

CHAPTER SIX

HOUSEHOLD VULNERABILITY, ADAPTATION STRATEGIES AND ADAPTIVE CAPACITY

6.0 Introduction

It has become common knowledge that the poor are likely to be hardest affected by climate variability and extremes (e.g. flood, drought etc). The capacity to respond to these events is, however, usually lowest in developing countries, especially among the poorest people in those countries. It appears that vulnerability to climate variability and extremes is closely related to poverty. This is because the poor seem to be the least able to cope with such extreme climatic events, for example, floods and droughts. Vulnerability and adaptation to climate variability and extremes are urgent issues among many developing countries including Nigeria. In this chapter, household vulnerability, adaptation strategies and adaptive capacity of the communities living along the Kaduna River floodplain at Shiroro LGA in Niger State in Nigeria are examined.

6.1 Household vulnerability

Definitions of vulnerability in the climate change literature tend to fall into two categories, viewing vulnerability either (a) in terms of the amount of (potential) damage caused to a system by a particular climate-related event or hazard (Jones and Boer, 2003), or (b) as a state that existed within a system before it encounters a hazard event (Allen, 2003). The former view has arisen from an approach based on assessments of hazards and their impacts, in which the role of human systems in mediating the outcomes of hazard events is downplayed or neglected (Jones and Boer, 2003). Climate change impacts studies have typically examined factors such as increases in the number of people at risk of flooding based on projections of sea level rise (Nicholls *et al.*, 1999). The focus has been on human exposure to hazard rather than on the ability of people to cope with hazards once they occur (Brooks, 2003).

The term hazard is used throughout this thesis to refer specifically to physical manifestations of climatic variability or change, such as floods, droughts episodes of heavy rainfall etc. Climatic hazards may be defined in terms of absolute values or departures from the mean of variables such as rainfall, temperature, water level, perhaps combined with factors such as speed of onset, duration and spatial extent (Brooks, 2003; Adger, 1999). Crucially, hazards as described in this report are purely physically defined. A disaster as measured in human terms (lives lost, people affected, economic losses) is therefore the outcome of a hazard, mediated by the properties of the human system that is exposed to and affected by the hazard (Brooks, 2003; Allen, 2003). Of the phenomena listed above, floods are particularly problematic, as their magnitude is mediated by anthropogenic factors such as river engineering and land use (Brooks, 2003). A flood associated with a heavy rainfall event may be more usefully viewed as a primary impact or outcome of that rainfall event, just as coastal floods are often the outcome of storm surges (Brooks, 2003). In these cases, it is the rainfall event or storm surge that constitutes the principal hazard.

The hazards and impacts approach typically view the vulnerability of a human system as determined by the nature of the physical hazard(s) to which it is exposed, the likelihood or frequency of occurrence of the hazard(s), the extent of human exposure to hazard, and the system's sensitivity to the impacts of the hazard(s) (Allen, 2003). Conversely, the view of vulnerability as a state (i.e. as a variable describing the internal state of a system) has arisen from studies of the structural factors that make human societies and communities susceptible to damage from external hazards (Allen, 2003; Brooks, 2003). In this formulation, vulnerability is something that exists within systems independently of external hazards. In contemporary time, emphasis has shifted from an impacts-led approach to a vulnerability-led approach, as interest in climate change and its impacts has developed. The impacts-led approach tends to concentrate on the evolution of physical hazards associated with climate variability, as a consequence of climate change (Adger *et al.*, 2004). This approach examines future human exposure to climate hazards based on climate modelling studies and projections of population.

The vulnerability led-approach, however, examines the underlying socio-economic and institutional factors, and to a lesser extent, political and cultural factors that determine how people respond to and cope with climate hazards (Adger *et al.*, 2004; Brooks, 2003). Vulnerability of a region, system or population group to a range of existing or hypothetical hazards may be assessed based on an analysis of the factors that determine how it is likely to be affected should it be faced with the hazards in question (Adger *et al.*, 2004). The vulnerability approach is therefore a useful tool with which to assess people's needs in terms of adaptation or improvements in their ability to cope with existing threats (Adger *et al.*, 2004). Therefore, in this chapter, the vulnerability led-approach will be employed to examine the underlying socio-economic and cultural factors that determine how people respond to and cope with flood hazards along the River Kaduna in Shiroro LGA, across all the three research sites (Group A-C). Comparisons between these grouped villages are made to understand the strength of social networks and the impacts of socio-economic and cultural factors on their 'coping' capacity.

Enhancing the understanding of vulnerability and the closely-related goal of identifying ways of reducing vulnerability clearly entail a focus on the causes of, or processes shaping vulnerability (Adger *et al.*, 2004). There are two sets of hazards that lead to vulnerability as mentioned earlier in the literature that includes traditional hazards and modern hazards (Eyles and Sharma, 2001). This research focuses on traditional hazards, since the area under study is a typical African rural community. Traditional hazards are associated with a lack of development - they are related to poverty; lack of access to safe drinking water; inadequate basic sanitation in the household and community; indoor air pollution from cooking and using biomass fuel; and inadequate solid waste disposal (WHO, 1990; Eyles and Sharma, 2001). These traditional hazards are common among the traditional villages in Shiroro LGA. Traditional hazards are factors that ensure limiting conditions for the development of rural communities and diffusion of infectious diseases, especially in the developing world (Eyles and Sharma, 2001), hence increasing vulnerability and also reducing coping capacity.

