

## Exploring how the Livelihood Prospects of the Fishing Communities around Nigeria's Shiroro and Kainji Dams are Correlated with Artisanal Fishing Activities

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**ABSTRACT:** The study examined how the livelihood outcomes of the fishing communities around the Nigerian Shiroro and Kainji Dams related with their artisanal fishing activities. Data from 460 respondents was gathered using a questionnaire routine. The respondents were chosen using proportionate and multi-stage sampling approaches. Data analysis involved the use of both inferential statistics and descriptive statistics. The findings reveal that, among respondents, (79.1%) placed fish catch and marketing as the most actively involved artisanal fisheries activity, with fish catch, processing, and marketing coming in second with 63.3%. Similar to this, fish catch, transportation, and marketing had 54.8% of respondents and was ranked third. Findings on the livelihood outcomes reveal that, Factor 1 represents variables related to "sustainable employment," with the highest loadings for "access to fishing ground" (0.737), Factor 2: This factor captures aspects related to "food security." The factor "Improved access to infrastructures" (0.669) has the largest loading. Factor 3: Captures factors connected to "income." The component "increased working capital" has the highest loading (0.773), Factor 4: "Access to diverse learning resources" (0.766) is a component with significant positive loadings related to quality education. Factor 5: Gathers information about "household stability." Adequate food supply (0.791) have the strongest loadings in this component. The results have implications that the livelihood outcomes after loadings on each element improved the livelihood conditions of fishers. Therefore, the study suggested that in order to help fishermen carry out their fishing operations with greater ease and to achieve better livelihood results, the government should provide financial facilities.

**Keywords:** Kainji and Shiroro Dams, Fishing Communities, Livelihood Outcomes

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### INTRODUCTION

One cannot stress enough how vital the fishing industry is to people's lives and the economies of many industrialized and emerging nations. Notably, fish accounts for over 60.0% of global protein intake, particularly in underdeveloped nations. Both Nigerians living in the country's cities and rural areas could directly and indirectly benefit from it. With a contribution to the agriculture sector's Gross Domestic Product (GDP) of between 3.00 and 5.00 percent, fishing is a particularly

significant subsector in Nigeria. The artisanal fishery in Nigeria supplies the majority of the country's domestic fish supply, despite its neglect. Through increased food supplies, jobs, and cash, artisanal fishing improves the lives of the impoverished (Okeowo *et al.*, 2015). Serving the population's nutritional needs is one of the main contributions made by Nigeria's artisanal fisheries to the country's economy. For body organs and tissues to grow, mend, and maintain properly, animal protein is necessary

(Okeowo *et al.*, 2015). According to Rosina (2018) calculations, 43.5 million individuals were directly involved in fish primary production, either through aquaculture or artisanal fishing. The majority of the 43.5 million individuals who fish for artisanal products are small-scale operators who fish both inland and coastal waters. According to Agnew *et al.* (2019), artisanal fishing and aquaculture are vital to the livelihoods of millions of people worldwide and help to reduce poverty and ensure food security.

The results of livelihood strategies, such as higher income, better health, less susceptibility to poverty, enhanced food security, and more sustainable use of natural resources, are referred to as livelihood outcomes.

A better understanding of the current configuration of elements inside the livelihood framework can be gained by looking at the outcomes, which show what drives stakeholders' actions and priorities. They may offer insight into people's propensity to react to novel opportunities and suggest performance metrics for evaluating support activities. The assets are directly impacted by livelihood outcomes, which also dynamically alter their degree of strategies and result. The product or outcome of livelihood activities is known as a livelihood outcome (Ismail, 2014).

A livelihood approach to development yields the wholesome indexes of growth and development for the individual, household, and community. It is not to be assumed that people are only interested in increasing their money; instead, attention should be focused on learning about the wealth of livelihood objectives. Thus, it will be easier to comprehend people's priorities, the reasons behind their actions, and the main obstacles they face. Ahmed and Adamu (2020) reported the following livelihood outcomes: In light of this, the following research issues were addressed in this study:

- i. How do the fishermen go about their artisanal fishing operations?
- ii. How do the fishing villages along the Kainji and Shiroro Dams make a living?

### **The study's objectives**

Analyzing artisanal fishing operations and how they connect to the livelihood outcomes of fishing communities around Nigeria's Shiroro and Kainji dams is the study's main goal.

The particular goals are to:

- i. assess the fishermen's artisanal fishing practices
- ii. assess the fishing communities' livelihood results along the Shiroro and Kainji Dams.

