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THE IMPACT OF SHIRORO DAM PROJECT ON FOOD SECURITY AND POVERTY STATUS OF RURAL FISHERFOLKS IN NORTH CENTRAL REGION OF NIGERIA

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Abstract
Food security and poverty are two important concepts embedded in Sustainable Development Goals (SDGs).A number of empirical studies across the world have shown that irrigation has either a positive or negative influence on fisherfolks' household incomes, food security and poverty alleviation. Hence, the study intends to assess the impact of Shiroro Dam Project (SDP) on food security and poverty status of rural fisher folks in Niger state, north central Nigeria. Primary data were collected with the aid of structured questionnaire. A multistage sampling procedure was used to select 363 fish folks from 2 LGAs and 12villages. 267fisherfolks who are non-beneficiaries of SDP were also selected as counterfactual to examine the impact. The data were analyzed using Propensity Score Matching and the Local Average Treatment Effect models. Results indicate that majority of Shiroro dam fisherfolks (SDF) are male (93.39%), married (86.78%) with mean age and fishing experience of 45 and 24 years respectively. The results revealed that 56% of SDF were food secured, while 25% of NBF were food secured. Poverty incidence for the SDF and NBF was 0.281 and 0.491 respectively. The average Kcals of the SDF was 1.602 units and the difference was statistically significant at 1%.The Treatment Effect on the Treated (ATT) on the average had a positive impact, statistically significant at 1% and increases food security (Kcals) of the SDF by 0.803 units or 42.49%. The result revealed that the expenditure incurred by SDF was ₦10.870 and the difference was statistically significant at 1% level of probability. The hypothesis, which stated that Shiroro dam utilization, has no impact on food security; fishery income and expenditure of the beneficiaries were rejected. There is need to integrate fish production both capture fisheries and aquaculture into dam construction and associated water management systems to increase their food security and poverty alleviation. Special attention should be given to fisheries in dam construction to cater for more fisherfolks.

Keywords: Food security, income, poverty, Shiroro dam fisherfolks (SDF), Nigeria

Introduction

Food security and poverty are two important concepts embedded in Sustainable Development Goals (SDGs). Food is the most basic of life needed for existence and a balance diet to maintain sound health (Oladimejiet al., 2017).Itis regarded as the basic means of sustenance, and its adequate intake in terms of quantity and quality, is key for healthy and productive life (Ejiga and Omede, 2016). However, in a developing country like Nigeria, small scale farmers who constitute the bulk, produce about 85% of Nigeria's total food are significant part of the world population who still go to bed half-hungry or completely hungry(World Poverty Clock, 2018).In addition, despite the large population involved in agricultural production including artisanal fisheries, the performance of agriculture in terms of feeding the country's population, which is growing at 2.6% per annum, is low. This has resulted in food hunger and poverty, which in turn, creates food insecurity and inaccessibility at the household and national levels (Irohibe and Agwu, 2014, Fashina, 2019). The interlock between food security and poverty is also clearly elucidated in SDGs. While SDG goal1 emphasises complete eradication of poverty by year 2050, SDG 2 highlights end to hunger, achieving food security, improved nutrition and promoting sustainable agriculture. Therefore, making food available in sufficient quantity and quality (food security) is considered as a basic prerequisite for poverty reduction and economic development of the nation. This issine qua non to achieving other 15 SDGs.

More broadly, the 2030 Sustainable Development Agenda aims to tackle the complex challenges facing the planet today, which are ending poverty, hunger and malnutrition, ensure food security and responding to climate change while achieving inclusive growth, building resilient communities and sustainably managing our natural resources (Food and Agriculture Organization, FAO, 2017). Despite this, the absolute number of undernourished and hungry people due to poverty has increased in recent years, from 784 million in 2015 to 821 million people in

2018, that is, around one person out of every nine in the world(FAO 2018). The situation is more precarious in Nigeria as the World Data Lab's Poverty Clock (2018) asserted that about 90 million people, about half of its population lives in extreme poverty.

The Nigeria fishery sub sector is of three major types, namely, the artisanal fisheries, the commercial fisheries and aquaculture. The commercial fisheries operates largely in the lagoons and creeks adjacent to the Atlantic Ocean and constitutes the smaller proportion of total fish output and mostly serve as export. On the other hand, artisanal fisheries constitutes the most significant fishery sub sector in terms of number of people employed and its contribution to total fish output ranged from 90.1% to 97.7 % with annual average of approximately 94 % in 1981-2005 but of recent decline (Oladimejiet al.,2019). Proper management of rivers and coastal water are critical for sustainable development as they can be a driver for food security, poverty reduction and economic development.