To examine the impact of flood and the underlying socio-economic and cultural factors that determine how people respond to and cope with flood hazards in the communities at the household level, a sample population of seventy-two persons were chosen (from the heads of the 60 households and 12 key decision makers in the communities), as described earlier. The average household number is 10 persons per household. A more focused sample allowed a more careful examination of some of the factors generating vulnerabilities to floods in the area. The sample population consists of a high dependency ratio with children and women dependant on the head of the family, usually a man (Fig. 6.1).

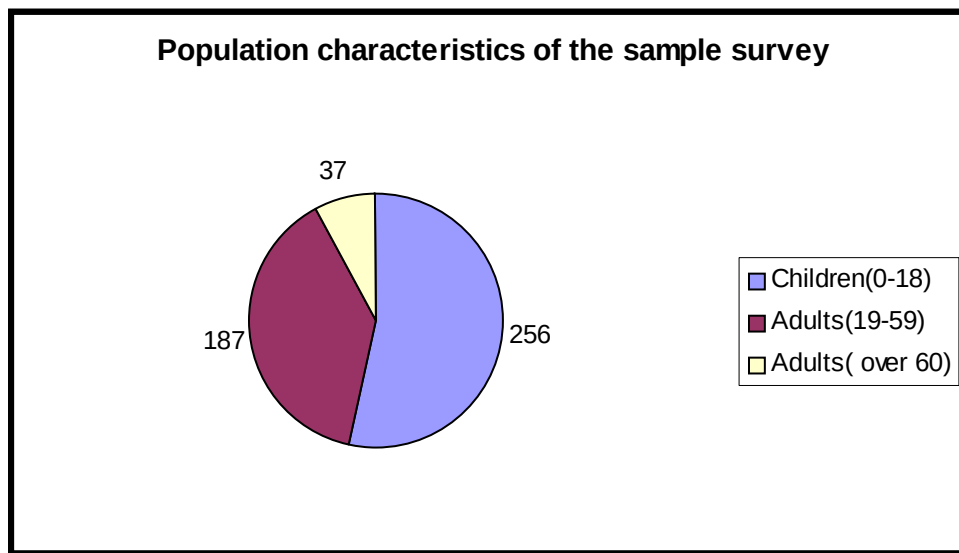


Figure 6.1: The population characteristics of the household sample survey (Source: Fieldwork 2005).

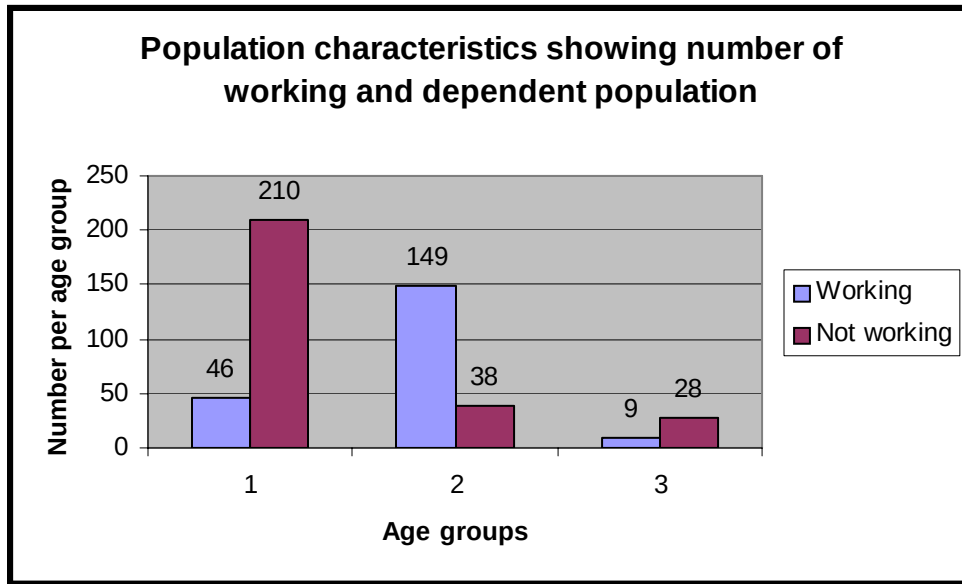


Figure 6.2: A bar graph showing level of dependency among the communities in Shiroro LGA (Source: Fieldwork 2005).

