

Ichthyofaunic Inventory and Fish Landings of Lom Pangar Hydropower Dam Reservoir in the Eastern Region of Cameroon

Achille Njomoué Pandong¹, Bruno Thierry Nyatchouba Nsangue², Ekmon Mbangue¹, N'Souvi Kodjo³, Maurice Vanlie Kontchou¹, Asser Yoke⁴, Léopold Tcham¹, Dieudonné Essola¹, Micah Adekunle David⁵

¹Laboratory E3M, National High Polytechnic School of Douala, University of Douala, Douala, Cameroon

²College of Marine Science, Shanghai Ocean University, Shanghai, China

³College of Economics and Management, Shanghai Ocean University, Shanghai, China

⁴Netherlands Development Organisation, SNV, Yaounde, Cameroon

⁵College of Fisheries and Life Science, Shanghai Ocean University, Shanghai, China

Email: njopanac@hotmail.com

How to cite this paper: Pandong, A.N., Nsangue, B.T.N., Mbangue, E., Kodjo, N., Kontchou, M.V., Yoke, A., Tcham, L., Essola, D. and David, M.A. (2020) Ichthyofaunic Inventory and Fish Landings of Lom Pangar Hydropower Dam Reservoir in the Eastern Region of Cameroon. *Open Journal of Marine Science*, 10, 245-259.

<https://doi.org/10.4236/ojms.2020.104019>

Received: August 3, 2020

Accepted: October 16, 2020

Published: October 19, 2020

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Abstract

The Lom Pangar hydroelectric dam project located in the eastern region of Cameroon was implemented by Electricity Development Corporation (EDC). The impoundment of the Lom Pangar dam created a large reservoir with an area ~590 km² and a useful storage capacity ~6 billion m³. Thereby, this impoundment has created favourable conditions for the proliferation of fishery resources. However, a fisheries assessment study based on fishing activities is essential to attain reliable information for implementing a management plan to achieve rational and sustainable exploitation. This study was carried out on the ichthyofaunic inventory and the assessment of fish landings in Lom Pangar hydroelectric dam reservoir from April 2016 to September 30, 2016. Three main groups of fishing gear have been identified, among which gillnets, traps and longlines occupy major fishing activities. Indeed, the spatial and landing sites surveys were conducted on species composition, size composition, and quantities of fish landed during the study period. Moreover, 37 species of fish divided into 16 families were found in seven different selected fish landing sites. Carp (*Cyprinus carpio*) was the major fish species abundantly caught by these fishing gears which accounted for 81.60% of the total catch, and the least species was sardine (*Sardinella aurita*). A total of 623,229 Kg of fish were landed which were dominated by those of the Wami landing site with 480,773 Kg representing 76.96% of the total landed catches. The smallest species caught was the white carp (7 cm) while the longest one was the catfish (71 cm). In addition, the species of fish in the breeding season are carp, catfish,

viper fish and red tail.

Keywords

Artisanal Fishing Gears, Ictyofaunal Inventory, Lom Pangar Hydropower Dam

1. Introduction

The Lom Pangar hydroelectric project in Cameroon is implemented by Electricity Development Corporation (EDC). Besides, the use of water from reservoirs for irrigation or hydroelectricity in this dam, some fishing activities take place in these water-bodies (Béné *et al.*, 2009) [1]. However, the impoundment of the dam created favorable conditions for the proliferation of fishery resources in the reservoir. Likewise, these Lom Pangar establishment sites are not at risk of being flooded during the period of heavy rains or full flooding of the retaining dam [2]. Fishery resources are the major source of animal protein in the diet of the Cameroonian population, especially for the most disadvantage sections of the population and represent 80% of the total supply of animal proteins. Indeed, the per capita demand for fish consumption was 17.90 kg per year in 2013 [3] [4] [5]. As a result, fishing is very active in the country and represents an important sector both from a socio-economic and food point of view. It is organized around four branches: industrial fishing, artisanal maritime fishing, inland fishing and aquaculture. However, fish production is unable to supply the demand for fish in the country. National production remains modest and fluctuates around 180,000 tons/year, including 93,000 tons for artisanal fishing, 75,000 tons for inland fishing, 8000 tons for industrial fishing, and 1000 tons for the aquaculture. Due to the fact that this production cannot meet the national demand for fishery products, which is estimated at around 400,000 tonnes/year, the country import about 220,000 tons of fish each year, which constitutes a significant flight of capital, estimated at around 100 billion FCFA/year. In order to ensure the country's food security and maintain economic growth, Cameroon must significantly increase its fish production.

During the last decades, some researchers such as Djama and Pitcher [6] [7], Njock [8] [9], and Djama [10] [11] demonstrated that the fisheries resources of Cameroonian waters are either fully exploited or in state of overexploitation. Despite the fact that the state of exploitation of inland fisheries is poorly documented, observations have been made on the decreased in landings in most impoundments and lakes inland indicating resource depletion [12] [13] [14] [15]. In addition, ENVIREP-CAM [16] reported a decrease in fish production at the Ladgo Dam between 1990 and 1991 (11,000 t to 10,675 tonnes). This trend has remained constant and in 2004 the production value (6000 tons) was about half of its 1990's value. The same goes with the other dams. In the Lake Tchad, Onuoha [17] indicated a decrease in resources due to many factors including

overexploitation. This downward trend in production is an indication of overexploitation. The sustainable management of these resources requires upstream scientific research. Hence a downward trend in fish catches due to overfishing, intensive fishing pressure, repeated and confined use of fishing grounds in a particular area [18]. In this context, the dam reservoir of Lom Pangar can constitute an important source of increase in fish production of the country. Rational exploitation of these resources requires the establishment of a real fisheries development policy focused on the sustainable management of the fishery resources of the reservoir. Indeed, fisheries assessment study based on the fishing activities is essential to attain reliable information for constructing a management plan to achieve rational and sustainable exploitation [5] [18] [19] [20]. In order to obtain data that are much more reliable and capable of providing relevant information, seasonal spatial and landing site surveys should be set up. Taking all this aspects into account including the lack of reported data to ensure the perfect facilitation of artisanal fisheries in the reservoir, the present study was undertaken to investigate the types and characteristics of artisanal fishing gear exploited in the Lom Pangar dam reservoir, their catch and size composition in order to estimate the overall fish production of the reservoir.

