RURAL LIVELIHOOD DIVERSIFICATION: A HOUSEHOLD ADAPTIVE STRATEGY AGAINST FLOOD VARIABILITY IN THE OKAVANGO DELTA, BOTSWANA

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ABSTRACT

This paper assesses the role of livelihood diversification in household adaptation to flood variability in the Okavango Delta, and locates it within the global discourse on adaptation to climate variability and change in developing countries. The contribution of livelihood activities to household income, level of livelihood diversity and the relationship between livelihood diversification and adaptation to flood variability was determined. Data from a survey of 623 households in five villages, focus group discussions and key informant interviews confirmed livelihood diversification as an important strategy for household adaptation to flood variability in the Delta. However, the household income portfolio was dominated by public transfers, underscoring the weak socio-economic status of the households and the effects of multiple shocks over and above flood variability. The study concludes that livelihood diversification and other household adaptive strategies may be sufficient for current flood variations, but may be inadequate for dealing with global climate variability and change in future.

Keywords: adaptation, climate variability and change, livelihood diversification.

1 INTRODUCTION

Global climate change alters normal climate variability in various regions, resulting in adverse effects on socio-economic systems throughout the world (Chambwera & Stage, 2010). In developing countries, the impacts of climate change pose major

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development challenges including retardation and possible reversal of current developmental gains (Chambwera & Stage, 2010). Consequently, many developing countries will experience energy, water and food stress (Intergovernmental Panel on Climate Change, 2007). The impacts may be felt at various economic scales and more so at the micro-economic level, including local communities and poor households (Paavola & Adger, 2006). Developing countries are the net recipients of climate change impacts, but have limited capacity to adapt (Niang *et al.,* 2007). For rural households in the developing countries of Africa and south-east Asia, livelihood diversification is a strategy for meeting household consumption needs, for generating additional income, and for coping with or adapting to the impacts of environmental and economic shocks (Anderson & Deshingkar, 2005). In sub-Saharan Africa, most poor households depend on the natural environment for their livelihood activities (Ellis, 2000a). The extent to which household livelihood activities are diversified determines household ability to adapt to shocks and to accumulate sufficient income to move out of poverty (Ellis & Freeman, 2005).

In the Okavango Delta of semi-arid north western Botswana, rural households are susceptible to the impacts of climate variability including flood-related shocks, such as extreme flooding and river desiccation (Kgathi, Ngwenya & Wilk, 2007). As one of their adaptive strategies, rural households engage in diversified livelihood activities and income sources (Kgathi *et al.,* 2007). Livelihood diversification, as a household adaptive strategy in the Okavango Delta may be challenged by biophysical, socio-economic, political and institutional factors relating to the intensified use of natural resources for human development and the desire to manage the Delta as a protected Ramsar site (Department of Environmental Affairs, 2008). Although livelihood studies have been conducted in developing countries, including Botswana, there is lack of in-depth knowledge on the extent to which adaptive strategies such as livelihood diversification can buffer households from the impacts of shocks.

The purpose of this paper is to improve knowledge on household livelihood diversification and its contribution to household adaptation to flood variability in the Okavango Delta, and provide lessons for household adaptation to shocks in developing countries. The specific objectives are: a) to determine the contribution of various livelihood activities to household income, b) to assess the level of household livelihood diversification, and c) to determine relationship between livelihood diversification and household capacity to adapt to flood variability in the Okavango Delta.

2 SETTING THE CONTEXT: SUSTAINABLE LIVELIHOODS, SOCIO-ECOLOGY AND DIVERSIFICATION

2.1 Sustainable livelihoods and socio-ecological framework

The sustainable livelihood and socio-ecological frameworks were used in this study to understand livelihood patterns and household response to shocks in the Okavango Delta. According to the sustainable livelihood framework, a livelihood is made up of assets (or capital), activities and access to assets modified by institutions, organisations and social relations that are endogenous or within household control (Ellis, 2000a). It is impacted on by shocks, trends and seasonality that are exogenous to and beyond household control (Ellis, 2000a). A livelihood is considered sustainable if it can withstand or cope with and recover from the impact of shocks (Scoones, 1998; Chambers & Conway, 1992). The ability of a livelihood to withstand these exogenous factors has both socio-economic and ecological aspects that can be understood through the socio-ecological framework. In the socio-ecological framework, a livelihood is part of the coupled human-environment interactions at the micro-economic scale (Berkes & Folke, 1998). The impact of shocks on livelihoods and household responses serve as the interface between these two subsystems which make up the biophysical and socio-economic aspects of the shock. Adaptation analysis needs to consider the impacted system characteristics and responses rather than just the shock itself. Smithers and Smit (2009) and Wisner *et al.* (2004), identified socio-economic factors as important contributors to household vulnerability to shocks.

2.2 Livelihood diversification

Livelihood diversification as defined by Ellis (1998) is 'the process by which households construct a diverse portfolio of activities and social support capabilities for survival and in order to improve their standard of living'. It should be distinguished from the related concept of income diversification, which refers to the composition of household income at a given point in time (Ellis, 1998). Livelihood diversification can be adopted as a strategy for the survival of the poor and as a strategy for accumulation by the rich. When pursued as a survival strategy, it is known as desperation-led or distress-push diversification, and when adopted as an accumulation strategy it is known as opportunity-led diversification (Mutenje *et al.*, 2010). The economic status of a household is a major determinant of the type of diversification. Poor households may find it difficult to pursue opportunity-led diversification due to high access qualifications and the difficulties associated with financing initial investments (Lay *et al.*, 2009).

