SOCIO-ECONOMIC ASSESSMENT OF THE CONSEQUENCES OF FLOODING IN NORTHERN NAMIBIA

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DECLARATION

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Date: 01 August 2014

ABSTRACT

This study was conducted in the Cuvelai Basin in Northern Namibia to assess vulnerability and socio-economic impacts of flooding on local residents, and to suggest ways to counteract the consequences of flooding in rural areas of the Basin. This followed severe flooding in 2009, 2011 and 2012. These combined flooding episodes had a substantial impact on local residents and the Namibian economy, with estimated losses of approximately US$136.4 million (NAD1364 million) in direct damage and US$78.2 million (NAD780 million) in indirect losses. The consequences of flooding amounted to ~1% of the country's 2009 Gross Domestic Product (GDP).

Rural residents in the Cuvelai Basin live predominantly on small farm holdings ('*ekove*') allocated by local village leadership, and depend heavily on subsistence farming for their livelihoods. Since higher-lying ground with soil best suited for crop production becomes scarcer, residents are allocated land in low-lying areas which are smaller and more susceptible to floods. The destruction of crops, farm and grazing land, trees and livestock, by floods and similar disasters is of a huge concern. The study sought to assess the impacts of flooding, geographical or physical circumstances that place residents at risk, and socio-economic conditions that lead to vulnerability. The study also attempted to assess whether traditional leaders (headmen) and village residents can use flood risk maps to create plans to reduce flood vulnerability.

Over the past flood years, initiatives by the government to cope with floods have been response (relief), short-term and heavily donor dependent. To cope with floods and agro-climatic changes in their basin, rural residents have evolved their practices, some of which are traditional, to help lessen the impacts of floods on their livelihoods. Unfortunately such knowledge is not fully acknowledged by policy, decision makers and disaster risk managers. As a result of this knowledge gap, the study's objective of compiling these practices, serves as a means to document localized traditional flood response, mitigation and adaptive measures. Moreover, the study will suggest contemporary adaptive measures as recommended by the local rural residents.

Residents in 314 households were interviewed during August to November 2012. The households were selected following recommendations by village headmen, and consisted of 273 flooded homes, 42 village leaders, and 35 homes that were not flooded from 45 randomly selected villages. The qualitative data was captured, pre-coded, processed and analysed in

Microsoft Excel, SPSS and STATISTICA to derive descriptive and inferential statistics. Following consultations with village headmen and residents, recommendations were made on practical adaptive strategies to flooding.

The study found that there is a need to foster community level participation, buy-in and involvement in disaster risk management strategies in order to reduce the gap between technical early warning mechanisms and indigenous knowledge. Results revealed that households with coinciding socio-economic and geographic vulnerability are heavily impacted by flood disasters. However, these two vulnerabilities are not directly proportional to each other. Other vulnerable groups in society were outlined and structural and non-structural mitigation and preparedness measures at household level were recommended by the residents.

It is the study's intention that this will assist in strengthening local residents adaptive capabilities during events of flooding, thereby mitigating their impacts. The project's intention of documenting this technical and indigenous knowledge, will serve as a knowledge base that can be compiled and integrated into an effective village friendly flood early warning system. It is further hoped that this initiative will garner support at the policy level and contribute to the prioritization of flood response to pending disasters being placed at the centre of development planning and execution.

Keywords and phrases:

Disaster Risk Management, flood mitigation, flood preparedness, flood response, flood reduction, geographic vulnerability, socio-economic vulnerability, structural vulnerability, flood impact on communities and households, structural and non-structural flood mitigation, Cuvelai Basin.

OPSOMMING

Hierdie studie is uitgevoer in die Cuvelai-opvangsgebied om die kwesbaarheid en sosio-ekonomiese impak van vloede op die plaaslike inwoners te bepaal ten einde maniere te vind om die gevolge van oorstromings in die landelike gebiede van die Cuvelai teen te werk. Ernstige oorstromings in 2009, 2011 en 2012 het 'n aansienlike impak op die Namibiese ekonomie gehad met geraamde verliese van ongeveer US$136.4 million (NAD1364 million) in direkte skade en US$78.2million (NAD780 million) in indirekte verliese vir die land. Ongeveer een persent (1%) van die land se 2009 bruto binnelandse produk (BBP) is benut om die gevolge van hierdie oorstromings aan te spreek.