2. Materials and Methods

2.1. Study Area

The study was conducted in Lom Pangar hydropower dam reservoir in the eastern region of Cameroon. The partial impoundment of the dam created a reservoir with an area around 590 km² and a useful storage capacity around 6 billion m³. In the present study, seven (7) fish landing sites were mostly used by fishermen to land the catch. Likewise, these sites are not susceptible to flooding during the period of heavy rains or full flooding of the dam as shown in **Figure 1**.

2.2. Data Collection

Primary data was collected by field survey which involved the investigation of the study areas in terms of artisanal marine fishing gears, quantities, species and size composition of fish landed. Data was collected from April 30 to September 30, 2016 at each of the seven sites, where a total of 493 fishermen were interviewed with a combination of field surveys, questionnaire interviews and participatory rural appraisal methods, and focus group discussion. The data was collected at each site by a facilitator from the Netherlands Development Organization (SNV-Cameroon). The taxonomic keys of Lower Guinea proposed by Stiassny *et al.* [21] were used to determine the families of the different species of fish caught on the landing sites.

The fish observed were identified at the species level according to Froese and Pauly [22]. Fish were weighed at each site using a load cell and then measured using an ichthyometer according to the guide of measurement of fishes [23]. These collected data were recorded on daily logs by boat. The anchoring time of

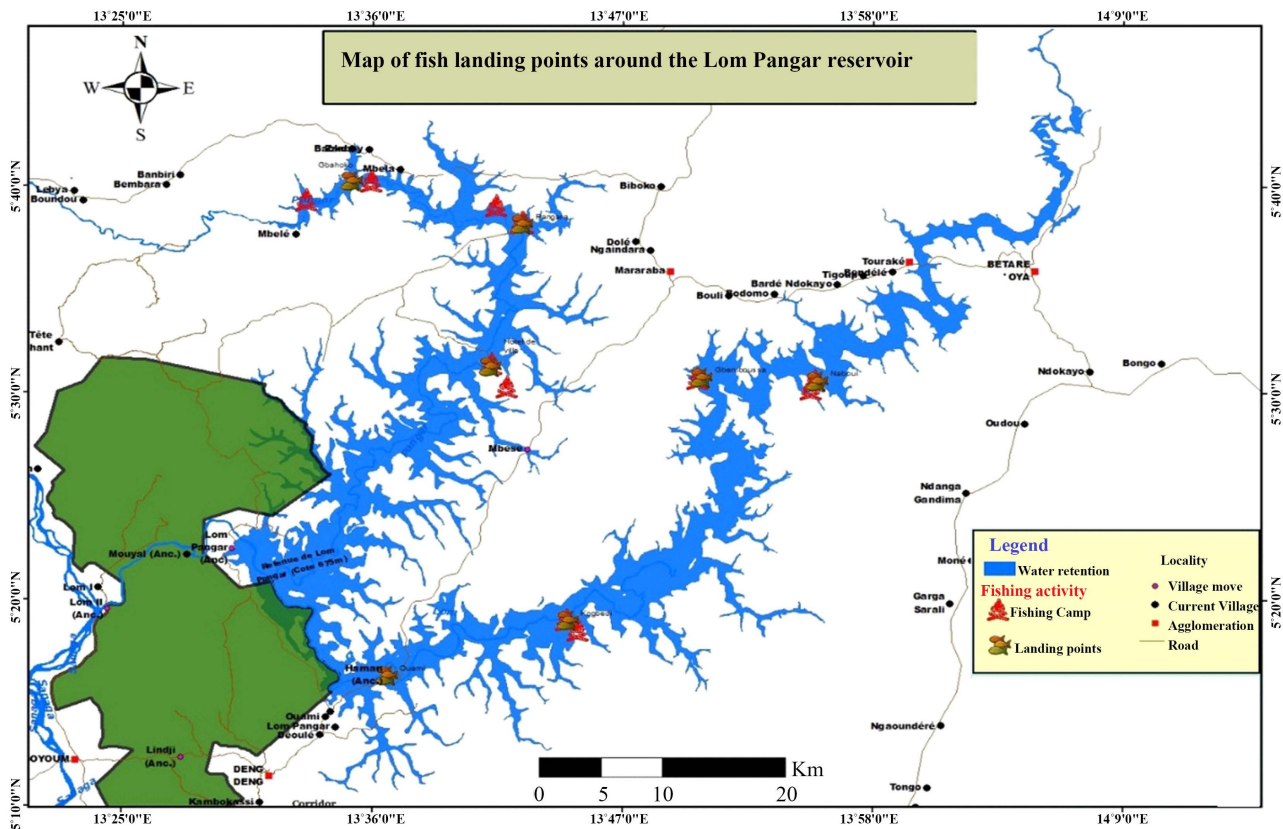


Figure 1. Distribution of deployment locations in survey of fish resources around the Lom Pangar dam reservoir.

each gear has also been estimated. The weight values of smoked and dried fish were converted to fresh fish by multiplying these values by three.