According to Anderson & Deshingkar (2005), the causes of diversification are mainly explained by the asset-based and insurance-based theories. The former state that the diversity of a household livelihood portfolio is determined by the assets which accrue to a household. The latter explain livelihood diversification as a strategy for ameliorating the adverse effects of income shocks and that its demand is directly related to the extent to which a household is risk averse (Anderson & Deshingkar, 2005). Using the household model and other analytical frameworks, Ellis (2000b) and Barrett *et al.* (2001) identified six determinants of diversification as, a) seasonality, where households diversify their incomes through labour switching from low to high return activities, b) risk, where households engage in a number of livelihood activities to spread risk and avert failure, c) labour markets, which may push migrants from poorly developed markets to active labour markets in urban areas, d) credit market failures, which compel rural households to engage in income earning activities to obtain access to finance, e) asset strategies, which enhance future livelihood strategies and may lead to temporary livelihood diversification, and f) coping behaviour, which may lead to the creation of new livelihoods or alter future patterns. According to Reardon (1997), these determinants are also linked to household characteristics and capital endowment.

There are close links between livelihood diversification and adaptation but the two concepts are dissimilar. Livelihood diversification is a form of adaptation as with other ways of sustaining a given livelihood portfolio such as intensification or extensification (Ellis, 2000a). Adaptation is 'a process, action or outcome in a system in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity' (Smit & Wandel, 2006). It can occur in anticipation or in reaction to a shock or be autonomous or planned (Smit & Wandel, 2006). Autonomous adaptations occur spontaneously, in reaction to, or in anticipation of, a shock, without the direction of governments or public agencies. Planned adaptations can be anticipatory or reactive, and may be directed by governments or public agencies (Smit & Pilifosova, 2001).

Livelihood diversification is a form of autonomous adaptation particularly when undertaken by individuals in response to, or in anticipation of, conditions faced by the household. Anticipatory adaptation corresponds to what Ellis (2000b) refers to as diversification by choice (or for accumulation) while responsive adaptation is associated with diversification by necessity (for survival). Livelihood diversification activities are commonly categorised according to the roles they play in coping, adaptation and accumulation (Carswell, 2000). The effect that livelihood diversification may have in extending the coping range of a household or enhancing its adaptive capacity makes it an important component of adaptation and the broader concept of vulnerability (Smit & Pilifosova, 2001). Vulnerability

of a social system, "...is the degree to which a system is susceptible to injury, damage or harm" (Smit & Pilifosova 2001). Adaptation and vulnerability are inversely related.

3 METHODS

3.1 Study area

The general study area is the Okavango Delta in the Ngamiland District of Botswana. In 2001 the district had a population of 122 024 people, which has grown at 2.1% per annum to 158 104 people in 2011, accounting for 7.8% of the national population (Central Statistics Office, 2002; 2011). Most of this population (64%) was found in rural settlements around the Delta.

The Okavango Delta, a world renowned Ramsar site, is an alluvial fan covering an area of about 12 000 km^2 with a generally low gradient (McCarthy *et al.*, 2003; Wolski & Murray-Hudson, 2006). The Delta (Figure 1), receives annual floods the size and coverage of which depend on rainfall in the catchment area of the Cuito and Cubango rivers in central Angola.

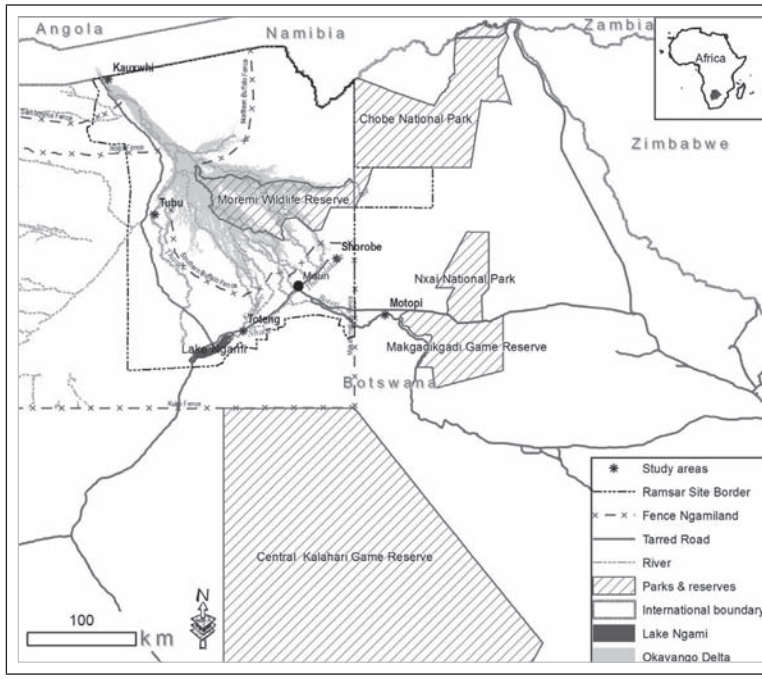

Figure 1: Map showing the Okavango Delta and the specific study areas.
Source: Motsholapheko *et al.* (2011)

