

**THE IMPACT OF THE OKAVANGO RIVER ON THE HEALTH OF THE  
COMMUNITY OF SEPOPA VILLAGE IN THE OKAVANGO DISTRICT, BOTSWANA**

**By**

**KETLABARENG PEACEFUL MOSARWANA**

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**DECLARATION**

I declare that THE IMPACT OF THE OKAVANGO RIVER ON THE HEALTH OF THE COMMUNITY OF SEPOPA VILLAGE IN THE OKAVANGO DISTRICT, BOTSWANA is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other institution.

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Ketlabareng Peaceful Mosarwana

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## ABSTRACT

**Introduction:** A qualitative study was undertaken to assess the impact that flooding of the Okavango river have on the health of the community of Sepopa village.

**Aim:** To assess the impact that flooding of the Okavango River has on the health of the community of Sepopa village.

**Study:** the study was conducted in the village of Sepopa within the community aged between fifteen years and above. The village has an estimated population of 2824.

**Method:** A non experimental descriptive research design using qualitative approach was used.

**Sampling:** Two types of sampling procedure were used, being simple random sampling and purposive sampling.

**Results:** The study revealed that 85% of the respondents reported or suffered from the injuries due to high waters brought about by floods, 92% reported to have fallen sick or having a member of their family who was sick with conditions related to floods. Of all the respondents, 54% explained they heard of deaths occurring in a river either due to drowning or crocodile and hippopotamus attacks. Lastly, 8% of respondents reported they never heard of any injuries, illness or death due to the impacts of floods.

**Conclusion:** It can thus be concluded that the river has an impact to the health of the community either before, during and after a flood event, activities may be undertaken by the population at risk, by policy makers and by emergency responders to reduce health risks. Proper planning aimed to reduce the harmful effects of flooding by limiting the impact of a flood on human health and economic infrastructure should be adopted.

**Key words:** health, sepopa village, impact, Okavango river

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## **DEFINITION OF CONCEPTS**

**Flood**; can be defined as a temporary covering of land by water outside its normal confines (Schanze, 2006).

**Flood** (in Okavango river) : can be defined as a temporary rise of water level, in a river resulting in its spilling over and out of its natural or artificial confines onto land that is normally dry, usually caused by excessive runoff from precipitation (Wolski and Murray-Hudson, 2006) .

## **LIST OF ABBREVIATIONS**

ASWSD	Accelerating Sustainable Water Services Delivery
CRED	Centre for Research on the Epidemiology of Disasters
CSO	Central Statistics Office
FAO	Food and Agriculture Organization
HSRC	Human Science Research Council
ICRAF	International Center for Research and Agroforestry
NEMA	National Environmental Authority
NePAD	New Partnership for Africa's Development
SADC	Southern African Development Community
SARDC	Southern African Research and Documentation Centre
SPSS	Statistical Package for Social Science
USGS	United States Geological Society

## CHAPTER 1

### INTRODUCTION

The focus of this study was to explore the impacts of flooding of the Okavango River on human health in the village of Sepopa and also to determine the causes of flood related morbidity and mortality. Because of constant flooding experienced by the area, it was believed that there was some kind of disruption to human health which was not there before. Okavango river started experiencing some floods in the year 2008 (Motsholapheko *et al.*, 2011). This follows the three decades of general decline of flooding that once occurred in the Okavango River. It was found out that due to these persistent floods in Sepopa village, there was increased number of outbreaks of communicable diseases, along with an increased risk for water and vector borne diseases which might be associated with floods (Motsholapheko *et al.*, 2011) , hence the choice of Sepopa village for study.

This chapter discusses the background to the problem that has prompted the study and focuses on the problem statement, research questions, aims and objectives of the study. It also gives a brief outlines of subsequent chapters.

#### 1.1. BACKGROUND INFORMATION

Floods are one of the widest spread disasters (EM-DAT: OFDA/CRED International Disaster Database, 2004). In the last century, there were over eight million fatalities attributed to floods (EM-DAT: OFDA/CRED International Disaster Database, 2004). Flood occurs when the earth cannot absorb all the rain that falls and excess water flows on the land (Clements, 2009). As Parker (2000) discusses in detail, floods can take many forms and it is not easy to pin down a precise definition for the term. Broadly speaking, however, and in the context of this study, the term flood will be used to refer to an excess accumulation of water across a land surface, an event whereby water rises or flows over land not normally submerged (Wolski and Murray-Hudson, 2006). Floods may vary in different ways which are; depth from a few centimeters to several meters may be stationary or flow at high velocity. Some are confined to narrow valleys or spread across broad plains. They may be of high intensity, creating high runoff or a build-up of surface water in areas of low relief. Rainfall contain sewage and pollutants, debris such

quantities of sediment that they are better termed mudflows (Few and Matthies, 2006). Floods may be slow to build up or rapid in onset as in flash floods. Some last from less than an hour to several months. In a nutshell floods can originate from a variety of sources; however, the principal causes can be summarized as: high rainfall, tidal and wave extremes, thawing of ice, and structural failure (Few and Matthies, 2006).

The leading cause of floods are heavy rainfall for a very long period of time which lead to gradual but persistent rise in water levels that causes rivers to inundate surrounding land for days or weeks at a time (Few and Matthies, 2006). In August 2002, for example, intense rainfall of long duration induced extreme flooding spanning five countries of Central and Eastern Europe (Caspary, 2004). Intense rain from storm and cyclones, on the other hand, may produce rapid runoff and sudden but severe flash floods across river valleys. The flooding from these events is typically more confined geographically and persists for shorter periods, but the violence of the event can be highly damaging and dangerous (Few and Matthies, 2006).

Floods may also be associated with regular climatic seasons such as mon-soon rains and other annual heavy rainfall periods. In some locations such as the major flood plains of Bangladesh, extensive flooding from seasonal rains is an expected annual occurrence to which human lifestyles and livelihoods are largely adapted, though such predictable flooding may still have health implications (Nishat *et al.*, 2000). However, seasonal flood levels vary from year to year, and such areas tend to be subjected to occasional flood events that exceed the normal range of expectation. In 1998, Bangladesh experienced flooding of an unprecedented magnitude (depth and duration), surpassing the previous record flood that occurred in 1988 (Nishat *et al.*, 2000). In 2004, the country was hit once again by floods of an equivalent scale (Alam *et al.*, 2005).

These disasters are growing in frequency worldwide due to a variety of human and environmental factors (Clements, 2009). The human factors that contribute to flooding are mostly associated with development and land use (Clements, 2009). Expanding populations and urbanization along shorelines and water ways place more people in flood hazard areas (Clements, 2009). Most major cities are built near water ways that have historically provided a means for transportation, drinking water and other urban necessities. Floods are one of the most threatening natural hazards for human society; this is evident from the increase in damages in the last fifty years due to a series of extreme floods (Clements, 2009). Recently, the Tsunami in the

south East Asia caused 220, 000 deaths which make it one of the most disastrous floods (Schanze, 2006).

Flooding is one of the most frequent and wide spread of all weather related hazards (Few and Matthies, 2006). Floods of various types and magnitudes occur in most regions of the globe, causing huge annual losses in terms of damage and disruption to economic livelihoods, businesses, infrastructure, services and public health. Long term data on disasters suggests that floods and wind storms (which frequently lead to flooding) are by far the most common causes of natural disasters worldwide (Few and Matthies, 2006). The International Federation of Red Cross and Red Crescent Societies (IFRC) reports that, in the last ten years from 1993 to 2002, flood disasters affected more people across the globe (140 million per year on average) than all other natural or technological disasters put together (IFRC, 2003). Further EM- DAT data collected by the Center for Research on the Epidemiology of Disasters (CRED) indicate that this numerical dominance continued through 2003 and 2004.

The Center for Research on the Epidemiology of Disaster (CRED), classifies an event as a disaster if at least one of the following has occurred: Ten or more people killed, 100 or more people reported affected, a call for international assistance, and or a declaration of a state of emergency (IFRC, 2003). According to their disaster data, floods come second only to drought or famine during recent years in causing direct mortality and account for more than half of all people affected by natural disasters. Since people affected are those that require immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and medical assistance, this measures provides an indication of the scale of health impacts associated with flooding (IFRC, 2003). Closer analysis of the statistics suggests that developing countries, in general, bear a disproportionate toll compared with industrialized countries (Few and Matthies, 2006).

Research into the health effects associated with flooding and the number of health reviews conducted seems to have increased relatively recently, perhaps driven by the increase in flooding seen during the 20th Century and the forecast from climate change modeling that this trend will continue (Few and Matthies, 2006). In the UK, research is being sponsored by a number of agencies, including DEFRA and the EA as part of their joint Flood and Coastal Defence Research and Development Program and includes a major study into health (particularly mental

health) and flooding, conducted in over 1500 homes in England and Wales (Few and Matthies, 2006). The health effects relating to flooding are generally split into those associated with the immediate event (with drowning being the most obvious) and those arising after the flood have resolved, i.e. post-onset, which may be related to exposure to flood waters, the clear-up process, or stress and anxiety. Health impacts can also be considered to be direct or indirect, with indirect impacts perhaps resulting from damage to infrastructure, food supply, etc. (Few and Matthies, 2006).

Floods have the potential to exact a major impact on the health of human populations, and for a given flood event the range of possible health outcomes is broad (Few and Matthies, 2006). These outcomes can result directly from health risks associated with the presence of floodwater (e.g. drowning, injuries and water related diseases) or indirectly via the impact of floods on shelter, livelihoods, and infrastructure and health systems. The degree to which a particular flood will affect human health depends upon a host of factors, including the:

- Nature of the flood event (i.e. regularity, speed of onset, velocity and depth of water, spatial and temporal scale of flood).
- Degree to which human populations and systems are vulnerable (e.g. socio- economic status, construction of houses, current status of population health, status of health care infrastructure)
- Capacity of human population and systems to adapt to (i.e. coping strategies) and
- Mitigate against the flood (e.g. early warning, evacuation and disaster preparedness) (Few and Matthies, 2006).

The mechanism by which human health are affected by flooding are often complex but are generally well understood. The main health outcomes may require human contact with flood water or may not, contact can be either in the home or the local environment (Few and Matthies, 2006). Health outcomes may also occur during different time periods. For example in the period immediately before the flood (pre-onset), injuries may occur as individuals remove themselves and their possessions from the rising flood water. Injuries may also occur during (onset phase) and after the flood (post onset) (Few and Matthies, 2006). Elevated levels of infectious disease may continue to occur sometime after the flood and adverse effects on mental health may only become apparent several months after the flood water have subsided (Few and Matthies, 2006).

Exposure to floodwater or water from sites that are intended to store or infiltrate rainwater may pose a health risk in humans. Such water may contain a variety of contaminants depending on the origin of the floodwater. Floodwater originating from rainfall-generated surface runoff may be contaminated by dirt from paved surfaces (including dog feces and bird droppings), while floodwater originating from flooded storm sewers may be contaminated by illicit connections to sanitary sewers (Marsalek and Rochfort, 2004) and floodwater originating from backflow from a combined sewer system will be contaminated with wastewater (Smith *et al.*, 2007). As a result, when flood occurs in an urban area, floodwater may contain human enteric pathogens such as norovirus and enterovirus, which are prevalent in urban wastewater (Lodder and De Roda Husman, 2005), or *Campylobacter*, *Giardia* and *Cryptosporidium*, which have been frequently reported in both animal feces and human wastewater (Schets *et al.*, 2008; Koenraad *et al.*, 1994). These enteric pathogens account for a large proportion of all gastrointestinal illnesses in the Netherlands and the US (De Wit *et al.*, 2001; Mead *et al.*, 1999) and may cause outbreaks when people are exposed to floodwater. The waterborne pathogens *Campylobacter*, *Cryptosporidium*, *Giardia*, norovirus and enterovirus can be seen as representative of the fate and transport of other pathogens potentially of concern from the waterborne route of exposure (Ferguson *et al.*, 2003). According to a systematic review (Cann *et al.*, 2013); the most common waterborne pathogens that were identified during outbreaks after extreme water events, such as flooding and heavy rainfall were *Vibrio* spp. (24%), *Leptospira* spp. (19%), *Campylobacter* (9%), *Cryptosporidium* spp. (9%) and norovirus (6%). However, it is unclear to which extent flooding pose a risk for public health. Health risks from exposure to water from the flooding of different urban drainage systems such as combined sewers, storm sewers and infiltration fields can expose people to these pathogens and dose response relations for different pathogens is vital. Other studies that were performed aimed to assess health risks due to ingestion of floodwater by determining the risk of infection for a set of waterborne pathogens that can cause gastrointestinal diseases. It is believed that some volumes of floodwater are ingested by people during exposure hence putting them at risk of infection.

While the devastation to properties is usually obvious following a flood event, the impacts on people (where drowning and serious injury does not occur) can be more subtle. Assessment of the health impacts of flooding, however, cannot generally be achieved through controlled prospective epidemiological studies, for obvious reasons. Thus, much of the literature is based on

opportunistic retrospective studies of flooding case studies or anecdotal evidence (Fewtrell and Kay, 2008).

Human vulnerability to floods is shaped by a combination of physical, social, economic and environmental factors, the attributes of the person or system that condition the impacts resulting from flooding. In the past physical aspects of vulnerability, the spatial distribution of populations and infrastructure in relation to flood hazards tend to receive more attention in hazards research (Hilhorst and Bankoff, 2004). But there is now increasing recognition given to the social aspects of vulnerability. For individuals, susceptibility to hazards depends largely upon behavior, well-being and the resources people have to enable them to avoid and recover from harm. These, in turn are largely determined by a wider social, economic, and political patterns that differentiate how flooding affect people and human systems (Cannon, 2000; Wisner, *et al.*, 2004). Analysis of vulnerability have therefore increasingly highlighted its socially constructed nature, underlining the importance of understanding how socio-political processes can create vulnerability and there by create disaster (Pelling, 2003; Hilhorst and Bankoff, 2004).

Wisner *et al.*, (2004) developed an analytical model that shows how underlying cases rooted in equality generate a progression of vulnerability that create the unsafe conditions in which hazards events turn to disaster. This process of vulnerability creation operates at different scales that the impact of flood disaster is so heavily skewed to developing countries is undoubtedly linked to disparities at the global level in resources available for risk reduction by government and citizens. Equally, at the intra community level, poverty and marginalization can create differential vulnerability, with the poor being both more susceptible and more exposed (UNDP, 2004; White *et al.*, 2004). Flood-prone marginally land in cities of low income countries for example often becomes the site of squatter settlements for the urban poor (Few and Matthies, 2006). But poverty and vulnerability are not one and the same, floods can reach the wealthy, too (Few, 2003). Indeed inappropriate floodplain and coastal development can generate vulnerability in all countries, affecting both the rich and the poor. It is also important to recognize that vulnerability is differentiated by social dimensions other than wealth. In both developing and industrialized nations, health and other impact may fall disproportionately on women, children, people with disabilities and the elderly (Few and Matthies, 2006). Jabry (2002) especially highlights the vulnerability of children during the onset and aftermath on natural disasters.

The gender perspective recognizes the fact that women predominate various types of care in the economy both within and across generations (Elson, 2002), especially in households. These cores put women at more risk of the impact of floods more especially those caring for patients affected by HIV/AIDS (Budlender, 2004). Care-giving activities undertaken by women in AIDS affected households include collecting fire wood and water; growing, storing, preparing and serving/distributing food; cleaning, washing, and bathing children and the sick. This is so because for those living with HIV/AIDS, access to safe drinking water is a critical factor due to their vulnerability to infections as their immune systems are impaired. As clearly put by Kaminga and Weglin-Schuringa (2003), access to safe water is an absolute necessity for people living with HIV/ AIDS as it is needed for drinking, washing their soiled laundry, taking medicines, and keeping their home environment in hygienic conditions. The increase in the impact of the HIV/AIDS epidemic led to the institutionalization of the home-based care program in Botswana which aims at sharing the responsibility of caring for the terminally ill patients (Butale, 2005). Lack of access to safe drinking water will make the AIDS-afflicted persons, particularly those under home care, more vulnerable to HIV/AIDS as opportunistic infections are likely to thrive in poor hygienic conditions. HIV/AIDS is not simply a health issue; it is also a “social, economic, political, cultural and human rights problem, which cuts across all sectors of developing societies” (Kaminga and Weglin-Schuringa, 2003). Thus strategies for prevention, treatment, care and support of those infected and affected by the disease should cut across all sectors of economy and society. This implies that the link between access to water and HIV/AIDS should necessarily be multidimensional. According to Hajat *et al.*, (2003), the adverse human health consequences of flooding are more complex and far fetching; some can last for few months and or possibly for years after the flood events. These problems are aggravated by the vulnerability of the affected population with more impacts noted on the elderly, children, women, disabled, ethnic minorities and those on low income as explained above (Hajat *et al.*, 2003).

According to a report of the World Commission on Water for the 21st Century, every human being should have access to safe drinking water as this resource is a necessary requirement for meeting basic human needs (Serageldin, 2000). Sustainable access to safe drinking water is one of the three targets set by the United Nations Millennium Declaration to achieve environmental

sustainability (UNDP, 2005). The target is essential to achieve in order to decrease the prevalence of water related diseases. Although physical infrastructure for portable water is available in the community, it may not be readily accessible to some social groups there, because access to portable water is determined by a number of factors such as the distance and time taken to the points of water collection (Howard and Bartram, 2003) and the ability to use water service delivery systems. Usability in turn depends on affordability as well as on institutional responsiveness and or accountability of service providers to client households. Floods on the other hand may destroy property leading to displacement of households and interrupt these water reticulation systems for potable water.

In the past floods response by government and other agencies focused largely on emergency relief efforts for affected populations and on structural mitigation attempts to prevent hazards through flood control engineering. Although structural mitigation measures, such as embankments and tidal barriers, will continue to play a major role in flood management, there is also a strong trend now towards advocating broader aspects of flooding preparedness and a less ready reliance on structurally responses (Smith, 200; Wisner *et al.*, 2004). Non structural flood mitigation and preparedness options include appropriate land –use planning, enforcement of building codes to avoid construction in flood-prone sites, insurance schemes and effective flood forecasting, warning and evacuation procedures (Few and Matthies, 2006). According to the International Federation of Red Cross and Red Crescent Societies (IFRC, 2002), priority disaster preparedness activities includes, risk and vulnerability mapping, disaster awareness and education early warning and evacuation systems, stockpiling relief materials, training in response skills, and planning at all levels to ensure coordination of disaster response. All of these activities can play their part in reducing risk to health. In Mozambique, for example, given the threat of future increases in flood intensity/frequency and the general prohibitive cost of local –scale structural defences, Christie and Hanlon (2001), stress the need for clearly marked evacuation routes and better and clearer public warning systems.

Good practice in flood preparedness is widely seen to involve cross-sectoral coordination by public and Non Governmental Organizations (NGOs) and external agencies in developing response plans at different scales that are in place before disaster strikes (Few and Matthies, 2006). For example, the red cross in Latin America has set up the Pan –American disaster

response unit (PADRU), based in Panama, to coordinate and strengthen regional and local capacity in disaster preparedness and response capability. It views the optimal scale of organization for disaster preparedness as dependent upon the type of activity with strategic relief, stock piles and international relief coordination best managed centrally but search-and-rescue operations and evacuation procedures best organized at a local level (IFRC, 2002).