The total fish collected with carrier boats was divided by the number of fishing days to obtain the average total catch per day which was divided by the number of active fishing boats to estimate the catch per unit effort as kg/boat/day. However, catch per fisherman per day (kg/fisherman/day) was calculated from the estimated daily catch per boat divided by the number of fishermen on the boat. The annual total catch from the whole lake (C_i) was calculated as a summation of annual catch for each sub-area (C_{bm}), where

$$C_i = \sum C_{bm} . \quad (1)$$

C_{bm} is the catch of each boat for each month.

$$C_{bm} = C_b \times B_s \times D_s . \quad (2)$$

C_b represents the daily average catch of one boat, B_s is the number of active fishing boats in area and D_s is the number of active fishing days [24].

2.3. Data Processing and Analysis Collection

With regard to the analysis of the data collected, we used statistical processing using the online software Google Drive. However, we transferred the completed questionnaires to Google Drive which automatically generates a spreadsheet to collect the results. All primary data collected was analyzed by simple statistical

methods using Microsoft Excel software.

3. Results

3.1. Landing Sites and Fishermen

Seven main sites for landing catches by fishermen around the reservoir have been identified: one in township Baya Mbedomo (Kogbedi) from Goura district, one in Lai (Naboui II), three in Yahoue (Gbenboussa, City Hall, Pangara) from Betare-Oya district, one in Mbitom (Gbahoko), and the last one in Kepere Deng deng (Wami) from Belabo district (**Table 1**). Catch data was collected from April 30 to September 30, 2016 on each site. Fishermen surveys took place at each site immediately upon landing and 493 fishermen were surveyed (**Table 1**). As presented in **Table 1**, the Wami landing site represented 40.53% of the fishermen (the greatest number of fishermen) while the Gbahoko site had the smallest number of fishermen (4.67%).

3.2. Fishing Gears and Methods

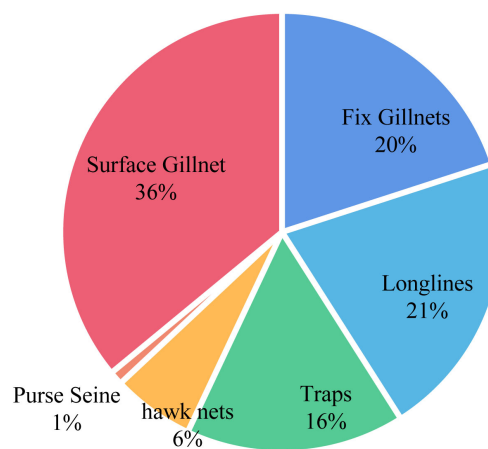
Five types of fishing gears and methods were observed during the period of study: gill nets, purse seine, traps, hawk nets, and longlines. Two types of gillnets with length of 600 m and mesh size varying from 10 to 50 mm were used in the reservoir such as, the monofilament surface drifting gillnet and the fixed gillnet. Three types of longlines such as fixed, drifting and trailing longlines with hook sizes ranging from 5 to 12 cm were identified as being the most used in the seven sites by fishermen. However, a trailing longline with a line length of up to 1 km was identified at the Wami site. Two types of traps were used by fishermen, including pots and traps. However, multifilament nets such as purse seines were the least used and least known. In addition, the use of purse seines and hawks remains marginal (**Figure 2**). Monofilament nets are widely used in comparison to multifilament in all the fishing gear used in the seven sites. Three main types of fishing gear were identified at landing sites such as gillnets, traps and lines (**Table 2**). The anchoring time of fishing gear varies between 11 and 24 hours depending on the landing site of the catches (**Table 1**). Gillnets had the most

Table 1. Distribution of landing sites by number of fishermen surveyed.

Township	District	Landing sites	Number of fishermen	% of fishermen
Goura	Baya Mbedomo	Kogbedi	54	10.95%
		Lai	70	14.20%
		Gbenboussa	40	8.11%
Bétaré-Oya	Yayoué	City Hall	62	12.58%
		Pangara	44	8.92%
		Mbitom	23	4.67%
Belabo	Képéré Deng-Deng	Wami	200	40.57%
		Total	493	100%

Table 2. Types of main fishing gears and their average anchoring time according to the landing site.

Average daily anchoring time of the gear/fishermen (hours)	Fishing gear used		
	Fishermen landing site	Gillnets	Longlines
Kogbedi	16	16	16
Naboui II	12	24	24
Gbemboussa	12	0	12
City Hall	11	0	0
Pangara vanne	15	14	16
Wami	17	17	17
Gbahoko	16	0	24

**Figure 2.** Fishing gears used in the Lom Pangar dam reservoir.

used fishing gear (56%) and hawk net the least used (6%) excluding purse seine (1%) (**Figure 2**).

3.3. Species Composition

Lom Pangar hydroelectric dam reservoir has a total of 16 families and 37 fish species, with *Cyprinus carpio* and *Clarias gariepinus* being the most exploited and *Sardinella aurita*, least abundant species. Most species targeted in the seven sites are semi-pelagic and benthic. As shown in **Table 3**, Gbahoko and Naboui sites are the ones with the highest number of species while Wami is the site with the lowest number of species.

3.4. Size Composition

The measurements were carried out on the species landed on each site. The sizes of fish species landed, expressed in minimum and maximum length are presented in **Figure 3** for each site. In the site of Naboui, the small fish sizes were observed on the *Petrocephalus spp* (13 cm) while the large fish sizes were observed

Table 3. Fish species composition in Lom Pangar hydroelectric dam reservoir in the eastern region of Cameroon.