Approximately 256 of the population are below 19 years of age. Eighteen percent (18%) are working while eighty two percent (82%) are not working and depend on their parents (Fig. 6.2). The population over sixty years is 37. Twenty four percent (24%) are working while seventy six percent (76%) are not working. The population between 19-60 is 187. Eighty percent (80%) of the population are working, while twenty percent (20%) are not working. Therefore only 204 (43%) of the population are working, while 276 (57%) are dependent on the productive population (Fig. 6.2). This high dependency ratio exerts added pressure on resources during this scarcity of food after flood disaster. Table 6.1 below summarizes the age characteristics of the population.

The population of the Shiroro communities are mainly Muslims. Because of the Islamic religion, which is the predominant in the communities, a man is allowed to marry up to four wives. The household interviews conducted show that all the wives residing in Group C (villages on the flood plain) are housewives (i.e. they only stay at home without working to take care of children and run day to day cleaning and cooking in the house), while those in groups B and A (villages residing few distance away from the floodplain

and those residing in Kuta and Galadima-Kogo town respectively) are partly housewives and partly working as a civil servants and traders, to earn some income (Tables 6.2a & b).

Table 6.1: Characteristics of population showing dependency ratio.

Age group	Number of population	Working	Not working
0-18	256	46	210
19-60	187	149	38
Over 60	37	9	28
Total	480	204	276

Source: Fieldwork, 2005.

Thirdly, the population, residing along the river depends on the agricultural outputs from their farmlands for their livelihood (Table 5.3). These Shiroro villages have lost most of the farmlands to flooding events on the floodplain. The increasing flood frequency has converted most of the farmlands to river course. Lewsey *et al.*, (2004) state that changes in rainfall intensity and extreme weather events that increase the scale of flooding and soil erosion can seriously damage agricultural capacity. Also the impact of climate stress is more pervasive on general well being, particularly on those dependent on agriculture with fewest alternative sources of income (Vogel, 2005; Devereux and Edwards, 2004).

Although, there is no available official record of GDP of the communities under study at the time of data collection, the income and the farm output, of households interviewed show that there is a contraction in the household income and output (deduced from the household data collected during the interviews) of the villagers along the River Kaduna as a result of farm losses (discussed in chapter five). Large contractions in income and output of these communities are one of the indicators of impact of climate stresses, including losses in farm labour opportunities and general loss of livelihoods (IPCC, 2001; Washington *et al.*, 2004; Vogel, 2005). In several countries, for example, in Southern Africa, there are marked contractions in GDP with droughts in 1991/92. The exceptions were those countries with economies being dominated by other sectors (e.g. Botswana and Namibia) that are strongly supported by mineral exports (Benson and Clay, 2004;

Vogel, 2005). Therefore the dependency of the villages residing on the floodplain on agricultural activities makes them highly vulnerable. The impact of floods on agriculture along the River Kaduna has generated to household livelihood insecurity among the villagers.

A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living (Chambers and Conway, 1992). A livelihood is sustainable, when it can cope with and recover from stress and shocks, maintain or enhance its capabilities for the next generation and which contributes net benefits to other livelihoods at the local and global levels in the long and short term (Chambers and Conway, 1992). Livelihood can be made up of a range of on-farm and off-farm activities that together provide a variety of procurement strategies for food and cash (Conway, 1989). Thus, each household can have several possible sources of entitlement, which constitute its livelihood (Conway, 1989). Entitlements include the rights, privileges and assets that a household has and its position in the legal, political and social fabric of society (Care, 2003). The risk of livelihood failure determines the level of vulnerability of a household to income, food, health and nutritional security (Care, 2003). The greater the share of resources devoted to food and health service acquisition, the higher the vulnerability of the households to food and nutritional security (Barrett, 1999).

Livelihoods, therefore, are secured when households have secured ownership of, or access to, resources (both tangible and intangible) and income earning activities, including reserves and assets, to off-set risks, ease shocks, and meet contingencies (Barrett, 1999). Households have secure livelihoods when they are able to acquire, protect, develop, utilize, exchange and benefit from assets and resources (Care, 2003). Consequently, there is a livelihood failure in Shiroro communities along the River Kaduna floodplain as a result of increasing frequency of flooding that have converted most of the farmland on which the communities depend on, to river course. This livelihood failure has resulted to household livelihood insecurity, because there is inadequate and unsustainable access to income and resources, for example, inadequate access to food, potable water, health facilities, educational opportunities, housing, and

electricity. Household livelihood security is defined as adequate and sustainable access to income and resources to meet basic needs (including adequate access to food, potable water, health facilities, educational opportunities, housing and time for community participation and social integration) (Frankenberger, 1996).