It has been known for thousands of years, at least since the time of Hippocrates that climate has wide ranging impacts on health. Increasing recognition of the process of climate change has led to a growing interest by health researchers in assessing the potential mechanisms by which changes in climate could influence health (Haines *et al.*, .2006). Such health effects will be modulated by factors such as socioeconomic development and by the degree to which effective adaptation measures are implemented. Although most studies have assessed the potential impacts of climate change in isolation from other environmental changes, in reality, climate change will be experienced against a background of other global changes such as population growth, urbanization, land use changes and depletion of fresh water resources that themselves have implications for health and which could, in some instances interact with climate change to magnify the impacts. There are several mechanisms by which climate can affect health. Extremes of temperature and rainfall, such as heat waves, floods and drought, have direct immediate effects on mortality as well as longer term effects. For example, populations that have experienced flooding may suffer from sustained increases in common mental disorders.

One of the major global concerns in climate change is the increased frequency of extreme events. Extreme rainfall events may occur more often and may cause flooding to occur more often (Easterling *et al.*, 2000). Climate change is leading to an increase in the occurrence and magnitude of extreme flood events. Flood as one of the mechanism of climate change is likely to affect biodiversity and the ecosystem goods and services that we rely on for human health. Changes in temperature and rainfall may also affect the distribution of disease vectors, e.g. those of malaria and dengue, and the incidence of diarrheal diseases. Sea level rise is likely to threaten low lying coastal populations, particularly in countries where economic conditions do not allow construction of sea defences and other counter measures. There are also concerns that flooding, may lead to population displacement and more environmental refugees. Research on the health impacts of flooding addresses three main topics: current associations between flooding and

disease; the effect of recent changes in climate; and the evidence base for projecting the future impacts of flooding on health. Impacts of flooding have been increasing globally for the past two to three decades. The detection and attribution of health effects to these changes has become a key research challenge. This change in climate is projected to continue and accelerate. At the upper end of the range effects will be more difficult to predict and likely to be more seriously adverse.

The extent of flooding, and the accompanying impacts, are expected to increase over the next 50–100 years owing to the effects of global warming (IPCC, 2007; Stern and HM Treasury, 2007) and factors such as disparities in wealth and access to resources (Evans et al., 2004). Regional changes to flood distribution may mean that areas not previously affected by flooding may become newly afflicted as a result of climate change (Few, 2006). However, over the years and particularly in developed countries, people have come to expect to be protected from flooding and have become less aware of the potential risks and likely health impacts of living within a floodplain. In England and Wales, river floods have been typically small scale, short lived and shallow, but since 1998, there have been more frequent incidents of extreme events and severe flooding, most recently in Boscastle (2004) and Carlisle (2005) (Environment Agency, 2005a, b). An estimated two million properties and over four million people are considered to be potentially at risk from river, estuary or coastal flooding (Evans et al., 2004); vulnerability to pluvial, groundwater and sewer flooding may significantly add to these numbers. Current trends in flood response show that there is a shift from mitigation to adaptation in order to lessen the impacts of flooding on human activities, their health and livelihoods (Schipper and Burton, 2009). This is partly due to realization that flood control measures have limitations due to changes brought about by climate variability and change (Few, 2003; Niang et al., 2007; Schipper and Burton, 2009). Additionally, many flood control measures are beyond the capacity and capability of many developing countries like Botswana, particularly when there is a high frequency of high floods. The low capacity to adapt to the impacts of flooding and other shocks in developing countries is associated with their low levels of human, financial, physical and natural capital, as well as weak institutional capacity or poor governance (Niang et al., 2007; Vanderpost, 2007; Eriksen et al., 2008; Leary et al., 2008). At the micro-economic level, this results in high vulnerability to shocks among households, particularly those that depend on natural resource-based livelihoods, example being the community of Sepopa village. Almost 100

000 Batswana depend on the Okavango River and Delta (Motsholapheko *et al.*, 2011). Over 70% of the riverside households fetch water from the delta during the dry season, 75% of households catch fish and collect edible or medicinal plants from the delta and almost 20% of households' plough crops on the delta floodplains (Motsholapheko *et al.*, 2011). Materials for building homes and making tourist crafts also come from the delta (Motsholapheko *et al.*, 2011).

Floods have been identified to be the most common hazard to cause disasters and have led to extensive morbidity and mortality throughout the world (Hajat *et al.*, 2003). The impact of floods on the human community is related directly to the location and topography of the area, as well as human demographics and characteristics of the built environment (Hajat *et al.*, 2003). Botswana experiences such floods in the Okavango River (Mendelsohn and Obeid, 2004). The Okavango River is a river in South West Africa. It is the fourth longest river system in Southern Africa running South East ward for 1600 km (Mendelsohn and Obeid, 2004). It begins in Angola where it is called Cubango River (Mendelsohn and Obeid, 2004). Further south, it forms the border between Angola and Namibia and then flows into Botswana, draining into the Moremi game reserve (Mendelsohn and Obeid, 2004). Okavango does not have an outlet to the sea; instead it empties into a swamp in the Kalahari Desert known as the Okavango delta (Mendelsohn and Obeid, 2004). Floods experienced in the Okavango River originate from the Angola highlands which are about 1250 km away (Mendelsohn and Obeid, 2004). It happens as the rain falls in January in Angola, which is three times higher than the one experienced by the Okavango district in Botswana. Although it rains in January in Angola, it takes about five months to experience the floods in the Okavango River. The flood water takes about one month to find its way through the numerous channels of the 250 km of the delta (Mendelsohn and Obeid, 2004). The floods reach their peaks between June and August, which are the Botswana's dry winter months (Wolski and Murray-Hudson, 2006). The delta and the river can sometimes swell three times its permanent size, stretching to the nearby dry land (Wolski and Murray-Hudson, 2006).

In the Okavango Delta, Botswana, flooding is a major biophysical event that influences human environment system interactions (McCarthy *et al.*, 2003). Though it enhances ecosystem performance by supplying water and nutrients through sediment transfer to support the Delta's rich biodiversity as well as household livelihoods (McCarthy *et al.*, 2003), these positive dimensions contrast with the negative impacts of extreme flooding that occurred during the 1970s, 1980s and again from 2009 which its occurrence causes human life disruptions. The

Okavango Delta system is subject to annual variability in flooding with extreme floods resulting in adverse impacts on rural livelihoods (Wolski and Murray-Hudson, 2006). The analysis revealed that water levels and discharges at any given channel site in this distributaries are influenced by a complex interplay of flood wave and local rainfall inputs, modified by channel floodplain interactions, in channel sedimentation and technical interventions, both at the given site and upstream (Wolski and Murray-Hudson, 2006). The Okavango Delta is a flood-pulsed wetland, which supports a large tourism industry and the subsistence of the local population through the provision of ecosystem services (Wolski and Murray-Hudson, 2006). In 2004 and 2009, extreme flooding resulted in livelihood disruptions in the Okavango delta areas (Motsholapheko *et al.*, 2011). The main impacts included crop damage, household displacement, and destruction of household property, livestock drowning and mud-trapping, destruction of public infrastructure and disruption of services (Motsholapheko *et al.*, 2011).

These floods disruption on cultivation in floodplains, destroying of property that lead to displacement of households, interruption of water reticulation systems, has an impact on the health of the population living within the delta as it also curtail transport systems affecting the transfer of goods and services so much needed in times of disasters (Bendsen and Meyer, 2003; Magole and Thapelo, 2005; Malala, 2009). Rural households have over long periods adapted in various ways to variable flooding levels. This sudden change in the ecosystem has forced the households living in these areas to develop some coping strategies such as switching to other livelihood activities like fishing, temporary relocation to less affected areas, and use of canoes for early harvesting or evacuation and also rely on government assistance sometimes for evacuation particularly for the most vulnerable households (Motsholapheko *et al.*, 2011). However, socio-economic changes such as population growth, economic transformation, alterations in household social fabric, land use policy and administrative changes have negatively affected past adaptive strategies (Wilk and Kgathi, 2007; Dube and Sekhwela, 2008).

The impacts of extreme flooding on rural livelihoods in the Okavango Delta have been documented (Bendsen and Meyer, 2003; Magole and Thapelo, 2005). However, the relative importance of the various adaptive strategies, the causes of low adaptive capacity and the vulnerability of households are still not well understood. Past incidents of this shock in various parts of the country have been reported in the 1970s and 1990s (Tsheko, 2003). Little is known

about the long-term impacts of floods on household livelihoods. According to Central Statistics Office (2009: p3), ‘‘known reliable records on floods’’ may be recent, dating from 1995. This may be attributed to the generally rare occurrence of extreme flooding and the relatively new institutional preparedness for this shock in Botswana. There is a specific need to identify the causes of low adaptive capacity and high vulnerability among rural African households, especially those that become victims of the impacts of extreme flooding and other livelihood shocks. This will help build strategies for strengthening their capacity to adapt.

It may seem hard to believe that a small, slow-flowing stream or gentle river could cause serious damage to people and the places in which they live and work, but looks can be deceptive. People used to enjoy living near rivers in the past mainly for food, water, transport and protection. Even today people enjoy the peace and tranquility flowing water can offer. Flooding can turn even the most harmless looking watercourse into a raging torrent of large-scale destruction - buildings may prove no obstacle to its power; food crops may be ruined leading to food shortages and even starvation, people’s lives may be lost through drowning disease and homelessness. Rivers can be things of beauty and the historic lifeblood of a settlement. In the past the community of Sepopa has been using flowing water to enhance life and living, whilst trying to contain its destructive powers when in flood, which was not so severe at times.

The consequences of flooding are by no means solely negative. Seasonal river floods, in particular, play a crucial role in supporting ecosystems, renewing soil fertility in cultivated floodplains (Wisner *et al.*, 2004). In regions such as the floodplains of Bangladesh, a normal level of seasonal flooding is therefore generally regarded as positive. It is only when a flood reaches an abnormal or extreme level that that it is perceived negatively as a damaging event (Parker, 2000).

## **1.2. RESEARCH PROBLEM**

Okavango River is the natural resource which supports an economically important tourism industry and the subsistence livelihoods of the local population and most families find wealth in its river banks (Ngwenya, 2009).

Okavango River started experiencing some floods in the year 2008 (Motsholapheko *et al.*, 2011). Floods of such magnitude once occurred in the years of 1970 and 1980 and since then it ceased to flood due to low rainfall that were experienced in Angola (Motsholapheko *et al.*, 2011). Following the three decades of general decline of flooding extent that occurred in the Okavango River, areas around the river went dry and became subjected to major human interventions, with vicinity of settlements and safari camps.

The inflow from Angola started to become slightly above average once again in the year 2008. In that same rain season, Botswana had experienced slightly above average rainfall as well. The same trend was experienced also in the year 2009 where the floods from Angola were above average following the above average rainfalls (Motsholapheko *et al.*, 2011). This trend followed year after year up to date causing floods.

In the ten years prior to 2011, flooding has been the most common type of disaster globally, responsible for almost half of all victims of natural disasters and for economic losses of nearly US \$185 billion (EM-DAT, 2011). It is thought that floods will increase the global burden of disease, morbidity, mortality, social and economic disruptions, and will place a continuing stress on health services, especially in low-resource countries. It is in these countries where most major floods occur and where vulnerability is the highest (Abaya *et al.*, 2009; Ahern *et al.*, 2005). Furthermore, floods damages crops and inundate farmlands, which lead to food shortages. Floods also damage property and displace those living in the flooded area, making health facilities inaccessible to those in need of medical attention due to flooding .

Botswana, as one of the developing countries is by no means spared by the effect of floods, it was found out that due to these persistent floods in Sepopa Village, there are increased number of out breaks of communicable diseases, along with an increased risk for water- and vector borne diseases which might be associated with floods. The incidence of diarrhea experienced in the area following periods of flooding increased, and the increase was linked to floods because flood waters are believed to carry pathogens and pollutants that can contaminate food and water source (Hunter, 2003). Vector-borne disease such as malaria was also found to be on the increase in the aftermath of floods mainly due to an increase in the habitats, such as stagnant pools, that is used by the vector population (Hunter, 2003). However, though relationships can be made, there is

seldom an analysis conducted in order to look at trends and causes between floods and outbreaks of diseases, hence the need for the study undertaken by the researcher so that informed decisions can be taken to address the problem.

### **1.3. RESEARCH QUESTION**

What are the impacts of flooding of the Okavango River on the health of the community of Sepopa village?

### **1.4. AIM OF THE STUDY**

The aim of the study is to assess the impact that flooding of the Okavango River have on the health of the community of Sepopa village.

### **1.5. OBJECTIVES OF THE STUDY**

Objectives of this study are:

- To explore the impacts of flooding of the Okavango river on human health in the study area.
- To determine the causes of flood related morbidity and mortality.

### **1.6. SUBSEQUENT CHAPTERS**

The research study is divided into the following six chapters and brief outline of the chapters are discussed below:

**Chapter Two: Literature Review:** This chapter focuses on the study of the existing literature on the impact of the river on the health of the community of Sepopa village, Botswana and elsewhere.

**Chapter Three: Research Methodology:** This chapter describes the research methodology, study site, study design, ethical consideration, sampling, data collection and data analysis used in the study.

**Chapter Four: Results:** Chapter four present the findings of the research study and interprets the results with the use of analyzed data and literature.

**Chapter Five: Discussion:** The discussion is based on the results obtained by primary research and focuses on the impact of the Okavango River on the health of the community of Sepopa village in order to address the aims and objectives of the study.

**Chapter Six: Conclusions and Recommendations:** This chapter provides a summary of the research study and a conclusion based on the results of the research. It also discusses recommendations based on the findings and conclusion of the study and advocates areas for future research in the impact of floods in the health of the community.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 INTRODUCTION

Concern about risk has become thematic of late modern society, and its role in an environmental context has been much discussed (Beck, 2006). Risks such as climate change have increased in magnitude and have become globalised and are therefore more difficult than in the past to calculate, manage or avoid. Beck (2006) suggests that sooner or later these risks will strike those who produce or profit from them. Modernity therefore finds itself in a state of reflexivity or self-confrontation with the effects of risk society. In relation to flooding, human actions (social acts) thus add both to the increasing probability of flood risk and the consequences. The technico-scientific rationalistic or realist approach to risk sees it as ultimately controllable and in the past there was an overwhelming presumption by humans of the ability to conquer nature. For example, people living in urban areas did not (and in many cases still do not) expect to be flooded as nature had been ‘tamed’ or controlled. This technocratic paradigm has until recently pervaded flood management institutions (Brown and Damery, 2002; Defra, 2005), creating a basis for moral judgments concerning implementation of risk-reduction procedures and a culture of blame.

Moreover, differences in expert/lay perceptions of and responses to risk often lead to increased public mistrust of institutions and science (Tapsell and Tunstall (2008). Hazards are socially constructed and based on our evaluations of risk. The public tend to define risk more broadly and take into account some of the societal implications of accepting the risks. Tapsell and Tunstall (2008) cites the tendency to be unnerved by the mobility of non-human life, nature is supposed to stay still. Floods are classifiable according to cause (high rainfall, tidal extremes, structural failure) and nature (e.g., regularity, speed of onset, velocity and depth of water, spatial and temporal scale) (Ahern *et al.*, 2005). Therefore, floods are water ‘in the wrong place’ or ‘at the wrong time’ (Tapsell and Tunstall (2008). However, ‘natural’ space is also changing over time, and more recently with global warming; there is no fixity as is often implied. According to Massey (2005), the non-human also has its trajectories and the event of place demands no less than with the human, a politics of negotiation. Therefore, if bio-physical and social factors

combine in place to mediate flood risk and impacts, what then might these impacts be on human health? For this study, good health is defined as a state of complete physical, mental and social well-being, and not merely the absence of disease and infirmity (WHO, 1948).

In this chapter, we further discussed the Flooding of the Okavango River, short term health outcomes of floods, longer term impacts of flood, vulnerability to flood exposure and ways of addressing immediate and future needs of the population affected.

## **2.2. Flooding, the Okavango River context**

Water is a key element in the economic, social and cultural development of any society. Throughout history, people have settled next to waterways and in flood plains because of the advantages that they offer. In spite of these benefits, water can also cause destruction and damage. In a nut shell, flood devastation results in loss of lives, widespread crop destruction, water borne diseases and associated economic disasters. Unlike flash floods associated with tropical cyclones and storms, floods in the Okavango River are usually expected at a certain time. As argued by Wisner *et al.*, (2004), these types of floods amount to known risk, implying that a certain level of preparedness is possible. However, experience shows that floods have a wide range of frequency, intensity and duration characteristics which complicate prediction and preparedness. Therefore, even those floods which are beneficial under normal circumstances are potentially dangerous. This ambiguous character means that there is always the risk of disruption of people's lives, loss of livelihood, damage to property, general human suffering and even death.

The Okavango delta is an alluvial fan with an aerial coverage of 12,000 square kilometer and a generally low gradient (McCarthy *et al.*, 2003; Wolski and Murray-Hudson, 2006). The delta receives annual floods the size and coverage of which depend, mostly on rainfall in the catchment area of the Cuito and Cubango rivers in central Angola. Mean annual rainfall in the Okavango Basin varies from 876 mm and 983 mm in the Cuito and Cubango rivers, respectively, to 450 mm in the Delta (McCarthy *et al.*, 2000; Wolski and Murray- Hudson, 2008). It is generally low and erratic contributing about 25% of all the water, and droughts are common (Anderson *et al.*, 2003). As a natural system, the Delta and the Okavango River has inter-annual

variability with periodic oscillations of wet and dry cycles (McCarthy *et al.*, 2000; Wolski and Murray-Hudson, 2008). Rainfall variations in the catchment have occurred in both the Cuito and Cubango, with gradual decline since the late 1970s (Gumbrecht *et al.*, 2004; Wolski and Murray-Hudson, 2008). Consequently, there were periods of very low inflow which contributed to desiccation of some parts of the Delta in the early 1990s to mid-2000s. The Delta is currently in the wet phase with more flooding observed in 2009 and 2010 (Motsholapheko *et al.*, 2011). Time series data from early 1930s; indicate that high inflows with possible extreme flooding have periodically occurred. The highest inflow was in 1968 measuring 16,000 cubic millimeters at Mohembo hydrological station (HOORC, 2010). The resultant flood may have attracted less public and research attention than the floods resulting from the 2004, 2009 and 2010 inflows. These inflows measuring between 11,000 cubic millimeter and 12,000 cubic millimeter, and the resultant floods occurred at a time when the entire delta had increased human activity with higher population concentrations, more economic activities and major land use changes. The Delta is a habitat for many aquatic and terrestrial species as well as an important livelihood resource base for the human population in the entire Ngamiland District (McCarthy *et al.*, 2003; Kgathi *et al.*, 2004).

Livelihood within the communities living in the banks of the Okavango River depends on several factors; they practice arable and livestock farming, some rely on formal employment, government social safety nets, remittances and fishing. This constitutes key sources of livelihood for a significant proportion of the river population (Ngwenya, 2009). Ngwenya (2009) also observed that income diversification, multi-local residences and migration characterize human adaptation to flood/climate variability in the Okavango basin. Although arable agriculture is primarily dryland or rain-fed and less dependent on drawing water from the Okavango River, it still remains the key food system within the area (Ngwenya, 2009). As such, the proximity to the river put residents at risk during flooding periods. In a study that was conducted by Motsholapheko *et al.*, ( 2011) on the Rural livelihoods and household adaptation to extreme flooding in the Okavango Delta, Botswana Household survey results indicate that in 2004, 7% of all households interviewed were affected by extreme flooding. These were in the villages in the upper- and mid-Delta. Some households lost their crops, while others were displaced or lost property and livestock.

In rural areas of Botswana, mostly in the Okavango district where Sepopa village falls, the water supply infrastructure has been largely developed but unreliable, though some handful have water connections to their homes, most community member use community water supply systems as the common mode of water supply. In these areas, water supply infrastructure is usually in the form of shared facilities such as communal taps (Peter-Varbanets *et al.*, 2009). These supplies have varying reliability, with an unacceptable proportion of apparently improved supplies being non-operational when inspected (Rietveld *et al.*, 2009). One of the major problems facing the drive to provide access to, and maintain continuity of improved drinking water supplies has been the lack of strong evidence of the effects of system failure on public health gains from these supplies (Lee and Schwab, 2005). Therefore, there is a great need for effective studies of the public health gains achievable from community safe drinking water supply interventions but more importantly there is also a need to investigate the effect of the reliability of these systems and assess the impact that poor reliability has on the public health objectives (Hunter *et al.*, 2009).

