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Determinants of livelihood strategies of fishing households in the volta Basin, Ghana

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Abstract: The main objective of this study is to identify livelihood strategies of fishing households in response to prevalent vulnerabilities they face within the Volta Basin. Questionnaires were administered to fishery households in the Basin using the multistage sampling technique. A non-hierarchical k-means cluster analysis partitioned the households into four livelihood strategies on which the multinomial logit regression was performed. These four identified strategies are fishery only, fishery and farming, fishery and non-farm, and fishery, non-farming and farming. The results from the multinomial logit regression revealed that marital status of head of household, number of months of food shortage experienced by a household per year, access to credit, access to extension services, distance to regular markets and district capital as well as experience in fishery were the major determinants of livelihood strategies. Implications for policy include the need for public extension services and training to invigorate fishery households' income. As majority of the fishery households combined fishing and non-fishing strategies, livelihood intervention programmes should prioritize improvement of the non-fishing activities and lead to opening other opportunities for rural development. This will take pressure off the fish stock by facilitating the regeneration of fish stock.

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PUBLIC INTEREST STATEMENT

The major dams in Ghana have contributed in many ways to the social and economic development of inhabitants, but the resultant changes in the environment have led to losses of livelihoods. After five decades of existence of the first of these dams, this article describes the types and factors that have influenced livelihood strategies adopted by households in response to changes made to the original Volta River. The results show that many of the households combined fishing and non-fishing approaches for survival. The decision on what approach to choose was determined by variables such as marital status of head of household, number of months of food shortage experienced by a household per year, access to credit, access to extension services, distances to regular markets and district capital and number of years spent fishing. An appreciation of these variables could assist to guide future interventions and policies to construct dams on rivers.

Subjects: Agricultural Development; Agricultural Economics; Fisheries Science

Keywords: volta Basin; cluster analysis; k-means; livelihood strategy; diversification

1. Introduction

Diverse livelihood portfolios are often viewed as an essential part of household economies in developing countries, especially rural economies. The relationship between fishing and livelihood diversification is important because fishing is an important component of rural livelihoods of households in the coastal areas. The Big Numbers Project (BNP) (2008) estimate that between 93 and 97 million of rural households in developing countries are either directly or indirectly involved in fishing or are into the processing and marketing of small-scale fisheries. Fishing is a highly gender-segregated profession, with men catching fresh fish, and women processing fish (Britwum, 2009). Despite the importance of fishery to the rural economy, steady increases in the number of rivers being dammed have been reported to affect the aquatic ecosystems that provide important environmental and socioeconomic benefits (Liu et al., 2013). Analyzing the role of natural resource-based occupational changes along the spectra of socioeconomic and infrastructure development in coastal communities in East African, Cinner and Bodin (2010) suggest that increases in household-level specialization in most occupational sectors, including fishing and farming. Cinner and Bodin (2010), further reported that at the community-level, rural coastal economies have diversified due to infrastructural and developmental changes. According to Prado, Seixas, and Berkes (2015), many coastal communities in developing countries have been going through complex dynamics of change relating to the degradation of ecosystems and changing government policies. Many of these policies severe consequences on the livelihood strategies of coastal residents.

Prior to the construction of the dam on the Volta River in Ghana, Volta River supported substantial local fishery especially in the Lower Volta Area. The Volta basin, as an ecosystem, functioned primarily for food production, supporting fishery, flood protection, water infiltration and groundwater recharge. An economic assessment by Lawson in 1963 showed that an estimated 1500 to 2000 women were involved in clam picking along the river between Tefle and Torgome. These women were earning an average income of approximately £100,000.00 (1963 British Pounds) annually (Lawson, 1968). However, the damming of the Volta River has led to the alterations of the livelihood strategy and income of coastal households. This has negatively affected inhabitants of the riparian communities in Ghana and their livelihoods. Shepherd, Kessy, Higgins, Scott, and Luvanda (2011) stated that the capacity to diversify livelihoods and income sources under such situations has become crucial for the survival of households. The postconstruction habitat modifications and resource decline started after the coming to being of the Akosombo dam but worsened upon the formation of the Kpong dam. This manifesting changes in the ecosystems of the Lower Volta Area as diminished income of households and lead to losses of livelihood opportunities.