Landelike inwoners in die Cuvelai-opvangsgebied woon op kleinhoewes, plaaslik bekend as *ekove*, wat toegeken word deur plaaslike gemeenskapsleierskap. Hulle is hoofsaaklik afhanklik van bestaansboerdery. Aangesien hoër-liggende gebiede met goeie landboupotensiaal toenemend skaarser word, word nuwe kleinhoewes toegeken in laer-liggende gebiede, waar die negatiewe gevolge van oorstromings op inwoners erger kan wees. Skade aan gewasse, landbougrond en weiding, boorde en vee deur oorstromings en soortgelyke rampe is dus kommerwekkend. Die doelstelling van die studie was dus om die impak van oorstromings te bepaal, die geografiese of fisiese omstandighede wat plaaslike inwoners in gevaar stel te evalueer, en sosio–ekonomiese toestande wat lei tot kwesbaarheid te bepaal. Verdere doelwitte was om vas te stel of gemeenskapleiers en plaaslike inwoners vloedrisikokaarte kan gebruik om vloedkwesbaarheid te bepaal, in oorleg met plaaslike owerhede en inwoners alternatiewe praktiese aangepaste strategieë vir oorstromings vas te stel en aanbevelings aan die nasionale rampsbestuursbeleid en praktyk waar toepaslik te maak.

Tydens die afgelope oorstromings was regeringsinisiatiewe om oorstromings te hanteer korttermyn vloedverligting, grootliks afhanlik van skenker. Om vloede en landbou-klimaatsveranderinge the hanteer, het landelike inwoners nuwe praktyke ontwikkel, sommige van tradisionele aard, om die impak van oorstomings op hulle lewensbestaan the verminder. Ongelukkig word sodanige kennis nie ten volle erken deur beleid, besluitnemers en ramprisikobestuurders nie. As gevolg van hierdie kennisgaping, dien die studiedoelwit om hierdie praktyke saam te stel die doel om gelokaliseerde tradisionele maatreëls aangaande vloedreaksie, versagting en aapasbaarheid te dokumenteer. Verder sal die studie onlangse maatreëls voorstel soos aanbeveel deur die plaaslike landelike inwoners.

Ten einde kwalitatiewe data van die gemeenskappe wat in die Cuvelai woon te bekom is daar vir vier maande (Augustus tot November 2012) opnames gedoen by 314 huishoudings, gekies op aanbeveling van die plaaslike owerhede wat insluit 273 vloedslagoffers, 42 gemeenskapsleiers, en 35 huishoudings wat nie deur vloede beïnvloed is nie, vanuit 45 verskillende gemeenskappe. Die kwalitatiewe data is opgeneem, vooraf-gekodeer, verwerk en ontleed in Microsoft Excel, SPSS en STATISTICA om beskrywende en inferensiële statistieke te bekom.

Die studie het bevind dat daar 'n behoefte is om die vlak van gemeenskapsdeelname te bevorder, inkoop en betrokkenheid by die ramp risikobestuurstrategieë te verkry ten einde die tegniese gaping tussen vroeë waarskuwingsmeganismes en inheemse kennis te verminder. Die studie het ook getoon dat huishoudings met ‘n gekombineerde sosio-ekonomiese en geografiese kwesbaarheid groter newe-effekte ondervind van vloedrampe. Die twee kwesbaarhede is egter nie direk eweredig aanmekaar nie. Ander kwesbare groepe in die samelewing is uitgewys, en strukturele en nie-strukturele versagting en paraatheidsmaatreëls op huishoudelike vlak is deur die inwoners aanbeveel.

Die studie se doelwit is om die aanpasbaarheid van die plaaslike inwoners tydens oorstromings te bevorder, en sodoende die impak te verminder. Dokumentasie van hierdie tegniese en inheemse kennis sal dien as 'n kennisbasis wat saamgestel en geïntegreer kan word in 'n effektiewe gemeenskapsvriendelike vroeë vloedwaarskuwingstelsel. Indien hierdie inisiatief ondersteuning vind op beleidsvlak, kan dit bydra tot die prioritisering van vloed- en rampreaksie in ontwikkelingbeplanning en uitvoering.

