem to be correlated to the age group, it can be noted that the type of threat is a function of the age group of the fishermen. This was confirmed by the Kruskal Wallis test, which showed that there was a statistically significant difference in the perception of the different pressures, whereas the difference in terms of the number of pressures perceived by each of the three age groups was not significant. Similar work had also been done by Nago *et al.* [20], Kaboré *et al.* [21] and Hounkponou *et al.* [22]. In the researches of Nago *et al.* the groups of respondents were analyzed according to the types of perception determinants cited. Concerning the research of Kaboré *et al.* it was mentioned the Farmers' perceptions of climate change, environmental impacts and endogenous adaptive strategies in the North Central of Burkina Faso. While, the work of Hounkponou *et al.* was about correlating the factors determining perception and the ages of the respondents on the one hand and the coping strategies in relation



**Figure 15.** Fishermen adaptation strategies and suggestions. Legend: TAC. Training, Awareness and Compliance; DCSCSA. Dam Closure during Spawning and Creation of Spawning Areas, RCR. Reservoir Cleaning and Repair; SMC. Strengthening Monitoring Committees; POA. Performing Other Activities; 3PFMGP. Prohibition of Pumping, Poor Fishing and Market Gardening Practices; CFP. Creation of fish pass; RIP. Removal of Invasive Plants; CNR. Creation of New Reservoirs.

to the level of prosperity on the other. The data collected during this study were mainly pressures causing the death and/or the disappearance of fish in the long term and fish which are concerned by the, factors causing water column fluctuation. The decrease in the water column of the reservoir could be explained by the consequences of climate change such as the decrease in rainfall [9] as well as the silting due to vegetable farming in the reservoir or around it. We could also note the effect of wind and water erosion; this is even more plausible for certain sites like Zangoula in Bagré reservoir where the northern part of the reservoir is devoid of any plant cover. Agricultural and electrical activities had already been reported by fishermen in Mali as being responsible for the decrease in floodings in the Inner Niger Delta [9]. Regarding the rise of reservoirs water temperature, in addition to the impact of climate change, Kyle *et al.* have shown that other variables such as solar radiation, the rising air temperature and plant cover could also increase the temperature of aquatic environment [23]. Arimoro *et al.* showed a strong positive correlation between the temperature of water and the temperature of ambient air [24].

#### **On the decrease of the water level**

The decrease in the water column of the reservoir could also be explained by the impacts of climate change such as the decrease in precipitation [9], evaporation due to the increase of temperature [25] as well as silting due to market gardening in or around the reservoirs. The effect of wind and water erosion could also be noted. Agricultural and electrical activities have been reported by fishermen in Mali to be responsible for reduced flooding in the Inner Niger Delta [9]. In Ghana, Laube *et al.* found a decrease of about 10% in mean annual rainfall across the Volta Basin, of which our study area is a part [26].

In terms of increasing water temperature in reservoirs, in addition to climate change impacts, it is showed that other variables such as solar radiation, increased air temperature, and lack of vegetation cover could also increase the temperature of the aquatic environment. Arimoro *et al.* have also showed a strong positive correlation between water temperature and ambient air temperature [24]. In a recent study, 72% and 87% of the surveyed households respectively informed about the increase in seasonal temperatures as well as the decrease in rainfall in their study sites (in Eastern Ghana and Southwestern Burkina Faso) [27].

#### **On fish mortality**

Seasonal mortality of fish concerns mainly the Mormyridae, Cichlidae and Mochokidae families'. Of all the species subject to seasonal mortality, species of the Mormyridae family are the most affected. As for the variables that would cause this mortality, the main ones would be marsh pollution, water temperature increase, first rains and bad fishing practices. Previous studies have shown a positive correlation between rising temperatures and mortality in human populations in Nouna [28]. It could be the same effect with aquatic communities and particularly, with fish fauna. According to the fishermen's groups interviewed,

Mormyridae are a group of fish with high fat content and therefore vulnerable to large increases in water temperature. In addition, studies have also highlighted their status as intolerable species [29]. Other studies have shown that changes in water temperature and dissolved oxygen are problematic for aquatic organisms such as fish [30]. Therefore, these changes in temperature and dissolved oxygen can lead to fish death [31]. There is little data on the pH range of *Mormyrops anguilloides*. However, since its thermal preferences are very low and vary between 22°C min and 24°C max (www.fishbase.org), this could explain its inability to adapt to large temperature variations such as high heat during hot periods. In addition, it is a species that prefers deep and calm waters. Arimoro *et al.* [24] also showed that Mormyridae, like species of many other families such as Schilbeidae, Clariidae, Bagridae, among others, are very sensitive species to organic pollution. Indeed, the first rains are likely to drain household waste such as very basic ashes that could degrade the quality of the receiving ecosystem. Pesticides used in market gardening and agriculture would also contribute to deteriorate the quality of aquatic ecosystems with, as a corollary, the death of fish [32]. Some authors have also shown that the agricultural method could have negative effects on fisheries production [33]. Indeed, agricultural residues such as nitrogen derivatives (ammonium) can, at certain concentrations, lead to fish death [34].