Mean annual rainfall in the Okavango Basin, varies from 876 mm and 983 mm (over Cuito and Cubango rivers, respectively) to 490 mm in the Delta, with periodic wet and dry cycles (McCarthy *et al.,* 2000). The inflow variations from the catchment lead to variability in flooding patterns (McCarthy & Bloem, 1998; Wolski & Murray-Hudson, 2006). The inundated area of the Delta has varied showing general reduction, from a maximum of 11 382 km^2 in 1979 to a minimum of 5 094 km^2 in 1996 (McCarthy *et al.,* 2003). The upper Delta, also known as the panhandle, comprises the main Okavango River channel and flood plains that are inundated annually, and there is limited drying. The mid-Delta consists of numerous river channels, islands and wide flood plains. This part of the Delta has been affected by both desiccation and extensive flooding in various time periods. The lower and distal parts of the Delta consist of river channels and flood plains, most of which had desiccation in the past 30 or 50 years (Bernard & Moetapele, 2005). Some of these areas have had extensive re-flooding since 2009.

The specific study sites, comprising the main village and nearby cattle-posts and arable lands, were: Kauxwi in the upper Delta, Tubu in the mid-Delta, Toteng in the western lower Delta near Lake Ngami, Shorobe in the eastern lower Delta, and Motopi in the distal Delta along the Boteti River. Among these study villages, Kauxwi is dominated by the Hambukushu ethnic group that mainly practices dryland arable farming. Tubu, Shorobe and Motopi are inhabited by the WaYei ethnic group known for aquatic life styles and *molapo* farming (flood recession cultivation). Toteng comprises the Herero/Mbanderu and Gcereku ethnic groups that mainly practise livestock farming. These villages had much in common in that they were all rural. However, they differed in terms of their location in the Delta and distance from Maun, the district capital, which provides most services. They were selected based on geographical location in order to explore the different conditions under which households adapted to flood variability in the Okavango Delta.

3.2 Sampling and data collection

Secondary data were obtained from literature sources, including government reports and past studies in the Okavango Delta. Primary data were acquired from a household survey, key informant interviews, field observations, informal discussions, focus group discussions, and interviews with experts on adaptation and household livelihoods. The number and location of households in the villages were verified using updated enumeration area maps from the Central Statistics Office. A list of all households in each study village was compiled, from which the sample size was estimated (Table 1).

Table 1: Population size, number of households and sample size by study village.

Village	* Population size 2001	Total number of households listed	Number of households sampled
Kauxwi	1313	243	97
Tubu	754	188	75
Toteng	2513	584	234
Shorobe	1815	356	142
Motopi	1130	188	75
Total	**7525**	**1559**	**623**

Source: Field work. *Central Statistics Office (2002).

A simple random sample of 623 households representing 40% of the accessible population was drawn. A detailed questionnaire was developed comprising structured and semi-structured questions on: a) household demographic and socio-economic background, b) household livelihood sources and earned income, c) impacts of extreme flooding and desiccation on households, and d) household coping and adaptive strategies. A pilot study was undertaken in December 2009, comprising a pre-test of the questionnaire, key informant interviews and pilot focus group discussions. The main household survey was conducted in the villages of Motopi, Shorobe, Toteng, Tubu and Kauxwi between February and August 2010. The questionnaire was directly administered to household heads or adult members of the selected households.

The main focus group discussions were conducted in the villages of Kauxwi, Motopi, Shorobe and Toteng. They consisted of five to 10 discussants, considered for their profound knowledge of the village and experience in the most practised livelihood activities. The discussants were asked to provide historical information on their village, indicating periods of desiccation and extreme flooding in their lifetime. In order to determine the effect of livelihood diversification on household capacity to adapt to flood-related shocks, households were asked to state the coping and adaptive strategies they used in the past 30 years to date. A total of 14 traditional leaders and members of village committees were also interviewed as key informants. Informal interviews were also conducted among 12 government officers in various sectoral departments.

Household income was estimated from monthly monetary, material and in-kind earnings in the 12 months prior to the survey. Market prices were used to determine values for material, in-kind exchanges and farm products utilised within the household. Earnings accrued once a year were converted to monthly values. Households were classified into low, medium and high income categories. These socio-economic groups were determined from ownership of assets, monthly income and the number of livestock owned (in cattle-equivalent-units). These

were obtained through wealth ranking conducted among key informants and focus group discussants in the study villages.

3.3 Data analysis

The level of livelihood diversification was estimated from data on livelihood types and total income, using the inverse Herfindahl-Hirschman diversity index (IHHD). Comparisons were made by location and household socio-economic status. The Kruskal-Wallis test was used to determine differences between attributes of non-parametric variables. Frequency distributions were used to describe livelihood patterns. The chi-square test of independence and odds ratios were used to determine associations between variables.

Worth explaining is the IHHD, which is commonly used in the estimation of market share distribution. It measures diversity by estimating the proportional distribution and the number of elements being studied. It was estimated using the following equation:

$$IHHDi = \left[\frac{1}{\sum a_j^2}\right] i \qquad (1)$$

Where a_j is the proportional contribution of each livelihood activity j to the total income of household i. The maximum value of the index is the total number of income sources, and the minimum value is one, obtained when income is derived from a single source (Anderson & Deshingkar, 2005). Additionally, the magnitude of the index is determined by the proportional distribution of income. Using this equation, livelihood diversity can be measured within and among households. In this study the proportional contribution of each livelihood activity to the income portfolio was calculated for each household. Using these proportions, the IHHD for each household was determined. These were used to obtain the overall and mean index and values for each village by household socio-economic status.