The importance of availability of high quality drinking water can be realized by the press release of UNO Secretary General on world water day 2002. “An estimated 1.1 billion people lack access to safe drinking water, 2.5 billion people has no access to proper sanitation, and more than 5 million people die each year from water-related diseases — 10 times the number killed in wars, on average, each year. All too often, water is treated as an infinite free good. Yet even where supplies are sufficient or plentiful, they are increasingly at risk from pollution and rising demand. One of the major pollutants to fresh drinking water is flood. When flood water are exposed to contaminants either due to accumulation of dirt on surface runoff or coming into contact with sanitary sewers. Such water may contain a variety of contaminants depending on the origin of the floodwater. It may contain human enteric pathogens which are prevalent in sewer waters more especially in urban wastewater (Lodder and De Roda Husman, 2005). These enteric pathogens account for a large proportion of all gastrointestinal illnesses in the Netherlands and the US (De Wit *et al.*, 2001) and may cause outbreaks when people are exposed to such floodwater.

By 2025, two thirds of the world's population is likely to live in countries with moderate or severe water shortages (Hinrichsen and Tacio, 2002). Water is an essential element for life.

Freshwater comprises 3% of the total water on earth. Only a small percentage (0.01%) of this freshwater is available for human use (Hinrichsen and Tacio, 2002). Unfortunately even this small proportion of freshwater is under immense stress due to rapid population growth, urbanization and unsustainable consumption of water in industry and agriculture. According to a UNO report, the world population is increasing exponentially while the availability of freshwater is declining. Many countries in Africa, Middle East and South Asia will have serious threats of water shortage in the next two decades. In developing countries the problem is further aggravated due to the lack of proper management, unavailability of professionals and financial constraint (PCRWR, 2005).

It is thought that floods will increase the global burden of disease, morbidity, mortality, social and economic disruptions, and will place a continuing stress on health services, especially in low-resource countries (Abaya *et al.*, 2009). It is in these countries where most major floods occur and where vulnerability is the highest (Abaya *et al.*, 2009; Ahern *et al.*, 2005; Assanangkornchai *et al.*, 2004; Fundter *et al.*, 2008). The characteristics of floods and their significant impact on human health over the last decade have been examined in epidemiological studies conducted in both high and low-resource countries. Additionally, reviews of epidemiological (Ahern *et al.*, 2005) and other (Du *et al.*, 2010) evidence of flood-related health impacts have been conducted. However, there remains a need to improve the understanding of the health risks in different settings and of the social and cultural modifiers of those risks (Ahern *et al.*, 2005), longer-term health impacts of floods (Ahern *et al.*, 2005; Carroll *et al.*, 2010; Milojevic *et al.*, 2011) and effective methods to mitigate these impacts.

At the community level, extreme flooding disrupted some services throughout the Okavango River with effects on households in the affected villages (Motsholapheko *et al.*, 2011). For instance, the floods disrupted three water treatment plants, causing water shortages in 22 villages of the Okavango Sub-District. Some households along the river resorted to using river water for domestic purposes including drinking. In the lower parts of the delta, some boreholes were also shut down after being submerged, resulting in widespread water shortages. Road transport services to major settlements were also disrupted after the main bridge in Toteng was submerged and remained so for 2 months (Motsholapheko *et al.*, 2011). This prompted district authorities to

reconstruct old gravel roads to divert traffic. Road links to some localities were also cut out urging some residents to relocate in order to access health, transport, education for children and most other basic services. In some localities, most community members especially the elderly stayed for some months without health and social welfare services (Motsholapheko *et al.*, 2011). Community tourism activities were also disrupted in these areas with subsequent loss in household income. Informal interviews indicated that a total of 240 community-based mokoro (canoe) polers and tourist guides spent three months without tourist clients. This resulted in loss of opportunities to earn monthly income especially that it occurred during the tourism peak season (March–September). During that time, a poler could earn up to BWP1 500 (approximately US\$200) a month (Motsholapheko *et al.*, 2011).

Gender is playing a significant role within the community as water resources and poverty dynamics in the Okavango basin indicate that men and women are constrained in different and often unequal ways as potential participants or beneficiaries of water resources (Ngwenya, 2009). One direct water related resource that cuts across age and gender is fishing. Whereas generally some natural resourced based livelihood activities in the area are gender specific, others cut across age and gender. Along the Okavango River, there are different communities living either in gazetted or ungazetted settlement. The majority of households in gazetted settlements draw potable water from communal standpipes, those in ungazetted settlement abstract untreated water from river flows and hand dug wells when the river is not flowing. Unreliability of water-supply and distance from homesteads has resulted in some community members within the gazetted settlements also to resort to collecting water in the river flows (Ngwenya, 2009). Ngwenya (2009) has observed that headcount poverty rate in Ngamiland is very severe ranging at 40% and 50% in Ngamiland east and Ngamiland west respectively. Furthermore, Ngamiland west has high proportion of women headed households with low levels of human capital development. Studies from elsewhere indicated that women tend to benefit differently from men in the fishing industry including marketing and processing. This therefore put the community at high risk of the impact of Okavango River on their overall wellbeing.

Though Sepopa community have livelihood activities with great overlap between men and women in respect that both men and women cut grass, river reed and collect veldt products and

water lily exposing them to the impact of the flooding river, women are also faced with performing other duties like cooking, washing, and watering livestock along with home-based care of ailing family members. These caregivers are sometimes affected by the water supply unreliability in the village hence opt for collecting water from the river directly to use domestically with the opinion that the water from the main channel is safe to drink and does not necessarily cause diseases. This therefore put women at more risk of the impact of the flooding Okavango River as compared to men who might be hunting for wildlife and birds instead (Ngwenya, 2009).

In a study that was conducted by Motsholapheko *et al.*,(2011), more female-headed households (60%) were affected by the floods inflows than male-headed households (40%). Disruptions were also observed in 2009 with 23% of households being affected and 61% of them being male-headed. The main impacts of extreme flooding were crop damage (53%), household displacement (18%), destruction of household property (12%), livestock drowning and mud-trapping (11%), and others (6%) including loss of human life due to drowning. Data from the District Administration office indicate that in 2009, extreme floods displaced 157 households (856 people) in twelve villages in the upper Delta (District Administration Ngami Sub-District, 2010). The displacement of households occurred throughout many areas in the river bank and included areas that were never affected by floods in many years. However, in 2009 and 2010 these villages had more household displacements, crop damage and loss of property with impacts on livelihood activities (Motsholapheko *et al.*, 2011).

A total 56 households (346 people) were displaced in several villages across the delta, the displacement resulted in permanent relocations to less risky areas as some affected households moved to newly allocated residential plots (District Administration Ngami Sub-District, 2010). For the first time in many years, a total of 31 households (150 people) were also displaced in areas that were never flooded before including its associated localities. An estimated 109 ha of molapo fields, for 67 households, were submerged by the floods in five villages of the upper Delta (District Administration Ngami Sub- District, 2010). As later confirmed by key informants, this resulted in food shortages for the affected households (Motsholapheko *et al.*, 2011). In localities around the delta, some households stated that flooding reduced livestock

grazing pastures as most of the flood plains were submerged for many months. This resulted in livestock deaths due to starvation and mud-trapping. Some households that were evacuated to enhance access to basic services left large numbers of livestock in islands. This made it difficult to monitor the status of such abandoned livestock with possible rise in predation, mud-trapping and straying. In some cases flooding separated households, weakening social ties and mutual assistance among kin (Motsholapheko *et al.*, 2011).

The destruction of crops in some fields has mostly been noted in some villages located in the banks of the river and their respective associated localities. It has been described by households as severe in some cases. In a study conducted by Motsholapheko *et al.*,(2011), household interviews indicated that 62% to 72% of households in some flooded areas had whole field crops destroyed by flooding. Most of these remained submerged for prolonged periods of time reducing the ploughing period with adverse effects on household food security. As also confirmed in key informant interviews, the losses adversely affected household food security and the ability of households to deal with the impacts of extreme flooding (Motsholapheko *et al.*, 2011).

### **2.3. Short term health outcomes of floods**

Hajat *et al.*, (2005), in reviewing the literature on the human health consequences of flooding in Europe, state that despite floods being the most common natural disaster in the region, the associated health risks are poorly characterized. In developed countries, floods may potentially impact upon human health in a number of ways, the most serious being by death from drowning or serious injury (Ramsbottom *et al.*, 2003; Ahern and Kovats, 2006; Tunstall *et al.*, 2006). More frequently, common health effects in developed countries result from minor injuries (Manuel, 2006), diarrheal episodes, (Wade *et al.*, 2004; Reacher *et al.*, 2004), respiratory disease (Franklin *et al.*, 2000) and psychological impacts (WHO, 2003). The effect of floods increasing the risk to public health from communicable diseases appears relatively infrequent due to good sanitation and water supplies and lack of overcrowding (Meusel and Kirch, 2005; Ahern and Kovats, 2006), although the risk could increase in the future with global warming. Toxicants in sediment and air may also pose a problem as evidenced following Hurricane Katrina (Manuel, 2006).

The effects of weather disasters on health are difficult to quantify because secondary and delayed consequences are poorly reported (WHO, 2003). However, studies have shown that individuals who have been exposed to a traumatic stressor may have serious and long-term physical health outcomes, including poor self-reported health status, more self-reported medical problems, and greater morbidity, mortality and service utilization relative to individuals who have not been exposed (Schnurr, 2001). According to Ohl and Tapsell, (2000), in the first population-based epidemiological study in England and Wales on floods and health, reported primary care attendance in Bristol rising by 53% and referrals and admissions to hospitals more than doubling after the 1968 flood in the town. Reacher et al. (2004) reported a significant increase in risk of gastroenteritis with depth of flooding following the Lewes, southern England, flooding of autumn 2000, along with worsening asthma and other respiratory illnesses, earache and skin rashes. A further effect of floods upon health is due to the likely disruption of normal health care provision and social programmes, as evidenced after Hurricane Floyd in the US (Ohl and Tapsell, 2000) and in the German, Dresden, floods of 2002 (Meusel and Kirch, 2005). Until recently there had been no large-scale research in England and Wales on the health effects from flooding. Results from the first nation-wide study of over 1500 flooded and at risk respondents (RPA, FHRC et al., 2004; Tunstall et al., 2006) concluded that flooding is likely to contribute to both short and long term physical and particularly psychological health effects. Moreover, these so-called intangible impacts of flooding can often assume more significance to people than financial losses (Ohl and Tapsell, 2000)

### **2.3.1. Mortality due to drowning and acute trauma**

Floods are estimated to have caused almost 53,000 deaths globally over the last 10 years (EM-DAT, 2011). Most flood related fatalities have occurred in resource-poor countries and communities, primarily due to greater vulnerability to disasters and poor disaster management systems (Ahern et al., 2005). The Centre for Research on Epidemiology of Disasters estimates the ratio of deaths related to floods in years 2002–11 in developing versus high resource regions worldwide to be almost 23 to 1 (EM-DAT, 2011). Profiles of fatalities vary based on the characteristics of the flood and personal vulnerability. The majority of immediate fatalities occur in flash and coastal floods, often due to drowning and acute trauma (Brunkard *et al.*, 2008;

Haines *et al.*, 2006; Jonkman and Kelman, 2005; Ragan *et al.*, 2008; World Health Organization, Flood — Technical Hazard Sheet). Historically (i.e. 1953 floods in The Netherlands, 1959 floods in Japan, 2005 floods in Louisiana), the highest levels of flood-induced mortality occurred near breaches and in areas where flood water is deep and swift (Brunkard *et al.*, 2008; Jonkman *et al.*, 2009).

Flood-related mortality has been studied in both high and low income countries (Ahern *et al.*, 2005). The most readily identified flood deaths are those that occur acutely from drowning or trauma, such as being hit by objects in fast flowing waters. The number of such deaths is determined by the characteristics of the flood, including its speed of onset (flash floods are more hazardous than slow-onset ones), depth, and extent (Ahern *et al.*, 2005). Many drowning occur when vehicles are swept away by floodwaters (Ahern *et al.*, 2005). Evidence relating to flash floods in high-income countries suggests that most deaths are due to drowning and, particularly in the United States, are vehicle related (Ahern *et al.*, 2005 ). Information on risk factors for flood-related death remains limited, but men appear more at risk than women (Jonkman and Kelman, 2005). Those drowning in their own homes are largely the elderly. Although the risk of deaths is most obviously increased during the period of flooding, in a controlled study of the 1969 floods in Bristol, United Kingdom, 50 percent increase in all-cause of deaths in the flooded population in the year after the flood were increased and most pronounced among those aged 45–64 years (Ahern *et al.*, 2005). Few other studies have examined such a delayed increase in deaths, but it was also reported by studies in relation to the 1953 storm surge flood of Canvey Island, United Kingdom. Inconclusive evidence for diarrheal deaths has been reported from several studies of floods in low-income countries. Surveillance data showed an apparent increase of mortality from diarrhea following the 1988 floods in Khartoum, Sudan, but a similar rise was also apparent in the same period (May–July) of the preceding year (Ahern *et al.*, 2005). Routine surveillance data and hospital admissions records similarly showed diarrhea to be the most frequent (27 percent) cause of death following the severe 1988 Bangladesh floods, but again the effect of the flood was not separately quantified from seasonal influences (Ahern *et al.*, 2005). Kunii *et al.*, (2002) conducted a cross-sectional survey after the 1998 floods in Bangladesh, and of 3,109 people within flood-affected households, seven (0.23 percent) died during, but not

necessarily a consequence of the flood, two from diarrhea, two from suspected heart attacks, and three from undetermined/unrecorded causes.

Observation from the past, citing the 1953 floods in The Netherlands, 1959 floods in Japan, 2005 floods in Louisiana indicated that the highest levels of flood-induced mortality occurred near breaches and in areas where flood water is deep and swift. It was also pointed out that patterns of fatalities differ between low and high-income countries and between Eastern and Western cultures, depending on environmental, socio-economic and cultural factors. In low-income countries, those at higher risk of flood-related death tend to be from ethnic minorities who are poor, live on floodplains and in unstable dwellings, females and the very young and elderly (Alderman *et al.*, 2012). This is being supported by an observation in the 1931 flash flood in Fiji where the risk for fatality increased among Indian farmers living predominantly on floodplains and in grass huts and children under 11 years old and in a 1993 flash flood in Nepal where the risk for fatality increased among people living in houses constructed of thatch as opposed to brick and those of low socio-economic status (Alderman *et al.*, 2012).

### **2.3.2. Injuries due to flooding**

Flood-related injuries may occur as individuals attempt to remove themselves, their family, or valued possessions from danger. There is also potential for injuries when people return to their homes and businesses and begin the clean-up operation (e.g., from unstable buildings and electrical power cables). Nonfatal injuries together with exacerbation of chronic illness are the leading causes of morbidity among affected residents and relief workers immediately following floods (Diaz, 2004; Sullivent *et al.*, 2006). Injuries can occur before, during and after the flood, throughout the clean-up phase and finally during repopulation (Abaya *et al.*, 2009). The most common reasons for flood-inflicted nonfatal injuries are cuts, falls, being struck by falling debris or objects moving quickly in flood water (Abaya *et al.*, 2009; Ahern *et al.*, 2005), and being bitten or stung (Diaz, 2004; Sullivent *et al.*, 2006). Motor vehicle injuries sustained during repopulation are also common (Sullivent *et al.*, 2006).

In Hurricane Hugo (USA, 1989) almost 90% of over 2000 patients treated in emergency departments were hospitalized for injuries, resembling the pattern observed in previous US hurricanes (i.e. Hurricane Andrew, 1992, Hurricane Opal, 1995) (Diaz, 2004). Surveillance conducted post-Katrina/Rita in Greater New Orleans recorded over 7500 nonfatal injuries among residents and relief workers. In both groups young to middle aged males were most at risk, partly due to the fact that they were the ones most actively participating in the relief and clean-up efforts (Sullivent *et al.*, 2006). While patterns of injuries varied between residents and relief workers, in both groups most injuries occurred during the clean-up phase with cuts as the leading mechanism of injury (27% and 19% respectively; Sullivent *et al.*, 2006). A greater number of residents compared to rescue workers were injured during the repopulation period, primarily due to falls (23% versus 10%) and motor vehicle crashes (9% versus 4%) (Sullivent *et al.*, 2006).

Ahern *et al.*, (2005) found out that in a community survey of the 1988 floods in Nimes, France, 6 percent of surveyed households reported mild injuries (contusions, cuts, and sprains) related to the flood (In Missouri after the Midwest floods of 1993, injuries were reported through the routine surveillance system. Between July 16 and September 3, 1993, a total of 524 flood-related conditions were reported, and of these 250 (48 percent) were injuries: sprains/strains (34 percent), lacerations (24 percent), other injuries (11 percent), and abrasions/contusions (11 percent), and similar data were also reported from Iowa (Ahern *et al.*, 2005). Surprisingly little information is available on the frequency of nonfatal flood injuries, as they are mostly not routinely reported or identified as flood related.

### **2.3.3. Toxic exposure caused by flooding**

Flood waters may act as trigger, releasing chemicals that are already stored in the environment. Toxic exposure-related health impacts are therefore greatest in populations living near flood-impacted industrial or agricultural areas (Euripidou and Murray, 2004; Fox *et al.*, 2009). However, the causal pathway between floods, contamination and related health outcomes in affected populations is yet to be scientifically verified (Haines *et al.*, 2006; World Health Organization Flooding and Communicable Diseases Fact Sheet). For instance, a review of longitudinal data on flood-related chemical contamination incidents in the United Kingdom

revealed that the relationship between these incidents and population morbidity and mortality remains inconclusive (Euripidou and Murray, 2004). In the past flood waters and land have been contaminated with carbon monoxide, pesticides, agricultural chemicals, dioxin and a number of heavy metals (Euripidou and Murray, 2004; Fife *et al.*, 2009; Fox *et al.*, 2009). Exposure to such contaminants is known to be associated with cancer, cardiovascular, gastrointestinal, kidney, liver, and neurological diseases (Euripidou and Murray, 2004; Fox *et al.*, 2009).

Elevated baseline soil toxicity not attributed to floods was responsible for elevated soil concentration of lead and arsenic following hurricanes Katrina and Rita (Schwab *et al.*, 2007). In the weeks following that disaster the main change in toxic exposure was related to a shortage of energy sources, resulting in a seven-fold increase in carbon monoxide and gasoline exposure and a 13-fold increase in exposure to lamp oil (Cox *et al.*, 2008). Incorrect use of portable power generators during Katrina was responsible for a majority of cases of carbon monoxide poisoning in affected areas (Cox *et al.*, 2008).