#### **On the disappearance of fish**

Pressures causing fish extinction frequently cited by fishermen include the opening of the dike resulting in fish migration to Ghana. Indeed, the construction of dams without fishways constitutes a barrier that prevents the migration of fish from downstream to upstream reservoirs. Others pressures are also cited by fishermen. These were poor fishing practices and pesticide pollution. In fact, the effects of pollution from agriculture on fish could be indirect by causing increased siltation and reduced dissolved oxygen availability [35]. In 2016, Lam *et al.* concluded after a study in coastal West African countries that the rate of current fishing pressure would result in declining fish stocks [36]. Among the endangered fish species highlighted in this study, some species such as *Heterotis niloticus* and *Lates niloticus* had already been reported by fishermen in the Sahelian Lake Higa in 2012 as having disappeared from their fishing grounds [16]. Codjo, *et al.* in a study conducted in Lake Toho in southern Benin had also shown an extinction of large fish in general and species of the genus *Hydrocynus*, *Heterotis*, *Clarias* and *Gymnarchus* in particular [37]. Other studies have also highlighted the adverse effect of human activities on fish fauna [38] [39].

#### **Other fish stressors and limitations of pressures cited**

Among the fish stressors, a group of fishermen from Beguédo (in the upstream part of Bagré reservoir) mentioned the beating of the water not as a stressor but rather as a factor responsible for the concealment or burying of fish. According to these fishermen, the beating of the water cannot stress the fish but only causes a temporary modification of their habitat. This shows a lack of knowledge about the effects of certain fishing practices. Other fishermen also



cited the opening of the dam gates during the flood period as a stressful variable, although this seems normal. In addition, the lack of a fishway downstream of the dam could explain the lack of fish return upstream. This again shows that some fishermen are unaware of fish stressors. However, for the vast majority of fishermen, beyond their knowledge of the harmful environmental and anthropogenic pressures on ichthyofauna, we note that they are also aware of the manifestations of climate change. A study by Nielsen and Reenberg [40] showed the perception of the same climatic variables by local populations located in the Burkinabe Sahel.

The pressures perceived by fishermen are found in the literature. Indeed, in several previous works carried out in Burkina Faso [25] [41] [42], pressures such as pesticide pollution, dam construction, overfishing, extreme weather events, temperature rise, evaporation and climate change have been cited as influencing water bodies as well as aquatic resources. A sociological study by Ayeri *et al.* in Kenya also showed that local stakeholders perceive the effects of climate change [43]. These include decreasing rainfall, increasing temperature, increasing frequency and intensity of high winds, the occurrence of famine in human populations and diseases in animals.

In addition, the work of Coulibaly *et al.* showed that the ability of fish to harbor certain parasites constitutes a threat to both the fisheries resource and a public health problem [44]. Yao *et al.* in Ivory Coast [45] and Rindoria [46] also demonstrated that fishery resources were negatively impacted by household waste and microbiological pollution. At none of the sites surveyed was parasitism reported as a pressure on fish resources. Several other studies conducted at the local level have shown that fish are hosts to parasites [47]-[52]. Thus, fishermen appear to be unaware of the effect of parasitism on the health status of fish.

#### **Adaptation measures and management strategies**

From the interviews conducted, adaptation is mainly through training, awareness and compliance. This shows the low resilience of fishermen to the adverse effects of climate change. In addition, other studies carried out in other countries have proposed adaptation and management measures. These include combating soil erosion through reforestation, increasing the carrying capacity of reservoirs [53], promoting and introducing adapted fish species [54] or using regulated nets and engaging in other income-generating activities [37]. On the national level, adaptation measures in the face of the adverse effects of changes such as the construction of water reservoirs has also been undertaken since the second half of the 20th century [1]. In addition, exchanges with resource persons have shown that fishermen migrate according to the availability of fish resources to other localities. This is further verified by the fact that some studies such as Henry *et al.* explained that migratory flows would be justified by a population adaptation strategy to climate change [55].

## **5. Conclusion**

The fishery resources of Burkina Faso are affected negatively by environmental

variables change. This study allowed us to assess the endogenous knowledge of fishermen in the Volta Basin with regard to the environmental and climatic impact on the lakes ichthyofauna. We were also able to establish the frequency of the various pressures and inventory the most endangered fish species. The data collected confirms our research hypothesis, namely, that fishermen perceive the nature and intensity of the pressures exerted on the ichthyological fauna in the basin level. Fishermen noted a decrease in the quantity and quality of fish catches due to the various stresses. These consequences will be all the more important in the future if no mitigation and/or adaptation measures are taken. However, some fishermen ignore the impact of certain pressures on the fish fauna. Therefore, it is important that measures are taken by decision-makers to promote the sustainable management of fishery. These include 1) taking fishways into account when building dams, 2) strengthening the technical skills of fishermen, 3) supporting and equipping fishery managers and 4) raising the awareness of the less well-equipped actors about the harmful effects of bad fishing practices. Finally, this study contributes to identify the different pressures on fisheries that are perceived by the fishermen of Burkina Faso and particularly those of our study sites.

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## Conflicts of Interest

The authors have not declared any conflict of interests.

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