Trefwoorde en frases:

Ramp Risiko Bestuur, vloed verligting, vloed paraatheid, vloed reaksie, vloed vermindering, geografiese kwesbaarheid, sosio-ekonomiese kwesbaarheid, strukturele kwesbaarheid, vloed impak op gemeenskappe en huishoudings, strukturele en nie-strukturele vloed versagting, Cuvelai-opvangsgebied atlas.

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ACRONYMS AND ABBREVIATIONS

4-O	Four-O (Ohangwena, Oshikoto, Oshana, Omusati) northern regions
ADPC	Asian Disaster Preparedness Center
ARV	Anti-Retro Viral [therapy]
AUDMP	Asian Urban Disaster Mitigation Program
BBC	British Broadcasting Corporation
CAFO	Church Alliance for Orphans
CBDRM	Community-Based Disaster Risk Management
CBFMP	Community-Based Flood Mitigation and Preparedness Project
CCA	Climate Change Adaptation
CCCM	Camp Coordination and Camp Management
CERF	Central Emergency Response Fund
CLBs	Communal Land Boards
CLR	Customary Land Registration
CLRA	Communal Land Reform Act
CPP	Country Pilot Partnership
DDRM	Directorate Disaster Risk Management
DEM	Digital Elevation Model
DEM	Directorate Emergency Management
DMCs	Disaster Management Committees
DREF	[International Federation’s] Disaster Relief Emergency Fund
DRFN	Desert Research Foundation of Namibia
DRM	Disaster Risk Management
DRMCs	Disaster Risk Management Committees
DRR	Disaster Risk Reduction
EOLSS	Encyclopedia of Life Support Systems
ESA	European Space Agency
FAO	Food and Agriculture Organization
FEMA	[American] Federal Emergency Management Agency
FEMCO	Flood Emergency Management Coordination Office
FGDs	Focus Group Discussions
FM	Frequency Modulation
GDP	Gross Domestic Product

GEF	Global Environment Facility
GRN	Government of the Republic of Namibia
HEARD	Health Economics and HIV/AIDS Research Division
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
IK	Indigenous Knowledge
IOM	International Organization for Migration
IRIN	Integrated Regional Information Networks
Km	Kilometer
MEA	Millennium Ecosystem Assessment
MRLGH	Ministry of Regional & Local Government & Housing
NAD	Namibian Dollar
NMS	Namibia Meteorological Services
NASA	National American Space Agency
NDPs	National Development Plans
NEDF	National Emergency Disaster Fund
NEWFIU	Namibia Early Warning and Food Information Unit
NFIP	[American] National Flood Insurance Program
NHS	Namibian Hydrological Services
NRCS	Namibia Red Cross Society
OFDA	Office of U.S. Foreign Disaster Assistance
OPM	Office of the Prime Minister
PDNA	Post Disaster Needs Assessment
PS	Permanent Secretary
RELUFA	REseau de LUtte contre la FAim
RCs	Regional Councils
RDRMCs	Regional Disaster Risk Management Committees
REMUs	Regional Emergency Management Units
RR	Rapid Response
RCVs	Red Cross Volunteers
SARCOF	Southern Africa Development Community (SADC) Regional Climate Outlook Forum
SARVA	South African Risk and Vulnerability Atlas
SPSS	Statistical Package for the Social Sciences

STATISTICA	Statistical Analysis Package
TA(s)	Traditional Authority(ies)
TRMM	Tropical Rainfall Measuring Mission
UFE	Underfunded Emergency
UN	United Nations
UNDP	United Nations Development Program
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's [Education] Fund
UNISDR	United Nations International Strategy for Disaster Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UN-Habitat	United Nations Human Settlements Programme
US$	United States [of America] Dollar
USA	United States of America
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization
WMO	World Meteorological Organization
wom	word-of-mouth

CHAPTER 1: FLOODS OF THE CUVELAI RIVER BASIN: A BENEFIT AND A CURSE

This case study in the Cuvelai Basin, Namibia, used non-probabilistic methods to assess vulnerability to floods of the rural residents at household level. In this paper, vulnerability is understood from three different perspectives: those vulnerable due to geography (geographic vulnerability), those vulnerable due to the level of socio-economic standing in society (socio-economic vulnerability), and finally from the point of measuring direct damages due to floods (structural/technical/physical vulnerability). Most importantly, the interaction of these three factors and its role in worsening overall vulnerability to floods are analyzed and described.