Follow from above, a number of empirical studies across the world have shown that irrigation has either a positive or negative influence on fisher-folks' household incomes, food security and poverty alleviation (Marmulla, 2001;Jackson and Marmulla, 2001, McCartney et al., 2018). Dams are important means of meeting food; water and energy and, the impacts of dams can be involuntarily imposed on rural farming households whose livelihoods are dependent on riverine fisheries and irrigation resources through contributions to economic growth while the services they provide may come at a cost (Skinner et al., 2009).Dams especially intended for irrigation, hydroelectricity and artisanal fishery activitiesenable households to achieve food security, accumulate assets, and reduce vulnerability to external shocks. It also provide income to rural and urban households, promoting growth and development of rural fishing settlements, and enhancing conservation and sustainability of water resources (Oladimejiet al., 2019). Reduction of income poverty through exploiting opportunities in dams such as fishery, often also improves access to education, health services, and clean water, which are vital components of SDGs.

However, despite government enormous investment in construction of dams for these purposes and various intervention policies to stem the tide of poverty and food insecurity amongst farming household, there is scanty study on impact of Shiroro dam on food security and poverty status fisher folks in the study area. In addition, past empirical studies on impacts of Shiroro dam on food security and poverty failed to examine the causal effect using PSM and LATE models and duo established an appropriate counterfactual situation that could facilitate the true identification of the causes of effect and eliminate prejudice of pseudo impact or at worst overestimated or underestimated change. It is against this background that this work is intended to examine the impact of Shiroro dam project on food security and poverty alleviation of rural fisherfolks in north central region of Nigeria.

Justification of the Study

Rivers provide huge potential for increasing fish production. This study provided the valuable benchmark information to the existing knowledge about the food security and poverty status of rural farm households in the study area. The outcome of this research work would be benefit to the policy makers and help future researchers in the field since the study made contributions on the subject matter upon which further research work can be done in the future. It is envisaged that the results of the study will contribute in the design of appropriate food security strategy policies for fisher folks to enhance their productive capacity hence alleviate their poverty status.

Methodology

Study Area

This study was conducted in North central region: Kwara and Niger States, Nigeria. Specifically,the populations of Shiroro andMuyaLGAs are projected in 2020 to be 322,918 and 141,767 people respectively using 3.2% growth rate (NPC, 2006).The climate, edaphic features and hydrology of the state allows sufficient opportunities for harvesting fresh water fish such as Alestesspp, Bagrusspp, Clariasspp, Gymnarchus niloticus, Heterotisspp, Labeospp, Mormysusspp, Latesniloticus, and permit the cultivation of most of Nigeria's staple crops such asmaize, yam, rice, millet and sorghum.

Niger State is located between Latitude 80 22' N and 110 30' N and Longitude 30 30' N and 70 20' E and covers a land area of about 74,244 sq. km, or about 8 % of Nigeria's total land area. The Shiroro hydropower reservoir is a storage based hydroelectric facility located in Niger State at the Shiroro Gorge with approximately between Latitude 90 46' 35 and 100 08' 36N and Longitude 6050' 51and 6053' 14N. It is located approximately 90 km southwest of Kaduna on River Dinya. The facility has an installed capacity of 600 MW (Kolo, 1996).The reservoir has a surface area of about 320 km2with a maximum length of 32 m and a total storage capacity of 7 billion m3 of water (Usman and Ifabiyi, 2012).About 70 % of inflows into the reservoir are from river Kaduna, with lateral contributions from rivers Dinya, Guni, Sarkin-Pawa, Erena and Muyi. Annual temperature around the reservoir varies between 27 and 35 0C (Abayomiet al., 2015).

Data Collection and Sampling Procedure Primary

Primary data were collected in 2019 fishing season, with the aid of a structured questionnaire and trained field enumerators for the study. Information collected includes: socio-economic characteristics of the fish in households and fishery inputs. Data on food security and poverty including income realized from fishing and household expenditure were also collected.

A multistage sampling procedure was used to obtain the sampled respondents. Two Local Government Areas (LGAs) Shiroro and Muya out of the twenty-five LGAs in Niger state were purposefully selected because of location of Shiroro dam and concentration of fisher-folks in the two LGAs. The list of beneficiary villages was obtained and 12 villages out of 31 villages were randomly selected through balloting, totaling 363 fisher folks. On the other hand, 267 fisher folks who are non-beneficiaries of Shiroro dam fishery expedition but engage in non-dam fishing nearby communities in Kwara state with similar socio-economic characteristics were randomly selected. These were selected from a sample frame of 962 fisher folks (Oladimeji, 2018) as counterfactual to examine the impact of the dam on food security and poverty status of the fisher folks. The selection of counterfactual also fulfills the selection criteria of likely distance of 60 – 70 miles between the two points and share similar socio economic characteristics and even language (Bradbury, & Bradbury, 2008).