#### **2.3.4. Communicable diseases**

Floods are associated with an increased risk for water- and vector borne diseases (World Health Organization Flooding and Communicable Diseases Fact Sheet). However health risks associated with handling the bodies of deceased people remain minimal if appropriate hygienic precautions are taken (Ligon, 2006; Morgan, 2004; World Health Organization, Flooding and Communicable Diseases Fact Sheet). The World Health Organization (WHO) has noted that immediately following floods, despite a higher risk of communicable disease transmission, outbreaks rarely occur (World Health Organization Flooding and Communicable Diseases Fact Sheet). The risk increases when infrastructure is heavily impacted, populations are displaced and water supply systems are damaged, leading to the contamination of drinking water facilities (World Health Organization Flooding and Communicable Diseases Fact Sheet; Watson *et al.*, 2007). Generally, diseases resulting from water contamination include cholera, diarrheal disease, hepatitis A and E, leptospirosis, parasitic diseases, rotavirus, shigellosis and typhoid fever (Ligon, 2006). Specific water-borne diseases related to floods include wound infections, dermatitis, conjunctivitis and ear, nose and throat infections (World Health Organization,

Flooding and Communicable Diseases Fact Sheet). Stagnant pools of flood water serve as ideal breeding grounds for pathogens that result in diarrhea and other waterborne infections. In a study that was conducted by Baqir *et al.*, (2011) on infectious diseases in the aftermath of monsoon flooding in Pakistan, some cases of diarrhea, cholera, and scabies were reported following the highest amount of rainfall that was recorded in the northern province of Khyber, with a confirmed outbreak of cholera in Swat.

## **2.4. Water-borne diseases**

### **2.4.1. Gastrointestinal diseases.**

Flooding has been shown to cause epidemics of water and vector borne diseases (Baqir *et al.*, 2011). Waterborne outbreaks of diarrheal illness after floods are thought to result primarily from the contamination of water. This occurs due to the disruption of purification and sewage disposal system. However, secondary effects of flooding, including crowding and subsequent fecal-oral spread of gastrointestinal pathogens may also contribute to the spread of diarrheal diseases (Kunii *et al.*, 2002). During July, 2004 floods in Bangladesh, outbreaks of diarrheal diseases occurred throughout Dhaka, with more than 17 000 patients seen at a single centre (Qadri *et al.*, 2004). Additionally compared with non flood period, patients who presented during the 1988, 1998, and 2004, floods due to diarrhea were found to be more severely dehydrated and of lower socioeconomic status (Schwartz *et al.*, 2006). The floods in Pakistan have resulted in a similar situation. 115 922 cases of acute diarrhea had been reported in fixed and outreach medical centers. In Khyber Pakhtunkhwa, the province worst affected, acute diarrhea was reported as a leading cause of illness, accounting for 17 % of medical consultations (Baqir *et al.*, 2011).

The risk for gastrointestinal disease (GI) following floods is higher in environments with poor hygiene and inadequate provision of clean drinking water (World Health Organization Flooding and Communicable Diseases Fact Sheet) and thus greatest in low-income countries. In the last 10 years exacerbation of diarrheal disease and related mortality following floods has been observed in some African countries (Abaya *et al.*, 2009. Post-flood resettlement, overcrowding and compromised quality of water and hygiene in Ethiopia, contributed to a high incidence of

diarrheal disease (*Abaya et al., 2009*). The 2008 floods in Mozambique resulted in a cholera outbreak (*Sidley, 2008*). .

#### **2.4.2. Hepatitis A and E.**

When water and sanitation supply is further taxed in of natural disasters, water often gets contaminated by human and animal waste carrying microorganisms with feco-oral transmission cycles. These are capable of producing diarrhea, dysentery, and viral hepatitis. The potential for hepatitis A outbreaks after flood related sewage contamination of portable water sources has been recognized (*Baqir et al., 2011*). Increases in the incident of hepatitis A have been noted in association with natural disasters and attributed to disruptions in water and sanitation facilities. Overcrowding may also contribute (*Baqir et al., 2011*). *Baqir et al., (2011)*, also noted a marked increase in the number of hepatitis A cases after the Khartoum floods in 1988. Similarly, after the 2005 earthquake in Pakistan, clusters of hepatitis E were common in areas with poor access to safe water. In all, over 1 200 cases of acute jaundice, many confirmed as hepatitis E, occurred among the displaced (*Baqir et al., 2011*).

Outbreaks of hepatitis E following floods are frequent in endemic areas and attributed primarily to contamination of water sources (person-to-person transmission accounts only for up to 2.2% of new cases) (*Aggarwal and Krawczynski, 2000*). Hepatitis E outbreaks are often large, posing a severe burden on the population (*Aggarwal and Krawczynski, 2000*). They may be particularly dangerous for pregnant women, as seen in 1991 in Kaupur, India, where out of 79,000 cases of waterborne viral hepatitis E, 13 out of 48 recorded deaths occurred among pregnant women (*Watson et al., 2007*). Outbreaks of hepatitis A are infrequent because most of the populations in low resource countries are immune (*Watson et al., 2007*).

It is essential that adequate sanitary and hygienic provisions are made in flood affected regions. This would significantly reduce the morbidity and mortality associated with viral hepatitis. It is also worth mentioning that although hepatitis A may be an issue during floods, most of the adult population in developing countries will possess a degree of immunity to it. This is due to the endemic nature of the disease (*Baqir et al., 2011*).

### 2.4.3. Respiratory infections.

In the aftermath of floods, infections of the respiratory tract are usually amongst the most common causes of morbidity and mortality in survivors (Baqir *et al.*, 2011). When devastating floods affected millions of people in Bangladesh in 1988, it was found that respiratory tract infections accounted for about 17.4% of all illnesses and 13% of all reported deaths (Siddique *et al.*, 1991). Similarly, it has been reported that 30 new cases of tuberculosis developed amongst 30 000 survivors of floods caused by the overflowing Kosi river in Bihar, India in 2008. Moreover, since symptoms of this condition may take several weeks to develop, it is possible that these cases were just the tip of an iceberg (Bhalla, 2008).

Reports from the United States (Diaz, 2004) and from South Asia (Ligon, 2006) revealed that upper respiratory infections (URIs) were the most common type of infectious disease occurring after floods. During the 2005 floods in England, recurring flu-like symptoms including throat infections, coughs and general sickness were reported by people whose homes had been affected (Carroll *et al.*, 2010). Flu-like symptoms were also the most frequently reported symptoms among sheltered evacuees in the days following Katrina (Murray *et al.*, 2009). A 2004 Institute of Medicine report concluded that serious adverse effects of indoor mold following floods among healthy adults were rare and occurred mainly in susceptible persons, such as asthmatics and children (Institute of Medicine, 2004). Studies conducted in the aftermath of hurricanes Katrina and Rita also failed to show fungal infections among residents whose homes were flooded (Barbeau *et al.*, 2010; Rabito *et al.*, 2008; Rao *et al.*, 2007). The 'Katrina cough', a widespread dry cough observed following the disasters, was attributed to a number of factors and not exclusively to indoor mold (Barbeau *et al.*, 2010). Mycotoxins were found in previously inundated homes even two years post-Katrina (Bloom *et al.*, 2009), however there was no evidence of health effects from indoor airborne exposure to these (Brandt *et al.*, 2006; Metts, 2008). In a recent study, Hsu *et al.*, (2011) for the first time quantified the change in the ratio of indoor microbial levels before and after floods. They demonstrated that the 2009 flood in Taiwan's metropolitan area resulted in a significant increase in concentration of indoor fungi, some of which (*Aspergillus versicolor*) are known to be associated with negative health outcomes (Hsu *et al.*, 2011).

The increased risk of respiratory tract infection is due to the loss of shelter and exposure to flood waters and rain. In the flood affected communities of Pakistan, 113 981 cases of respiratory tract infections have been reported (Baqir *et al.*, 2011).

#### **2.4.4 Skin and eye infections**

Besides exacerbation of ARIs, earache and skin rashes are common post-flood complaints (Reacher *et al.*, 2004). In the month following the 2005 floods in Thailand, out of 102 patients complaining of skin problems 59 were diagnosed with inflammatory dermatoses (58%) and 40 with infectious skin conditions (39%) (Vachiramom *et al.*, 2008). Skin rash was also confirmed in over 40% of construction workers repairing buildings damaged in Hurricane Katrina (Noe *et al.*, 2007). Epidemiological investigation revealed that, after adjusting for race and occupation, there was a 20-fold increase in the risk of contracting skin disease among workers who slept in previously inundated huts as compared to others (95% CI: 5.9, 70.2) (Noe *et al.*, 2007). It was suggested that rashes may have been caused by mites, known to breed in flood-impacted buildings (Noe *et al.*, 2007). Studies have shown a significant growth of indoor mold following floods, demonstrated by high indoor/outdoor ratios of mold spores (Barbeau *et al.*, 2010; Hsu *et al.*, 2011; Schwab *et al.*, 2007).

Skin and eye infections often occur as a result of direct contact with polluted water. This includes wound infections, dermatitis and conjunctivitis. However in general, these diseases are not known to be major causes of epidemics (Baqir *et al.*, 2011). Extensive water damage after hurricanes and floods increases the likely hood of mould contamination in the buildings, exposure to which can cause adverse health effect. Skin conditions related to this are particularly common, regardless of the type of the mould or the extent of contamination (Brandt *et al.*, 2006). In one study conducted in Thailand, it was found that eczema is the most common dermatosis during floods (Vachiramom *et al.*, 2008). According to Baqir *et al.*, (2011), approximately 143 870 skin infections have been reported in fixed and outreach medical centers across the southern province of Sindh. As a group, these are the third most common causes of illness, after respiratory infections and acute diarrhea (Baqir *et al.*, 2011). The risk of eye infections also mounts as torrential rains occur. In the aftermath of floods in 1993, the University of Iowa saw a

record number of eye infections related to water-borne pathogens (Baqir *et al.*, 2011). The contamination of the water supply by sewage and the prevailing high temperatures were cited as potential reasons for this.

#### **2.4.5. Leptospirosis**

Leptospirosis is an acute febrile illness contracted through direct skin contact with the areas contaminated with the urine of infected rodents is the only flood-related water-borne disease that has proven to be epidemic (WHO, 2003). Outbreaks of leptospirosis following floods have been observed in a variety of environments globally in both rural and urban areas (Gaynor *et al.*, 2007; Lau *et al.*, 2010; WHO, 2003), although highly populated areas with suboptimal drainage (i.e. urban slums) (Gaynor *et al.*, 2007; Lau *et al.*, 2010), low-lying areas and small island states (Lau *et al.*, 2010) have been found to be most at risk. Initial symptoms of leptospirosis may resemble those of other diseases often occurring after floods (Gaynor *et al.*, 2007; Lau *et al.*, 2010; Maskey *et al.*, 2006). In the past a resemblance to other febrile diseases, inappropriate sample collection and a lack of testing facilities have resulted in a severe under-diagnosis of infection (Gaynor *et al.*, 2007; Lau *et al.*, 2010; Maskey *et al.*, 2006). WHO (2003) has reported that the incidence of leptospirosis may reach over 100 per 100,000 with case fatality rate ranging from less than 5% to 30%. Leptospirosis is endemic in much of South-East Asia and floods have been shown to increase the risk of infection (Kawaguchi *et al.*, (2008). According to Lau *et al.*, (2010) and Maskey *et al.*, (2006), Leptospirosis incidence in Mumbai, India, increased eightfold as a result of the 2005 floods, with a two-fold increase in infection in rural areas of Lao PDR that has seen recent flooding on one's property (Kawaguchi *et al.*, 2008). In Argentina (1999–2005) over 75% of all new cases of leptospirosis were detected during the rainy season, when flooding is common (Vanasco *et al.*, 2008). In that study, contact with contaminated flood waters increased the odds of infection more than four-fold (Vanasco *et al.*, 2008). At the university campus in Honolulu at least two students contracted leptospirosis following the 2004 flood, which was due to poor drainage on the campus and wound exposure to flood water (Gaynor *et al.*, 2007).

Drainage material contaminated with rodent urine may also collect on roads after floods. This creates a potential source of infection for those walking bare foot. Children who are attracted by puddles of rain water are therefore at risk (Baqir *et al.*, 2011).

## **2.5. Vector-borne diseases**

The relation between flooding and vector-borne disease is complex. Many important infections are transmitted by mosquitoes which breed in or close to a stagnant or slow moving water (puddles, ponds). Floodwaters can wash away breeding sites and hence lower mosquito-borne transmission (Sidley, 2000). On the other hand, the collection of stagnant water due to the blocking of drains especially in urban settings can also be associated with increases in transmission, and there have been numerous such reports from Africa, Asia and Latin America (Ahern *et al.*, 2005). The 1982 El Nino event, for example, caused extensive flooding in several countries in Latin America and apparently sharp increases in malaria (Ahern *et al.*, 2005). The Mozambique floods of 2000 also appeared to have increased the number of malaria cases by a factor of 1.5 to 2 by comparison with 1999 and 2001 (Ahern *et al.*, 2005), although the statistics are difficult to interpret in light of the major population displacement that the flood caused. The reports of flood-related outbreaks in India do not provide particularly strong epidemiologic evidence (Ahern *et al.*, 2005).

Mosquitoes transmitting diseases often breed in receding flood waters. Floods can therefore potentially increase the spread of vector borne diseases such as malaria, dengue, hemorrhagic fever, yellow fever and West Nile fever (World Health Organization Flooding and Communicable Diseases Fact Sheet). However, dengue transmission is seasonal and not directly attributed to floods (Watson *et al.*, 2007). Vector-borne diseases are transmitted to humans through the bites of mosquitoes carrying the virus, and onset of the disease in humans usually occurs several weeks following the floods (World Health Organization Flooding and Communicable Diseases Fact Sheet). In addition, vector-borne diseases may also occur when the flood-impacted individuals and rescue workers are bitten by animals usually bats or skunks (Ligon, 2006). The risk for flood-related vector-borne disease outbreaks can be influenced by

factors such as increasing exposure to vectors (i.e. by sleeping outside and overcrowding), changes in vector habitat (World Health Organization, Flooding and Communicable Diseases Fact Sheet) and compromised vector control programs during floods (Watson, *et al.*, 2007). Flood-related malaria epidemics have occurred in malaria-endemic countries, such as African countries (Abaya *et al.*, 2009; Sidley, 2008), the Dominican Republic (World Health Organization, Flooding and Communicable Diseases Fact Sheet), and elsewhere, such as the dry coastal region of northern Peru (Watson *et al.*, 2007) and Pakistan.

Malaria epidemics in the wake of a flooding are a well known phenomenon in endemic areas worldwide. These have been seen after flooding in Costa Rica (1991), the Dominican Republic (2004), Mandla, Benin (annually) and northern Peru (periodic) (Wang *et al.*, 2006). Baqir *et al.*, (2011) states that there was a sharp spike in incidence of malaria following torrential rains and flood water that inundated large swathes of land in Karachi in 2006. It was also reported that the prevalence of cerebral malaria had increased. Particularly worrying was the fact that it subsequently began appearing in resistant forms that did not respond to the conventional therapy, enabling it to pose an even greater threat (Ebrahim, 2006). Interestingly, the onset of floods initially reduces mosquito breeding. However, as the flood recede, stagnant pools of water left behind serve as a perfect breeding ground for malaria causing mosquitoes. In most cases, the lag time is usually around six to eight weeks before the onset of a malaria epidemic (Kunii *et al.*, 2006).

## **2.6. Longer-term impacts of floods**

The long-term impact of floods on mortality is complex and not well understood. Long-term mortality may be attributed to floods directly, such as increases in diarrheal deaths in low-income countries (Ramin and McMichael, 2009; Schwartz *et al.*, 2006) or indirectly, by impacting health, food and economic systems, exacerbating poverty, malnutrition and non-communicable diseases. During the first year following a flood, the mortality rate in affected populations may continue to increase by up to 50% (Fundter *et al.*, 2008), as confirmed with the 47% increase in proportion of deaths in the first year following Hurricane Katrina (1317 deaths per month versus 924 per month relative to a four year baseline) (Stephens *et al.*, 2007).

Retrospective analysis of the burden of floods on health in China revealed that two years post-flood the all-cause mortality and years of potential life lost for five leading causes of death were significantly higher in groups exposed to floods (Li *et al.*, 2007).

### **2.6.1. Non-communicable diseases**

In 2008, 36 out of 57 million people in the world died from non communicable diseases (NCDs) (63% all deaths), in particular from cardiovascular disease, cancer, chronic lung diseases and diabetes (Friel *et al.*, 2011; WHO, 2011). Low and medium-income countries have experienced 80% of all NCD-attributable deaths, with this trend expected to continue (Friel *et al.*, 2011; WHO, 2011). Chronic disease and related conditions (CDRCs) can be worsened by disasters, increasing a person's vulnerability to adverse health outcomes following a flood (Sharma, *et al.*, 2008). Reports from the United States show that CDRCs account for one of the largest proportion of flood-related hospitalizations, particularly among the elderly. In the immediate post-flood period this burden has been found to outgrow that related to non-fatal injuries (Diaz, 2004; Centers for Disease Control and Prevention, 2006; Sharma *et al.*, 2008). Surveillance data from New Orleans two months post Katrina and Rita showed that of 21,673 health care visits, almost 60% were for illness (24.3% CDRCs) (Sharma *et al.*, 2008), with heart disease accounting for 11% of CDRCs (Brunkard *et al.*, 2008). Inability to maintain a stable medication uptake was the main barrier to continuity of care for chronic conditions during the disaster, with inadequate information and financial constraints as contributing factors (Arrieta *et al.*, 2009). In the Japanese flood of 2006, individuals 75 years or older and those receiving long-term care service were more likely to have their medications interrupted as a result of floods, with the interruption causing a four-fold risk of worse health outcomes as compared to patients with continued care (Tomio *et al.*, 2010). No similar surveillance data appear to have been collected in low-resource countries, however, with low income countries carrying the largest burden of chronic disease globally, a substantial impact of floods on NCDs would be expected.

### **2.6.2. Psychosocial health**

Physical and social functioning deteriorates as a result of direct and longer-term losses and stress caused by floods (Desalvo *et al.*, 2007; Heo *et al.*, 2008; Norris *et al.*, 2004) and these effects have been well documented in low and high-resource countries. Mental health disorders most commonly found in people affected by natural disasters such as floods are post-traumatic stress disorder (PTSD), followed by depression and anxiety (Liu *et al.*, 2006; Mason *et al.*, 2010; Norris *et al.*, 2005). Psychosocial symptoms often reported are earache, headache and bodily pain (Carroll *et al.*, 2010; Chae *et al.*, 2005; Reacher *et al.*, 2004). Studies of floods report prevalence of mental health disorders ranging from 8.6% (Liu *et al.*, 2006) to 53% (Heo *et al.*, 2008) in the first two years following floods. Psychological distress may also account for a portion of the physical illness experienced following floods (Reacher *et al.*, 2004) and together these have a lasting impact on the quality of life of survivors. The most profound psychosocial effects are long-term, gradual and co-morbid (Friel *et al.*, 2011) and may be more prevalent in poor resource environments (Norris *et al.*, 2004). Several risk factors for the development of psychological disorders following natural disasters have been identified, such as the degree of exposure (Assanangkornchai *et al.*, 2004; Heo *et al.*, 2008; Liu *et al.*, 2006; Mason *et al.*, 2010; Neria *et al.*, 2008; Norris *et al.*, 2004; Reacher *et al.*, 2004) previous flood experience and disaster preparedness (Assanangkornchai *et al.*, 2004; Morrissey and Reser, 2007; Paranjothy *et al.*, 2011), female gender and older age (Desalvo *et al.*, 2007; Liu *et al.*, 2006; Mason *et al.*, 2010; Neria *et al.*, 2008), socioeconomic status (SES), family structure, religion (Assanangkornchai *et al.*, 2004), social support (Neria *et al.*, 2008), self-reported physical health (Desalvo *et al.*, 2007; Galea *et al.*, 2005; Mason *et al.*, 2010; Paranjothy *et al.*, 2011; Tapsell *et al.*, 2002), and personality factors (Assanangkornchai *et al.*, 2004; Mason *et al.*, 2010; Morrissey and Reser, 2007; Neria *et al.*, 2008). It is also suspected that psychosocial impacts may be higher in rural as compared to urban communities due to older age, lower education level of the rural population (Berry *et al.*, 2008; Berry *et al.*, 2011; Heo *et al.*, 2008) and living with the constant threat of severe climate events (Morrissey and Reser, 2007).