Poverty is another major factor that makes these communities along the Kaduna River highly vulnerable. The data collected show that the populations residing along the river floodplain are poor. The average income per household is low, less than 6000 Naira or 40 USD per month, although the data collected may not be a good representation of monthly income of the population. Other factors include, lack of access to information and other facilities by low-income earners. The fieldwork also showed that the communities lack access to information technology, good roads and potable water (Plate 5.3). Although, Shiroro community is housing the second largest hydroelectric power-generating dam, there is no electricity in all the villages along the Kaduna River in Shiroro communities. During the rainy season, the Shiroro dam management usually releases water from the reservoir downstream. But, due to a lack of access to information facilities, the villagers downstream of the Shiroro dam are always taken unaware by the floodwater released from the dam. Although, the respondents from the dam management stated that notices are made through the media before water is released, the inhabitants have neither radio nor television and therefore cannot get access to the information. In addition, the inhabitants of the Shiroro villages on the floodplain claim that the land (floodplain) is inherited from their forefathers, and that they cannot abandon such inherited property. On the basis of their custom, ownership of land is further a factor enhancing vulnerability in the area.

Respondents argue that the piece of land along the floodplain was the only area within the community that belonged to them and they cannot go to another persons' land to build houses or farm. Therefore the inherited land must be protected and handed over to the next generation as their father and forefathers did. Such a custom, however, has compounded the vulnerability of the villagers. Most farmers, who have lost their farmland along the river to erosion and flood, now depend on the remaining farmland

outside the flood plain to feed their families. In order to maintain the continuity of the communities living on such inherited floodplain, the villagers had to be sand-filling their compounds regularly to raise the level (height) of the compounds. A critical understanding of how the societal system will be affected by climate variability and extreme is understanding how the system will or can adapt to stress and changes (Easterling *et al.*, 2004).

Table 6.2a: Vulnerability and adaptive indicators in Kuta and Galadima-Kogo.

Vulnerability and adaptive indicators	Group A	Group B	Group C
Income	Income per household on average is above N20, 000 per month	Income per household on average is below N20, 000 but above N6, 000 per month	Income per household on average is below N6, 000 per month.
Insurance/Co-operative Society	Have some insurance policies, like medical insurance. Belong to co-operative societies like trade union, teacher's association, Local Government civil servants association	There is no insurance policies, but has some co-operative societies, like farmer's co-operative societies, drivers union and traders association	No insurance policy, no trade union, but have farmer's and fishermen's association
Livelihood	Mainly civil servants, industrial workers and traders	Mainly civil servants and farmers	Only farmers and fishermen are found here.
Dependency	Low level of dependency on working group (less than 40%). Both husband and wife are working in most households	High level of dependency on the working group (about 57% of the population are dependent). Very few wives are working. Others are engaged in farming activities and household work	High level of dependency on the working group (more than 60%). All wives are housewives and do not work or trade except helping their husbands some times in the farm.

Source: Fieldwork 2005.

Table 6.2b: Vulnerability and adaptive indicators in Kuta and Galadima-Kogo.

Social Services	Have electricity, boreholes, good access roads, Have hospitals and health centres, schools, civic centres	Have electricity, but not well distributed. Hand pumps are available but mainly out of order, have access roads but mainly un-tarred roads, Have health centres, few primary schools, no civic centre	Have no electricity, no good access road, and no borehole, depend only on Kaduna River for water sources. Have no social services.
Custom	Has a very flexible culture. It is a heterogeneous society (Population consists of different ethnic groups)	Consists of mainly of the indigenous ethnic group, with few other ethnic groups in the community.	A homogeneous society (only one ethnic group), with strong cultural background.
Social Network	Do not live a communal life. There are a lot of interactions with the external communities. There are new ideas and information flow in and out of the communities in this group.	Live a communal life. Have a central head who co-ordinate the activities in the village. There is interaction with the external communities. There is new ideas and information flow among this group.	Live a communal life. Have a central head who co-ordinate the activities in the village. Do not have much interaction with the external communities. New ideas and information flow is limited.

Source: Fieldwork 2005.

The prominent factors contributing to aggravated flood effects at Shiroro communities on the Kaduna floodplain were poverty and the strong dependence on agriculture. These villagers were not capable of building structures (houses) to withstand flood impacts. Also, they are not empowered financially to relocate to other places, rather the government only allocated land for the inhabitants to relocate. The communities on the floodplain are reluctant, however, to relocate since they do not have the means to build other houses elsewhere. Finally, the floodplain is a fertile ground for agricultural activities, and the only source of their livelihood is agriculture. Other contributing factor is the negligence on the side of government. This is because government did not provide

the basic needs of these communities, for instance there is no access to good road, health facilities, schools and water. The villages under study are housing the second largest hydroelectric generating power dam (Shiroro Hydroelectric Power Generating Dam), which supplies the country electricity but the host communities do not have electricity. Having examined the major factors that make Shiroro communities along the Kaduna River highly vulnerable, attention now focuses on the adaptive strategies and adaptive capacities of these communities.