## **METHODOLOGY**

### **An explanation of Shiroro Dam**

Along the Kainji and Shiroro Dams, the study was conducted. According to NPC (2006), Shiroro's population is expected to reach 322,918 by 2020, growing at a pace of 3.2%. The state's hydrology, edaphic characteristics, and climate provide ample opportunity for growing the majority of Nigeria's staple crops, including maize, yam, rice, millet, and sorghum, as well as for harvesting freshwater fish like *Tilapia spp.*, *Bagrus spp.*, *Clarias spp.*, *Gymnarchus niloticus*, *Heterotis spp.*, *Labeo spp.*, *Mormysus spp.*, and *Lates niloticus*. The Shiroro hydropower reservoir is a storage-based hydroelectric facility situated in the Shiroro Gorge in Shiroro Local Government, Niger State. Its approximate coordinates are 9° 57' 25N and 6° 49' 55E. On the Dinya River, it is situated around 90 kilometers southwest of Kaduna. According to Jared (2021), the facility has an installed capacity of 600 MW. Rivers Dinya, Guni, Sarkin-Pawa, Erena, and Muyi contribute lateral waterways to the reservoir, accounting for around 70% of its intake. Around the reservoir, the annual temperature ranges from 27 to 35°C (Nicholas, 2015).

### **Kainji Dam's description**

The coordinates of Kainji Lake are 4°21' and 4°45'E, and latitudes 9°5' and 10°55'N. Primarily situated in Niger State, it traverses both Kebbi and Niger States. In Nigeria, Kainji is the biggest artificial lake and the country's second-largest lake (Umar and Illo, 2014). It was established in 1968 when the Niger River was dammed up at New Bussa in the Borgu Local Government Area of Niger State as a result of the building of the Kainji Dam. Its maximum length and width are 134 km and 24.1 km, respectively. Its mean and maximum depth is 11 and 60 m, respectively. Its surface area is 1,270 km<sup>2</sup>, its volume is 13 × 10<sup>9</sup> m<sup>3</sup>, and its catchment area is 1.6 × 10<sup>6</sup> km<sup>2</sup>. Kainji Lake typically has dry spells followed by periods of rain. From April to October, the Lake receives between 1,100 and 1,250 mm of precipitation annually (Tafida *et al.*, 2021). The months of March and August record the highest monthly temperatures, which are around 30°C, and the lowest, which are approximately 25°C. Study after study on the Lake Basin has shown the socioeconomic features of the people living there: most fishermen are members of the Sarkawa sub-tribe of the Kebbi Hausa, while others are members of the Laru, Gungawa, Lopawa, and Nupe tribes (Shettima *et al.*, 2014). The primary traditional occupation of these people is fishing; other jobs include farming, raising livestock, and engaging in small-scale local entrepreneurship in the form of gear/craft

manufacturing, pottery, and mat weaving, as well as maintaining an eight-turbine dam that receives water from the Guinea highlands via the Jos Highlands and the River Niger. Kainji Lake can accommodate 960 megawatts of installed power. The actual Kainji Lake has a maximum depth of 12.1 meters and a surface water level of about 1,243 km<sup>2</sup>. About 135 kilometers long and 30 kilometers broad at its widest point, Kainji Lake is used for irrigation and a small-scale fishing business.

### Sample size and sampling procedure

550 fishing villages along the Kainji dam were found during the survey. 3,823 people live in the fishing settlements along Kainji. This figure (3,823) shows the sampling frame from which the study's sample size was derived. The study used proportionate and multi-stage sampling methods. First, the Kainji Dam in the North Central Region was specifically chosen because artisanal fishing is a common activity there. Second, 50 villages along the Kainji dam were chosen at random to participate in the study. Thirdly, 460 respondents were chosen along the dam using the proportionate sampling technique, which was then utilized to determine the study's sample size.

### Procedure for gathering data

For the study, standardized questionnaires created in accordance with the goals of the investigation were employed to collect primary data. Copies of this were given to the participants who were chosen for the research.

### Techniques for data analysis

Descriptive and inferential statistics were employed in the analysis of the gathered data. To examine objective 1, descriptive statistics were employed, including frequency distribution count, percentages, and ranking. Analyzing objective 2 also involved the use of inferential statistics, or factor analysis.