Direct trauma exposure has been consistently reported as a risk factor for developing adverse psychosocial outcomes in both high and low-resource countries (Assanangkornchai *et al.*, 2004; Heo *et al.*, 2008; Liu *et al.*, 2006; Mason *et al.*, 2010; Neria *et al.*, 2008; Norris *et al.*, 2004; Reacher *et al.*, 2004). Following the 1999 floods in Mexico, the 6 month post-disaster symptoms

of trauma and depression were found in 25% of the impacted population overall, and in over half of those who experienced flash flooding, unexpected mudslides, mass casualties and displacement (Norris *et al.*, 2004). Ten weeks following an unexpected, severe flood in Thailand, subjects who reported their loss as severe were four times more likely to report PTSD symptoms (Assanangkornchai *et al.*, 2004). In a remote village in Korea, flood-related injury, relative's deaths or damage to possession were significant risk factors for depression (51%) and PTSD (22%) at 18 months post-disaster (Heo *et al.*, 2008). Longitudinal studies of mental impacts of floods provide insights into the nature of long-term psychiatric co-morbidities (Ahern *et al.*, 2005; Du *et al.*, 2010). In a longitudinal study of trauma and depression following the 1999 floods in Mexico, Norris *et al.* (2004) found that despite the initial decline in symptoms, in the longer term (2 years) the prevalence of trauma and depression stabilized at levels much higher than those in the general population. Similar findings were reported in Thailand (Assanangkornchai *et al.*, 2007), where in addition, an 'anniversary reaction' was observed with an increase in psychiatric symptoms one year following the flood, despite a significant downward trend in mental health symptoms in the first year (Assanangkornchai *et al.*, 2007). This may be because floods can result in acute and delayed onset of PTSD, with different symptoms emerging at short and long-term (Vachiramom *et al.*, 2008).

Personal and environmental factors moderate between the trauma and the occurrence of and levels of anxiety, stress and the resulting symptoms and these include personal health history and gender (higher incidence in women, Fordham, 1998; Galea *et al.*, 2005), the accumulation of stressors (Verger *et al.*, 2003), lack of personal control (Reghr *et al.*, 2000; Massad and Hulsey, 2006), perceived and received social support, perceived ability to cope (Declerq and Palmans, 2006; Ozer *et al.*, 2003; Peres *et al.*, 2005) and resilience (Bonanno, 2004). Erikson (1994) shows that there is individual trauma and collective trauma in a disaster and that trauma can be regarded both as an individual and a broad social concept. He shows the impact of a disaster on the individual, communality and the community and argues that the anxiety and stress effects of the trauma are accommodated as a medical condition known as PTSD. Young (1995) traces the development of PTSD as a recognized mental disorder and shows how its classification has changed over time, how its origins in a specific situation of war has developed into general and universal situations. Whilst these studies show that damage to homes and possessions directly

through the floods are traumatic, some also show that disputes with industrial companies (Erikson, 1994), with insurance companies and building contractors are also sources of severe psychological stress (Tapsell and Tunstall, 2008). However, they only identify the events that trigger the stress and they have not identified the underlying psychological processes which give an understanding of the strength of the stress. An exception to these studies is a non-empirical paper by Fullilove (1996) who draws on the psychology of place literature to identify the processes of attachment and identity and their importance in psychological health on displacement. More recently, Tapsell and Tunstall (2008) show in a longitudinal study how people's perception of, and relationship to, locality and home as a secure environment changed after floods. Reviews of approaches to understanding place and home (Manzo, 2003; Moore, 2000) reveal an extensive range of literature and that the perspectives of Transactionalism and Phenomenology have been used to provide frameworks for analyzing the psychological processes in the understanding of the meaning of place and home.

It is a fear of more personal damage and dramatic sudden change which brought severe stress and sometimes clinically diagnosed depression. The loss of control to the flood waters, insurance companies and builders left people with feelings of frustration, helpless, despair, isolation and an impotence which meant that they felt that they could not go through all that again. It can be seen through this evidence that psychological stress in flood disasters is multi-faceted. An understanding of these facets and psychological processes underlying the stress by those supporting those flooded, that is health authorities and organizations such as Communities Reunited, would help to get the right type of support in the right place at the right time.

### **2.6.3. Malnutrition**

As seen in Bangladesh, Africa and some parts of Australia, floods inundate land and destroy crops. While in high-resource countries crop destruction impacts the economic and mental wellbeing of farmers and their families (Berry *et al.*, 2008; Berry *et al.*, 2011), in low-resource countries it depletes the already low baseline levels of resources and population health (Abaya *et al.*, 2009; Bourque *et al.*, 2006; Friel *et al.*, 2011; Goudet *et al.*, 2011). When Hurricane George

struck the Dominican Republic in 1998, 300 people died and many were affected by severe food and medication shortages; when it struck the American territory of Puerto Rico, it claimed eight post-disaster fatalities (Bourque et al., 2006). In countries such as Bangladesh or Ethiopia, where baseline malnutrition is among the highest in the world (in both countries nearly half of children under five are stunted) flood-related destruction of crops has aggravated an already dire food supply (Abaya et al., 2009; del Ninno and Lundberg, 2005). As a result, floods have been associated with malnutrition in infants and young children in rural areas (del Ninno and Lundberg, 2005) and urban slum dwellings in developing countries (Goudet *et al.*, 2011).

A two year longitudinal study following the 1998 floods in Bangladesh revealed that children in flood-affected households were systematically smaller than those not impacted (del Ninno and Lundberg, 2005). Pregnant mothers from urban slums in Dhaka identified flood as a root cause of malnutrition in infants and young children, helping to clarify the complex relationship between floods, food shortage, maternal malnutrition, decreased levels of breastfeeding, diarrheal disease among children, and child malnutrition (Goudet *et al.*, 2011). Based on these findings, it was argued that natural disasters need to be considered within the existing causal models of malnutrition (Goudet *et al.*, 2011).

#### **2.6.4. Birth outcomes**

By affecting physical and mental health of pregnant mothers and their ability to access health services, floods may impact on the health of newborns. Studies of women with prenatal disaster exposure have indicated that high levels of prenatal stress are associated with poor pregnancy outcomes (Tong *et al.*, 2011) and negative health outcomes in children, including behavioral problems and psychiatric disorders (Kinney *et al.*, 2008). The risk of negative impacts on birth outcomes and child's health increases with the level and timing of disaster exposure within the gestational period (Kinney *et al.*, 2008). In post-disaster interviews, women who were pregnant during hurricanes Katrina and Rita expressed feelings of loss and uncertainty that were attributed to disaster experience, and worry about the potential impacts of disaster on their pregnancy outcome (Badakhsh *et al.*, 2010). A study conducted with women who became pregnant within six months following Katrina showed that severe hurricane exposure was significantly associated

with worse birth outcomes (Xiong *et al.*, 2008). In that study, severe hurricane exposure was a risk factor for low birth weight delivery and preterm birth after adjusting for maternal characteristics, smoking and alcohol use and medical history (Xiong *et al.*, 2008). In North Dakota exposure to floods was similarly associated with maternal medical risks, along with low and preterm births, after adjusting for maternal characteristics and smoking (Tong *et al.*, 2011). Another study revealed that hurricane exposure during pregnancy was significantly associated with the risk of child being born with autism spectrum disorder if exposure occurred during a more sensitive gestational age as compared to less sensitive gestational period (Kinney *et al.*, 2008).

## **2.7. Vulnerability to flood exposure and health outcomes**

Health consequences of floods depend on geographic and socio-economic factors, as well as the baseline vulnerability of the populations affected (Ahern *et al.*, 2005; Du *et al.*, 2010). Vulnerability to disaster is a function of both physical and social factors. The former includes exposure to risks such as floods and storms surges. The latter involves social and political arrangements that limit or enhance the capacity of individuals or social groups to cope with and adapt to hazard or external stress placed on their livelihood and wellbeing (Adger and Kelly, 1999). Scholars who draw on social vulnerability theory argue that vulnerability is determined by social inequalities rooted in gender, class, culture, race, age, and other power structures together with situational factors such as where people live, their physical and mental health, literacy status, household size and composition, and resources available to them to cope with crises (Cutter *et al.*, 2003; Cannon, 2010).

In societies that are more inequitable women tend to be at higher risks of disaster because of pre-existing disadvantages in social, economic, political, legal, and cultural status and opportunities (Terry, 2009). This problem is particularly evident in developing countries where a higher proportion of the poor and those who lack access to resources and decision-making in information, finance, personal health, education, training, and rights, are women and girls (UNDP, 2007; UNESCO, 2012). Women's lack of training and education, for example, means that they are forced to work in low-wage informal sectors and earn lower income which may

limit their ability to diversify their livelihood capabilities, or increase their resilience against climate-related shocks such as floods or drought (FAO, 2011). Studies from Bangladesh have shown that in addition to poverty, social marginalization and the lack of potentially lifesaving skills such as swimming can also increase women's vulnerability to climatic disasters (Alim, 2009). To build women's resilience against climate-related hazards, social vulnerability theorists argue that attention must be paid to the socially constructed sources of vulnerability in the household and society, and particularly to the gender differentiated vulnerabilities and opportunities that men and women have in daily life. Used uncritically, this theoretical approach can lead to unproductive generalizations about women as a social category and can overemphasize women's dependency and need (Fordham, 2004; Enarson *et al.*, 2006).

Enarson *et al.* (2006) noted that apart from poverty, women's susceptibility to disaster is also influenced by their gendered roles as mothers and caregivers; their ability to seek safety during disaster emergencies is often restricted by their responsibilities to the very young and the very old, both of whom require help and supervision (Babugura, 2010). Additionally, women generally bear the task of finding solutions to the socioeconomic instability and food situation following natural disasters or destroyed harvest (Ariyabandu, 2003; Jungehulsing, 2012). Such gendered responsibilities are historically rooted in cultural practices and power structures in societies. The gendered inequality that women face in normal and disaster times is often reinforced by customary laws, globalization processes, and hyper-urbanization (Enarson and Morrow, 1998). These elements play a significant role in narrowing women's access to financial and productive assets necessary to cope and recover from extreme weather events. For female-headed households dependent on agriculture, land, for example, is their most productive asset but statutory or customary laws often restrict women's land and property rights in many parts of the world (World Bank, 2001, 2007). Such laws hinder women from using their lands as collateral to enable economic recovery in post-disaster situations.

Patterns of fatalities differ between low and high-income countries and between Eastern and Western cultures, depending on environmental, socio-economic and cultural factors (Shimi *et al.*, 2010; Yeo and Blong, 2010). In low-income countries those at higher risk of flood-related death tend to be from ethnic minorities who are poor, live on floodplains and in unstable dwellings,

females and the very young and elderly (Jonkman *et al.*, 2009; Pradhan *et al.*, 2007; Yeo and Blong, 2010). In a 1931 flash flood in Fiji the risk for fatality increased among Indian farmers, living predominantly on floodplains and in grass huts and children under 11 years old (Yeo and Blong, 2010). In a 1993 flash flood in Nepal the risk for fatality increased among people living in houses constructed of thatch as opposed to brick and those of low socio-economic status (SES) (Pradhan *et al.*, 2007). Gender differences were also observed, girls were at double risk of fatality as compared to boys (13.3/ 1000 versus 9.4/1000) and at each age group women were at a double risk compared with men. There were strong similarities in the profiles of fatalities observed in Nepal to those observed in Bangladesh following the 1970 cyclone (Pradhan *et al.*, 2007). Reports from medium and high-income countries show that the elderly, males, and poor communities of color experience more flood related casualties compared with other communities (Brunkard *et al.*, 2008; Yeo and Blong, 2010; Zahran *et al.*, 2008). In the two months following Hurricane Katrina in Orleans Parish, blacks were overrepresented among fatalities above the age of 18, with a mortality rate up to four times higher than that of whites (Brunkard *et al.*, 2008). Analysis of flood-related casualties in east Texas revealed that the risk for death or injury in a county increased by 42 % with every unit increase in representation of a socially vulnerable population (Zahran *et al.*, 2008). Large and unexpected floods put the elderly, who need assistance with evacuation and access to medical services, and who may be reluctant to abandon their home, at greater risk of harm and fatality (Jonkman and Kelman, 2005; Yeo and Blong, 2010). Analyses of mortality patterns following hurricanes Katrina and Rita show that the elderly were significantly overrepresented among fatalities (Brunkard *et al.*, 2008), with 85% over the age of 50 and almost half over the age of 75 (Jonkman and Kelman, 2005). A third of all deaths occurred in flooded areas inside residences which were spared from the floodwater. Those fatalities were due to dehydration/heat stroke, heart attack/stroke, or other causes associated with lack of sustaining medical supplies (Jonkman *et al.*, 2009).

Differential vulnerability among low and high-income countries and communities to flood exposure and its associated negative impacts is a key issue to address when discussing the floods impact on human health. Developing as opposed to high-income countries face ongoing pressures which render floods particularly devastating, such as low baseline health and poor infrastructure (Shimi *et al.*, 2010), changing disease patterns, conflict, poor government, high

debt burdens (Ramin and McMichael, 2009) and the negative impacts of economic globalization (Leichenko and O'Brien, 2002). Floods exacerbate these ongoing pressures and in the long-term deepen the poverty and vulnerability of the people (Shimi *et al.*, 2010). Nevertheless, even within medium- and high-income countries existing disparities place vulnerable groups (i.e. poor communities of color, ethnic minorities, the urban homeless and people with chronic diseases) at a higher risk of severe flood exposure and related negative health outcomes (Assanangkornchai *et al.*, 2004; Barbeau *et al.*, 2010; Zahran *et al.*, 2008). Although difficult, these differences in vulnerability to floods need to be addressed via an environmental approach combining social and physical environmental factors (Yeo and Blong, 2010).

Household socio-economic, cultural and political characteristics define the sensitivity or social vulnerability, while adaptive capacity comprises the ownership of or access to all forms of capital (Hahn *et al.*, 2009). Government interventions in the form of relief assistance and social welfare make up an important element for building coping and adaptive capacity.

## **CHAPTER 3**

### **RESEARCH METHODOLOGY**

#### **3.1. INTRODUCTION**

This chapter highlights the methodology that was used for the study, we further explain the study site, study design, sampling, data collection and data analysis.

#### **3.2. Study site**

The study was conducted in Sepopa village which is located in the North West part of Botswana in the Okavango sub district. Sepopa is a village in North West district of Botswana, located close to the beginning of the Okavango delta, some 325 km North of North West of Maun, the tourist capital of Botswana and the administrative centre of Ngamiland district. Maun, which is the gate way to the Okavango Delta and Sepopa village, is the fifth largest town in Botswana, with a population of about 55 784 people (CSO, 2011). Maun just like the rest of the Ngamiland and Okavango district experience dry season during May-August and faces a rainy season during November to April. Maun is accessible both by road and air and has an international airport (Maun International Airport) which is close to the tourist attractions such as Okavango Delta, Moremi National Park and Makgagadi pans. Maun also has a very good road network of which are in a good condition, connecting near and far destinations around the region.

According to the 2011 census survey, Sepopa village has the population of 2824. The village is divided into four (4) wards, namely: Kgosing, Mabudutsa, Botshabelo and Boyeyi. The main ethnic groups found in Sepopa are Bayeyi and Bambukushu, with the Bayeyi tribe forming majority of the population. Setswana is used as the local language. The study was conducted in the natural setting of the study subjects. Thus, there was no manipulation of the settings and/or subjects.

##### **3.2.1. Study design**

A Non-experimental descriptive research design using qualitative approach was used. Descriptive designs are used in studies where more information is required in a particular field

through the provision of a picture of a phenomenon as it occurs naturally (Brink, 2009). The descriptive design was chosen to enable the researcher to determine the impacts of the Okavango River on the health of the Sepopa community.

### 3.2.2. Sampling

The study used two types of sampling procedures being simple random sampling and purposive sampling. Simple random sampling was used in selection of participants within the community while purposive was employed in the selection of focus group participants. Explanation of each and how it was applied is given below.

#### 3.2.2.1 Sampling procedure for focus group discussion

Focus groups are panels, facilitated by a moderator, who meet for a specified time period to exchange perspectives, knowledge, and/or opinions on a particular topic. Groups are rarely more than a dozen members (Gibbs, 1997).

Three groups were used in focus group discussion. Purposive sampling was used first to select a group of community leaders, while the second group was that of Church leaders and alternative medicine providers. The third focus group discussion will be conducted with the local clinic staff members. Each of the focus group will have ten members as recommended by Gilbert (2006).

**Table 1:** Composition of the focus groups.

Focus group 1:	This focus group discussion involved ten selected community leaders within the village of Sepopa. Purposive sampling method was used. For the leader to be selected, he/she should be in constant contact and directly linked with the community. A central place was selected where the community leaders gathered and discussed.
Focus group 2:	The second focus group involved leaders of the local churches, and alternative medicine providers within the village of Sepopa.

	Purposive sampling methodology was used in selecting participants, based on their ability to assist member of the community when they are sick and come to consult their services, and a meeting place was selected.
Focus group 3:	The third focus group discussion was conducted with the local clinic staff. The group comprised of ten participants randomly selected from a sample frame of 15. All health care providers were selected regardless of their cadre. Health care workers were chosen because they are the first line of contact if health care is needed within the community and are actively involved in curative care.

### 3.2.2.2 Sampling procedure for personal interviews

Sampling for Personal interviews was carried out using simple random sampling targeting the population of the study in Sepopa village. A total of 20 subjects were selected for this study or until saturation was reached.

### 3.2.3. Data collection

In this study, different research methods were used in Sepopa and an explanation of each is given below.

#### 3.2.3.1 Primary research

According to Owl Research (2006), primary research refers to the information that one collects oneself. It involves collecting data about a given subject directly from the outside world. Ryerson (2006) indicates that primary research data is collected specifically for the study at hand, and it is obtained by the researcher either observing the studied subject or phenomenon or communicating directly with the subject.

In this study, the primary research was conducted using the two methods of data collection, being focus group discussion and personal interviews.

Two separate questionnaires were designed for this research. The first one was designed for the focus group discussion, and the second one for personal interviews.

#### **3.2.3.1.1 Focus group discussion**

It is an in-depth examination of one particular topic or concept and consists of 8 – 12 participants, who are led by a moderator whose aim is to learn and understand what people have to have to say and why they need to do so. It is a form of a qualitative research in which a group of people are asked about their attitudes towards a product, service, concept or idea. In this occasion, people were asked about their understanding and their knowledge of effects of floods on their health. Questions were asked in an interactive group setting where participants were free to talk to each other, on the other hand the researcher being able to study participants and gain information from the discussion in a natural setting.

According to Gibbs (1997) focus group research involves an organized discussion with a selected group of individual to gain information about their views and experiences of a topic. It is suited to obtain several perspectives about the same topic and also gaining insight into people's shared understanding of everyday life. This conversations are able to draw upon respondent's attitudes, feelings, beliefs, experiences and reaction in a way that would not be feasible using other methods such as observation , one -to- one interviewing or questionnaire surveys. Gibbs (1997) observed that a focus group discussion enables the researcher to gain a large amount of information in a short period of time.

A questionnaire with open ended questions was developed with the questions focusing on the objectives of this research, and they were used to guide all the focus group discussion.

After all the focus group discussion has been conducted, the written record from all the groups was analyzed according to a matrix that allowed the researcher to compare the information. The information obtained from the group discussion was used for triangulation with the information collected during the survey.

#### **3.2.3.1.2 Personal interview**

According to Owl Resource (2006), personal interviews are one-on-one or small group questions and answer sessions where the interviewer asks individual or a small group questions to obtain

needed information. Personal interview gather a great deal of information from a small number of people and are useful when one needs to obtain an expert or knowledgeable opinion on a subject.