The construction of these two dams have led to activities such as fuelwood harvesting, charcoal burning (Tonah, 2008), palm wine tapping, local gin distilling, mat weaving, sand winning (Obour, Owusu, Agyeman, Ahenkan, & Madrid, 2016) and stone quarrying in the Volta basin. These activities are extractive in nature and depended on locally available resources. The intensity of the exploitation of these extractive resources has raised questions of sustainability and resilience of livelihood strategies as they expose future generations to significant ecological risks and scarcities (Tonah, 2008; Tsikata, 2005). In the context of the Volta basin in Ghana, the overdependence on fishing as a source of livelihood was fast depleting the natural resource and deepening poverty (Asante, 2006). Fabio et al. (2003a, 2003b) diagnostic study on the poverty profiling and the diversification strategies of households in the Volta Basin is the only studies on the entire international Volta Basin of Ghana.

Within the interplay of the ecological changes occasioned by the creation of these two dams and its attendant livelihood losses, the pertinent questions worth asking are;

- Which sustainable livelihood strategies have evolved among fishery households?
- What principal factors influence the choice of those strategies?

The broad objective of this paper, therefore, is to examine the livelihood strategies of fishery households within the Volta Basin in Ghana. The specific objectives are:

- To identify the major livelihood strategies adopted by fishery households;
- To examine the determinants of the choices of fishery households livelihood strategies.

The remainder of the paper proceeds as follows: the next section discusses theoretical and empirical literature on livelihood diversification. This is followed by a narration of the sampling technique, study areas, data collection and analytical methods adopted. Section three is a presentation of the detail results gathered from the analyzed data. The discussions of the results with reference to the literature presented are also made in this section. The last section of the study presents the conclusions and recommendations of the study.

2. Brief literature review

While empirical studies on diversification may be widely applicable in the economic and socio-cultural contexts, results from empirical studies differed between the different regions of the world. In spite of this, it is generally agreed in the empirical literature that the purpose of diversification is to develop portfolios of income generating activities with low covariate risk (Asravor, 2017; Ellis, 2000). The literature also shows that numerous factors affect the diversification strategies of household in agriculture and aquaculture but in a general context, these factors can be categorized into “pull” (positive) or “push” (negative) factors (Brugère, Holvoet, & Allison, 2008; Ellis, 2000). According to Asravor (2017), the pull factors are favorable factors or opportunity-led and leads to diversification of livelihood strategies, whereas push factors are survival-led or harsh conditions that force farm households to diversify their income activities off their main income generating activity.

Empirical studies devoted to the diversification of fishery households are limited as many studies have focused on crop and livestock farmers (Asravor, 2017; Eneyew, 2012). Martin, Lorenzen, and Bunnefeld (2013) examined the relationship between fishing, livelihood diversification and poverty in the lower Mekong basin, in Laos. From their analysis of the household survey data, Martin et al. (2013) found that participation in fishing is common and positively associated with higher occupational diversity and more agricultural activities. Additionally, Martin et al. (2013) reported that alternative livelihoods within the rural setting are unlikely to cause fishers to leave fishery, but instead strengthen the livelihood portfolio as a supplementary activity. Fishing forms a greater proportion of income, employment and food security for the poor in the coastal areas.

Cinner, McClanahan, and Wamukota (2010) posited that household livelihoods in tropical coastal communities are not dependent on a single livelihood strategy but often a multiplicity of occupational sectors, such as agriculture, fisheries, and informal economic activities. These non-fishing and agricultural economic activities include small shops, transportation, and mechanic work among others. To understand the diversification of smallholder farmers’ in Ghana, Asravor (2017) employed the Margalef index of diversification. The results revealed that households had diversified on their farm and in informal economic activities. It also showed that social capital (dependency ratio, marital status), and human capital (extension services) significantly affected the type of diversification strategy practiced.

3. Materials and methods

3.1. Study area

The study was undertaken in selected coastal administrative districts in Ghana. These selected districts are located in the segments labeled LV₁, LV₂ and LV₃ included North, Central and South Tongu, Ada East, Asuogyaman, and Lower Manya (Figure 1). In addition, the Pru district in the Brong Ahafo region, which constitute Stratum VII was also sampled for this study (Figure 1). The characteristic of the study area is presented in Table 1.

3.2. Sampling technique

The multistage sampling technique was employed to sample the fishing households. The Volta Basin encompasses four administrative regions, that is, the Greater Accra, Volta, Eastern regions and Brong Ahafo region. The first stage of the multistage sampling involved the selections of districts in these regions. The districts were purposively selected because they were known to have many communities and households involve in fishery, hence are affected by any activities along the Volta Basins. After purposively selecting these districts, the second stage involved the use of the simple random sampling technique to select the various communities that can be found in these selected districts. To sample these communities, District Assemblies were first contacted for the list of all the communities that fall within each of these districts. At the community level, all the households within each community were numbered. The “sample” command in R was then employed to select households that were administered with the questionnaire. Before the administration of the questionnaire to each household, opinions and community leaders were each informed about the survey and permission were sought. On average 2 h was spent administering the questionnaire to each household. In all, the 802 households were selected for the study.