6.2 Adaptive strategies and adaptive capacities

Adaptation to environmental change is a fundamental human trait and is not a new concept. Throughout times past, human societies have shown a strong capacity for adapting to different climates and environmental changes, although not always successful (Easterling *et al.*, 2004). As evidenced by the widespread and climatically diverse location of human settlements throughout the world, humans have learned how to thrive in a wide variety of climate regimes, ranging from cold to hot and from humid to dry (Schneider, *et al.*, 2000). The resilience and flexibility exhibited in the patterns of human settlements evidence an inherent desire and some measure of capacity to adapt (Easterling *et al.*, 2004). Most natural systems and many human activities are sensitive to the changing climate (Adger *et al.*, 2004). The extent to which these systems will be harmed by changes depend on the magnitude of change and on the capacity of the natural or human system to adapt (Adger *et al.*, 2004). It follows that an assessment of the vulnerability of our society to climate change requires an understanding of both the likely future climate variability and extremes and the evolving socio-economic situation that determines our capacity to adapt (IPCC, 2001).

In the absence of planning, our society, like natural systems, will adapt autonomously to changing weather patterns, as it will to other changes in social, economic and environmental conditions (Brooks, 2003). The cost and residual damage will probably be higher than if appropriate planning decisions are made (Brooks, 2003). Such autonomous adaptation is reactive and frequently incremental (Brooks, 2003). A critical review of the way society, for example, Shiroro LGA are responding to climate variability and extreme

(flood) in the past and present, as will be shown later in this section, suggests that the community tends to muddle through rather than use forward planning. Planned adaptation relies on a deliberate response to identifiable impacts resulting from the effects of climate variability and extremes (Adger *et al.*, 2004). Several adaptive strategies or activities were found in this research. Social networks emerged as key adaptive factors as did the construction of storage facilities, and the formation of co-operative societies. Each of these strategies is discussed in more detail below.

Adaptive capacity of societies depends on the ability to act collectively in the face of the threats posed by climate variability and change (Adger *et al.*, 2004). Individual, groups within society, organisations and government make decisions on adaptation on behalf of the society (Adger *et al.*, 2004). A variety of processes that shape vulnerability and adaptive capacity of people are driven by a range of causal mechanisms that need to be understood if effective adaptation is to occur e.g. economic wealth, technology, information and skills, infrastructure, institutions and equity (IPCC, 2001). Lack of technology has the potential, for example, to seriously impede a nation's ability to implement adaptation options by limiting the range of possible responses (Scheraga and Grambsch, 1998). It is argued therefore, that a region with the ability to develop technology may have enhanced adaptive capacity (Scheraga and Grambsch, 1998). Examining the social dynamics and outcomes of adaptation moves beyond simply accounting for economic costs and benefits of adaptation (Brooks, 2003). One element of this research has been to explore the nature of these society-environment interactions, particularly the role of social network in adaptation processes.

A social network is a social structure between actors, mostly individuals or organizations (Wasserman and Faust, 1994). The social network indicates the ways in which these groups or organisation are connected through various social familiarities ranging from casual acquaintance to close familial bonds (Conley and Udry, 2001). The social structures found among the three major land use systems identified are different from each other. Groups A and B are closely related but that of Group C is quite different from A and B. In groups A and B, the population is a heterogeneous society, i.e., the

inhabitants are made of different ethnic groups. Communal life is not strong because of different ethnic groups that exist. There are interactions among the inhabitants, but more interaction exists with the external communities in the groups A and B. The interaction with the external communities gives way for new ideas and information flow in and out of the communities. In Group C, the population per village is, however, a homogenous society, i.e., the inhabitants in each village is made of only one ethnic group. Communal life is very strong in these communities because only one ethnic group exists per village, which makes the culture and norms very strong. Interactions among the inhabitants are very strong, with a very loose relationship with the external communities. This loose relationship with the external communities, however, restricts information flow and new ideas in and out of the communities.