During this research, personal interviews targeted people in Sepopa village who met the inclusion criteria. Each participant was interviewed personally by the researcher using the guiding questions which were designed and used during the interview sessions and recording of responses was done in English, using the tape recorder.

### **3.2.4 Data analysis**

#### **3.2.4.1 Personal Interview**

Data entry and analysis for personal interviews was done by the researcher using a computer program software packages SPSS designed for qualitative data analysis to enable complex organization & retrieval of data. The findings and the results were presented using frequency distribution table, percentages, graphs, correlations, standard deviations and chi- square.

#### **3.2.4.2 Focus group discussion**

The written records from all the groups were analyzed according to a matrix that allowed the researcher to compare the information. The information obtained from the group discussion was used for triangulation with the other information collected during the survey. Brief description of the whole data analysis process is explained below:

The transcription was kept by the interviewer and independent coder, who is a specialist in qualitative research. The two were the only ones with access to the audio-taped cassettes to maintain confidentiality.

Tesch (1990) and Creswell (1994) identified the following method of data analysis which the researcher adopted:

1. The researcher listened to the tape to get the sense of the whole, internalize the content and transcribed the content verbatim. The researcher then read carefully through all the transcripts to get the sense of the whole.

2. The researcher interviewed and reviewed the document randomly because no format was suggested. It was either the most interesting or the first one. The researcher read through it in order to get the underlying meaning. Asking himself questions such as: “what is it about? What is the underlying meaning? What does the data say? The researcher wrote notes at recognizable place where he will not forget.
3. After the researcher had completed the task for all documents, he made a list, clustered the same topics together, and put them in columns as major topics, unique topics and other topics. As the process continued, the researcher was busy analyzing and synthesizing the data.
4. The researcher took the list and returned to the data to allocate codes to the topics in an abbreviated form and the code was written next to the correct segment.
5. The researcher found the most descriptive wording of topics and turned them into categories and the total list of between categories to show interrelationships.
6. After when all the data have been coded, the researcher cut and pasted codes into piles by code. This is the point where the researcher took data extracts out of their original context (the interview or focus group transcript) and put them together with other examples of data on the same topic to start looking for patterns across the data. SPSS (Statistical Package for Social Science) Computer packages was used in this process as it is designed to enable the researcher to manage this kind of analysis.

### **3.2.5 Ethical consideration**

Approval to conduct the study was obtained from the Ministry of Health research Units after the approval by the Medunsa Research and Ethical Committee. Authorization to collect data was obtained from Okavango District Health Management Team and the village head man. Participants were not informed about the study for the researcher acted as a complete participant in the study.

## CHAPTER 4

### RESULTS

#### 4.1. INTRODUCTION

In this chapter we discuss the results of the research which was conducted in the village of Sepopa, in the Okavango district, Botswana. We further discuss the impacts of flooding of the Okavango River on human health in the study area and the causes of flood related morbidity and mortality.

#### 4.2. Source of drinking water in Sepopa village.

In Botswana, water supply to rural villages such as those of the study area is the responsibility of the Water Utilities Corporation which took over from the Department of Water Affairs in April 2012. Previously Department of Water Affairs had the overall responsibility for supplying water to the major urban villages, whereas the Water Utilities Corporation was the main supplier of water to urban centers. In 2012 April, Water Utilities Corporation was given the sole mandate of supplying water to all remotest and urban centers. A large part of the population in Botswana depends on groundwater sources for its water supply (SMEC, 1991). Although surface water sources account for 35% of the total supply, they provide 90% of water used in urban areas. In contrast, the majority of rural villages obtain their water from groundwater sources which account for 67% of the total water supply in Botswana (Arntzen et al., 2002). In the study area, there are several sources of water for communities in Sepopa such as off-plot, outdoor (communal) and on-plot outdoor and/or indoor (private) water connections, as well as other sources such as open perennial water from river channels and pans.

**TABLE 4.1. SOURCES OF WATER IN THE VILLAGE OF SEPOPA.**

Sources of water.	Number	Percentage (%)
Communal stand pipes	9	69
Household water connections	4	31
Total	13	100

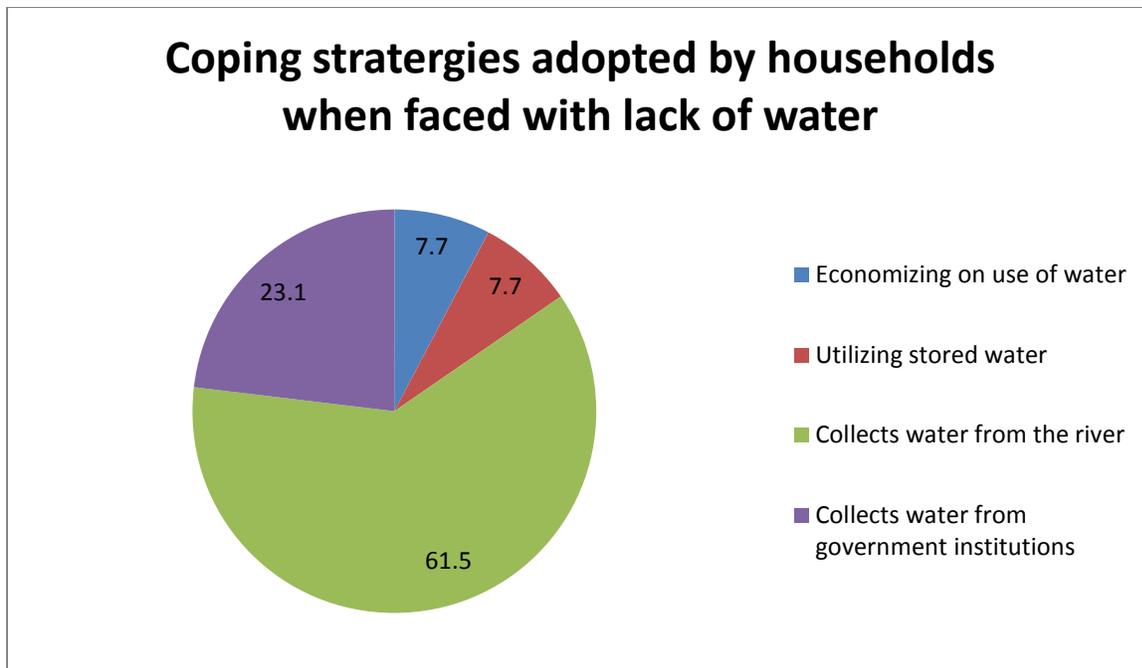
The survey revealed that most of the households obtain their water from communal standpipes (69%) as compared to 31% of the households who obtained water from out-door piped connections in their households. Water from communal standpipes is currently free while those with on-plot connections (both outdoor and indoor) pay for water. However, socio-economic status, measured by possession of productive assets, makes a difference between those who can afford to install a standpipe in the yard or to pay water tariffs. The study also revealed that 66% of those who obtain water from the communal standpipes are saying they are very far from where they are staying, travelling for more than 300 meters to collect water.

#### **4.3. Coping strategies adopted by households when faced with lack of water.**

Access to water is not only about affordability, but also about reliability. Water supply is sometimes very unreliable. This unreliability is also very unpredictable, making it extremely difficult for households to prepare coping measures. The unreliability of water supply could be chronic, seldom, occasional or seasonal. The survey revealed that water may not be available for up to 5 days, and this creates a situation where alternative sources of water supply are utilized. Households adopted four main coping strategies when faced with lack of water: (1) economized on the use of water by either re-using waste-water or using water sparingly, (2) utilized stored water from reserve containers/tanks, (3) collected water from other sources such as river, and also (4) collected water from government institutions.

**Table 4.2. Coping strategies adopted by households when faced with lack of water.**

Coping strategy	Number of respondents	Percentage (%)
Economizing on use of water	1	7.7
Utilizing stored water	1	7.7
Collects water from the river	8	61.5
Collects water from government institutions.	3	23.1
Total	13	100



**FIGURE 4.2. Coping strategies adopted by households when faced with lack of water**

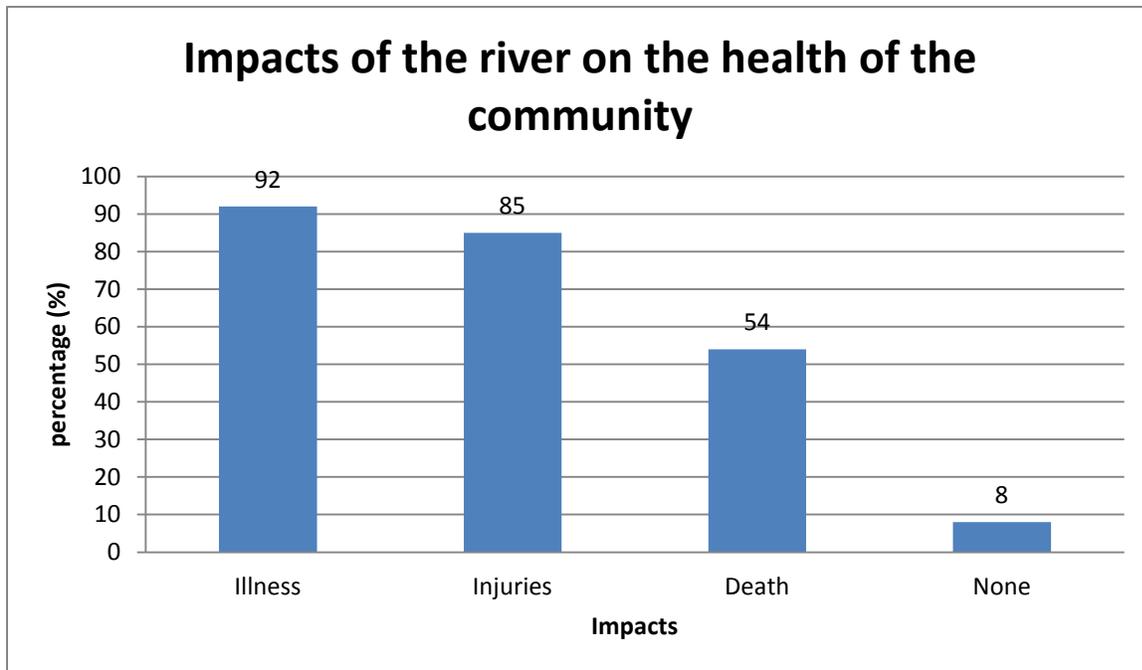
Of all the households interviewed, 61.5% explained that they do obtain water from the river when taps are dry, 23.1% collected water from government institutions, whereas 7.7% either utilized water they collected in reservoirs for future use or economized on the use of water.

#### **4.4. Impacts of floods on the health of the community**

A number of physical health effects experienced either during the flood or in the days and first few weeks immediately following the event were reported by respondents in Sepopa. These physical effects appear to be influenced by a lot of factors such as gender roles and responsibilities, socio economic factors and preexisting health conditions. Respondents have highlighted that males are the ones spending more time in the waters fishing, and that even more time is spent if fishing is done as a source of income. They also stated that the recent last incident they experienced of a person dying in the river was of an epileptic person who was attacked by fits while fishing with friends. These reflect the effects reported in the literature cited earlier.

**Table 4.3. Impacts of the river on the health of the community**

Impact	Number of respondents	Percentage (%)
Injuries	11	85
Illness	12	92
Death	7	54
None	1	8



**Figure 4.3. Impacts of floods on the health of the community**

Of the 13 respondents, 11 (85%) reported or suffered from the injuries due to high waters brought about by floods, 12 (92%) reported to have fallen sick or having a member of their family who was sick with conditions related to floods. Of all the respondents, 7 (54%) explained they heard of deaths occurring in a river either due to drowning or crocodile and hippopotamus attacks. One (8%) of respondents has never heard of any injuries, illness or death due to the impacts of floods.

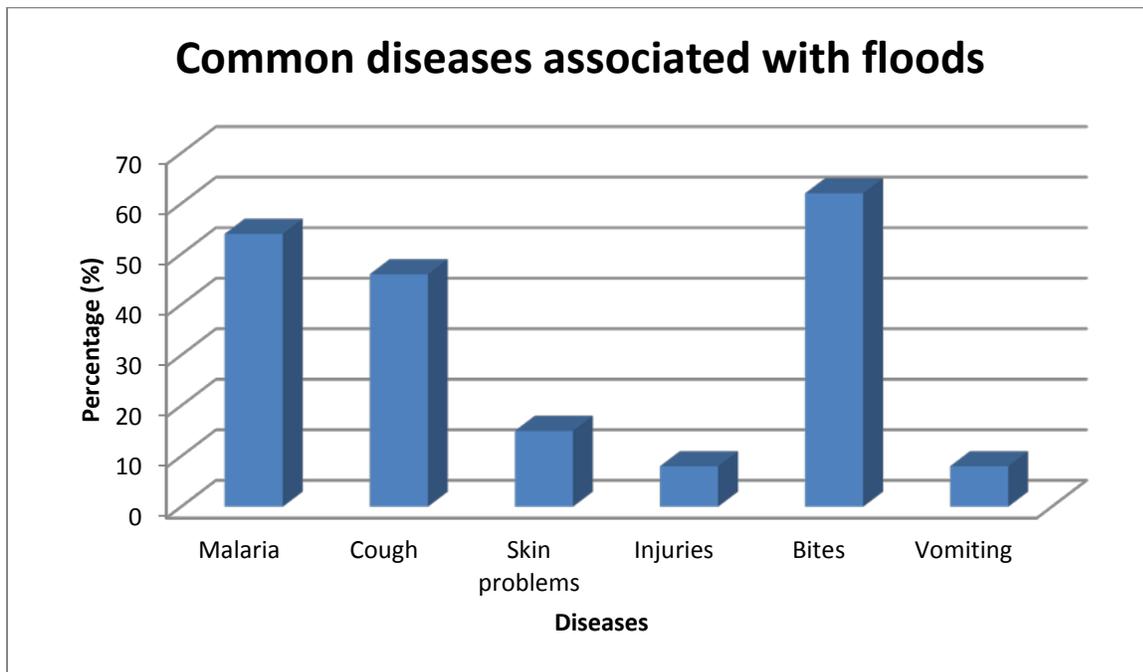
#### **4.5. Common diseases associated with floods.**

When the flood water level was at its peak, one would argue that affected community have a higher chances of developing health problems or found out that existing health problems are

exacerbated. These maybe due to a lot of factors that are associated with flooding of river, water reaching areas that are normally dry. Factors such as lack of distribution of water, the type of water storage vessels used in the households, not putting a lid on the vessel, no use of latrines, perceived change of drinking water, food scarcity, and poor economic status may greatly add to the impacts.

**Table 4.4. Common diseases associated with floods**

Disease	Number of respondents	Percentage (%)
Malaria	7	54
Cough	6	46
Skin problems	2	15
Injuries e.g. cuts, bruises	1	8
Bites (crocodile, snakes, Hippopotamus)	8	62
Vomiting	1	8
Diarrhea	6	46



**Figure 4.4. Common diseases associated with floods**

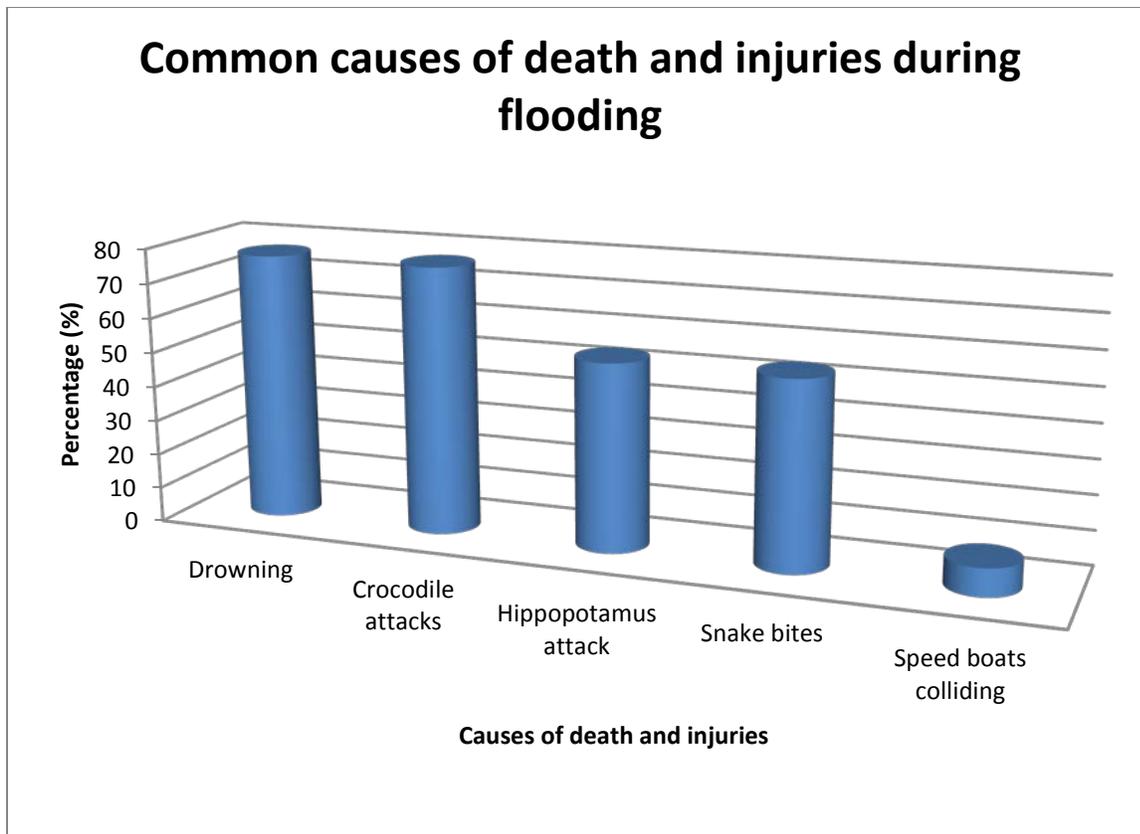
Many respondents alleged that their general health condition was affected during periods where flood waters were at the peak where 54% of the respondents reported having suffered or having their family member who suffered from malaria. The most prevalent condition was bites due to crocodiles, hippopotamus or snakes at 62%, followed by cough and diarrhea on the third place at 46%, skin problems at 15%, and 8% of the respondents perceived vomiting and injuries to be a problem also.

#### **4.6. Common causes of death and injuries during flooding**

In Sepopa, one of the key characteristics of the flooding is the fact that it takes place yearly and the speed of water is slow. Therefore many people take these floods as a normal phenomenon where no caution is required. Even when warnings to take caution are spread, where more water is coming, people do not respond accordingly. Due to long periods of dryness some people had been allocated plots in steep areas that were previously the flood routes, therefore such localities are at times infested by crocodiles and hippopotamus that are carried along by flood water from the main channels, floodwaters also contained contaminants such as litter and sewage materials.