Figure 1. Study Areas: LV₁, LV₂, LV₃ and the principal strata of the Volta Lake.

Source: CSIR Water Research Institute, Accra

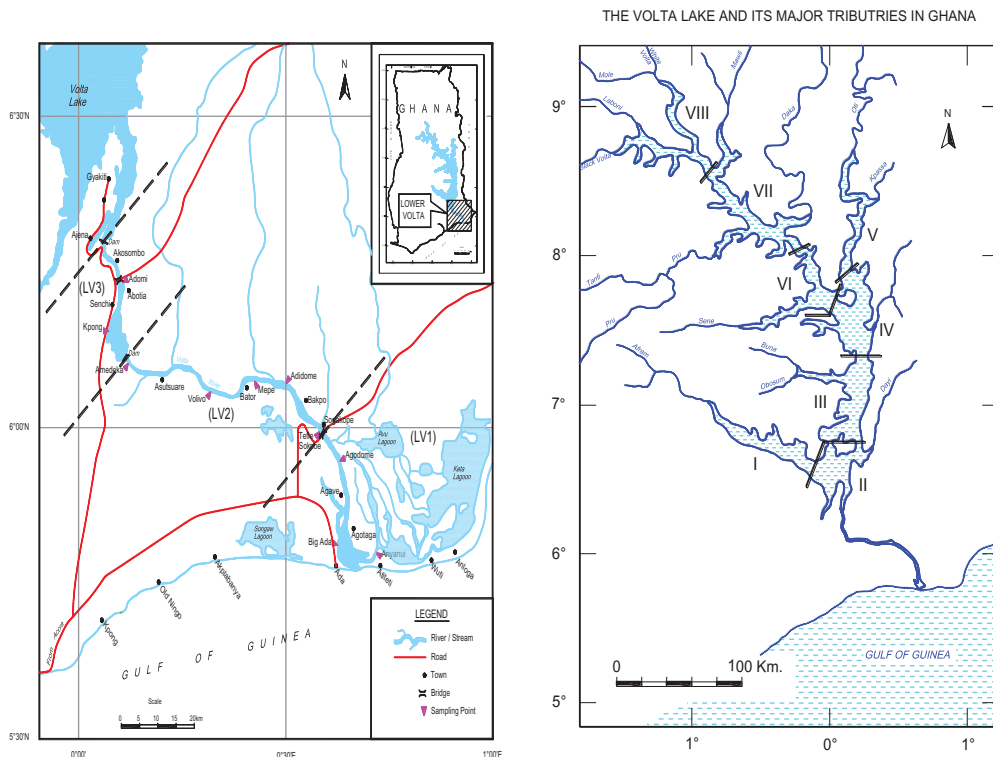


Table 1. Characteristics of the segments of the Volta basin studied

Segment	Characteristics
LV ₁ (Lower Volta Area I)	Formation of sandbar at the estuary limiting inflow of seawater into the river at high tide;
	Reduction of floodplain agriculture;
	Explosion of aquatic weeds that blocked fishing grounds;
	Infestation of creeks, streams and main fishing channels by aquatic weeds;
LV ₂ Lower Volta Area II	Collapse of floodplain farming;
	Cessation of influx of seawater at high tide leading to collapse of shell fish fishery;
	Trapped between the 2 Volta dams;
	Receives limited inflow of seawater;
LV ₃ Lower Volta Area III	Experiences reduced water flow (speed) in the main channel;
	Collapsed flood plain agriculture;
	Weed-choked creeks, streams and main channel limiting extent of fishing;
	Constitutes the most riverine segment of the Volta Lake;
Stratum VII	Under the influence of large inflows thus, providing large volumes of water and fish;
	Constitutes the hub of fishery on the Volta Lake;
	Benefited from a number of national and international interventions aimed at improving livelihoods of households

Sources: Institute of Aquatic Biology [IAB] (1995); Petr (1974); Fisheries Department (1995) and Henle and Eckert (1970); FAO (2008).