Analytical Tools

Descriptive statistics, Foster, Greer and Thorbeecke (FGT) index and, the propensity score matching (PSM) and Local Average Treatment Effect (LATE) models were used to achieve the aims of the study. The cost-of-calorie index method as employed by World Food Programme, (2015) and Idi *et al.* (2019) was used to determine food insecurity line. The method yielded a threshold value that is usually close to the minimum calorie requirement for human survival of 22600 Kcal (FAO, 2008). Two steps, identification and aggregation, were involved in constructing the index. Following from above, the food insecurity line is given as

$$lnX = a + bC \quad \text{......................................(1)}$$

Where X is the adult equivalent food expenditure and C is the actual calorie consumption per adult equivalent in a household. The recommended minimum daily calorie requirement per adult equivalent is 22600 kcal and this was used to determine the food insecurity line, using the equation:

$$S = e^{(a+bL)} \quad \text{...(2)}$$

Where: S = cost of buying the minimum calorie intake (food security line),
a = intercept b = slope, L = recommended minimum daily energy (calorie) level 2260 Kcal (FAO, 2008). Based on the S calculated, households were classified into 4 strata depending on which side of the line they fall (World Food Programme, 2015). The FGT (1984) poverty index was used to determine poverty status among the fisher folks. It is generally given as:

$$p_{ai} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^{a} \quad \text{....................................(3)}$$

(Adopted from Olorunsanya, 2009, Oladimeji *et al.,* 2018)

Where: P = FGT index, n = total number of respondents, q = number of fisher folks below the poverty line, yi = per capita household expenditure / income of the fisher folks, z = the poverty line, α is a non-negative poverty aversion parameter decomposed into three indicators: - prevalence of poverty (P_0), poverty depth (P_1) and severity of poverty (P_2). From the mean of per capita household expenditure / income, poverty line was drawn as two thirds of the mean per capita household income.

The results of poverty measures were tested for robustness to the changes in the estimated poverty line with the use of stochastic dominance. The estimated poverty line, 2/3 of mean per adult equivalent income obtained from the survey was varied at interval of 15 % following Olorunsanya, 2011, Oladimeji *et al.,* 2018 analysis. The impact of Shiroro dam project on the food security and poverty status of fisher folks were achieved using the propensity score matching (PSM) and Local Average Treatment Effect (LATE) models. It entails computation using either Probit or Logit regression models. Thus:

$$P(Xi) = Pr(Z= / |Xi) \quad (4)$$

(Adopted from Idi et al., 2019)

Where Z denotes participation indicator equaling 1 if the individual fisherfolks participates, and 0 otherwise, p(Xi) is a consistent estimate of the propensity score evaluated at Xi while Xi were the variables used for the matching. Pr score was estimated in the first stage and computed for each fisherfolks, the actual matching was carried out after P score was computed. To examine this causal effect of beneficiaries of Shiroro damon food security and poverty status by fisherfolks, the matching approach was employed. The estimated propensity scores are then used to estimate the Average Treatment Effect on the Treated (ATT)whichisthe parameter of interest as

$$\delta \equiv E\{Y_i^1 - Y_i^0 / D_i = 1\} = E\{E\{Y_i^1 / D_i = 1, P(Z_i)\} - E\{Y_i^0 / D_i = 0, P(Z_1)\} / D_i = 1\}. \quad | \quad (5)$$

Adopted from Idi et al., 2019)

Where: Y_i and Y_ii are the potential outcomes (food security and poverty status) in the two counter factual situations of receiving treatment (Shiroro dam fisher folks) and no treatment(non-participant).Where: P (Z_i) is the P-Score, Y_i and Y_iiare the Shiroro dam fisherfolks beneficiaries and non-beneficiaries respectively in the two counterfactual situations of receiving treatment (fisherfolks income benefit from Shiroro dam and non-treatment (non-beneficiaries of Shiroro dam.