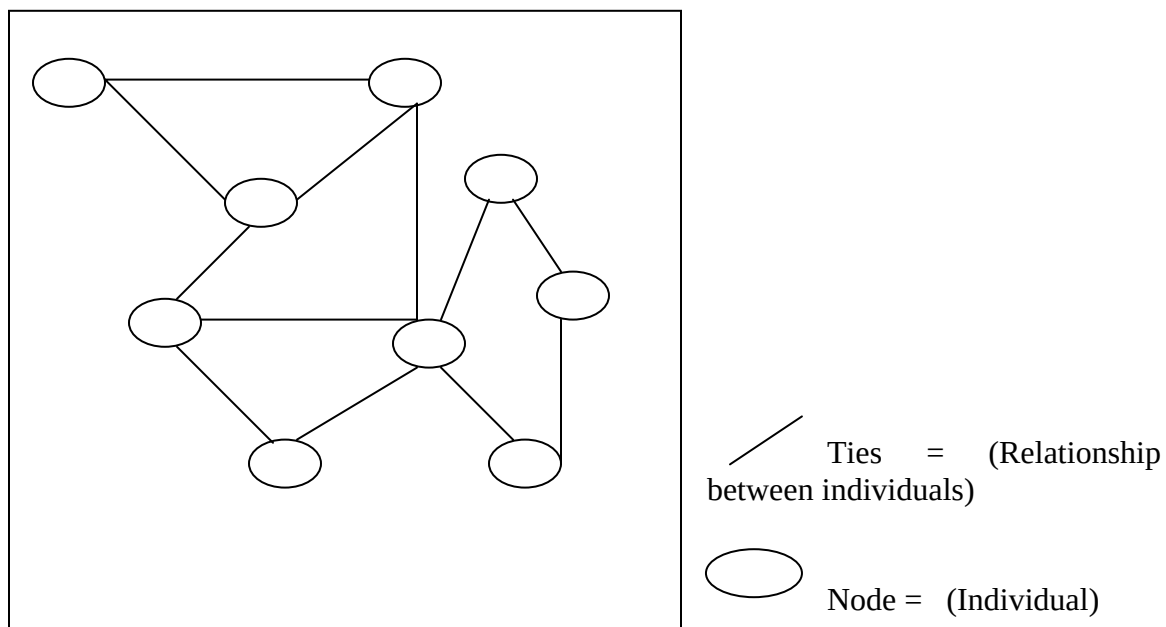


Figure 6.3: An example of a social network diagram (Source: http://en.wikipedia.org/wiki/Social_networking).

Social network theory views social relationships in terms of *nodes* and *ties* (Granovetter, 1973). Nodes are the individual actors within the networks, and ties are the relationships between the actors. There can be many kinds of ties between the nodes. In its most simple form, a social network is a map of all of the relevant ties between the nodes being studied (Granovetter, 1973). These concepts are often displayed in a social network diagram,

where nodes are the circles and ties are the lines (Fig. 6.3). The shape of the social network helps determine a network's usefulness to its individuals. Smaller, tighter networks can be less useful to their members than networks with lots of loose connections (weak ties) to individuals outside the main network (Granovetter, 1973). More "open" networks, with many weak ties and social connections, are more likely to introduce new ideas and opportunities to their members than closed networks with many redundant ties (Granovetter, 1973). In other words, a group of friends who only do things with each other already share the same knowledge and opportunities. A group of individuals with connections to other social worlds is likely to have access to a wider range of information. It is better for a particular network to have connections to a variety of networks rather than many connections within a single network (Wasserman and Faust, 1994).

Social network theory produces an alternate view, where the attributes of individuals are less important than their relationships and ties with other actors within the network (Conley and Udry, 2001). This approach has turned out to be useful for explaining many real-world phenomena, but leaves less room for individual agency, the ability for individuals to influence their success (Conley and Udry, 2001). Social networks in the group A and B are stronger than the social network in Group C. This is because the nature of social network in groups A and B allow for better interactions and connections to other social worlds which gives these communities (Group A and B) access to a wider range of information. In groups A and B which consists of heterogeneous populations, members also have good social amenities, for example, good road networks, schools, hospitals, piped water, electricity and new information technologies (such as internet, telephone, and postal services). In Group C, the social network appears to be weak, because the nature of social network in the group does not allow for good interaction and connection to other social worlds that could give these communities (Group C) access to a wider range of information. This may be attributed to the homogenous nature of the communities that exist in Group C, with strong culture and norms that restrict their interactions with other social world. Secondly, the communities in Group C lack social amenities, which may limit people's interest from other social world, in living in such

communities. The social networks in groups A and B therefore, are stronger than the social network in Group C. The weakening social network in Group C affects the adaptive capacity of the inhabitants to flood events. This research study, carried out among the communities in Shiroro LGA shows that social network is an important element for coping with climate variability and hazard, particularly among the villages on the floodplain. Although, the communities on the floodplain along the River Kaduna do not have good access roads to aid evacuation or relief supply delivery nor facilities to aid early warning, as a result of flood hazard, which the communities are currently facing, they have, however, devised means of coping especially at the time of need by forming farmers' cooperative societies, building storage facilities, and adopting various sand-filling techniques.

Building storage facilities is one of the adaptive strategies adopted by the Shiroro communities, living along the Kaduna River flood plain, to cope with the flood events. The entire household in these villages along the Kaduna River (Group C) have storage facilities for grains and cereals (Plate 6.1). These local silos helped the households to store and preserve agricultural products for future use. Also due to lack of access to market and financial institutions in Group C, every household was mandated to have silos to preserve the agricultural produce pending on the time and day they need money and other foodstuff. Agricultural products therefore, were sold at the time of need for other products (e.g. palm oil, rice, cocoa-yam, ground-pea, cowpea, sorghum, onions etc) that were not available.



Plate 6.1: Local storage facilities (Silos) made from clay soil.

Storage facilities, however, are not common among households in Group A. Data collected from the field indicates that the presence of storage facilities among households living outside the floodplain (Group A and B) is an indication of a commercial farmer, while those households without storage facilities are mainly civil servants and traders. In Group A, storage facilities are found among few traders, who buy some agricultural produce for sale, but store them for months pending on the time when the market price for such goods are higher than the price they bought them. Others are the very few subsistence farmers residing in the town (Group A) but have some farmland at Group B or C. In Group B, most storage facilities are owned by farmers and are an indication of households with large farmlands and depend mainly on agriculture. Presence of storage facilities is, therefore, more pronounced in Group C than in A and B, because of the persistence flooding and unavailability of market in Group C.