3.3. Data collection

A total of 802 household heads constituted the respondents from which data was obtained through the administration of a structured pretested set of questionnaires from July 2015 to December 2015 in the study area. However, after data cleaning, during which nonresponses and unrelated feedbacks were eliminated, 715 respondents became the sample on which the analysis was based.¹

3.4. Estimated model

In this study, analytical technique and model utilized are presented in this section. The analytical technique employed to measure the diversification strategies of the fishery households was the k-means while the multinomial logit model was used to examine the determinants of the fishery household diversification strategies.

3.4.1. Diversification measure

The income-based approach is the main basis for the analysis of identifying household livelihood strategies (Barrett, Bezuneh, Clay, & Reardon, 2005; Brown, Stephens, Ouma, Murithi, & Barrett, 2006). Specifically, the k-means Cluster Analysis procedure was employed in this study. The k-means approach used the Euclidean measure to determine dissimilarities, that is, the distance between the final cluster points. It further assigned each observation (x_i) to only one cluster (Marzban & Sandgate, 2005). Thus, more succinctly, given a set of observation ($x_1, x_2, \dots, x_n$) with each observation being a d -dimensional of a real vector, the purpose of k-means clustering is to partition the sampled observations (n) into k ($\leq n$) sets $f = (f_1, f_2, \dots, f_k)$ in order to minimize the variance or within-cluster sum of squares (WCSS). Thus, the within-cluster is written as:

$$\arg_f \min \sum_{i=1}^k \sum_{x \in f_i} \|x - \mu_i\|^2 = \arg_f \min \sum_{i=1}^k |f_i| \text{Var } f_i \quad (1)$$

where the mean of points in f_i is given by μ_i and is equivalent to the minimization of the pairwise squared deviations of points in the same cluster:

$$\arg_f \min \sum_{i=1}^k \frac{1}{2|f_i|} \sum_{x, y \in f_i} \|x - y\|^2 \quad (2)$$

Using the identity of equation (3) we deduce the equivalence. From the law of total variance, where the total variance is assumed to be a constant equation (3) and is equivalent to maximizing the sum of squared deviations between points in *different* clusters (between-cluster sum of squares).

$$\sum_{x \in f_i} \|x - \mu_i\|^2 = \sum_{x \neq y \in f} (x - \mu_i)(\mu_i - y) \quad (3)$$

The choice of k-means over the wards and hierarchical clustering approaches was because the k-means approach helped the researcher identify strategies which are “similar” and are “dissimilar” to the other strategies belonging to other clusters. Thus, the k-mean approach enabled the researcher to segregate groups with similar traits (livelihood strategies) and assign them into clusters (strategy). The k-means was used in this study because it is conceptually simple and is computationally fast. According to Kaushik and Mathur (2014), there is no clear evidence that any other clustering algorithm performs better in k-means general as it has the advantage of clustering large data sets with its performance increasing as the number of clusters increases.

3.4.2. Determinant of diversification

To identify the determinants of rural household's decision to engage in various livelihood strategies, the researchers assumed that a rational household would choose among mutually exclusive livelihood strategy alternatives that offered them the maximum utility (Eneyew, 2012; Eneyew & Bekele, 2012). From the random utility argument, fishery households' decision to choose a livelihood strategy is categorized as a function of a set of livelihood strategies. Given the four-

alternative choices (fishery only; fishery and farming; fishery and non-farming; and fishery, farming and non-farming), we applied the multinomial logit model to estimate the livelihood choice with discrete dependent variable.

Given the random utility model (RUM), we assume that the decision-maker (fishers) choose from a set of mutually exclusive alternatives $j = 1, 2, 3, \dots, J$ and obtains a certain level of utility U_{ij} from each alternative. Since we do not observe the decision makers' utility, but observe some attributes of the alternatives faced by households, then the utility is decomposed into deterministic (V_{ij}) and random (ε_{ij}) part:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (4)$$

A fisher selects livelihood strategy $U = 1$ if

$$U_{ik} > U_k \quad (5)$$

Where U_{ik} denotes a random utility associated with the livelihood strategy $j = k$, and V_{ik} is an index function denoting the fishers' average utility linked with this alternative. The second term ε_{ik} is a random error which is specific to a producer's utility preference (McFadden, 1974). The livelihood strategies modeled is stated as:

$$L_{ij} = \beta_j X_{ij} + \varepsilon_{ij} \quad (6)$$

where L_{ij} is a vector of the livelihood choices $j = 1$ for fishery only; 2 for fishery and farming; 3 for fishery and non-farming; and 4 for fishery, farming and non-farming of i^{th} fisher, β_j is a vector of channel-specific parameters. ε_{ij} is the error term assumed to be normally distributed (mean 0 and variance 1) and X_{ij} is a vector of fishers' characteristics.