4 RESULTS

4.1 Household livelihood activities and income

The overall income portfolio in the study area consisted of 12 household livelihood activities. Interviewed households engaged in a mean number of three livelihood activities. Few households (8%), mainly the poor, had one livelihood activity supplemented by public transfers, which refers to social welfare and *Ipelegeng*/ labour-intensive-public-works (LIPW) in this study. The most common livelihood activity was livestock farming, undertaken by 73% of all households interviewed. It was followed by dryland arable farming (49%), social welfare (49%) and *molapo* farming at 39% of the households. Formal employment was undertaken

by a lower proportion of households (21%) than both informal employment (29%) and *Ipelegeng*/LIPW (22%) (Figure 2).

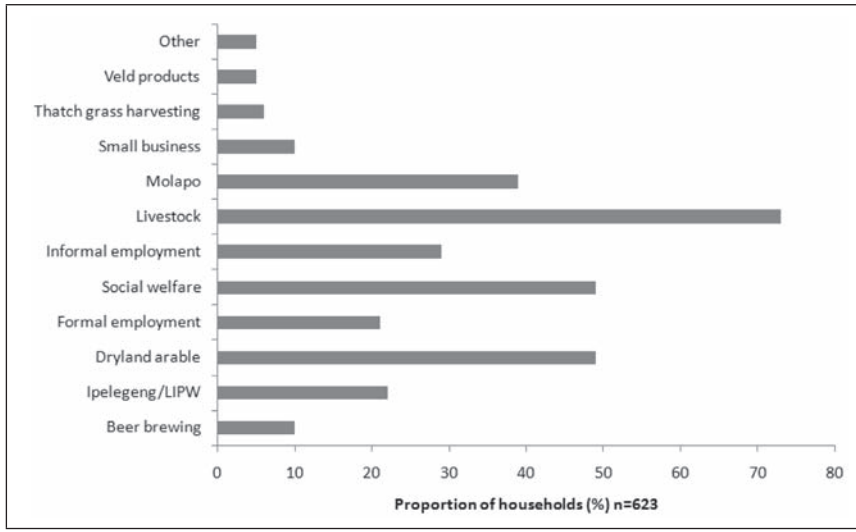

Figure 2: Proportion of households and livelihood activities in all the study villages.
Note: the proportions do not add to 100%; households stated several livelihood activities.

The combinations of livelihood activities differed by location, indicating differences in the way households responded to spatial and temporal flood variations. Most households in Kauxwi (81%) practised dryland arable farming rather than livestock farming. This was substantiated in focus group discussions, where discussants indicated that grazing pastures in Kauxwi were limited to the flood plains and nearby grasslands, while in the other villages, additional pastures were available further away from the river. Large proportions of households in Tubu practised both *molapo* farming (97%) and livestock keeping (81%). Assuming that the livelihood patterns reflect past and current adaptation to flood variability, this was influenced by the prolonged desiccation in some western parts of Tubu. Households preferred livestock keeping during prolonged periods of desiccation as shown by the high proportion of households which practised livestock farming in the lower Delta villages of Toteng (86%) and Shorobe (63%), and the distal Delta village of Motopi (87%). Worth noting is that households in Shorobe and Motopi practised livestock farming though they were of the same ethnicity as those in Tubu, further attesting to the influence of temporal variations in flooding.

Households had various explanations for maintaining multiple livelihood activities. One respondent said '*molapo* farming is too risky as it can be disrupted

by annual flooding' and that activities such as '*molapo* and dryland farming are seasonal'. According to households, though such activities were crucial for household food security they were unreliable. Another respondent said 'animal diseases make livestock farming less economic as we cannot sell when we need money'. This meant that the persistence of risk associated with some activities also made it imperative for some households to maintain multiple activities. One household head summed it: 'cattle, act as savings for an average *Motswana*[1] and arable farming provides basic food'.

Even within a specific livelihood activity there was diversity in the products, reflecting household desire to spread risk. Arable farming households planted an average of five and a maximum of 10 different crops on a subsistence basis. There was an association between the main type of crops planted and location. The Pearson's chi-square (χ^2=356, degrees of freedom= 12, p=0.001) was highly significant at five percent level. Households in Kauxwi planted 'mainly millet' (49%) or a combination comprising of 'millet, sorghum and maize' (45%) under rain-fed conditions, partly because of limited flood plains in the upper Delta. In the mid-Delta village of Tubu, most households (88%) planted, and preferred maize to sorghum and millet. Informal discussions, with some residents in Tubu, indicated that sorghum and millet yields were poor due to excessive moisture in *molapo* fields.

Most households in the periodically desiccated lower Delta village of Toteng (92%) planted 'mainly maize' and some non-grain crops under rain-fed conditions. This was common among the Herero/Mbanderu ethnic group who, according to key informant interviews, started arable farming after the 1996 district-wide culling of cattle to eradicate the cattle lung disease (contagious bovine pleuro-pneumonia [CBPP]). In the lower Delta village of Shorobe, most households planted 'mainly maize' (50%) or 'mainly sorghum' (33%), depending on the flood conditions in *molapo* fields and rainfall in dryland fields. The proportions of households that planted these crops in Motopi were 28% and 44%, respectively. This indicates that sorghum was preferred in areas experiencing prolonged drying of the river.