Family	Scientific name	Local name						
		Kogbedi	Naboui	Gbemoussa	City hall	Pangara	Wami	Gbahoko
Cichlidae	<i>Cyprinus carpio</i>	carpe	carpe	carpe	carpe	carpe	carpe	carpe
	<i>Hemichromis bimaculatus</i>	carpe blanche			carpe blanche			
	<i>Oreochromis niloticus</i>							ndouksoudou
	<i>Petrocephalus spp</i>		définy					famba
	<i>Marcusenius mento</i>		ghella					ghella
	<i>Petrocephalus simus</i>		ghella					ghella
Mormyridae	<i>Campylomormyrus tamandua</i>							zokforo
	<i>Petrocephalus balayi</i>		ghella					ghella
	<i>Mormyrus spp</i>		tchitiawa					
	<i>Pollimyrus kingsleye</i>							mbeta
	<i>Momyrops spp</i>		soudoumouka					
	<i>Brienomyrus spp</i>							danga denge
Alestidae	<i>Brycinus macrolepidotus</i>		ghotta					
	<i>Phenacogrammus major</i>			ghotta				
Aridae	<i>Alestes spp</i>					gale au nez		gale au nez
	<i>Arius heudelotri</i>		machoirion					
Hepsetidae	<i>Arius spp</i>			poisson soleil				
	<i>Hepsetus odoe</i>	poisson panthère				poisson panthère		
Cyprinidae	<i>Barbus martorelli</i>	queue rouge	queue rouge	queue rouge	queue rouge	queue rouge		queue rouge
	<i>Barbus rainbaulti</i>							gbota
Claridae	<i>Barbus spp</i>		gozoro					gozoro
	<i>Clarias gariepinus</i>	silure	silure	silure	silure	silure	silure	silure
	<i>Clarias pachynema</i>		silure noir					silure noir
	<i>Heterobranchus longifilis</i>							bgebom
Mochokidae	<i>Clarias submarginatus</i>		silure blanc					
	<i>Clarias platycephalus</i>		silure tachete					
Bagridae	<i>Synodontis rebeli</i>				kpok-kpok			kpok-kpok
	<i>Synodontis spp</i>							gougnet
Characidae	<i>Chrysichthys nigroditatus</i>	machoirion	machoirion	machoirion	machoirion	machoirion		machoirion
	<i>Hydrocynus foskali</i>							gong
Channidae	<i>Hydrocynus vittatus</i>							sa'a
	<i>Parachanna obscura</i>	poisson vipère	poisson vipère	poisson vipère		poisson vipère	poisson vipère	poisson vipère
Polynamidae	<i>Polydactylus quadrifilis</i>		avouri			faux capitaine		avouri
Clupeidae	<i>Sardinella aurita</i>		sardine	sardine		sardine		sardine
Shilbaeidae	<i>Schilbe mystus</i>							salala
Centropomidae	<i>Lates niloticus</i>							goboi
Claroteidae	<i>Parauchenoglanis spp</i>					poisson militaire		poisson militaire