The study proposes ways by which to counteract the consequences of flooding in rural areas of the Cuvelai Basin. Additionally, it seeks to develop mitigation strategies for communities to adapt to the impact of floods. Over the past flood years, initiatives by the government to cope with floods have been response (relief), short-term and heavily donor dependent. To cope with floods and agro-climatic changes in their basin, rural residents have evolved their practices, some of which are traditional, to help lessen the impacts of floods on their livelihoods.

Unfortunately such knowledge is not fully acknowledged by policy, decision makers and disaster risk managers. As a result of this knowledge gap, the study’s objective of compiling these practices, serves as a means to document localized traditional flood response, mitigation and adaptive measures. Moreover, the study will suggest contemporary adaptive measures as recommended by the local rural residents.

It is the study’s intention that this will assist in strengthening local residents adaptive capabilities during events of flooding, thereby mitigating their impacts. The project’s intention of documenting this technical and indigenous knowledge, will serve as a knowledge base that can be compiled and integrated into an effective village friendly flood early warning system. It is further hoped that this initiative will garner support at the policy level and contribute to the prioritization of flood response to pending disasters being placed at the centre of development planning and execution.

This chapter introduces the flooding concept and provides the reader with an overview of the flood situation in the broader context, and more specifically, within the context of the Cuvelai Basin. The background on past floods as well as the previous response channels thereof is also reviewed. With the causative problems established, the rationale and significance of the research is also outlined. Aims and objectives of the study are also provided in this chapter. An overview of what other chapters in this paper entail is given here:

Chapter 2 reviews literature on vulnerability and vulnerability assessment. This data is articulated in a much broader way both through hazard perspective and politico-socio-economic perspectives; with various definitions of vulnerability concept being offered. Some research maintains that people are vulnerable to floods because of where they live and vulnerability can be defined spatially. Exposure is thus part of geographic vulnerability, but in itself cannot define geographic vulnerability. Some literature has espoused that not all vulnerability can be expressed geographically, as differences within a given place can make some people more vulnerable than members of their own immediate household. In this instance, socio-economic vulnerability, which is the nexus of resistance and adaptive capacity, is professed. However, "if in social vulnerability assessment the focus is on determining the indicators of societies' coping capacities to any natural hazard and identifying the vulnerable groups or individuals based on these indicators, in physical (or technical) vulnerability assessment the role of hazard and their impacts is emphasized, while the human systems in mediating the outcomes is minimized" (Ciurean et al. 2013:15). This provides the third component of vulnerability and vulnerability assessment, from the actual impact on the ground. All the three types of vulnerabilities are described in detail in this chapter.

Chapter 3 reviews the impact of flooding on rural livelihoods, and examines livelihoods literature. International perspectives are also considered, as some international researchers have suggested that floods are a result of anthropogenic climate change, thus a brief review on the impact of human-induced climate change on floods is presented.

The residents of the Cuvelai Basin depend heavily on subsistence farming for their livelihoods. The destruction of crops, farm and grazing land, trees and livestock, by floods and similar disasters is of a huge concern. The chapter reviews literature on these topics. Risk factors, including land allocation that may lead to several vulnerabilities have been reviewed. Since vulnerability assessment is a highly subjective field, and often varies from place to place, from researcher to researcher and depending on the purpose of the study, there is no pre-determined metric devised to measure or assess socioeconomic and other vulnerabilities. Some vulnerability assessment approaches are criticized by some researchers, but other researchers elsewhere support them. The issue of trust in a 'risk society' has been reviewed. The chapter concludes with several approaches used in vulnerability and social studies which are described in detail in Chapter 4.