Livestock farming households kept different livestock types with a general preference for cattle and goats. This was shown by the high overall means for these livestock types in all the villages (Table 2).

Table 2: Mean number and types of livestock owned in each village.

Livestock type	Mean number of livestock					
	All villages	Kauxwi	Tubu	Toteng	Shorobe	Motopi
Cattle	20.1	2.7	21.4	29.4	13.3	24.9
Goats	11.9	2.1	13.6	17.1	7.4	15.7
Sheep	1.7	0	0.2	4.4	0.1	0.1

Donkeys	2.5	1.1	5.5	2.4	1.5	3.2
Horses	1	0.1	1.6	1.7	0.2	0.8
Poultry	4.8	5.2	5.4	4.6	4.6	4.7

However, there were differences by location. The upper Delta village of Kauxwi had the lowest mean number of cattle (2.7) and goats (2.1) compared to other villages. This showed low relative importance of livestock compared to dryland arable farming in the upper Delta, where there was no desiccation but limited pasture. Toteng had the highest mean number of cattle, goats and sheep, and this indicates the importance of these livestock types in the western lower Delta, where there was prolonged drying and intermittent flooding of Lake Ngami. The Kruskal-Wallis test ($p=0.001$, at five percent significance level) showed that there were significant differences in the distribution of all livestock by location, except for poultry. The results indicate that intra-livelihood diversification in livestock farming is also determined by varying flooding patterns in the Delta.

4.2 Household income portfolios

In the household income portfolio for all villages, public transfers contributed a total of 34% to household income (Figure 3).

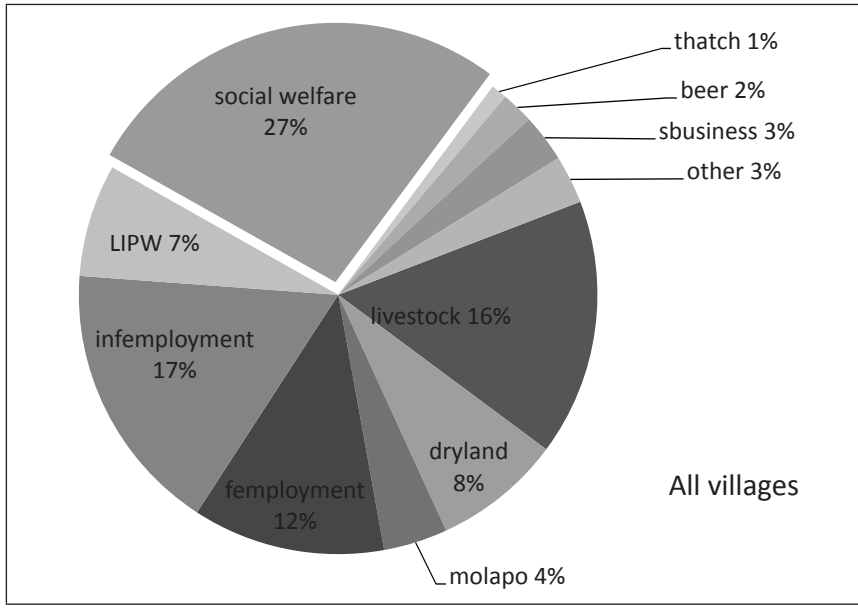

Figure 3: Household income portfolio for all study villages.

This meant that public transfers were the main contributor, followed by informal employment (17%), livestock farming (16%) and formal employment (12%). Although dryland arable farming was among the livelihood activities considered by households as most important, it contributed seven per cent to the household income portfolio. Other activities, such as small business, beer brewing, thatch grass and petty trade, contributed three per cent or less.

Household income portfolios also differed by village due to varying socio-economic conditions within which livelihood activities were undertaken. For instance, in the village of Kauxwi, public transfers contributed 26%, being slightly surpassed by informal employment at 27%. This may have been due to the availability of temporary employment in the village electrification project and the construction of flood relief houses, which were ongoing at the time of the survey.

When livelihood activities were aggregated into broad categories of farm, non-farm, off-farm, and public transfers, the results showed that off-farm activities made the least contribution (less than 10%) to household income in all the villages, compared to other livelihood types (Figure 4).

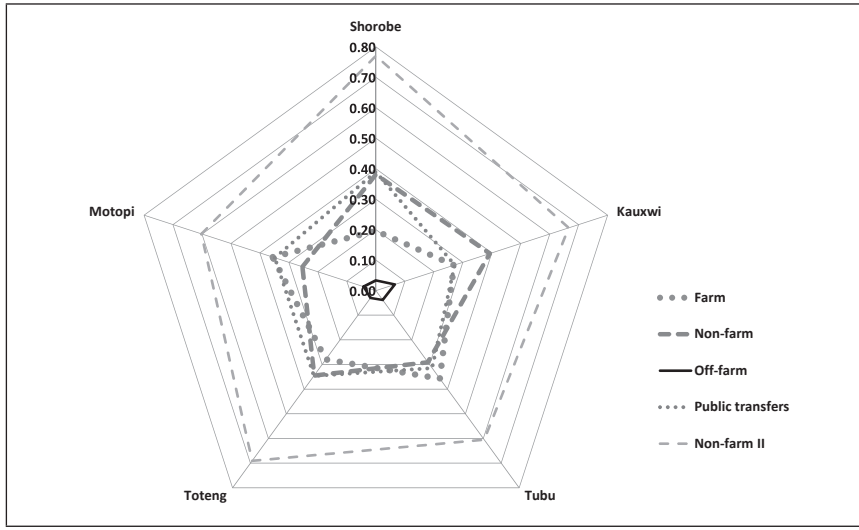

Figure 4: Broad categories of livelihood activities by village.