As a result of the persistent flooding, the communities living on the floodplain (Group C) sand-fill their compounds to raise the level of the land. This helps in preventing the

floodwater from wrecking their houses (Plates 3.2, 5.1 and 6.1). The sand-filling exercise is the work of women and children, while men construct channels around the compound to re-direct the flood flow. These activities did reduce the in-flow of water into the compounds. Also the traditional pattern of building houses among the villages along the Kaduna River is an adaptive measure to prevent floodwater from entering their houses. The entrance doors, for instance, are raised to prevent floodwater from entering into the house (Plate 5.6). In groups A and B, sand-filling exercise is uncommon since they are not living on a floodplain and they only experience an occasional flooding as a result of excess rainfall which does not constitute a serious problem to the communities. There are good road networks with water channels that increase surface run-off during flooding at the settlements in groups A and B, hence making the impact of such flooding less problematic. Although, in Group B, there are less water channels than in Group A, because the settlements in Group B are more of rural settlement. In Group B, most of the water channels are provided by the community, which is maintained from being filled up with sands and other rubbishes like cellophane bags, leaves, broken bottles etc, by the youths. Sand-filling exercise to cope with the flood events is only found among the villages in Group C. But water channelling is more pronounced with better system among the villages in groups A and B as an adaptive measure.

In an attempt to achieve successful adaptation, the Shiroro communities formed co-operative societies as an adaptive strategy to cope with flooding events. A successful adaptation is defined as the one that follows climate variability and extremes causing adverse impacts and maintains a system at approximately the same level of welfare or services as was provided before the change (Easterling *et al.*, 2004). If the adaptation can completely offset the loss from climate change variability and extremes, it is termed successful (Scheraga and Grambsch, 1998). Although less straightforward, adaptation also should be considered successful if it maintains services or welfare with a small or minimal loss (Easterling *et al.*, 2004). For example, adaptation is still successful if it offsets most agricultural income loss, but leaves an individual farmer with a small loss (Easterling *et al.*, 2004). Villages in Group C, for example, have adopted various social measures to withstand shocks and maintain services or welfare of the communities by

offsetting the loss from flood hazard completely or with a small or minimal loss. An example of this measure is the formation of co-operative societies.

A co-operative society is a group of people who have realised that they share a similar common problem and thus they come together to join hands with an aim of finding a solution (Chawane, 1991). These common problems could be, market (collection point or clients), water for irrigation, transport, roads, inputs (drugs and seeds) floods, storage etc (Chawane, 1991). A co-operative society can also be described as an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (Northcote, 1947). A co-operative society is another means of forming a legal entity to conduct business besides forming a company (Northcote, 1947). The benefits derived from being a co-operative society member are many considering the fact that a co-operative society is guided by Co-operative Act thus anyone who invests in a co-operative society has invested safely and wisely (Chawane, 1991). Co-operative society pools together human resources in the spirit of self and mutual help with the object of providing services and support to members (Chawane, 1991). The Co-operative Principles under which a co-operative society operates and carries out its business are voluntary and open for membership to come in or go out (Northcote, 1947). It Promotes economic activities, education and information technology. Co-operative society encourages co-operation among co-operatives and concern for the social and ecological environment (Northcote, 1947).

Farmer's cooperative societies in Group C have been created to help members at the time of need. A few months before cultivation, any household that has low or insufficient harvest during any harvesting period, or has been affected by flood event or locusts attack gets help from every member in the village in which he belongs. The head of the village usually announces the shortcomings and the number of people that need help to get seeds for cultivation. This is to help members of the village to regain and remain in agricultural production, since agriculture is the only livelihood of the communities. In Group B, there are also farmer's cooperative societies, but with different objectives as found in Group C.

The primary aim of the farmer's co-operative society among the villages in Group B is to help members financially during any social activities for example, burial ceremony, child naming, marriage ceremony etc. An interview conducted shows that floods rarely occur in Group B and does not constitute disaster to the community. During the year 1988 flood event, however, that was caused by heavy rainfall in these villages (Group B), most farmlands were affected leaving every farmer helpless. Farmers' co-operative societies in these villages did not offer any assistance to the members. Assistance in such occasional flooding events usually comes from outside, for example, some humanitarian groups and government assistance, not from the co-operative societies. Also, during drought that usually affects every member of the community, such co-operative societies do not really help out since the resources among the members are usually affected. In Group A, the inhabitants are mainly traders and civil servants. The types of social groups found here are: traders associations, local government workers union, teachers association, drivers union etc. These social groups in Group A are more of trade union that is formed to pursue the interest of the workers.