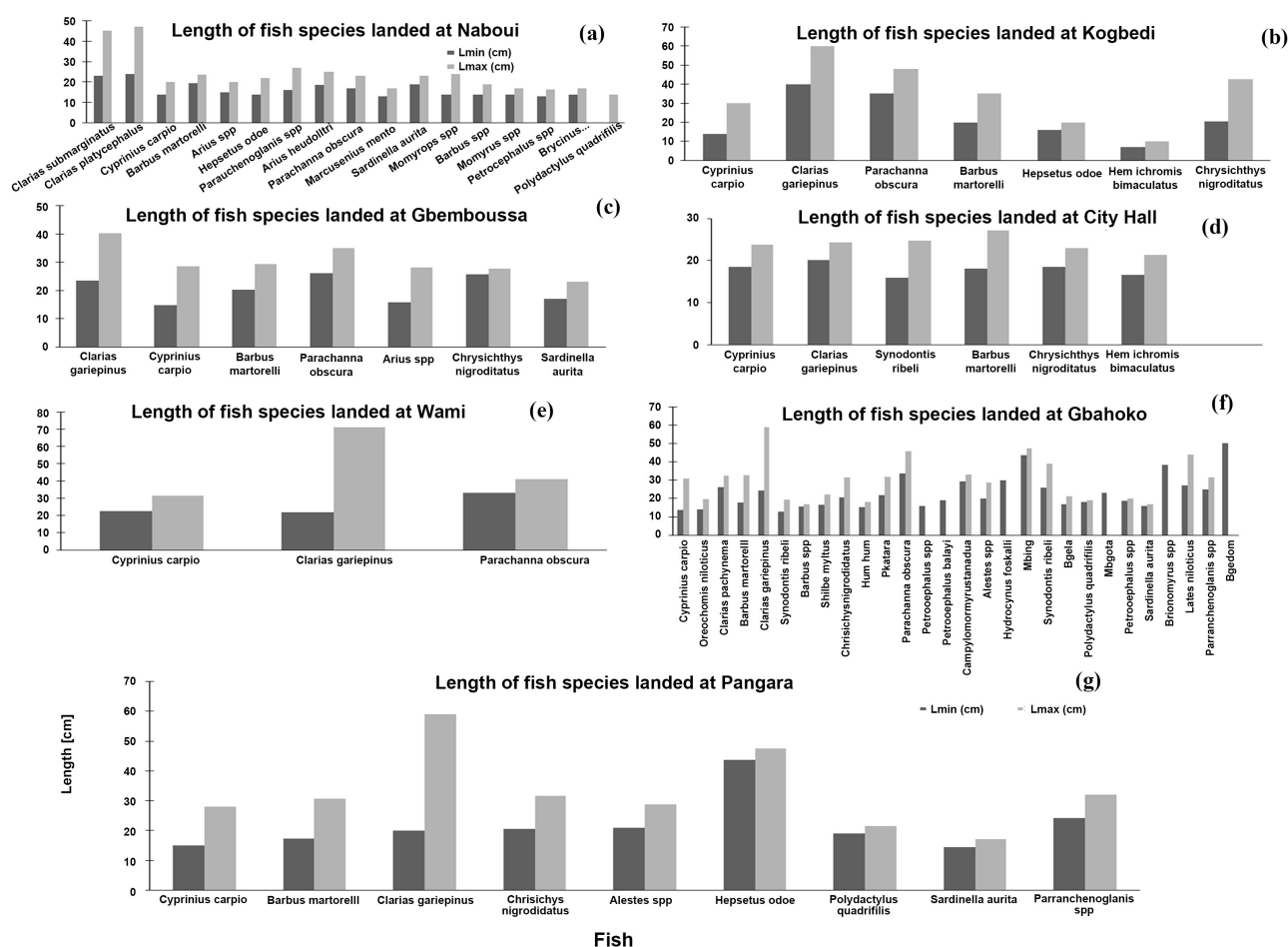


Figure 3. Fish size composition in each site.

on the *Clarias platycephalus* (47 cm). One may note that the *Clariidae* family had longer lengths compared to the one of other species. The fish size ranged from 7 cm (*Hemichromis bimaculatus*) to 60 cm (*Clarias gariepinus*), 15.78 cm (*Cyprinus carpio*) to 40.25 cm (*Clarias gariepinus*), 15.89 cm (*Synodontis spp*) to 27.22 cm (*Barbus martorelli*), 22.5 cm (*Cyprinus carpio*) to 71 cm (*Clarias gariepinus*), and from 12.72 (*Synodontis rebelli*) to 58.77 cm (*Clarias gariepinus*) in the sites of Kogbedi, Gbemboussa, City Hall, Wami, and Gbahoko, respectively.

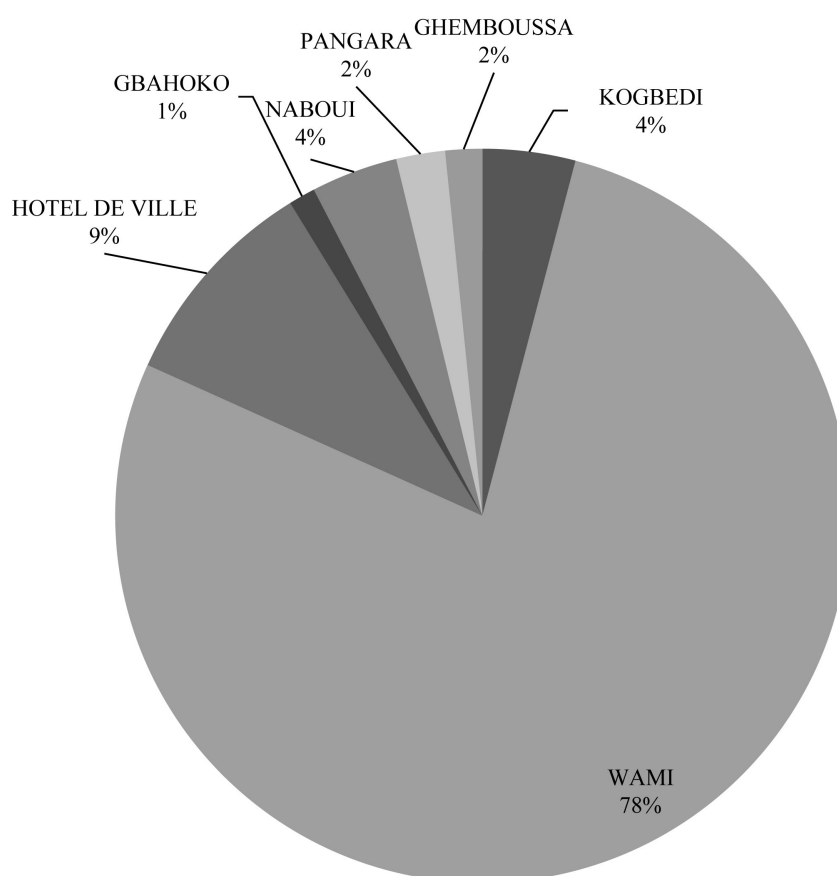
3.5. Quantity of Catches Landed

The catches are landed in three forms such as fresh, salted or smoked fish. Quantities of fresh, dry and smoke main species of fish landed by site are shown on **Table 4**. As presented in **Figure 4**, the total catches landed in Lom Pangar hydroelectric dam reservoir were 78%, 9%, 4%, 2%, and 1% for the sites of Wami, City Hall, Naboui, Kogbedi, Pangara, Gbemboussa, and Gbahoko respectively.

As shown in **Figure 5**, three main species of fish are smoked: *Cyprinus carpio*, *Clarias gariepinus* and *Clarias camerounensis*. *Cyprinus carpio* was the

Table 4. Quantities of fresh, dry and smoke main species of fish landed by site.

	<i>Cyprinus carpio</i>	<i>Clarias gariepinus</i>	<i>Clarias camerounensis</i>	
Kogbedi	68.00	36.00		104.00
Wami	40,476.00	10,555.00		51,031.00
City hall	6305.00	591.00	931.00	7827.00
Gbahoko	81.80	22.70		104.50
Naboui	436.90	2183.20		2620.10
Pangara	42.00	30.00		72.00
Gbemboussa	251.03	75.97		327.00
TOTAL	47,660.73	13,493.87	931.00	62,085.60
Proportions	76.77%	21.73%	1.50%	100.00%

**Figure 4.** Quantities (kg) of fresh fish landed by site.

smokiest fish, which quantities were 40,476 kg and 6305 kg in the Wami and City Hall sites, respectively. *Clarias gariepinus* were captured only in the City hall site (931 kg).