If we make Y to be the unordered categorical dependent variable that takes on a value of zero or one for each of the J choices, then the general multinomial logit model is given as:

$$\Pr(Y_i = j) = \frac{\exp(\beta_j' X_i)}{\sum_{j=0}^J \exp(\beta_j' X_i)} \text{ for } J = 1, 2, 3 \quad (7)$$

Where:

$\Pr(Y_i = j)$ is the probability of choosing either fishing only, fishing and farming, fishing and non-farming, and fishing, farming and non-farming; j is the number of livelihood activities engaged in; X_i is a vector of explanatory factors conditioning the choice of the j^{th} alternatives; β is a vector of the estimated parameters.

The estimated equations provide a set of probabilities for the $j + 1$ choice restricted for a decision-maker with characteristics. In order to remove an indeterminacy in the model, a convenient normalization that solves the problem is $\beta_0 = 0$. Therefore, one can define the general form of the probability that individual i^{th} choose the alternative j^{th} in the following way:

$$\Pr(Y_i = j/X_i) = \frac{\exp(\beta_j' X_i)}{1 + \sum_{j=0}^J \exp(\beta_j' X_i)} \text{ for all } J > 0 \quad (8)$$

The MNL coefficients are difficult to interpret and associating the β_j with the j outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually used and derived as (Greene, 2003):

$$\theta_j = \frac{\partial P_j}{\partial X_j} = P_j \left[\beta_j - \sum_{j=1}^J P_j \beta_j \right] = P_j [\beta_j - \bar{\beta}] \quad (9)$$

The marginal effects measure the expected change in the probability of a specific outcome being made with respect to a unit change in an explanatory variable (Greene, 2003).

The choice of the multinomial logit model over the ordered logit and the mixed logit or the probit or logit model is because the predictor variables are individual specific, and the choices facing the household are unordered. STATA version 13 was the statistical package used to analyze the data gathered from the survey.

3.5. Definitions of variables

Table 2 presents the definition of variables used in the estimation of the multinomial logit model. In terms of the socioeconomic characteristics of the households, the statistics shows that approximately 79.2% of the household heads were married. The household with the minimum members had the household size of three (3) persons whereas the highest household size was nine (9) persons. The number of dependents within the sampled households ranges from 0 to 8. This is an indication that there were households without any dependent.

The human capitals or assets of the sampled study showed that the average fishing experience of the fishing households in the study area was 21 years while the minimum experience was 9 years and the maximum fishing experience was 33 years. Many of the household heads do not have any formal education (69.4%). The summary of the explanatory variable on agricultural extension services shows that very few of the fisher households had access to agricultural extension service.

Table 2. Socio-demographic and economic characteristics the fishing households

Explanatory variables	Descriptions	
Social capitals/assets:		
Marital status	1 = Married, 0 = otherwise	0.792
Household size	Number of persons in the households	6.0 ± 3.31
Dependency ratio	Level of dependency on household workforce	1.0 ± 0.90
Human capitals/assets:		
Fishing experience (HH)	Years of fishing	21.0 ± 12.43
Formal education (HH)	1 = Formal education, 0 = otherwise	0.694
Extension services	1 = Access to extension service, 0 = otherwise	0.021
Financial capitals/assets:		
Receipt of remittances	1 = Receives remittance, 0 = otherwise	0.07
Access to credit	1 = Access to credit, 0 = otherwise	0.84
Natural capitals/assets		
Fishing seasons	1 = distinct number of fishing seasons, 0 = otherwise	0.161
Food shortage	Number of months of food shortage	3.84 ± 1.13
Physical capitals/assets		
Distance to regular fishing site	Kilometres	2.77 ± 1.94
Distance to regular market	Kilometres	6.54 ± 3.78
Value of fishing assets	Value in Ghana Cedis	5,444.00 ± 4,767.99
Distance to district capital	Kilometres	9.13 ± 4.31

Sources: Authors computation (2016).

The analysis in terms of financial capital or asset showed that most fisher households had access to credit (84%) for their fishing activities. Very few expressed receiving remittances (7%) from household members or relatives leaving in the big cities.

The natural capitals/assets indicated a fishing regime (season) with no distinct number of fishing seasons. An indication that fisher households have an all-year-round fishing activity. On average, three months of food shortage was experience within a year by respondents.

The distance to the regular fishing site, regular market and district capital averaged 2.77, 6.54 and 9.13 km respectively. In addition, physical capital or asset showed that the value of fishing asset owned by the household averaged GHC 5,444.00 but range between 5,444.00 ± 4,767.99.