Furthermore, Hünermund and Czarnitzki, (2016) adopted from Imbens and Angrist (1994), opined that Local Average Treatment Effect (LATE) estimator could be used to remedied the noncompliance problems experienced in estimation of the average treatment effect (ATE) for the population. LATE estimation was achieved using equation 6 below:

$$E[Y^1 - Y^0 \mid T = C] = \frac{E[Y \mid Z = 1] - E[Y \mid Z = 0]}{E[D \mid Z = 1] - E[D \mid Z = 0]} \quad \text{..........(6)}$$

T-statistics was used to determine the hypotheses that state that Shiroro dam project had no impact on food security and poverty status of fisher folks. This was achieved to test whether there is significant difference between returns (income) between Shiroro dam and control fisher folks. The formula is given by:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \quad \text{..............................(7)}$$

(Adopted from Oladimeji *et al.,* 2016)

Where: X1 = average return from fisheries for Shiroro beneficiaries' fisherfolks (N) X2 = average return from non- beneficiaries' fisherfolks (N), variance from return of beneficiaries, variance for return from non-beneficiaries, n1and n2 = sample size of beneficiaries and non-beneficiaries fisherfolks.

Results and Discussion

Socio-economics and Production Data used in Regression Model

The descriptive statistics of variables used in regression model is reported in Table 1. The results indicate that majority of Shiroro dam fisher folks (SDF) beneficiaries are male (93.39 %), married (86.78 %) with mean age and fishing experience of 45 and 24 years and standard deviation of 2.9 and 4.0 years respectively. However, access to credit among SDF had a mean of about ₦63,000 and only 17.08 % of the fisher folks could access credit from both formal and informal sources. In addition, only 21.77 and 11.57 % of these respondents had at least secondary education and extension contact respectively. It is pertinent to note that half of SDF beneficiaries (49.31 %) had no formal education. This has implication in the fisher folks' ability to understanding some logistics of fishery management which would obviously be lower compared to those that have formal education. However, a higher level of educational attainment may discourage some artisanal folks from participating actively in artisanal fishing operation.

Table 1: Distributions of the variables used in regression model

Variable		Shiroro fisherfolks n=363			Controlfisherfolks n=267		
		%	±stdev	min: max	%	±stdev	min: max
Gender (dummy)	Male	93.39	-		97.75		
	Female	6.61			2.25		
Marital status	Married	86.78			77.9		
	Single	10.19			17.6		
	others	3.03			4.49		
Age (years)	18 - 30	18.46	45±2.9	18 (81)	10.86	51±7.09	20 (75)
	31 - 40	32.78			35.58		
	41 - 50	28.37			31.09		
	51 - 60	13.5			15.36		
	>60	6.89			7.12		
Education (years)	Nil	49.31	5.1±1.7	0 (15)	24.34	7.9±3.21	0 (15)
	Primary	28.93			41.57		
	Secondary	17.91			21.72		
	Tertiary	3.86			12.36		
Fishing	1-5	14.88	24.9±4	2(59)	5.99	21±2.32	3(65)
Experience (yrs)	6-10	20.11			34.83		
	11-15	27.82			47.57		
	>15	37.19			11.61		
Household size	1-5	16.25	6±1.7	3(27)	25.84	11±2.2	4(31)
	6-10	22.87			36.33		
	11-15	39.39			27.72		
	>15	21.49			10.11		
Extension contact	No contact	88.43		0(3)	97.00	2.3±0.8	0(5)
	Contact	11.57			3.00		
Volume of credit	access	17.08	63±8.9	10(500)	13.48	37±9.4	0 (48)
obtained ('000₦)	No access	82.92			86.52		
Livelihood	Fishery only	73.30			48.31		
	+ crop farm	14.17			23.22		
	+livestock	6.81			13.48		
	Others	5.72			14.98		

Source: Field Survey, 2019,*Note: X= mean, stdev: st deviation, min: minimum and max: maximum*

By the same token, the bulk of non-beneficiaries fisher folks (NBF) were also male (97.75%); 77.9 % were married with mean age and fishing experience of 51 and 21 years respectively. The findings is in agreement with study of Oladimeji (2018) who noted that majority of fisher folks in north central and north western Nigeria are less educated, virtually had no access to formal credit and extension contacts but in their productive age.

The result of dominance indicators of production inputs in Table 2 indicated that the sampled SDF beneficiaries used mostly motorized canoe (69.55), possessed improved fishing nets (75.8 %) and 65 % imbibed outboard engine. The results is compared with NBF with majority using paddle canoe (78.6 %), improvised manual outboard engine and fishing nets. The NBF beneficiaries relied mostly on loglines and traps, artificial baits and source local materials to make their fishery accessories with no access to training. The production factors cum socio-economic characteristics as well as access to SDF programme and trainings could be major catalyst that enhances more fish caught among SDF compared with NBF.