Public transfers were still dominant in Shorobe (39%) and Toteng (35%), but were surpassed by non-farm income sources in Kauxwi (39%) and farm income sources in Tubu (36%) and Motopi (36%). When public transfers were included in the non-farm category, the aggregate contribution of non-farm activities to household income was higher than that of other livelihood categories, varying from 60%

in both Tubu and Motopi to 77% in Shorobe. Overall contribution of non-farm income sources to household income, including public transfers, was 77%.

The level of livelihood diversity, as shown by the overall IHHD value of 1.47 with a standard deviation of 0.54, indicated that household income was moderately diversified; the index exceeded the value of one which denotes specialisation. The values of the overall IHHD also varied between income groups as they increased from 1.41 for low income to 1.57 for high income households (Table 3).

Table 3: Livelihood diversity indices by village and income groups.

Village	Livelihood diversity indices (IHHDs)			
	All income groups	Low income	Medium income	High income
Kauxwi	1.49 (0.57)	1.46 (0.54)	1.86 (1.17)	2.09 (0.88)
Tubu	1.60 (0.70)	1.43 (0.62)	2.18 (1.15)	1.75 (0.57)
Toteng	1.39 (0.47)	1.33 (0.45)	1.41(0.44)	1.46 (0.51)
Shorobe	1.50 (0.53)	1.47 (0.50)	1.66 (0.58)	1.60 (0.61)
Motopi	1.46 (0.52)	1.38 (0.47)	1.53 (0.46)	1.59 (0.68)
All villages	1.47 (0.54)	1.41 (0.51)	1.54 (0.58)	1.57 (0.57)

Note: Standard deviations are in parenthesis

This indicates that high income households had relatively diversified livelihood portfolios compared to low and medium income households. The IHHD values for the villages of Kauxwi, Toteng and Motopi showed increasing diversity across socio-economic groups. In the villages of Tubu and Shorobe the values increased from low to medium income households, but decreased from medium to high income.

A comparison of means among these indices showed that there were significant statistical differences between income groups in each location, and this was confirmed by the Kruskal-Wallis test ($p= 0.001$, at five percent significance level). Across village communities, high income households also had more diversified livelihood portfolios than low income households. The villages of Shorobe and Tubu had higher index values for medium income than high income households. Furthermore, their overall indices were higher than in other villages indicating higher livelihood diversity than the other villages. These differences may be related to the specific socio-economic conditions in those villages. For instance, both villages are located close to settlements that provide district and sub-district level administrative and commercial services. This may provide opportunities for non-farm activities, in the case of Shorobe households, and relatively large markets for farm products, for Tubu households. As earlier indicated, Shorobe had

a high proportion of households engaged in non-farm activities whereas Tubu had high proportions of households engaged in farm activities.

Households also differed in the way they combined livelihood activities. These livelihood diversification strategies can be described as: a) crop-or-livestock, where households engaged in either arable farming or livestock farming, b) crop-livestock integration where they combined arable farming and livestock farming, c) farm-off-farm consisting of own farm and off-farm activities, d) farm-non-farm, made up of own farm and non-farm income sources, excluding public transfers, and e) 'others', consisting of livelihood activity combinations which could not fit into the first four categories.

The type of livelihood diversification strategies used by households was associated with location. The association between the type of diversification strategy used and location, as shown by the Pearson's chi-square (χ^2=75.3, degrees of freedom=16, p=0.001), was highly significant at five percent level. The results (Table 4) also showed that household use of various diversification strategies was associated with spatio-temporal variability in flooding.

Table 4: Household percentage frequencies for various livelihood diversification strategies by household characteristics.

Household characteristics	Livelihood diversification strategies					
	Crop-or-livestock	Crop-livestock	Farm-off-farm	Farm-non-farm	'Others'	Total
Location (n=587)						
Kauxwi	23	21	42	9	5	100
Tubu	15	50	18	16	1	100
Toteng	23	30	20	22	5	100
Shorobe	22	19	19	30	10	100
Motopi	13	30	7	44	6	100
Socio-economic status (n=585)						
High	13	32	10	40	6	100
Medium	16	39	14	27	3	100
Low	24	24	27	17	7	100

Households in the study village of Kauxwi mainly adopted the farm-off-farm diversification strategy (42%). This strategy was temporary and involved engagement in temporary paid employment, either as 'piece-jobs' in other people's fields and homes or in projects of short duration. It therefore addressed the seasonal lag in household use of labour until the next ploughing season. The households in Tubu (50%) and Toteng (30%) mainly adopted crop-livestock diversification

strategy. However, the two villages differed in that Tubu had experienced partial drying, while Toteng had intermittent flooding of Lake Ngami. Households may have found crop-livestock diversification to be suitable for long-term fluctuations in flood water availability. In Shorobe and Motopi where there was prolonged drying of the river, most households (30% each village) resorted adopted farm-non-farm diversification strategy. This strategy involved long-term involvement in paid employment and other activities which generated steady income for prolonged periods of time.