The continuous variables of all the binary variables reported in Table 2 were also collected during the data collection period. Table 3² shows some of the analysis.

The empty spaces imply that households did not provide the researcher with the needed information. Table 3 shows that on average the entire Volta Basin recorded 3 days of extension visit, an average of GHc100 remittance and GHc120 worth of credits. Table 3 shows that majority of the responding households did not provide details of the amount of money received in the form of remittance or credit. For majority of households visited, these, were not applicable or they could not recall the amount received.

4. Results

4.1. Livelihood strategies

Table 4 presents the livelihood strategies identified through non-hierarchal (k-means) cluster analysis for the Volta Basin, Ghana. The results show that most of the household in the Volta Basin are engaged in fishery and non-farming (56.81%)

The least livelihood diversification strategy identified in this study was fishery and farming (8.20). The farming practices of households are the cultivation of crop and the rearing of livestock and

Table 3. Continuous variables of the Dummy responses

	Volta Basin	LV1	LV2	LV3	Stratum7
Number of extension visit (days)	3			2	1
Average remittances received (GHc)	100		100		
Amount received as credit (GHc)	120				120

²These were dropped by Stata during the course of the analysis, hence we settled on using the dummy responses.

Table 4. Livelihood Strategies identified through Non-hierarchal (k-means) cluster analysis for the Volta Basin, Ghana

Cluster	1	2	3	4
Name of strategy	Fishery only	Fishery and Farming	Fishery and Non-farming	Fishery, Farming and Non-farming
Number of HH	198	56	388	41
% of HH	28.99%	8.20%	56.81%	6.00%

Source: Authors compilation (2016).

poultry birds. The common crops cultivated by these households are maize and cassava while the common livestock reared were sheep, goats and pigs. The main poultry birds kept were chicken while a few kept ducks and guinea fowls. These farming practices were undertaken on smallholder bases, and most farm produce are kept for consumption purposes. There were fewer cases where farm produce was sold in the market for cash.

The non-farm livelihood activities engage in by the households were generally petty trading. Women were mostly involved in the sale of food stuffs and toiletries while men were mainly mechanics and carpenters.

4.2. Choice of livelihood strategy in the volta basin

Table 5. presents the result of the choice of livelihood strategies in the Volta Basin. The result indicated that 14 of the explanatory variables were significant at 1%, 5% and 10% significant levels. Overall, the diagnostics statistics shows that the model was statistically significant at 1% while the pseudo R-square show that 17% of the variation in the dependent variables was explained by the changes in the independent variables.

The base strategy for the determinant of livelihood diversification strategies was fishery, non-farm and farming. Detail results presented in Table 4 show that compared to households in the base category, household heads who were married decreased their participation in fishery only strategy by 19%, whereas married household heads increased their participation in fishery and non-farming strategies by 25%.

The coefficient of household size was positive for fishery and farming. This implies that compared to households in the base category, an increase in household size is more likely to increase the probability of engaging in fishery and farming strategies by 0.8% at the 5% level of significance. The study also reports that compared to the base category having access to credit significantly reduce the participation of households in fishery strategy by 31%.

Table 5 also shows that compared to the base category, an increase in the dependency ratio significantly leads to a 3% reduction in the adoption of fishery and farming strategies. Receipt of remittances from member of the households living outside the community was found to adversely impact in the adoption of fishery plus farming strategies by approximately 7%.

Compared to the base category, an increase in the number of fishing seasons positively affected the participation in fishery only but negatively affected the participation in fishery and non-farming livelihood strategy. Thus, the finding shows that a month increase in the fishing season leads to a 24% increase in the fishery only livelihood strategy and a 24% decrease in fishery plus non-farming livelihood strategy of households in the Volta basin.

The distance to the regular market center and also the distance to the regular fishing site were significant and directly influence the participation in fishery plus farming strategy and fishery plus non-farming strategy by 0.08% and 0.36%, respectively. The availability of extension services had a direct relationship on diversification into fishery plus farming (96%) and fishery plus non-farming plus farming activities (46%).

The finding also shows that compared to the base category, an increase in the value of fishery assets will lead to a decrease in the participation of fishery only as a livelihood diversification strategy but increase the participation in fishery and non-farming livelihood diversification strategy.