Table 2: Dominance indicators of production variables

	Shiroro dam fisherfolks	Controlfisherfolks
Variable	Dominance indicator	Dominance indicator
Canoes type	69.5% used motorized	78.6% used paddle canoe
* Fishing gears (m)	75.8 possessed improved fishing nets	64% used loglines & traps
Outboard engine (Hp)	65% imbibed outboard engine	78% improvised manually
* * Accessories	78% used improved fishery accessory	83% embraced local accessory
Accessibility to dam	100% have access to dam	100 % did not have access
Training	89% have access to training	73% have no access to training

Source:Field survey, 2019;* improved fishing gears *include cast nets; drift nets; gill nets, beach and seine,** * *improved fishery a ccessories & tech nology include hanging ratios, modes of capture, net materials; time/trips practices and type of baits used*

Level of Food Security among the Rural Fish Farming Households

It is germane to examine food security status SDF and NBF as demonstrated in Table 3. The calorie intake shortfalls are estimated based on the nutritional threshold level (2260 Kcals/day/adult) with cost implication of ₦540.95 /day/adult. The level of food insecurity according to Fashina (2019), measures the calorie consumption directly by categorizing the degree of severity of food insecurity. Thus, based on the level of food security, about 203 (56%) of SDF beneficiaries were food secure while only one quarter (25%) of NBF were food secure.

Table 3: Food security status and cost implications of SDF and NBF

Food security status	**Calorie consumption / fisherfolk / day**	**Cost Implication of Kcal (₦)**	**Shiroro Fisherfolks**		**Control Fisherfolks**	
			F	**%**	**F**	**%**
Food secure	Above 2260 Kcals	540.95	203	55.92	67	25.09
Marginally fi	Between 1800 & 2260	475.09	104	28.65	78	29.21
Moderately fi	Between 1500 & 1800	345.05	31	8.54	89	33.33
Severely fi	Below 1500 Kcals	<345.05	25	6.89	33	12.36
Total			**363**	**100**	267	100

Note: fi denote food insecure, Adopted fromMeseret (2012), World Food Programme, (2015), Idi et al.(2019). The cost implication is author initiative

Although, these category of respondents show zero or minimal evidence of food insecurity, it is evidence from the result that fisher folks that benefit from the dam are less food insecure as only 15.43% are either moderately food insecure (8.54%) or severely food insecure (6.89%). This is compared to 45.69% NBF who either fall to moderately food insecure (33.33%) or 12.36% that are severely food insecure.

Poverty Status of Shiroro Dam and Control fisherfolks

The poverty status among the SD and NB fisherfolks were analyzed using FGT indices and presented in Table 4. The result revealed that the mean fisherfolk's monthly per capita income (MCI)of SDF beneficiaries and NB were₦20.986.7 and ₦15,009.0respectively with FAO recommended of $1.9 per adult per day. The result showed that the poverty incidence for the SDF and NB (MCI approach) was 0.281 and 0.491 implying that 28% and 49% of the SDF and NBF respectively were poor. The poverty depth was 0.141 and 0.246 representing 14.1% and 24.6% respectively for SDF and NBF whose average monthly per capita income was below the poverty line. This gap represents the percentage of income required to bring poor households below the poverty line up to the poverty line. It can be inferred that poverty was more prevalent and severe among NB compared to SDF.

Table 4: Poverty status of Shiroro dam and control fisherfolks per month

	Shiroro dam fisherfolks		Non participants fisherfolks	
Parameters	**M / CI[a]**	**$1.9 / day[a]**	**M / CI[b]**	**$1.9 / day[b]**
Non-poor	0.719	0.705	0.509	0.40.82
Poor	0.281	0.295	0.491	0.518
Poverty indices				
Poverty incidence (P_0)	0.281	0.295	0.491	0.518
Poverty gap (P_1)	0.141	0.148	0.246	0.259
Poverty severity (P_2)	0.006	0.006	0.030	0.035
Mean / capita income (m/ci)	20986.7	-	15,009.0	-
Poverty threshold 2/3 of MPI	13991.1	-	10,006.0	-
Poverty threshold 1.9 USD		₦20,790		₦20,790
2/ 3Poverty threshold 1.9 USD		₦13,860		₦13,860
t-value (M / CI[a] X M / CI[b])	2.33**			
t-value ($1.9 / day[a] X $1.9 day[b])	2.01**			

Source: Field Survey, 2019,*Note: $1.9 (USD) equivalent* ₦693 *in 2019, M / CI denote mean per capita income, ** denote statistically significant at 5%*

Impact of Shiroro Dam on Food Security and Poverty Status of Fisher folks

The impact of Shiroro dam on fisher folks' food security and poverty status were achieved through Propensity Score Matching (PSM) and Local Average Treatment Effect (LATE) model. The two analytical tools concurrently tackled the problem of selection bias and particularly non-compliance or problem of endogeneity.