The type of livelihood diversification strategy used was also associated with household socio-economic status. The Pearson's chi-square (χ^2=50.8, degrees of freedom=8, p=0.001) was highly significant at five percent level. As shown in Table 4 above, most high income households (40%) used farm-non-farm, while medium income households (39%) used crop-livestock, and most low income households (27%) used farm-off-farm diversification strategy.

4.3 Household coping strategies

Survey results showed that when the extreme floods of 2009 and 2010 occurred, 62% of the interviewed households coped spontaneously while 38% were assisted by the Government through disaster relief interventions. Among those that spontaneously coped, 31% switched their labour to other livelihood activities, 18% temporarily relocated and continued to be involved in other livelihood activities while the rest (13%) used other coping strategies. The results further indicated that most households that coped spontaneously were in farm-non-farm (30%) rather than in crop-or-livestock (26%), crop-livestock (25%) and farm-off-farm (19%) diversification strategies (Figure 5).

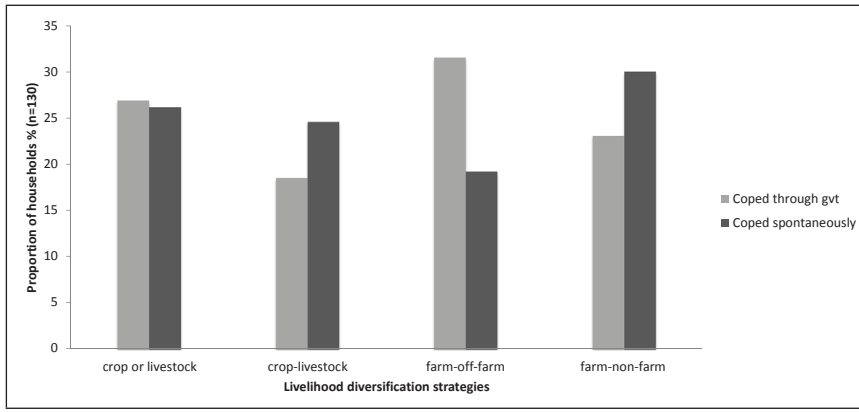

Figure 5: Livelihood diversification strategies by forms of household coping.

The odds ratio comparison (Figure 5 above) of households that spontaneously coped with extreme flooding to those assisted by the Government showed that households that adopted crop-livestock or farm-non-farm were more likely to cope spontaneously with the floods than households that adopted crop-or-livestock or farm-off-farm diversification. As indicated in section 4.2, crop-livestock was associated with medium income households; farm-non-farm was associated with high income households, while the other two strategies were associated with low income households. This meant that medium and high income households were more likely to cope spontaneously than low income households, which also had low livelihood diversity. Worth noting is that the majority of households in the survey were low income households (65%), while medium and high income households made up 15% and 20%, respectively.

In the more than two decades of river desiccation, households in the study villages were adversely affected by loss of surface water. This resulted in general livelihood decline with 21% of households experiencing collapse in livestock keeping, *molapo* farming or both activities. Arable farming households coped with the impacts by ploughing *molapo* fields under rain-fed conditions (83%), switching from *molapo* farming to dryland farming (11%), labour switching from *molapo* farming to livestock farming (4%) and others (2%). These coping strategies involved labour and other resource switching associated with multiple livelihood activities.

Most livestock farming households (80%) coped with the loss of surface water by using alternative water sources such as hand-dug wells and boreholes. Others coped by temporarily relocating to wetter areas (10%) or hauling water for their livestock using vehicles (10%). Hand-dug wells were used by households of all socio-economic groups while boreholes were used mainly by wealthy households. Most households that used alternative water sources within the same location were those in crop-livestock (33%) and farm-non-farm (28%) than those in crop-or-livestock (19%) and farm-off-farm (16%). Households with more diversified livelihoods were more sedentary than their counterparts who had less livelihood diversity. Moreover, the proportion of households that relocated to wetter areas was higher among low income households (62%) than medium (14%) and high income (24%) households.

5 DISCUSSION

The results showed that livelihood diversification is an important strategy for household autonomous adaptation to flood variations in the Okavango Delta. This was underscored by the high proportion of households that diversified livelihood activities, and spontaneously coped with extreme flooding (62%) and desiccation (79%). Typical of wetland livelihood patterns in most developing countries,

households maintained multiple and mostly natural resource-based livelihood activities that enhanced adaptation through risk spreading.

The level of overall household income diversity measured using the IHHD, was 1.47 ranging from 1.41 for to 1.57 for low and high income households, respectively. From this variation, it was difficult to determine whether or not this indicates diversification for survival or accumulation because it was based on cross sectional data (see Dimova & Sen, 2010). However, from the household reasons to diversify, it may be conceded that households diversified in order to avert risk, to cope with seasonality and because of poor credit and labour markets as suggested by Ellis (2000a). The level of livelihood diversity may be lower than the actual value because during the survey, there was a foot-and-mouth disease outbreak which resulted in restrictions on livestock sales with adverse effects on household income. Additionally, the underestimation may be due to the general difficulty of measuring household income (see Skordis & Welsh, 2004). Despite this, the index shows that the livelihood portfolio was slightly diversified. The index value was lower than that of a study undertaken by Ellis (2000a) in rural Tanzania, which varied from 2.2 to 2.8 in different areas. However, it was higher than that reported by Anderson and Deshingkar (2005) at 1.28 for six study villages in rural Andra Pradesh.