Based on the collected data, the catches composition (catches quantity) was estimated as occurrence kilogram (Kg) for each species at each site (**Figure 6**). *Cyprinus carpio* represented the highest percentage of all species caught in all

the sites except the Naboui site which is dominated by the catches of *Clarias gariepinus*. Indeed, *Cyprinus carpio* catches represented 87%, 68%, 82.01%, 69.44%, 19.83%, and 60.01% of total catches collected in the sites of Wami (d), Kogbedi (a), City Hall (c), Gbemboussa (b), Naboui (f), and Pangara (e), respectively. While, the *Clarias gariepinus* catches represented 13%, 27%, 7.31%, 11.50%, 64.83%, and 10.77% of total catches collected in the sites of Wami, Kogbedi, City Hall, Gbemboussa, Naboui, and Pangara, respectively.

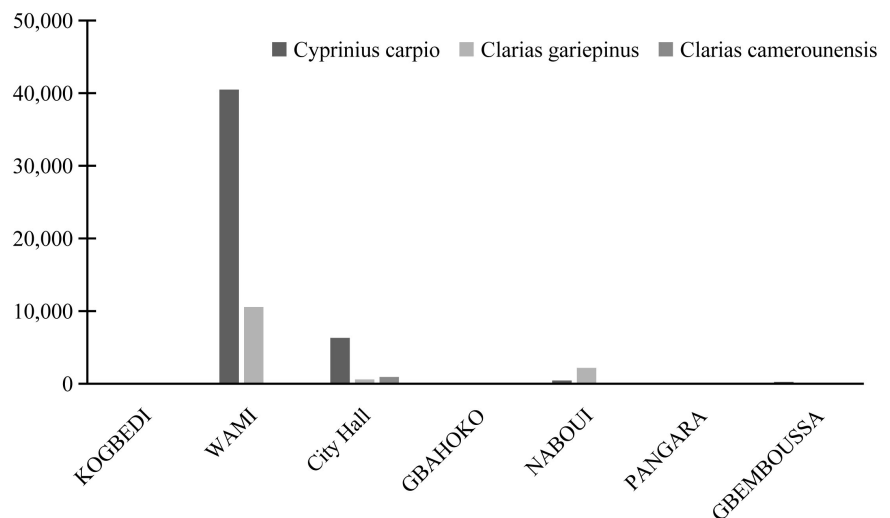
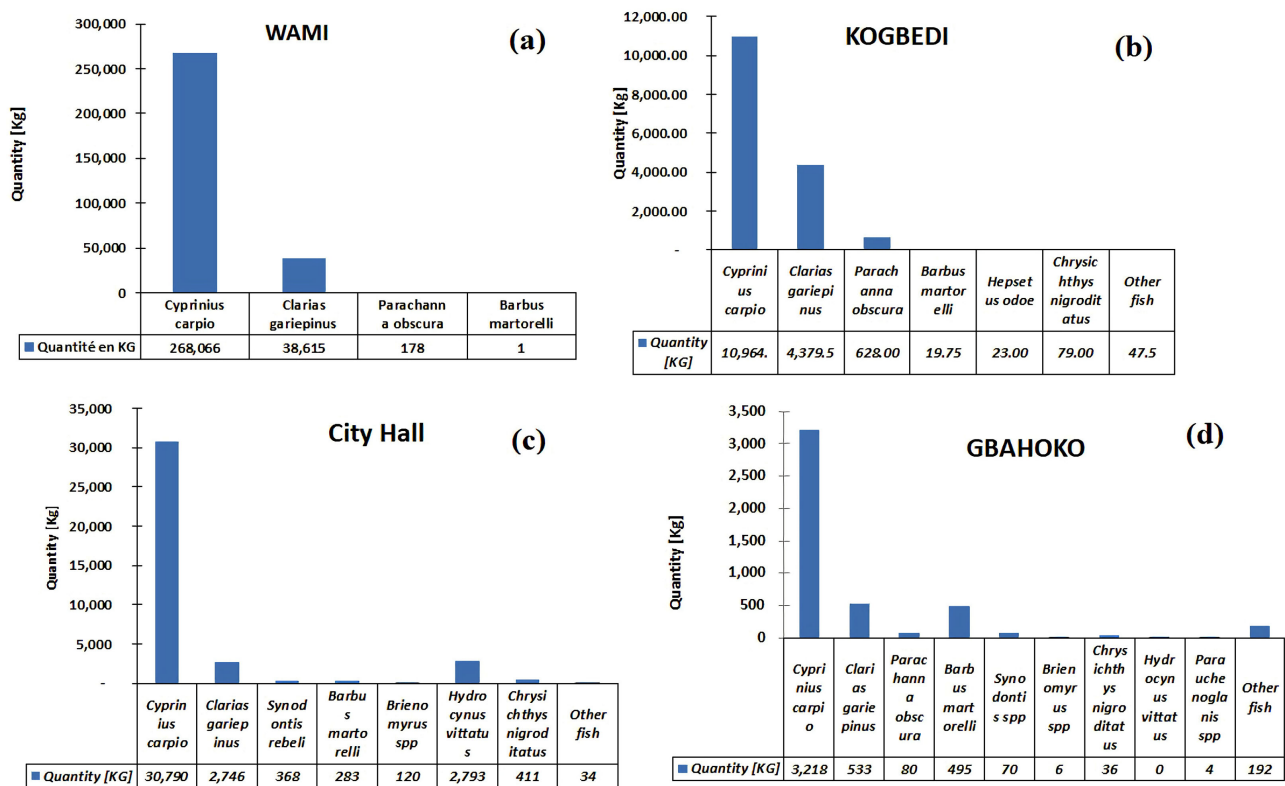


Figure 5. Total quantity (Kg) of smoked or dried fish landed by species and by landing site in September 2016.