### Model for factor analysis

In order to accomplish goal 2, factor analysis was used. The results of the fishermen' livelihood analysis were examined using factor analysis. The process of breaking down a large number of variables into smaller numbers of factors is called factor analysis. According to Umunna *et al.*, (2020), this method creates a common score by extracting the largest common variance from each variable. We can use this score as an index of all variables in subsequent study. As a component of the general linear model (GLM), factor analysis makes a

number of assumptions, including that there is a linear relationship. It incorporates pertinent variables into the analysis, and the relationship between the variables and the factors is accurate. This is how the factor analysis model looks:

$$x = \mu + \Lambda f + u \dots \dots \dots (1)$$

Where  $x$  = vector of observed responses,  
 $f$  = vector of common factors, and  
 $u$  = vector of unique factors defined on a population.  
 The matrix  $\Lambda$  is a  $p$  by  $k$  matrix of factor loadings.  
 It is assumed that the vectors  $f$  and  $u$  have mean zero and are uncorrelated

## RESULTS AND DISCUSSION

### Engaging in artisanal fisheries

The artisanal fishing practices that the fishermen engage in are displayed in (Table 1). According to the results, the most highly engaged activity was placed first by (79.1%) respondents, closely followed by (63.3%) respondents who ranked second for fish catch, processing, and marketing. Fish packaging and marketing made up (36.5%), fish marketing only had (31.9%) respondents, fish transportation and marketing made up (27.2%), and fish catch, preservation, and marketing had 26.3% of the total respondents. In a similar vein, fish catch, transportation and marketing had (54.8%) respondents and was ranked third. Comparably, the group of respondents with the lowest frequency is made up of those who process and market fish (23.9%), those who preserve and market fish (23.5%), and those who merely catch fish (22.6%).

The data make it evident that the majority of respondents were involved in the catch and commercialization of fish. Fish catch transportation and marketing, as well as processing and marking, come next. Fish processing and marketing, fish preservation and marketing, and fish catch solely were the least common activities among the respondents. Different kinds of nets, traps, boats, and canoes are among the equipment used to collect fish. Field observations revealed that whereas some boats had outboard motors attached, others did not. The fishermen are able to go farther offshore thanks to the powered boats. The results show that the respondents' catches, which were sustainable for their livelihood, ranged from 50 kg to 62.5 kg. When fishing is the primary source of income, access to the gathering of fisheries resources and the related trading and processing operations may be the only means of subsistence and preservation of food purchasing power. As a result, fish gave fishing families the much-needed revenue they required to maintain their

**Table 1:** Distribution of the Fishers According to Artisanal Fisheries Activities Engaged (n = 460).

Activities	Frequency*	%	Ranking
Fish catch and marketing	364	79.1	1
Fish catch, processing and marketing	291	63.3	2
Fish catch, transportation and marketing	252	54.8	3
Fish catch, packaging and marketing	224	48.7	4
Fish packaging and marketing	168	36.5	5
Fish Marketing only	148	31.9	6
Fish transportation and marketing	125	27.2	7
Fish catch, preservation and marketing	121	26.3	8
Fish processing and marketing	110	23.9	9
Fish preservation and marketing	108	23.5	10
Fish catch only	104	22.6	11
Fish catch, preservation, processing, packaging and marketing	98	21.3	12
Fish catch, preservation, processing and marketing	86	18.7	13

Source: Field Survey, 2023 \* Multiple responses were recorded

way of life. Women predominated in the fields of fish processing and marketing. The most popular fish processing techniques employed by research participants were smoking, which was followed closely by sun drying and frying. In the two research areas, salting is a less common fish processing technique.

According to fish processors, fish smoked in spherical ovens smoked more flavorfully and had a lower chance of burning. In the research region, freezing is a less common technique for processing fish. This is because the fishing towns are located far from urban centers and not many of them own refrigerators. The locals are partial to fresh fish over frozen. The fish is sprayed with a suitable amount of salt, allowed to sit for one to five days, and then dried before being stored. Fish can also be prepared for the market by frying it. Either the wives of the fishermen or the processors who purchase fresh fish straight from the fishermen engage in these operations. In Nigeria, women control nearly all aspects of fish selling. These traders continue to drive a hard bargain with their suppliers and an even harder one with their customers, despite the fact that they are frequently the wives or family members of the fishermen. Fishermen typically sell their catch to their women folk first, who handle the smoking and marketing of the fish, even if the fish are to be smoked before being sent to market. They often take the fish to market, selling what they can as fresh; at the end of the day, they smoke the remainder. Until there is enough to justify moving it to the market, they frequently build up their supply (Unongo, 2010. Fish is packed either fresh or processed into bamboo or sorghum stalk baskets, paper cartons, wooden or plastic boxes, and sacks made of coconut stalk, jute, or synthetic fiber. To minimize breakage and losses during shipping, the larger containers are lined with leaves from plantain or banana plants, and the fish is packed within. Motor vehicles, bicycles, motorcycles, and foot are the main modes of transportation, particularly in metropolitan areas (Agnew et al., 2019. Women purchase catches on a regular basis and pay the fishermen ahead of time, so