The results are consistent with those of other studies in Africa which reveal that rural households have multiple sources of income. According to Ellis (1999), non-farm income sources account for 30% to 50% of rural household income in sub-Saharan Africa, and may be between 80% and 90% in southern Africa. Therefore, our estimate of 77% was close to and consistent with that of southern Africa. It is also suggested that the contribution of non-farm livelihood activities to household income in Africa is increasing over time, through a process known as de-agrarianisation (Bryceson, 2002).

The livelihood patterns also confirmed the dominance of public transfers in the household income portfolio. Public transfers were followed by informal employment and livestock farming. These livelihood sources were not correlated with other livelihood sources which were affected by the risk of flooding, hence diversification was beneficial. The dependence on public transfers may be temporary being determined by economic trends in the country, but it reflects general household vulnerability to the impacts of flood variability and other livelihood shocks in the Delta. According to Mullins, Fidzani and Kolanyane (2006) public transfers were hardly mentioned by households as a source of livelihood before the culling of cattle to eradicate CBPP in 1996.

The choice of diversification strategies and success in coping with flood variability, were associated with household socio-economic status. Low income households adopted farm-off-farm and crop-or-livestock diversification strategies which were not well diversified and therefore not effective in household adaptation

to the impacts of flood variability. These households either used government assistance to cope with extreme flooding or faced livelihood activity collapse as in the case of desiccation. This relates to the varying levels of access to assets which, as it may seem, once addressed, successful autonomous adaptation may be realised. However, the solution may not be that simple since access to various forms of capital is modified by existing institutions and policies. It is also related to how developed or how well such institutions function (Dorward *et al.*, 2003). Unlike extreme flooding, household response to desiccation was not supported through direct government interventions. This was related to the generally centralised response to shocks in Botswana and that desiccation coincided with shocks of national significance such as drought, CBPP outbreak and the HIV/AIDS pandemic.

6 CONCLUSION

This paper determined the extent to which livelihood diversification contributes to the capacity of households to adapt to flood-related shocks in the Okavango Delta. From a study of five villages the main findings are four fold. Firstly, households maintained multiple and mainly natural resource-based livelihood activities on a subsistence basis. This reflected careful planning to avert risk, respond to seasonalities, and to handle the impacts of poor credit and labour markets. The household income portfolio was dominated by public transfers indicating that households were vulnerable to flood-related and other livelihood shocks. The persistence of other shocks such as livestock diseases undermines the viability of some traditional livelihood activities such as livestock farming. For policy and planning this means that orthodox policy approaches against processes that enhance diversification such as migration, may no longer be relevant. Additionally, the search for new overtures to counteract the impacts of shocks, as shown by recent efforts by the Government of Botswana to find alternative markets for livestock products in countries with similar foot-and-mouth disease regimes, is a positive development. The main lesson for developing countries is that household dependence on natural resource-based livelihoods may be the greatest threat to rural livelihoods under climate change conditions, and the main challenge is to identify alternative and complementary livelihood activities.

Secondly, the level of livelihood diversity showed that income sources for rural households in the Okavango Delta, were slightly diversified; it augments the observation that households are vulnerable to shocks because household income was dominated by public transfers. The level and patterns of livelihood diversification demonstrate that the household adaptive capacity may be sufficient for current flood variations, but inadequate for future climate variability and change. Although it was difficult to determine whether households diversified for survival

or accumulation, diversification was used as an adaptive strategy in anticipation of or in reaction to impacts of flood variability. The level of diversification has inherent spatial and temporal variations determined by socio-economic conditions. If combined with other measures it may help to determine the adaptive capacity, or the vulnerability status of households, with reasonable accuracy.

Thirdly, livelihood diversification positively contributes to the adaptive capacity of between 62% and 70% of households in the Okavango Delta. For the majority of households in the Delta it is an effective adaptive strategy against flood-related shocks. Therefore it may serve as a starting point for planned interventions and be supported for enhanced adaptation against climatic shocks in the Delta and similar regions. However, livelihood diversification cannot be the only adaptive strategy against shocks because it cannot effectively buffer all households from the impact of multiple shocks. Climate change as a major threat to all socio-economic sectors may necessitate that other strategies be identified and strengthened to improve household ability to manage the impacts and capitalise on the opportunities availed by the shocks. The fact that household vulnerability, in the study villages, is linked to institutional factors indicates that it can be reduced by realigning policies and regulations to enhance the capacity of households to autonomously adapt to shocks.

Fourthly, high income households adapted to the impacts of flood variations more than the low income. Therefore, lack of access to capital may be a limiting factor for household ability to diversify for enhanced capacity to adapt to shocks. Policies that enhance household socio-economic status may be crucial for household adaptation to shocks in the Okavango Delta and other areas in developing countries. The principles of equity may need to be integrated in all efforts aimed at identifying vulnerable groups and assisting them to cope with or adapt to the impacts of flood-related and other shocks. This is because efforts aimed at assisting the poor and vulnerable households often benefit the rich and less vulnerable community members. Flood variations are not the only source of livelihood shocks in the Delta or elsewhere in the world. Therefore, adaptation to climatic shocks needs to be part of the broad policy framework on poverty reduction and the attainment of sustainable livelihoods in preparation for future climate variability and change.

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NOTES

1 *Motswana* (plural Batswana) means citizen of Botswana.

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