Table 5: Comparison between NN, R and K algorithms using fisherfolks' income

Algorithms by matching	T-value	Rubin's B	Rubin's R
Nearest neighbor (NN)	7.09	14.42	1.16
Radius (R)	6.74	17.00	1.42
Kernel (K)	6.85	24.98	1.04
PSM Diagnostic statistics			
Observation	630		
Mean	0.390		
Standard deviation	0.098		
Minimum	0.0042		
Maximum	1.0000		

Source: Field Survey, 2019,

For propensity score, three algorithms matching were used to match the socio-economic characteristics between SDF and NBF based on the t-value, Rubin B and Rubin R in Table 5. These are the Nearest Neighbor Matching (NNM), the Radius Matching (RM) and the Kernel Matching (KM). According to the three algorithms, the difference in means of the socio-economic characteristics between the SDF and NBF is completely eliminated based on the statistically significant t-value at 1% level of probability. In terms of the Rubin's, the three algorithm is less than 25% which implies that the three were effective in balancing the covariates across SDF and NBF based on the Rubin's B criterion. However, in terms the Rubin's R, it can be said that all the 3 algorithms were effective in balancing the covariates across the treated and control groups. Overall, it can be concluded that the NNM is the best algorithm for the estimation of the impact of dam utilization on food security and poverty status.

Propensity scores were obtained through Logit regression model and fisherfolks involved in the Shiroro dam were matched on the basis of the proximity of their propensity scores of beneficiaries to the fisherfolks in the counterfactual using individual socio-economic characteristics to form matched pairs of observational similar individual characteristics (Table 6). All other fisherfolks whose propensity scores for involvement in Shiroro dam fishing were different from the range of scores for the Shiroro fisherfolks were dropped from the analysis.

Table 6: Maximum likelihood estimates of the propensity score for Shiroro dam

Variable	.	**SE**	**T-value**	**P > /Z/**	Marginal effect
Constant	-1.087	-0.359	-3.03	0.000	0.0965
Age	0.321	0.164	1.96	0.059	0.0063
Marital status	0.087	0.105	0.83	0.521	0.0732
Household size	- 0.390	0.188	-2.08	0.036	-04210
Cooperative	0.457	0.427	1.07	0.347	0.127
Education	0.521	0.521	1.00	0.357	0.0086
Credit	- 0.076	0.019	-3.91	0.000	-0.07231
LGA (dummy)	0.342	0.195	1.75	0.072	0.214
LR Chi^2 (7)	73.09				
Prob $>$ chi^2	0.000				
Pseudo R^2	0.324				
Wald test	0.087				
Observations	630				

Source: Field Survey, 2019,Note: *** P<0.01 and **<0.05 levels of probability.

Impact of Shiroro Dam Utilization on Food Security of Fisherfolks

Table 7 shows the impact of Shiroro dam utilization on food security of fisherfolks. The result revealed that the average Kcals, a proxy for food security, of the SDF beneficiaries was 1.602 units and the difference was statistically significant at 1% level of probability. This means that on the average, if the level of the Kcals consumed were retained by the SDF, they would be able to supply adequate calories to meet the recommended energy requirements of 2260 Kcals per person per day by 160%. Therefore, an involvement in Shiroro dam fishing will lead to a corresponding increase in Kcals consumed by 0.403 units. It could be inferred that the average impact estimation shows that Shiroro dam utilization by fisherfolks had a significant and positive impact on their food security.

The Treatment Effect on the Treated (ATT) on the average had a positive impact, statistically significant at 1% and increases food security (Kcals) of the SDF by 0.803 units or 42.49%.It could also be concluded that utilizing Shiroro dam for fishing impacted positively on the SDF by 0.803 units. The Average Effect of the Treatment (ATE) for SDF beneficiaries' fisherfolk' sincrease by 0.043 units compared to the treated fisherfolks. The Treatment Effect on the Untreated (ATU) was estimated by matching a similar treated fisherfolk to each non-treated household. The result showed that ATU had a significant (P<0.01) and positive coefficient of 0.083 units impact on food security, this is the counter factual outcome of the treated had it been they were not treated.

The LATE estimate was carried out for food security using WALD estimator proposed by Imbens and Angrist (1994).The LATE estimate was statistically significant and showed that engaging in Shiroro dam utilization will lead to 0.092 units increase in Kcals. Heckman et al. (1997), Hunermund and Czarnitzki (2016), Idi et al. (2019) obtained similar results using propensity score matching and LATE estimate in their various studies on impact.