serving as an informal credit provider. Women's decisions about the market are influenced by the significant interdependence between female fishmongers and female fishermen. The long-lasting marketing relationship between fish dealers and fishermen gives small-scale artisanal fishermen a guaranteed market outlet and traders a reliable supply source (Ahmed and Adamu, 2020. Fish can be preserved and processed using conventional techniques such as drying, salting, smoking, boiling, and fermenting (Jared, 2021). In Africa, especially in Nigeria, the most common techniques include smoking, roasting, and drying (Ifeanyi-obi and Iremesuk, 2018). A variety of techniques are used, including distributing small fish on rocks, the ground, or mats; threading and hanging larger fish on split palm fronds; and placing larger fish separately on permanent racks made of timber supporting reeds or split bamboo (Nicholas, 2015. The fish are rotated on a regular basis so that the entire surface can dry. This kind of sun-drying leaves the fish vulnerable to insect and animal pest attacks, allows sand and dirt contamination, and gives no control over the drying times (Tafida *et al.*, 2021.

Before being sold, fish is packaged in the study area. This explained 4.6% of the responses. Fish items are packaged by placing and wrapping them in specific materials or containers, such bags, cans, nylons, cartons, and so on. It involves packing fish items into any available container so they can be sold or stored. Fish items that are packaged are more appealing to customers and marketers and facilitate handling while in transit (Shettima *et al.*, 2014. Fish or fish items that have been processed must be packaged for simple marketing. Processed fish can be marketed, transported, and packaged in a variety of ways. Fish can be processed using nearly as many traditional processes as there are ways to package it.

The type of processed fish product and the purpose of packaging it determine the materials and packing techniques to be employed. Fishermen are able to package both fresh and dried fish. Basic packaging

**Table 2:** Factor Analysis of Livelihood Outcomes of Artisanal Fishers (n) = 460.

Items	Factors					Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
	Sustainable Employment	Food Security	Income	Quality Education	Household Stability	
Access to fishing ground	0.737					0.606
Poverty reduction	0.662					0.505
Enhanced fish catch	0.640					0.485
Access to land	0.610					0.410
Improved access to infrastructure		0.669				0.527
Increased investment in fishing		0.631				0.462
Livelihood diversification		0.620				0.442
Increased availability of food supply		0.615				0.380
Increased working capital			0.773			0.644
Fishing experience			0.770			0.635
Increased length of time at the dam			0.730			0.621
Selling price of fish			0.710			0.603
Increased total household income			0.670			0.563
Access to diverse learning resources				0.766		0.601
Access to quality teachers				0.754		0.567
Access to better infrastructures				0.748		0.460
Adequate food supply					0.791	0.649
Access to quality health care service					0.461	0.597
Access to income					0.372	0.587
Access to safe and adequate housing					0.372	0.556
% Variance	8.900	8.976	10.673	11.468	9.336	
% Cumulative	8.900	17.876	28.549	40.017	49.353	

Source: Field Survey, 2023 Method: Varimax with Kaiser Normalization (0.30 or above) Note: Factor loadings: are the correlation coefficients between the variables and the factors. Communality: Measure of the % of the variables variation.

supplies that are frequently found in tropical regions include paper, cardboard, metal sheets, foils, and various types and shapes of plastic. Paper and carton are still used to package fish items even though the usage of plastics and polyethylene is growing quickly. The appropriateness of packaging materials and techniques is crucial for quality control. This is due to the possibility that all processing efforts could be ineffective if the conditions are not met, which would cause the fishermen to suffer severe financial losses as well as emotional distress. The way fish is packaged, transported, and marketed has a significant impact on its quality when it is delivered to a processing facility or a consumer. Packaging materials consisting of appropriate materials should be utilized to preserve the quality of fish products during transportation (Umunna *et al.*, 2020).