**Table 4.5. Common causes of death and injuries during flooding**

Causes of death and injuries	Number of respondents	Percentage (%)
Drowning	10	77
Crocodile attacks	10	77
Hippopotamus attacks	7	54
Speed boats colliding	1	8
Snake bites	7	54



**Figure 4.5. Common causes of death and injuries during flooding**

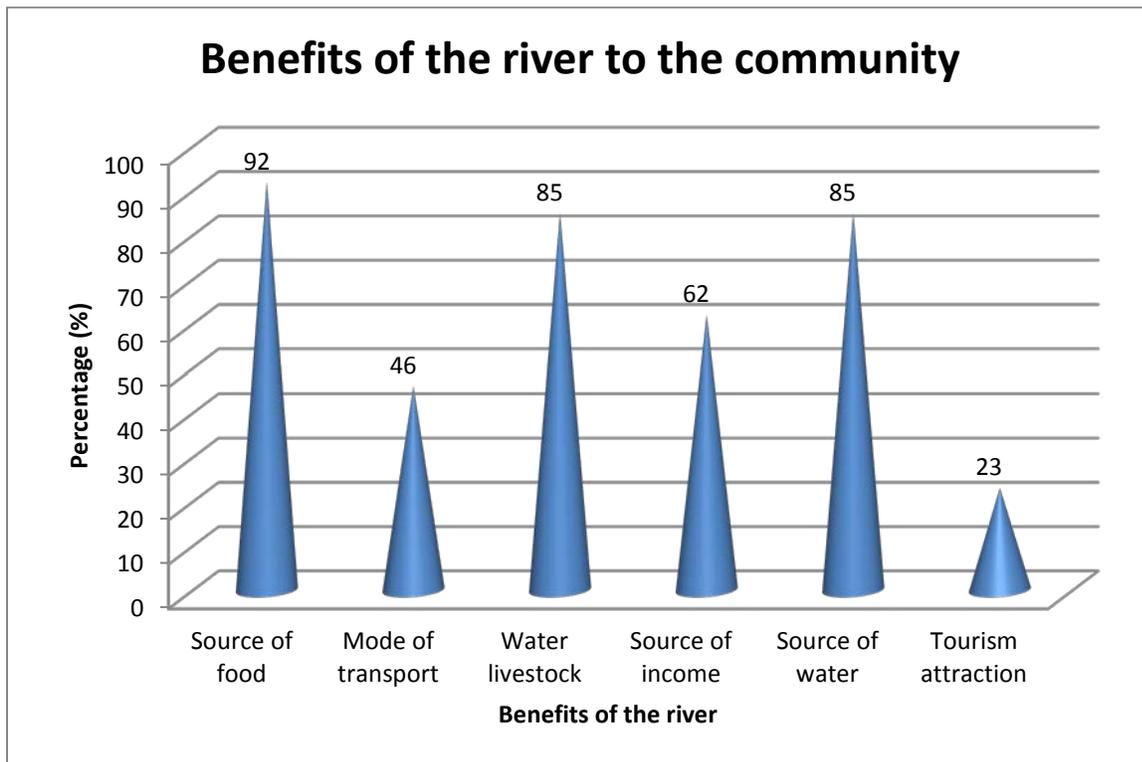
Table 4.5 shows the common causes of death and injuries experienced in the village of Sepopa during flooding. The result of the study reveals that many respondents 77% have sited drowning and crocodile attacks as the common cause of death and injuries, followed by snake bites and hippopotamus attack at 54%, and lastly speed boats colliding due to over grown bushes in the middle of the river obstructing the view at 8%.

#### **4.7. Benefit of the river to the community.**

Although physical infrastructure for water may be available in the community of Sepopa that though not always reliable, or may not be readily accessible to some social groups there, staying near the river is a great advantage. Access to natural resources such as river is beneficial to the community in many ways as illustrated below.

**Table 4.6. Benefit of the river to the community.**

Benefit of river	Number of respondents	Percentage (%)
Source of food	12	92
Mode of transport	6	46
Water livestock	11	85
Source of income	8	62
Source of water	11	85
Tourism attraction	3	23



**Figure 4.6. Benefit of the river to the community.**

Table 4.6 shows the benefit that the river has to the community of Sepopa. The above table reveals that 92% of the respondents use river as a source of food where they gather food like fish, water lily, palm tree, a hunt hippopotamus. The table further reveals that 46% use river as a mode of transport connecting several villages in the panhandle of the Okavango delta, while 85% water their livestock in it. The results went further to reveal that 62% of the respondents use river as a source of income, selling what they gather in it to earn a living, and also 85% of respondents use it as a source of water. The least number of respondents at 23% have indicated that they use it as a source of tourism attraction.

Three focus groups were also recruited, involving 23 people in total. Each of the groups comprised between four and ten participants. All of the focus groups in the three studies were conducted by the same moderator to ensure consistency and continuity. Participants recruited for the groups included community leaders, health care workers, traditional healers and pastors. All the groups comprised a mixture of ages and mixed gender to reflect the structure of society, although more men than women were represented more specially in a group of community leaders. All participants agreed to take part generally without any hesitations.

This qualitative approach in the form of focus groups was taken with people who had experienced floodwaters for many years in their stay in Sepopa village. This method was chosen because it can be most advantageous when time is short and also when there are limited financial resources available, as was the case with this research. However, the great strength of qualitative research, demonstrated in the study, was the validity of the data obtained. Focus groups yielded extremely rich data and the technique was not so difficult to grasp. It was also felt that the technique would give a rich insight into people's experiences, attitudes, perceptions and concerns and produce novel or unexpected insights and understanding. Focus groups thus allowed respondents to express views in their own language and to emphasize what they see as important.

In all the focus groups, respondents reconfirmed the effects that the river has on their health and also emphasized more on the benefits of the river as was reported previously. Respondents have explained that the river has been experiencing floods of varying magnitudes ever since the village was established in the late 1960s, and that they have ever since adapted to this experience. They also admitted that they do experience some impacts of the river to their health like increased cases of malaria, diarrhea and cough not forgetting the increased number of crocodile and hippopotamus attacks that they attributed to the experience of being flooded, as water will be carrying along with it the crocodiles from main channels while hippopotamus will be troubled by mosquitoes in the river hence seeking refuge in the river banks more specially at night. Though the effects of the river are there, both focus groups shared the common idea that the river is their source of livelihood. Many respondents explained that without the river, they would not be able to survive. They use it as a source of food, income, mode of transport, and as a tourism attraction in the village. Focus group concerning the health care workers has also added

that they are aware of the health impacts of the river, but are not in a position to change the lifestyle of the community but only to intensify health education on the importance of community protection. They proved the allegations that malaria is on the increase citing that for the past two years, they have registered a tremendous number of malaria cases and as such the government has initiated a program of distributing mosquito treated nets along with intensified indoor residual spraying. Thus, the majority of many physical health effects associated with the experience of being flooded reported from Sepopa village tended to be in the early weeks and months following the flood and generally receded over time when flood waters recede. For the small minority of respondents who reported ongoing health problems are those who reports to be in constant contacts with water and experience skin irritations, cough and diarrhea, this is mainly due to coming into direct contact with contaminated floodwaters.

## **CHAPTER 5**

### **DISCUSSION**

#### **5.1. INTRODUCTION**

A study to assess the impact of the Okavango River on the health of the community of Sepopa village in the Okavango district Botswana was conducted and an outline is hereby given to show the outcome of the study.

#### **5.2. Source of drinking water in Sepopa village.**

Many villages in the Okavango district have several sources of water for communities that are residing in such areas. Generally the source of water depends on the distance of such a village from the Okavango river tributaries or the population of the habitants. Commonly such source ranges from off-plot, outdoor (communal) and on-plot outdoor and/or indoor (private) water connections, as well as other sources such as bowsed water, well-points, boreholes and open perennial water from river channels and pans. Many of these villages experience serious problem of unreliable water supply caused by, among other things, the breakdown of diesel-powered water pumps, busting of water distributing pipes, and the failure of timely delivery of diesel fuel. In Botswana, water supply to rural villages such as those of the study area is the responsibility of the Water Utilities Corporation which took over from the Department of Water Affairs in April 2012. In Sepopa village, the main source of drinking water is the combination of both outdoor (communal) and on plot outdoor and /or indoor private water connections. The water that is distributed to the community is drawn from the Okavango River and purified in the water treatment plant situated in the outskirts of the village.

The results in table 4.1 show that the majority of the residents of Sepopa village use communal stand pipes, represented by 69% of respondents as compared to 31% of household water connections.

These results are consistent with the study that was performed by Ngwenya and Kgathi (2006) on HIV/AIDS and access to water: A case study of home based care in Ngamiland, Botswana where the first survey revealed that most of the households obtain their water from communal

standpipes (73%) as compared to 16.7%, 4.8%, and 5.6% of the households who obtained their water from out-door piped connections, in-door piped connections, and other sources, respectively. The second survey revealed that 72% of the households in the study areas collected water from communal standpipes. The rest of the households obtained water from out-door piped connections (10%), indoor-piped connections (10%), and from other sources such as streams, rivers and pans (8%). These findings are also consistent with Kelekwang and Gowera's (2003) study that showed villages with a population of 1000–4999 in Botswana had 96.5% of their households with access to piped water. Ngwenya and Kgathi (2006) in that study, cited that the per capita number of private connections is influenced by distance to the District Capital of Maun. For instance, the villages of Sehitwa and Shorobe which are only 100 and 60 km from Maun, respectively, have higher per capita number of private connections of 30% and 36%. On the other hand, the villages of Etsha 6, Seronga, and Gudigwa, which are more than 260, 540 and 540 km, respectively, have much lower figures for per capita number of private connections of 21%, 21% and 17%, respectively. This is mainly because people who live near the district capital of Maun have more access to services and employment opportunities and tend to be more affluent.

### **5.3. Coping strategies adopted by households when faced with lack of water.**

Water is the most important natural resource and essential for life, as it provides habitat for diverse type's of aquatic life in rivers, lakes and oceans and makes 65% of human body. The great historical cities grew around rivers and lakes because of human dependence on water. Many villages in the Okavango district follow the same trend as above as evidence by Sepopa village which is situated in the southwestern part of the Okavango Delta commonly called the Panhandles. The village is located near to the permanently flooded Okavango River main channel, and its households have perennial access to river water. This river in the past used to be the centre of the main livelihood activities of these villagers which differ from one tribe to the other, but include arable agriculture, livestock agriculture, collection of veld products, and fishing.

As the village grew, the survey revealed that most of the households stopped their dependence on the river water as developments such as piped water were obtained either from communal

standpipes or from the out-door piped connections in their households. Access to water is not only about affordability, but also about reliability. Water supply is sometimes very unreliable. This unreliability is also very unpredictable, making it extremely difficult for households to prepare coping measures. The unreliability of water supply could be chronic, seldom, occasional or seasonal. The survey revealed that water may not be available for up to 5 days, and this creates a situation where alternative sources of water supply are utilized.

The results reveal in table 4.2 that 7.7% of the respondents have cited economizing on use of water as the strategy they adopt when faced with lack of water. The above view was confirmed by the fact that some of the households in the study areas said they sometimes suspended bathing or doing laundry in an attempt to economize on water, or even reuse the water more than once. The table went on to show that 7.7% of the respondents utilized stored water which they would have collected in the tanks and reservoirs and other water containers in response to the unreliable and unpredictable water supply they are faced with. Informal interview revealed that those who are able to store water in containers and reservoirs are mostly those with out-door piped connections in their households. While those collecting water from the communal stand pipes are lamenting about the long distances they travelled to collect water. The main coping strategy adopted by majority of the households as indicated in table 4.2 is the collection of water from the Okavango river standing at 61.5%, the river is perennial and experiences annual flooding therefore the community have abundant access to river water. Table 4.2 also shows that 23.1% of the respondents collect water from the government institutions that they are residing next to. In the village of Sepopa, all government institutions buildings are fitted with water tanks that collect rain water during rainy season or can be filled by residents in preparation for the hard times of chronic water shortage.

#### **5.4. Impacts of Okavango River on the health of the community**

Botswana's environmental challenges of poor soil fertility, low levels of rainfall and recurring droughts create risky farming conditions for arable farmers (Magole and Thapelo, 2005). Most ploughing seasons end in failed crops or very low yields. However, farmers in Okavango sub-district have an alternative system of arable production which appears to deal with these constraints. The yearly flood of the Okavango River brings with it nutrient-rich soil and some

form of natural irrigation. Despite this advantaged position, the farmers are faced with challenges from inconsistent floods (too severe or too small, too late or too early); crop damage from pests, livestock and wild animals; and institutional issues pertaining to land management. Of these, flood issues are the most important for the community of Sepopa, where the impact of the Okavango river is studied pertaining to their health.

In the past, most communities of Okavango were almost completely dependent on subsistence agriculture (Magole and Thapelo, 2005). Today people have to some extent been successful in reducing their dependence on this sector by commercializing some non-agricultural activities. As a result, the majority of people in Okavango maintain a diversified income generation system as a means of reducing risks in a variable hydrological environment. The main economic activities in the sub-district are rainfed and flood recession cultivation (molapo farming), livestock rearing, fishing, hunting, gathering of veld products, small scale commercial enterprises like the production and sale of crafts, sales of natural resources (firewood, thatching grass, reeds, building poles), local food and beverages, wage labour in the tourism industry, and formal employment in the government and the private sector (Bensen, 2002). It is clear that even today natural resources, which in this area depend on the Okavango River flood regime, are still the most important sources of livelihood. Any problems therefore with the flooding system will present a major upset to the livelihood strategy of the people (Magole and Thapelo, 2005).

Though floods vary greatly in their character and in the size and vulnerability of the populations they affect, some caution is required in terms of public health responses and when drawing general lessons from a global literature, we should bear in mind this different characteristics. Some floods are catastrophic and affect thousands of people who may have little capacity to protect themselves; literature revealed that flood in a low-income country where emergency and support services are not able to cope with the immediate and longer-term effects leads to greater impact on health. Comparison of different flood events suggests that the risk of death is influenced by both the characteristics of the flood (e.g., its scale and duration, the suddenness of onset, the velocity and depth of water, the lack of warning) and of the population that it affects. Floods with the largest mortality impacts have occurred where infrastructure is poor and the population at risk has limited economic resources. The formulation of policies to protect against

flood related health risks is limited by the paucity of evidence on epidemiologic risk factors and public health interventions

The current study showed that floods that are experienced in Sepopa village are of slow-onset and such floods can be catastrophic in low-income settings, therefore literature indicates that there is need to improve understanding of the health risks in different settings and of the social and cultural modifiers of those risks. There is also more to understand about the long-term consequences of flooding on health and about the mechanisms by which such consequences can best be prevented or alleviated. Though flooding of the Okavango River is an annual event as experienced in Sepopa village, a lot of its impacts on the health of the community are not known. Majority of what is known is based on the popular perceptions regarding some important aspects of flooding, such as flood-induced damage to crops. It is also believed that a large number of projects that are currently being undertaken to mitigate flood are generally based on certain popular myths. These myths might not only obstruct but also create many unanticipated problems in the implementation of flood mitigation measures. The researcher believes that the present review of flood research will help both individuals and government revise their misconceptions regarding some aspects of flooding in Sepopa village. This may, in turn, facilitate measures to better respond to the country's chronic flood problem.

The result in table 4.3 shows that 85% of the respondents have cited injuries as one of the common impact of the Okavango River on the health of the community. Though the flow is of the slow onset, it is also associated with injuries which are either due to falls in the ditch that are dug by sand soil harvesters, being pricked by broken piece of wood or bottles, and many reported incidents of crocodile and snake bites and hippopotamus attacks. The table also revealed that 92% of the respondents believed illness is the most prevalent impact that the river has on their health, with illness ranging from the direct contact of water, using river water for domestic purpose and or by the virtue of residing next to the river bank. The results reveal also in table 4.3 that 54% of the respondents believes death is one of the impacts the river has on their health. Death could be due to drowning in the high waters brought about by the floods or attacks from the crocodile and hippopotamus that are brought along by the flowing water from the main channels. Still in table 4.3, 8% of the respondents believe the river has no impact on their health.

They believe that they see no difference in their health by virtue of residing next to the river as compared by their counterparts who stays in dry lands.

### **5.5. Common diseases associated with floods.**

It is believed by the public and health authorities in the world that potential outbreaks of communicable diseases normally arise after natural disasters, due to the contamination of water and disruption of water-purification and sewage-disposal systems. Nevertheless, some studies have demonstrated that such outbreaks rarely occur and that mass immunization against such diseases like cholera and typhoid fever are unnecessary. However, since some areas can be inundated for a longer period, during that time those affected might be forced to live in harsh conditions without good access to food, safe water or medical care, this could indirectly affect mortality and morbidity. As has been shown in previous studies, the flooding might bring an increase in levels of endemic illnesses in flood-affected areas, rather than an epidemic of a specific disease. Many literatures have cited floods as a disaster that is able to affect millions of people and millions of houses, leading to many millions of people to be evacuated. Many reports described an increase in diarrheal diseases in post-flood period others inducing epidemics before water receded, and finally living over thousand cases of morbidity and hundred cases of mortality due to diarrhea. However, the number of the reported cases might not represent the real incidence in the communities affected by floods. There have been few reports clarifying the factors associated with the incidence of diarrhea in flood disasters.

This study showed in table 4.4 that the annual floods in Sepopa village had a substantial impact on the health of the communities affected, and caused a particularly high incidence of bites either by snakes, crocodiles or hippopotamus standing at 62%. Of all the thirteen respondents, eight of them have indicated that they know of a person who was bitten by either a snake, a crocodile or attacked by the hippopotamus, either being a family member or a neighbor, this was also confirmed by all the three focus groups interviewed, where the one consisting of the health care workers have confirmed an increased number of bites cases consulted at the local health facility during the periods where water has risen.

Table 4.4 shows further that seven out of thirteen respondents 54% are testimony to the increased incidence of malaria disease, citing more specially the increased number of mosquitoes which is large in size and many in numbers. Respondents explained that the increased number of mosquitoes is due to many breeding site in waters that filled the swamps that are generally dry.

The table further indicates that 46% of the respondents have cited diarrhea and respiratory problems as the common diseases. This disease pattern was quite similar to those cited in other literature. Common cause of death and illness after flooding in many studies are attributed to nonspecific diarrheal diseases where the causative pathogens varied from *Vibrio cholerae* to entero pathogenic *Escherichia coli* and that those affected had low socioeconomic status, poor sanitary conditions and hygiene practices, which might be associated with the diarrhea outbreak, and little intervention such as water purification tablets distribution had been implemented. In some affected communities, diarrhea epidemics are believed to be attributable to submerged pump wells, which is also the case in Sepopa village where the water purification plant is situated near the river bank was once submerged. Also access to the plant is sometimes difficult with flood water covering all the roads leading to it, preventing movement of workers and vehicles. However, as has been shown in our study and by other researchers, household water storage and handling could be an important factor in increasing diarrhea morbidity.

Though when a flood occurred in which the water level had risen by degrees, this did not seem to lead to high mortality as a result of direct causes such as drowning and injuries, as is often the case in flash floods. This is represented in table 4.4 where injuries are standing at 8%. Respondents also put vomiting at the bottom of the common conditions as represented by the lower percentage of eight as indicated in table 4.4.

### **5.6. Common causes of death and injuries during flooding.**

In developing countries, there seem to be little to no effectiveness of public health measures, including early warning systems when it comes to floods as evidenced by the results of the study. Nonetheless, the wide range of risks to health and well-being, both physical and mental, is understood, though there remains scientific uncertainty about the strength of association and public health burden for specific health effects. The immediate risks of trauma and death are

generally clear, but it seems that longer-term impacts, specifically on mental well-being, are often underestimated and probably receive too little attention from public health authorities including the affected persons themselves.

Although annual inflow of the Okavango River is seen as a blessing to the community it does not always bring good news. There are times when the river experiences abnormal floods. Abnormal floods which occurs once every few years and results from excessive rainfall both in Botswana and Angola is regarded by farmers as an undesirable and damaging phenomenon. It causes widespread damage to standing crops and properties and sometimes costs animal and human lives. Although the people of Sepopa have evolved numerous adaptive strategies to benefit from normal flooding, an abnormal one surpasses their ability to adjust. However, experience shows that floods have a wide range of frequency, intensity and duration, characteristics which complicate prediction and preparedness. Thus, even those floods which are beneficial under normal circumstances are potentially dangerous. This ambiguous character means that there is always the risk of disruption of people's lives, loss of livelihood, damage to property, general human suffering and even death. Floods are beneficial only within certain limits of timing, duration, and magnitude. If flooding occurs either earlier or later than the normal time, if it stays for a longer period than usual duration, or if flood water rises higher than the usual height, covering more dry grounds far from its original route, it is perceived as abnormal and perceived to have tremendous consequences to the health of the community.