These examples of adaptive measures have some limitations. The sand-filling of the compounds by the communities, for example, can only prevent mild flood events but not severe flooding like that of the 1999 and 2003. Also, giving out seeds (yam seeds and grains) to members that are affected by low agricultural yields, depend greatly on the numbers affected. During extreme events such as drought, flood and pest attack (locust), for example, that may affect most of the villagers, such help does not occur because the seed or grains will not be sufficient. During such events (flooding or drought) villagers are dependent on resources from outside their villages including donor funding and humanitarian relief organisations. Villagers are more vulnerable to such extreme events and take much longer time to recover. Although coping strategies identified in Group C are popular and well activated in terms of flooding, they are being severely compromised by factors such as poverty, environmental degradation, weakening social networks, lack of technology and infrastructure, which determine adaptive capacity.

The communities along the River Kaduna at Shiroro LGA in Niger State of Nigeria lack the above factors that determine adaptive capacity. In addition, developing countries also have greater vulnerability to climate change because they have less adaptive capacity than developed countries. Smit *et al.*, (2001), identify the determinants of adaptive capacity as economic resources, technology, information and skill, infrastructure, institutions and equity. Developed countries generally possess more of these determinants than developing countries. Developed countries have higher income per capita than developing countries (e.g. the countries belonging to the organisation for Economic cooperation and Development generally are considered to be developed countries and they possess 30% of the world's population and 70% of the world's income) (World Resources Institute, 2003). These countries tend to have the best technology, the highest level of schooling and training, the best access to information, the most developed infrastructure, and the most stable and effective institutions (World Resources Institute, 2003). It is interesting, however, that equitable distribution of income does not appear to be correlated with level of development (World Resource Institute, 2003). Many developing countries, for example Nigeria, has less income disparity than developed countries, for example Canada (World Resources Institute, 2003).

On the whole, because developing countries, including Nigeria, tend to possess less adaptive capacity than developed countries, for example, United States of America, it is reasonable to expect that adaptation would be less effective in coping with adverse effects of climate variability and extremes (flood), especially the communities along the River Kaduna in Shiroro LGA of Niger State, with a very low income, poor infrastructure, weakening social networks and environmental degradation. Therefore, this research shows that the adaptive capacity of the communities along the River Kaduna in Niger State is being severely compromised by factors such as low income, weakening social networks, lack of information and skills and poor infrastructures.

Despite the constraints and limitations outlined above, the persistent flood hazard occurring along the Kaduna River floodplain has motivated the inhabitants to devise various means of coping with the flood hazard. The social networks do, however, remain

relatively weak among the communities in Group C as a result of poverty and culture that exist. In groups A and B, the social networks appear to be stronger, because of the better standard of living that exist in the communities. In groups A and B, their coping strategies are popular in their own way, since they only experience an indirect impact of flooding through increase in market prices of agricultural produce. The coping strategies in groups A and B are geared towards reducing the effects of high cost of living induced by flood disaster e.g. by forming trade unions, workers associations etc where members can be assisted financially in time of need. Also, the reasons for forming co-operative societies differ among the communities living on the floodplain and those outside the flood plain. While those on the floodplain (Group C) are meant to cope with the flood hazards, those outside the floodplain are geared more towards coping with increasing prices of agricultural products in the market. By lessening the severity of possible damages, adaptation is a key defensive measure. Adaptation is particularly important given the mounting evidence that some degree of climate variability and extreme is inevitable. Therefore, strengthening the adaptive capacity of the Shiroro communities along the River Kaduna floodplain is very important, by providing them with the basic social amenities (e.g. electricity, water, shelter, roads, schools and health facilities) to enable these communities cope with the flood events.

Household vulnerability is common at Shiroro LGA especially among villages residing along the River Kaduna floodplain. The communities are one of the most flood prone areas in Niger State, with fertile alluvial deposits for agricultural production. Demographic findings show that the population is skewed towards a high dependency ratio, which consists of large numbers of children and the elderly. In every household, it is usually only a man that works and is the provider for the entire members. Women (wives) do not work rather they usually stay in the house to take care of children.

Every household in the villages on the floodplain depends on agriculture as the only source of their livelihood. There is also a great disparity in water availability between urban and rural areas. All the villagers on the floodplain depend only on the Kaduna River for drinking and other household use. The town dwellers, however, have boreholes that supply tap water in their homes, which is clean and fit for drinking. Moreover, research shows that there are different coping strategies adopted by the communities to cope with the environmental hazard in the areas. These coping mechanisms include, provision of local silos, sand filling of compounds, raising doors to a higher level to keep flood waters away from entering the house

This research further revealed that the social networks are key adaptive strategies, but that they vary across and within communities. In Group C, for example, there appear to be weak social interactive links. This is because the nature of social network in the group C does not allow for good interactions and connections to other social ‘worlds’ that could give these communities (Group C) access to a wider range of information. Moreover, the weakening social network in the group C, which is not characteristic of groups A and B, may be attributed to the homogenous nature of the communities, with strong culture and norms that restrict their interactions with other social world. The social networks in groups A and B are stronger than the social network in the group C. In the next chapter, this research report will be concluded with the key findings of the research.