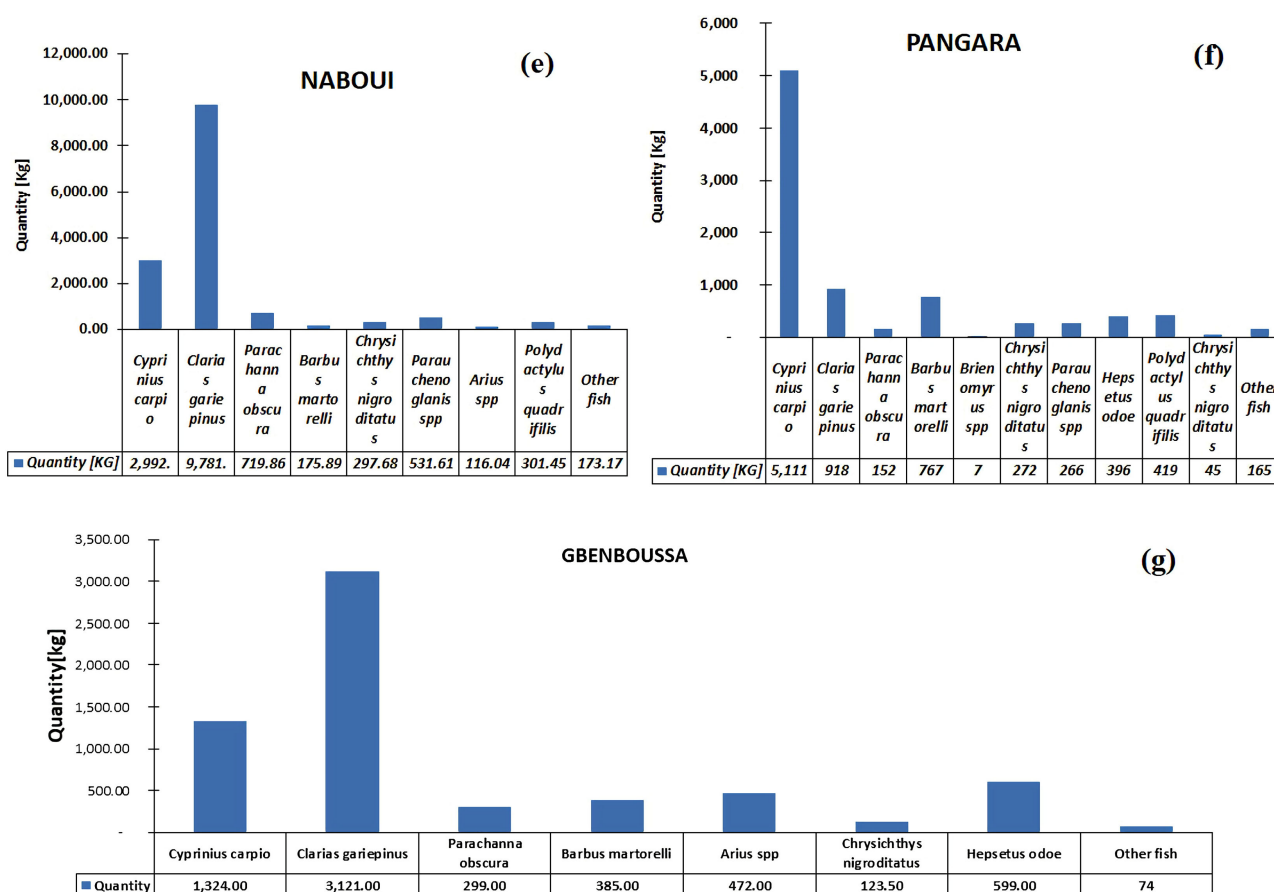


Figure 6. Catches composition (kg) by landing sites in September 2016.

Two families make up more than 96.8% of the catches landed in Lom Pangar hydroelectric dam reservoir, these are the *Cichlidae* (*Cyprinus carpio*) and *Clariidae* (*Clarias gariepinus*). While others (*Parachanna obscura*, *Barbus martorelli*, *Chrysichthys nigrodentatus*, *Parauchenoglanis spp*, *Synodontis rebeli* *Hepsetus odoe*, *Arius spp* etc. are represented as 3.2% of the total catch (Figure 7).

4. Discussion

Studies have shown that most African fishermen are more oriented towards artisanal fisheries (around 80 percent), which provides a source of food security and livelihood for many local communities [25]. Therefore, one of the main missions of sustainable fisheries management is to ensure the sustainability of fishery resources, to guarantee food security and respond to the demand for fishery resources while maximizing profiles [24] [26]. During the survey, it was found that the seven fish landing sites in the Lom Pangar hydropower dam reservoir employs more than 493 fishermen's and provides more than 623 tons of fishes for the Cameroonians.