The results in table 4.5 shows that 77% of the respondents have reported drowning as the most common cause of death due to the flooding of the Okavango River. Drowning is more common in children who will be playing in the waters that will be reaching near their homes because of floods, and also adults who will either be fishing or harvesting other foods from the river. The table also reveals that 77% of the respondents cited crocodile attacks as the common cause of death and injuries to residents who use river as the key source for survival. Victims are attacked while they fish, harvest reed and grass or when they graze their animals on the river banks. The table went further to illustrate that 54% of the respondents have mentioned hippopotamus attacks as the common causes of death and injuries during flooding. Because large areas will be covered with water, the only places left for hippopotamus to graze will be mostly in the backyards of the households of those residents residing next to the river, as such it will be putting them at risk of

being attacked. In the village of Sepopa, common mode of transport in the river is the wooden canoes, which is used by fisher men when fishing or as a mode of transport across the river. Hippopotamus have the tendency of attacking people using such mode of transport leading to serious injuries or death or even drowning if victims cannot swim. Table 4.5 demonstrates that 8% of the respondents allude to speed boats colliding as possible causes of death and injuries. This is more common when the bushes in the river are not cleared to give a clearer view of the channels that are followed when travelling in the river, as such accidents are common when the channels are curving. The table went on further to reveal that 54% of the respondents have cited snake bites as other causes of death and injuries. Respondents have revealed that women are mostly affected by snake bites as they harvest grass and reed in the river which in most cases snakes hide under.

#### **5.7. Benefits of the river to the community.**

In the Western world and many literatures, flood is uniformly viewed negatively and considered a natural hazard but the people of Sepopa village perceive flood as both a resource and a hazard, as evidenced by the results of the study. Often when flowing water is termed 'flood', danger or disaster is implied. Indeed floods have been associated with huge economic loses, disruption and loss of people's lives (Wisner et al., 2004). Wisner et al., (2004) submit that floods accounted for the largest share of economic loses and fatalities from all natural hazards experienced in the late 1980s and throughout the 1990s. Smith (1991) wrote that floods are the most common of all environmental hazards. Furthermore, it would appear that destructive floods have become increasingly frequent and serious, with severe flooding reported every year in parts of Asia and Africa. It is in this context that the fear of floods is justified. However, in other areas, especially in wetland areas such as deltas which do not depend on local precipitation, but get flooded by waters rolling down from headstreams in other areas, floods are a normal and an essential component of agricultural and ecological systems (Wisner et al., 2004). According to Smith (1991), more than any other environmental hazard, floods bring benefits as well as losses. Kundzewicz et al., 2002 argues that they are natural phenomena that have always existed, and people have tried to use them to advantage to the extent possible.

Along the flooding river and downstream delta wetlands, such as those created by the Nile, Niger and Okavango Rivers, floods are critical for maintaining and restoring many of the important services provided to humans by wetland ecosystems. Flood-associated benefits, according to Wisner et al., 2004 include the provision of critical habitat for fish, waterfowl and wildlife; maintenance of high levels of plant and animal diversity; replenishment of agricultural soil nutrients and transporting sediments which maintain downstream deltas and coastal areas. These flooding areas have for a long time attracted farming, fishing and hunting communities and of late tourism ventures. Agriculture benefits from the more fertile soils with improved moisture retention; fishing opportunities are enhanced by nutrient-rich waters brought to ponds, lakes, lagoons and river channels; while tourism is attracted by the scenic beauty of the unique water feature as well as the rich variety of the flora and fauna found in the area. Unlike flash floods associated with tropical cyclones and storms, these floods are usually expected at a certain time. As argued by Wisner et al., 2004, these types of floods amount to known risk, implying that a certain level of preparedness is possible.

The ideology is also backed by Magole and Thapelo (2005) study where government and NGO disaster relief organizations responded to the floods in panic and desperation while affected communities appeared calm and laid-back. To the extent that they (communities) refused to evacuate flood plains and island settlements to make way for the considerably high and potentially dangerous flood of 2004; the communities' reaction was surprising as the floods were so severe upstream, that they caused damage to property, threatened lives and reduced yields significantly. However, they found out that studying the farming community of Tubu revealed that community members have other considerations which make them perceive the inherent risk differently from outsiders. A normal flood resulting from usual rainfalls and annual inflows from the highlands of Angola is considered a resource by farmers in the Okavango region. It is beneficial in the sense that it makes the land productive by providing necessary moisture and fresh silt to the soil for farmers ploughing on the river bank and also provides abundant water supply for their livestock. Moreover, fish caught during flood season constitute the main source of protein for many. Additionally, several households in Sepopa depend on fisheries in the floodplains for their livelihood and the life cycle of some key fish species depends on the ability to migrate between the rivers and the seasonal floodplains.

This thought is supported by the study that was conducted by Magole and Thapelo (2005) where communities view flooding (whether severe or normal) more as part of the biodiversity production system and a source of livelihood than a destructive force. It was found regarding molapo farming that, first, even under hazardous flooding conditions crop yields are still better compared to those under alternative dry land farming. Secondly, destructive floods occur at 10- to 20-year intervals, making the gamble worthwhile because overtime the flood-related benefits outweigh the risks. Thirdly, because the molapo farming communities are poor, other sources of livelihood are not adequately developed to take over from molapo farming. Fourth, the system has evolved into an old tradition which the farmers are not willing to part with. Hence the farmers are adamant that abandoning the production system is not, as yet, an option for them

The result in table 4.6 show that 92% of the respondents explained that the river is their source of food. It is in the Okavango River where they catch fish for food, harvest water lily, and other natural indigenous fruits. They do also hunt hippopotamus for meat. The table also shows that 46% of the respondents utilizes river as the mode of transport. Most villages in the Okavango district are situated along the river therefore the shortest route connecting them is through using river as the mode of transport. Table 4.6 went on further to reveal that 85% of the respondents use the river as a source of water for their livestock. Respondents explained that their area is a sandy desert therefore it is difficult and very expensive to dig boreholes, as such they resorted to using the river as a source of water for livestock as it is perennial. It is also shown in table 4.6 that 62% of the respondents use the river as a source of income. This is so in the sense that they sell what they harvest in the river. The result of the research reveal in table 4.6 that 85% of the respondents use river as a sources of water. Water from the river is mostly used in periods where the village experiences some water shortages. It is also found to be used on daily basis by those households residing next to the river who believe community standpipes are far from where they are staying. The results however show that 23% of the respondents use the river as a source of tourism attraction. Those respondents explained that they run a business of transporting tourists along the multiple channels and tributaries of the Okavango River.

## **CHAPTER 6**

### **CONCLUSION AND RECOMMENDATIONS**

This chapter provides an outline of the researcher's findings and comments that are made to assist in further research. The chapter further provides an overview of the finding and the measures of corrections in areas that are of concern to the researcher. This chapter concludes the research. The study introduced the background and objectives in chapter one, explored the general concepts of the impact that the river has on the health of the community of Sepopa in chapter two backed by literature review, highlighted the methodology that was used for the study and further explain the study site, study design, sampling, data collection and data analysis in chapter three, outlined the results in chapter four, and presented and discussed the findings in chapter five. This chapter makes recommendations on the basis of the findings and and conclusions described in chapter five.

#### **6.1 CONCLUSION RELATED TO THE AIM OF T HE STUDY**

This was a qualitative study conducted in Sepopa village in the Okavango district, Botswana where an assessment of the impact of the flooding Okavango River has on the health of the community of Sepopa village. This study was specifically conducted in that area of the Okavango district for a purpose. This region was an ideal choice for this evaluation as it constantly receives annual flooding from the highland of Angola. The whole evaluation was based on the specific objectives, which were to explore the impact of the Okavango River on human health in the study area and to determine the causes of flood related morbidity and mortality.

##### **6.1.1. IMPACT OF FLOODING OF THE OKAVANGO RIVER ON HUMAN HEALTH.**

Relatively few properties and hence people were affected by flooding in the case study area and there were no predicted deaths or serious injuries; these results were supported by anecdotal knowledge of the events. Diseases like mental health problems, characterized as psychological distress which might be estimated for adults were not highlighted during the response. These might be because less knowledge and association about such health impacts to the effects that the river can have on their health is limited. The impacts that they dwelled more on were of the

physical nature where injury can be seen or the body of a dead person. It has been stated in the study that health impacts of floods can occur during or after flooding events, therefore relatively low numbers of flood related deaths were recorded in the study area in comparison with other regions. The number of deaths associated with flooding is closely related to the life-threatening characteristics of floods (rapid rising of water, deep flood water and objects carried by the rapid flow of water) and the behaviour of victims. Injuries (such as sprains, strains, lacerations and contusions) may occur during flooding, but are more frequent in the aftermath of a flood disaster as residents return to their homes to clean up damage and debris. Infectious diseases are not common and are normally confined to illnesses endemic to the flooded region. Most of these illnesses are attributable to reduced sanitation or to overcrowding among displaced people. Some studies have shown an increased incidence of common mental health disorders for long periods after a flooding event. Anxiety and depression may last for months and possibly even years after the flood event and so the true health burden is rarely appreciated. All this was not the case in the study area, because the current study showed that floods that are experienced in Sepopa village are of slow-onset and as such not catastrophic. Though such floods can be catastrophic in low-income settings, therefore literature indicates that there is need to improve understanding of the health risks in different settings and of the social and cultural modifiers of those risks. The need to understand more about the long-term consequences of flooding on health and about the mechanisms by which such consequences can best be prevented or alleviated. Though flooding of the Okavango River is an annual event as experienced in Sepopa village, a lot of its impacts on the health of the community are not known. Majority of what is known is based on the popular perceptions regarding some important aspects of flooding, such as flood-induced damage to crops. It is also believed that a large number of projects that are currently being undertaken to mitigate flood are generally based on certain popular myths. These myths might not only obstruct but also create many unanticipated problems in the implementation of flood mitigation measures. The researcher believes that the present review of flood research will help both individuals and government revise their misconceptions regarding some aspects of flooding in Sepopa village. This may, in turn, facilitate measures to better respond to the country's chronic flood problem and also financing of more research in the field of health impact of floods.

There were 85% of the respondents who cited injuries as one of the common impact of the Okavango River on the health of the community. It was pointed out that though the flow is of the slow onset, it is can also be associated with injuries which in the study area can either be due to falls in the ditch that are dug by sand soil harvesters, being pricked by broken piece of wood or bottles, and many reported incidents of crocodile and snake bites and hippopotamus attacks. The impact with high incidence of 92% is that of illness. It is believed to be the most prevalent impact that the river has on the health of the community, with illness ranging from the direct contact of water, using river water for domestic purpose and or by the virtue of residing next to the river bank. The results of the study went on to reveal that 54% of the respondents believe death is one of the impacts the river has on their health. This could be due to drowning in the high waters brought about by the floods or attacks from the crocodile and hippopotamus that are brought along by the flowing water from the main channels. Least of the respondents at 8% believe the river has no impact on their health. They believe that they see no difference in their health by virtue of residing next to the river as compared by their counterparts who stays in dry lands.

However, despite all this challenges outlined above, the community of the study area along with other areas, especially in wetland areas such as deltas which do not depend on local precipitation, but get flooded by waters rolling down from headstreams in other areas, floods are seen as a normal and an essential component of agricultural and ecological systems which brings befits as well as loses. But it can be argued from the community perspective that despite the loses they bring along, they are a natural phenomena that have always existed, and people have tried to use them to advantage to the extent possible. Such floods are seen as critical in maintaining and restoring many of the important services provided to humans by wetland ecosystems. Flood-associated benefits also included the provision of critical habitat for fish, waterfowl and wildlife; maintenance of high levels of plant and animal diversity; replenishment of agricultural soil nutrients and transporting sediments which maintain downstream deltas and coastal areas. It was also found out in this study that these flooding areas have for a long time attracted farming, fishing and hunting communities and of late tourism ventures. Agriculture benefits from the more fertile soils with improved moisture retention; fishing opportunities are enhanced by nutrient-rich waters brought to ponds, lakes, lagoons and river channels; while tourism is attracted by the scenic beauty of the unique water feature as well as the rich variety of the flora

and fauna found in the area. It was also discovered that unlike flash floods associated with tropical cyclones and storms, these floods are usually expected at a certain time and as such amount to known risk, whereby certain level of preparedness from the community is possible.

Although the infrastructure to deliver water in Botswana is in place, the burden of adequate distribution is worsened by the reduced access to water supply among households in rural areas, especially those who collect water from communal standpipes. There is a problem of the unreliability of water supply caused by the breakdowns of diesel-fuelled pumps, high frequency of busting water pipes, and the failure to deliver diesel fuel in time. This problem has led to an increase in the use of water of poor quality and other practices of poor hygiene as well as a high opportunity cost of water collection. The use of untreated water has potential to increase the risks of public health, further worsening the impacts that the river has on the health of the community.

Access to water can be an important asset, which affects the health of the household. Access to a sufficient and reliable supply of potable water is therefore an important household coping strategy. As shown above in terms of ostracism, unreliability of water in the community changes the norms of reciprocity, and contributes to the risk of exposing community to the health impacts of flooding. A holistic approach to access to water is considered not only the physical needs of members of the community, but the total living environment, institutional and social relations in which activities of daily living takes place. Access to water is important for community members as they are better able to cope with increased stress due to travelling long distance to fetch water in the communal stand pipes. The survey revealed that water may not be available for up to five days, and this creates a situation where alternative sources of water supply are utilized. The survey showed that households have adopted four main coping strategies when faced with lack of water which are: economizing on the use of water by either re-using waste-water or using water sparingly, utilizing stored water from reserve containers/tanks, collecting water from other sources such as river, and also collecting water from government institutions. Among all this coping strategies, collection of water from other sources such as the river has a high representation of 61.5% of respondents. This mean therefore that majority of the community of the village of Sepopa is exposed to the impacts the Okavango River has on their health.

The results of this study also suggest that, as the respondents' points out, water should not be strictly treated as an economic good. Its importance as a basic need and social good is clearly demonstrated by this study literature where majority of the human body is made up of water. We therefore support the view that water is an economic good in most cases (except during a severe drought) and the critical issue is whether it should be treated like other private goods or like public goods. Depending on the amount of water supplied to the household, water should be treated like an ordinary private good or a public good. It is an obligation of the Government of Botswana to supply water for basic human needs; hence it is necessary to treat water differently at different levels of consumption, at the same time spreading the distribution of communal stand pipes equally within the community so that access is improved. Given that access is not only about direct monetary cost to the consumer, but also about supplies of water of good quality where and when it is most needed, it is recommended also that the Government subsidize installation of on-plot water infrastructure such as standpipes.

## **6.2. LIMITATIONS**

The major limitations that the study had was that there was no comparison of various factors between those affected and not affected in relation to staying close to the river bank or in higher grounds within the village. There was no comparison of sanitary conditions and hygiene practices before and during the flood. There also might be a selection bias in our study. Although we tried to ask one adult per household who knew the health of family members and impacts of floods to household conditions well, females were dominant among the respondents because males were either reluctant to come out and answer the questions or not present at home at the time of the study. Since females tend to know more about health status, especially of children, and other family members on the other hand being more engaged in all household chores and water handling in Sepopa village, it might be possible that the results related to family's health, water and sanitation were accurate but biased on the impacts the river has when it comes to male.

## **6.3. RECOMMENDATIONS**

**6.3.1.** Recommendations are made on the basis of the finding and conclusion above. Many of the recommendations were derived from people's comments when they were asked what they would like to be done differently to reduce the impact of the river on their health.

- Department of lands and housing should survey the old plots allocated to the community and those households which were allocated plots on the natural route of the Okavango river should be relocate to higher grounds.
- Department of water utilities cooperation should increase the number of communal stand pipes within the village to improve on water access and distribution.
- Government should subsidize installation of on-plot water infrastructure such as standpipes.
- Early warning of flooding risk, and appropriate citizen response, has to be put in place as it is shown to be effective in reducing disaster-related deaths.
- Health education on the impacts of utilizing untreated water should be intensified.
- Parents should be extra careful in mending their children during periods of floods.
- There should be a disaster management committee in the village.
- Safer modes of transport should be used in the river during periods of floods.
- Households should adopt a system of storing water in well closed containers for future use.

### **6.3.2. FUTURE RESEARCH.**

Further research should be conducted on the five major villages of the Okavango region on the impact of the river on the health of the community using a different research method and approach.

### **6.4. SUMMARY AND CONCLUSION.**

Before, during and after a flood event, activities may be undertaken by the population at risk, by policy makers and by emergency responders to reduce health risks. Proper planning aimed to reduce the harmful effects of flooding by limiting the impact of a flood on human health and

economic infrastructure should be adopted. This is accomplished by relocating structures away from flood-prone areas, planning appropriate land use, and managing costs of flood plains. Mitigation measures may reduce but not eliminate major damage. Early warning of flooding risk, and appropriate citizen response, has been shown to be effective in reducing disaster-related deaths. From a public health point of view, planning for floods during the inter flood phase aims to enable communities to effectively respond to the health consequences of floods, and to enable the local and central authorities to organize and effectively co-ordinate relief activities, including making the best use of local resources and properly managing national and international relief assistance.

In addition, medium to long-term interventions may be needed to support populations who have been flooded. These should include initiatives such as public health authorities being alerted to the possibility of post-flood diseases and injuries, and the identification of and provision of health services for individuals with post-flood health problems. It seems likely that effective vulnerability reduction will necessitate the involvement of a range of sectors at the local, regional and sometimes national level. There is a need for statistical indicators of vulnerability and the harm caused by major emergencies. Data from these indicators will assist in monitoring and evaluating vulnerability reduction, and identification of communities at risk. It is important that an approach to relief, disaster preparedness and mitigation starts with programmes with a developmental focus on increasing the health and safety of the potentially affected populations. An overall objective of disaster management committee should be to describe the health effects of disasters and the factors contributing to these effects and provide clues to diagnosis, help medical care providers match resources to needs, and permit better contingency planning.

The department of water utilities cooperation should adopt and demonstrated the practical and inexpensive strategies for reducing water-borne diseases by disinfecting drinking water immediately after collection (point-of-use disinfection) and storing the water in narrow-mouthed, closed vessels designed to prevent recontamination (safe storage). Moreover, it is crucial to provide more sanitary information and modify hygiene practices in a pre-disaster period. Although protection, prevention and mitigation of flooding are very important, periodic flooding seems to be technically unavoidable. Hence, people in flood-prone areas should build the

capacity to cope with and recover from floods by reorganizing their communities with self-help and self-reliance measures.

It can generally be concluded that despite the losses they encountered, especially in yields, farmers made it clear that abandoning their fields and moving to dryland areas was not an option. They insisted that they are river people who are meant to live near the water and use water-related natural resources. This strong cultural connection to flood plain cultivation and other considerations seem to encourage a view of risk by the affected communities which is characterized by a lack of desire to control the natural environment and hence accepting the inherent risk. All in all, destructive floods appear to occur less frequently than they used to. The two most-recent floods occurred 20 years apart (1984 and 2004). Furthermore, from the records of inflows of water and community experience, recently severe floods are smaller in volume than the previous ones, presenting a possibility that the damage they caused may not be as severe as that caused by earlier ones. Lastly the availability of other sources of livelihood, especially livestock rearing, fishing and gathering of reeds and grass appear to be effective as a strong reason enough for them not to relocate even in the event of severe floods.

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