5. Discussion

The households studied can be said to be diversified in their livelihood activities. This corresponds with the assertion by Smith, Nguyen Khoa, and Lorenzen (2005) and Martin et al. (2013) that

Table 5. Estimates of choice of livelihood strategy by fishery households of the Volta basin of Ghana

Strategy ³	Fishery only		Fishery and farming		Fishery and non-farming	
	Coefficients	Marginal effects	Coefficients	Marginal effects	Coefficient	Marginal effects
Marital status	1.0592** (0.5227)	-0.1859 (0.0826)**	0.0616 (0.1838)	-0.0322 (0.0454)	1.0592 (0.229)***	0.2471 (0.0686)***
Formal education (HH)	-0.1126 (0.0991)	-0.0350 (0.25838)	-0.0653 (0.2537)	-0.0014 (0.0065)	-0.3781 (0.6021)	-0.1348 (0.0998)
Household size	0.4929*** (0.1834)	-0.2172 (0.31880)	0.1216 (0.0357)***	0.0084 (0.0027)**	0.3252 (0.4030)	0.0115 (0.10377)
Dependency ratio	-0.2289 (0.2519)	-0.1976 (0.2829)	0.3493 (0.1614)*	-0.0269 (0.0124)*	-0.0658 (0.0452)	-0.0826 (0.1218)
Access to credit	15.7478 (4.6684)***	-0.3067 (0.0105)***	0.0136 (0.0924)	-0.3807 (0.2664)	0.0119* (0.0066)	0.0756 (0.1093)
Number of months of food shortage	0.2137 (0.0947)**	-0.0476 (0.0159)**	-0.063 (0.1007)	-0.3058 (0.2553)	-0.0149 (0.0153)	-0.0811 (0.1116)
Receipt of remittances	-0.1977 (0.2887)	-0.0060 (0.0063)	1.3602 (0.6712)*	-0.0668 (0.0214)**	-0.3502 (0.2685)	-0.0146 (0.0334)
Number of fishing seasons	1.1763 (0.3919)**	0.2369 (0.0870)**	0.4355 (0.5911)	0.0063 (0.0087)	1.1763 (0.3952)**	-0.2383 (0.0967)**
Distance to regular fishing site	0.1840 (0.0616)**	-0.0348 (0.0122)**	-0.5003 (0.3885)	-0.0364 (0.0874)	0.1840 (0.0620)**	0.0036 (0.0013)**
Distance to regular market	0.0028 (0.0069)	0.0889 (0.10166)	0.1127 (0.0424)**	0.0084 (0.0016)***	0.0011 (0.0028)	0.0022 (0.0035)
Value of fishing assets	-0.00003 (1.45E-05)*	-7.10e-06 (3.28E-06)*	0.0209 (0.0362)	0.0233 (0.06972)	0.00003 (1.2E-05)**	4.16e-06 (1.27E-06)**
Fishing experience (HH)	-0.031 (0.0123)**	-0.0058 (0.0023)**	-0.0457 (0.0340)	-0.0242 (0.097)	0.0310 (0.0107)**	0.00003 (9.38E-06)**
Distance to district capital	0.1717* (0.0867)	0.0267 (0.01827)	0.0349 (0.0161)*	0.0024 (0.0012)*	0.0058 (0.0354)	-0.1337 (0.0863)
Access to extension services	0.0534 (0.0902)	0.0047 (0.0027)	17.9287 (3.9322)***	0.9617 (0.2136)***	-0.0232 (0.0384)	-0.10777 (0.0860)
Wald Chi ²	3749.54***		3749.54***		248.63***	
Pseudo R ²	0.1702		0.1702		0.1702	
Prob>Chi ² = 0.0000						
Number of observations ⁴ = 683						

Note: The marginal effects are defined by the dy/dx values and ***, **, * are, respectively, significant at <1%, 5% and 10% probability level.

³ The base strategy is Fishery, non-farm and farming.

⁴ Though 715 observations were used for the MLR, some observation were dropped hence 683 observations were used for the final estimation.

specialization in fisheries rarely happens in developing countries and majority of fishery households diversified their livelihood strategy.

Marital status is an important determinant of the diversification behavior of household heads. Marriage is usually accompanied by numerous responsibilities, especially child care and the payment of bills. Household heads will, therefore, diversify their income, hence the decrease in the reliance of fishery only to the diversification into fishery plus non-farming strategy. As indicated by Asravor (2017) farming is seen as a very risky business, hence many farm households diversify their farming activities away from farming by entering into non-farm. Similarly, it could be that the households studied were avoiding the riskiness of relying on fishery alone by diversifying their activities. Those with formal education were better enlightened to efficiently manage their activities.