However, the fish production from the Lom Pangar hydropower dam reservoir has gradually increased every year. The increase in production is due to the

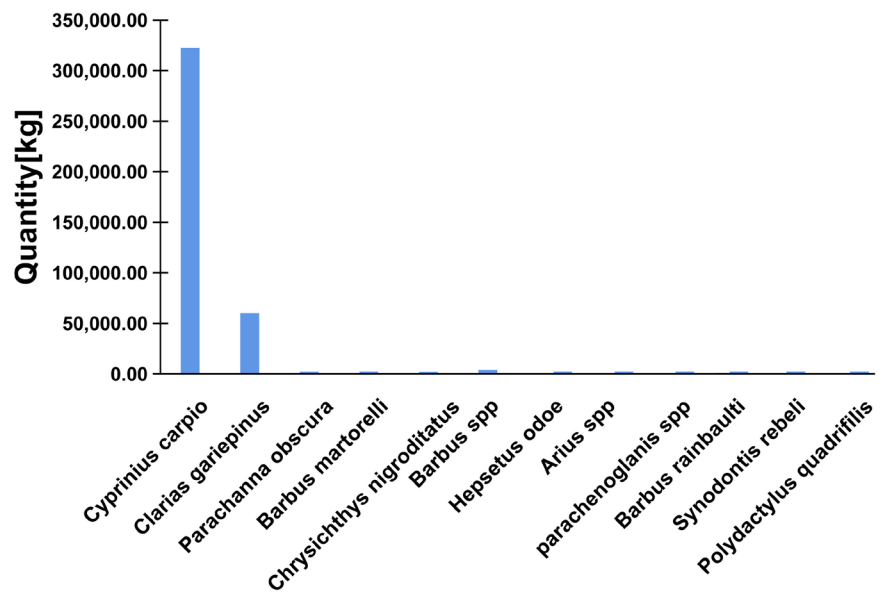


Figure 7. Most catch species in Lom Pangar hydroelectric dam reservoir in September 2016.

number of fishermen's increase every year. In addition is also because the Cameroonian government, through its policy of reducing imports and community development, has set up subsidies since 2016 allowing the population to settle in the area and practice fishing and agriculture. The factors that can influence this increase in production are climatic variations and water management. As presented above, the Wami site is the most frequented by fishermen. This site, located not far from the foot of the dam, is rich in water and consequently in fishery resources, hence the massive presence on this site of Mosgoun fishermen, very experienced in the practice of fishing. In addition, the proximity of the town of Belabo, easily accessible to sell the production, can also justify the abundant presence of fishermen in Wami [26].

Three main categories of fishing gears are used in the study area: gillnets, including surface drift gillnets and fixed gillnets; longlines and traps. Among these, surface drift gillnets, all monofilament, are the most used to target small pelagics (36%) followed by fixed nets (20%). Longlines occupy 21% while traps are used at around 16%. The use of the hawk is marginal and only 6% of fishermen use this fishing gear in the reservoir. In general, these gears are selective for certain species and sizes of fish. Therefore, commercial fishermen apply their knowledge of gear selectivity to improve the efficiency of catching target species of specific sizes [27]. In the present study, these fishing gears were particularly selective for *Cyprinus carpio* and *Clarias gariepinus*. One of the reasons for their good selectivity is due to the fact that the control of the effort of these fishing gears is generally expressed in terms of a set of standard with time interval necessary for the management objectives and also due to the fact that they reduce the fish mortality [28].

The present investigation revealed that the fishermen of Naboui leave longli-

nes and traps in the water for 24 hours. Likewise, Gbahoko fishermen can leave traps in the water at the same time. This is the longest anchorage time of a fishing gear in the reservoir. However, 37 species of fish belonging to 16 families were identified in the study area. The distribution of these species was 24 species landed in Gbahoko and 17 species in Naboui. Thus, Gbahoko and Naboui sites are the ones with the highest number of species, while three main fish species only are landed at the Wami site by fishermen during the period of study. This may be due to the transition from a riparian state to a lacustrine state during the formation of watercourses at other sites. It should be noted that five (5) species of fish are common at all landing sites, notably *Cyprinus carpio*, *Barbus martorelli*, *Clarias gariepinus*, *Chrysichthys nigroditatus* and *Parachanna obscura* (Table 4). The specie *Brycinus macrolepidotus* was only landed at the Naboui site during the period of study. It was shown in this study that the total quantity of fish landed in dried or smoked form during the impoundment study period was approximately 62 tonnes. Three species are predominant: *Cyprinus carpio* (77%), *Clarias gariepinus* (22%); *Clarias camerounensis* (1%). Landings of the species *clarias camerounensis* have been recorded only in City Hall (0.93 tons). The most important landings were recorded in Wami (51 ton), then in City Hall (7.82 tons) and in Naboui (2.62 tons). It was in agreement with the results obtained by ENVIREP-CAM [16] in the dams (Lagdo, Mbakaou, Mape and Bamendjin, Maga dams), natural lakes (Lake Chad basin, Barombi, Ossa) and in rivers (Sanaga, Wouri, Mungo, Nyong, Doume, Logone, Ntem).

5. Conclusion

The impoundment of the Lom Pangar dam reservoir created favorable conditions for the development of fishing activities, practiced mainly by Mosgoun fishermen. The most commonly used fishing gears are gillnets, traps and longlines. These gears captured in September 2016 approximately 623 tons of fish, which constitutes a significant increase in Cameroon's fishery production, which is still heavily in deficit. The Wami site is by far the most productive with around 480 tons of fish landed during the study period. *Cyprinus carpio* was the most landed species among 37 species identified in the study area. In order to guarantee sustainable exploitation of the resources of this dam reservoir, further studies should be carried out on the fishing gear used, in particular on their selectivity.

Acknowledgements

This publication was undertaken in the framework of the Lom Pangar hydroelectric dam project, implemented by the Electricity Development Cooperation (EDC) under the support of the Netherlands Development Organisation (SNV) in Cameroon.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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