Table 7: Average treatment effect on the treated of Shiroro utilization on food security among fisherfolks

Estimation by	Sample	Treated	Control	β	SE	T-statistics
Food security	Unmatched	1.602	1.199	0.403	0.076	5.30
	ATT	1.890	1.087	0.803	0.323	2.49
	ATU	1.384	1.467	-0.083	0.029	-2.86
	ATE			0.043		
WALD Chi^2 test				0.092	0.035	2.63
Participant versus				1.602	0.624	2.57
Non-participant				1.199	0.521	2.30
Observed diff.				0.403	0.182	2.21

Source: Field Survey, 2019,*Note: ***P<0.01 and **P<0.05 level of probability. NNM=Nearest Neighbor Matching, M=Radius Matching and KM=Kernel Matching. Standard errors in parentheses*

Similarly, Table 8 shows the impact of Shiroro dam utilization on poverty status of fisherfolks. The result revealed that the expenditureincurred by SDF beneficiaries was 10.870 units and the difference was statistically significant at 1% level of probability. The Treatment Effect on the Treated (ATT) on the average had a positive impact, statistically significant at 1% and increases income of the SDF by 0.602 units.The Treatment

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Table 8: Impact of Shiroro dam on fisherfolks' Expenditure (a proxy for poverty)

Estimation by	Sample	Treated	Control	β	SE	T-statistics
Fisherfolks'	Unmatched	10.870	10.027	0.843	0.256	3.29***
Expenditure ('000₦)	ATT	11.598	10.996	0.602	0.199	3.03***
/ month	ATU	10.690	10.207	0.483	0.187	2.58***
	ATE			0.432		
WALD Chi^2 test				10.908	1.901	5.74***
Participant versus				10.870	0.897	12.12***
Non-participant				10.027	0.606	16.55***
Observed diff.				0.843	0.375	2.25**

Source: Field Survey, 2019, Note: treated = beneficiaries and control = non-beneficiaries

The LATE estimate was statistically significant and showed that engaging in Shiroro dam utilization will lead to 10.908 units increase in income.

The hypothesis, which stated that Shiroro dam utilization has no impact on food security, fishery income and expenditure of the beneficiaries in the study area, was conducted using T-test (Table 9). Fisherfolks' food security involved in Shiroro dam utilization (treated) after matching was 3,091.5 Kcal/fisherfolk/day while that of fisherfolks who were not involved in the dam utilization (control) was 1,990.5 Kcal/ fisherfolk/day. This signifies that the impact of Shiroro dam utilization on food security (ATT) was 1,101.0 Kcal/fisherfolk/day. This was statistically significant at 1 % level of probability. This implies that the null hypothesis, which states that Shiroro dam utilization has no impact on food security of the beneficiaries in the study area was rejected at 1 % level of probability.Similarly, the hypotheses, which stated that Shiroro dam utilization, have no impact on either income or expenditure of beneficiaries was also rejected. This is because the difference between the income (₦26,370.50) and expenditure (₦34,559.20) were statistically significant at 1% level of probability.

Table 9: T-test of the Impact of Dam Utilization on Food Securityand Poverty Status of Beneficiaries

Variable	Treated	Controls	ATT	SE	T-stat
Food security (Kcal/person/day)	3,091.5	1,990.5	1,101.0	521.0	2.11**
Poverty: income proxy (₦) /yr	65,900.5	39,530	26,370.50	11,227	2.35**
Poverty: expenditure (₦)/year	69,007.2	34,448	34,559.20	9,007	3.84***

Source: Field Survey, 2019, Note: *** & ** denote statistically significant at 1 & 5 % respectively. ATT = Average Treatment Effect on the Treated.