Fishermen in the research area frequently transport fish. It represented 14.6% of those surveyed. Fish that isn't sold at the dam site is transported from the surrounding areas to nearby markets. Transporting processed fish from riverbanks, farms, or warehouses to sales locations is known as fish transportation. Fish must be moved from the dam/farm or processing factories to the market's customers via middlemen. Typically, fishermen sell their goods at the farm gate or dam site. Fish products can be transported via any mode of transportation; the key is to maintain the proper temperature to prevent the growth of spoiling organisms. In the tropics, processed fish is mostly distributed via road transportation. Wheelbarrows, walking, bicycles, motorbikes, taxis, pick-up trucks, buses, trucks, and lorries are some of the modes of transportation. The distribution of fish from processing villages to wholesale

markets and thereafter to retail establishments depends heavily on this section (Umar and Illo, 2014). Furthermore, fish catch, preservation, processing, packaging, and marketing accounted for 21.3% of fishermen, whereas 18.2% of fishers were involved in these activities. The bulk of artisanal fishing operations in the research area are carried out by these two types of fishermen.

### Fishers' livelihood outcomes

Table 2 examined the Artisanal Fishers' Livelihood Outcomes. The factor analysis of the livelihood outcomes for fishermen is presented in (Table 2). Table 2 displays the outcome of a Factor analysis with Varimax rotation, which is a rotated component matrix. The factor loadings for each variable on each of the rotatable components (factors) are shown in this matrix. Factor 1: This factor shows characteristics associated with "sustainable employment," where the highest loadings are associated with access to fishing grounds (0.737), intermediate loadings are associated with "poverty reduction" (0.662), enhanced fish catch (0.640), and access to land (0.610), in that order. The inference is that having access to fishing grounds and other factors will encourage effective fishing techniques, which in turn will give fishermen a source of employment and lead to sustainable livelihood results. Factor 2: This component encompasses elements associated with "food security." In this category, "Improved access to infrastructures" (0.669) has the highest loading, closely followed by "Increased investment in fishing" (0.631), "Livelihood diversification" (0.620), and "Increased availability of food supply"

(0.615), all of which have modest loadings. As a result of having access to these resources, fishermen have a higher level of food security as a sustainable livelihood outcome. Factor 3: Comprises variables associated with "income." "Increased working capital" (0.773) has the highest loading in this component; moderate loadings are found for "fishing experience" (0.770), "lengthened time on the dams" (0.730), "fish selling price" (0.710), and "increased total household income" (0.670), in that order. For fishermen, this component is extremely important because it may be used to buy more equipment, hire more crew members to fish, and finance other livelihood endeavors that raise social standing and general standard of living. Factor 4: The quality education component includes strong positive loadings for "Access to diverse learning resources" (0.766), with access to superior infrastructures (0.748) and excellent teachers (0.754) following closely behind. This component stands for choice variables pertaining to the research area's fishermen' livelihoods and their access to high-quality education. Having access to the aforementioned elements makes it possible for fishing households to get high-quality education, which can enhance the efficiency of fishing operations and result in sustainable livelihood outcomes. Unongo (2010) and Shettima *et al.*, (2014) agreed that if the fishermen are educated and/or are experienced in fishing, they will be competent to read and comprehend bulletins and fisheries instructions aimed at increasing productivity and livelihood outcomes. They will be more knowledgeable about the best places to fish, the flow of the water, and the right equipment to utilize.

Factor 5: Comprises elements associated with "household stability." This component captures factors related to housing appropriateness as a result of engaging in fishing and other livelihood activities. The strongest loading in this component is for adequate food supply (0.791), followed by "access to quality health care services" (0.461), and moderate loadings for "access to income" (0.372) and "access to safe and adequate housing" (0.372). As a result of the fishing communities' livelihood activities, having access to these choice elements will lead to household stability, which will either directly or indirectly improve fishing efficiency in the two research locations. The results imply that the livelihood outcomes that followed the loadings on each element improved the conditions of the artisanal fishermen. Twenty (20) variables that make up the livelihood outcomes of artisanal fishermen were extracted using factor analysis, which finds components that explain the most variance in the data. Usman and Ifabiyi (2021) opined that the outcome showed that the variables were whittled down to five elements for easy comprehension. The rotation procedure was effective since it converged after five iterations using the Varimax with Kaiser Normalization rotation approach, which attempts to make

the factor interpretations more understandable and straightforward.

## Conclusion and recommendations

The following suggestions are offered in light of the enormous advantages that come from the sustainable exploitation of the country's water bodies and in an effort to solve the problems facing the artisanal fishing sector. These suggestions will significantly enhance the amount of fish produced and the fishermen's standard of living.

1. To improve livelihood outcomes, change agents should inform fishermen about the importance of changing their attitudes toward artisanal fishing activities.
2. In order to allow fishermen to effectively carry out their fishing operations with the goal of enhancing food security, the government should provide them with recognition.
3. Fishermen should receive subsidized fishing inputs from the government.

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