In developing countries, such as Ghana, increasing household size is associated with more labor for agriculture activities. Households with more family labor are more diversified than those with very little labor (Asravor, 2017). In the fishing communities, diversification in both fishery and farming strategies are paramount to larger households since it provides these households with alternative sources of income and consumption of balanced diets (protein and carbohydrate diet).

The higher dependency ratio is associated with a lower level of participation in fishery livelihood strategy. The plausible explanation was that an increase in dependency ratio increased the number of household members within the bracket (less than 18 and greater than 65 years) were not able to either farm or fish or do both. Additionally, fishers who had access to credit reduced their reliance on fishery only strategy. Access to financial credit has been documented to lead to diversification (Jansen, Damon, Pender, Wielemaker, & Schipper, 2003) among rural households. With access to credit, households have basic capital to diversify into either farming or non-farming business or both. Jansen et al. (2003) argue that households with large access to credit promote nonfarm activities rather than increased investments in inputs for their basic or main fishery livelihood activity.

Extension services significantly influenced the diversification strategies of households. This finding was confirmed by Asravor (2017). Extension services gave the fisher folks the knowledge, training and skills needed to either diversify or specialized their livelihood activities. In most cases, fisher households with access to agricultural extension service have a higher tendency to diversify their farming activities than those with very little access to extension services.

The empirical findings of this study broadly confirmed the empirical literature, which posits that despite the risk involved in fishing, households located in coastal areas of developing countries preferred fishing (Cinner, Daw, & McClanahan, 2009). The importance of fisheries to the small-scale families is that being a safety net and its contributions to pro-poor growth.

From the random utility maximization perspective, we argue that fishery households' decision to choose a particular livelihood strategy is a function of the set of livelihood choice available. The choice made by the household is, therefore, based on the maximum satisfaction that the head of household derives (in terms of the income generated) from the livelihood activity(ies) subject to a set of constraints that he or she faces. This largely confirms the assertion of Eneyew and Bekele (2012) and Eneyew (2012).

6. Conclusions and recommendations

This study undertook an appraisal of the livelihood strategies of households in the Volta Basin of Ghana. The study concludes that although fishing is risky and laborious venture, it remains the major occupations preferred by households in the Volta Basin of Ghana. Our study concludes that the riskiness of fishing had led many fishing households in the Volta Basin to diversified their livelihood activities. In their livelihood strategies, although fishery activities remained central in the composition of all strategies. The four main livelihood strategies employed by the fishery households are fishery only, fishery plus farming, fishery plus non-farming and fishery plus farming plus non-farming. The study concludes that most

households in the Volta Basin engage in an additional livelihood activity apart fishery. Fishery plus non-farming was the dominant strategy employed whereas the least strategy used was fishery, farming and non-farming. On the aggregated, the decision to adopt a particular strategy was mostly influenced by the demographic characteristics of the households. In spite of this, the human capital, financial capital, and natural capital also play important roles in the livelihood diversification strategy of households. In details, the conclusion is that the marriage household heads, household heads with larger family size and a higher number of dependents were more diversified. Furthermore, livelihood diversification strategies were significantly influenced by access to credit, food insecurity, remittances, fishing season, distances to fishery activity grounds and markets, value of fishery assets, experience of head of household, distance to district capital, and extension contact. In the sub aggregated Lower Volta south of the Akosombo dam, again marital and formal educational statuses of the head of household, household size, dependency ratio, access to credit, distance to fishery activity grounds, distance to markets; experience of head of household and extension contact.

Based on these conclusions, we recommend that livelihood intervention programmes should prioritize the improvement of non-fishing activities as it led to the opening of other opportunities for rural development and take pressure off the fish stock to facilitate regeneration. To be successful, however, support in the form of credit and training must go together if alternative income sources of the households are to be relied upon.

7. Limitation of the study

Although there is no doubt that this study is of importance to the research community in general, West Africa and Ghana in particular, there is a limitation in using the binary data. The reliance on binary data for some variables might lead to omissions of revealed subtle differences between households. Binary outcome measures are less sensitive to change than continuous measures; thus, binary measure may impact the relative efficacy of estimates. Binary outcomes as used in this paper are widespread and perceived to be advantageous due to its simplicity in the interpretation. The challenge of using it is the loss of information which leads to the loss of power to detect relationships, and the probable inflation of type I error. To overcome these challenges, attempts were made to use some of the richer disaggregated data collected during the study (see Section 3.5). These variables were automatically dropped by the software whiles running the multinomial logit model.

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Note

1. During the analysis using the MNL, Stata automatically dropped some variables. Thus, the analysis was based on 683 respondents.

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