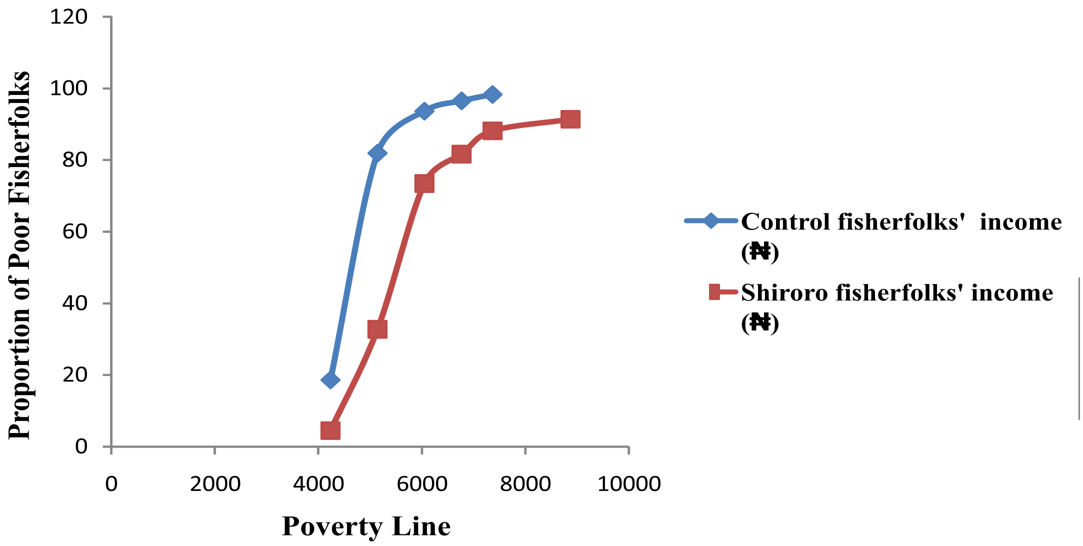
Table 10 depicts ATT of Shiroro dam utilization on poverty alleviation among fisher folks by socio-economic characteristics using the three algorithms.

Socio-economic characteristics	**Shiroro dam X Control fisherfolks**		
Impact by	**NNM**	**RM**	**KM**
fishery livelihood	0.543***	0.461**	0.681*
(₦)	0.209	0.215	0.364
credit accessed ('000₦)	111.12	1167.03	1169.47
	147.27	938.00	1039.03
Fishery investment ('00₦)	11043.90***	1873.31***	1900.26***
	401.64	399.07	456.73
fishing trips (number)	5.09***	6.08**	6.72***
	2.07	2.71	2.00
fish caught (kg)	997.04*	432.90*	452.74*
	532.05	233.00	233.00

Source: Field Survey, 2019, *Note: ***, **, *denote statistically significant at 1, 5 and 10 % level of probability. Standard errors in parentheses*

The results indicated that the impact of Shiroro dam on fishery livelihood, fishery investment, fishing trips and fish caught were positive and statistically significant at different level of probability except the amount of credit accessed. This implies that these variables significantly affect the involvement in Shiroro dam utilization in line with Idi et al. (2019).

The result of decomposition of poverty based on fishery income earned in Table 9 was reinforcing in Fig. 1. The Cumulative Distribution Function (CDF) of fisher folks that utilize the dam for fishery activities lay completely above fisher folks that had no access to the dam.



Source: Data Analysis, 2019,

Figure 1: Distribution of Dominance Analysis by Income Earning

This gave an indication of presence of stochastic dominance, meaning that this sub-group of fisherfolks who are not benefitting from the dam will always be poorer than their counterparts. It further implies that the head count ratio was robust to all possible choices of poverty lines within the specified range. Therefore, rural households that utilize Shiroro dam for fishery activities will always maintain a better standard of living compared to non-beneficiaries fisherfolks. The result is comparable with study of Idi et al. (2019) on impact of microcredit utilization on maize output and food security in Kaduna State, Nigeria.

Critical Issues and a Priori Expectations

Marmulla, (2001); Jackson and Marmulla, (2001), McCartney et al. (2018) established that construction of dam may contribute to decline in fish population through a number of factors. These include blocking or delaying upstream fish migration, difficult in fish passage through hydraulic turbines or over spillways, habitat loss or alteration, discharge modifications, changes in water quality and temperature, increased predation pressure, as well as delays in migration caused by dams among others. This may invariably reduce the fisherfolks' catch and harvest from the river. However, despite all these odds, this study showed that treated fisherfolks (SDF) thrived better than control fisherfolks in fish caught contrary to a priori expectation. It should be noted that SDF employed river diversion for private pond (aquaculture) to stock fry or fingerlings among other measures, which was computed as part of income from Shiroro dam fishery activities.

Conclusion and Recommendations

The study examined impact of Shiroro dam project on food security and poverty status of rural fisherfolks in north central region of Nigeria. The results showed significant positive impacts of fishing in Shiroro dam project. The more fisherfolks operate in Shiroro dam fishing, the more they are food secure and the higher their income and invariably reduce poverty level. There is need to integrate fish production both capture fisheries and aquaculture into dam construction and associated water management systems to increase their food security and poverty alleviation. Special attention should also be given to fisheries in dam construction to cater for technical design that will enhance fish survival and accommodate more fisherfolks. The need for drafting legal instruments, which will facilitate modification of dam structures to incorporate mitigation measures and help altering dam operation rules to be more beneficial to fish biodiversity and fisheries, is recommended.

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