Approaches used by other researchers to conduct flood vulnerability and socio-economic studies are reviewed in Chapter 4. Namibia is faced by a huge challenge of lacking climate historic data. Few socio-economic studies have been conducted to address flooding and mitigation of impacts thereof, and are not based on actual quantified data, but rather extrapolated from very limited secondary sources. As a result, there are very few local methodologies documented. The research methods used to determine factors such as: study sites; spatial extent of sampling transects; actual sample of the study; spatial distribution of interviewed households; data collection; capture and manipulation; and vulnerability indicators alluded to in Chapter 3, are informed by the pilot study before the main data collection of this paper, and are discussed in this chapter. The results are documented in Chapter 5 (part 1) and in Chapter 6 (part 2).

Chapter 5 presents results of the data collected pertaining to the flood impact and vulnerability of the Cuvelai Basin. The nature of the interviewees and their understanding of flooding concepts are presented. The capacity of rural local residents to work with and interpret flood maps has also been tested and results are presented. Moreover, the results on the impact of flooding on rural livelihoods as identified in Chapter 3 are detailed. Results on geographic, socio-economic and physical vulnerabilities and their interrelations as raised in Chapter 2 have also been documented in this chapter.

In Chapter 6, the results of data with regards to flood history and household practical adaptive strategies in the Cuvelai Basin are presented. Flood history is described from the residents' perspective and is predominantly qualitative in nature. After evaluating the current situation, some of the actions taken by flood-affected residents in the past that differ from current practices in counteracting the consequences of flooding are highlighted. Practical adaptive strategies that help residents cope with flooding are also described. The use and application of indigenous knowledge by residents in flood risk management is also presented.

The results presented in Chapters 5 and 6 are discussed in Chapters 7 and 8 respectively. Chapter 7 comprises the flood impact and vulnerability analysis and the results as presented in Chapter 5 are discussed. The vulnerability of flood-affected residents to floods has also been investigated in detail. Chapter 8 details the results presented in Chapter 6. Flood history, household mitigation and adaptive strategies are presented here. The application and usefulness of indigenous knowledge in flood risk management at household and village level are also outlined in in this chapter. The final chapter concludes the findings of the study. Main findings and points of interest are also summarised here.

1.1 UNDERSTANDING THE FLOOD CONCEPT

Flooding can be defined as an overflowing of large amounts of water beyond its normal confines especially over what is normally dry land, World Meteorological Organization (WMO) (WMO 2013). According to Fedec & Sousa (2009), a flood is a significant rise of water level in a stream, lake, reservoir or coastal region. Questia (2004) defines flooding as the inundation of land by the rise and overflow of a body of water, commonly occurring when water levels exceed the carrying capacity of a river system in which it runs. The American Federal Emergency Management Agency (FEMA) (FEMA 2011) further specified that flood effects can be local, impacting a neighbourhood or community, or having a larger capacity, affecting entire river basins. This is most especially true in the Cuvelai Basin, where potentially the whole basin is at potential risk to flooding due to its geography, and some villages and households tend to be more highly prone than others.

Flooding is said to be one of the most common environmental hazards on a worldwide scale, after disease (Smith 2009), attributed to the widespread spatial distribution of rivers and associated flood plains, as well as low lying coasts and the long-standing attraction for human settlement. Though flood disasters are more common in Asia (41%), 17% of recorded flood disasters have occurred in Africa and have affected people mainly through loss of shelter [and other economic and agricultural losses] (Smith 2009).

The annual floodwaters of the Nile and other large rivers deposit fertile soils along the surrounding floodplains, which is used extensively for agriculture. Every year, the annual Nile floods bring to Northeast Africa the water and silt that supports life in the Sahara Desert. Ancient Egypt would not have existed to build their ancient pyramids, temples and tombs if it were not for the Nile River floods (Tanner 2005).

In a similar manner, the Cuvelai Basin, in northern Namibia encompasses the coming and going of floods which brings most life to the area and has made it suitable for cultivation and other agricultural activities. As a result of the relatively fertile soils and availability of shallow fresh groundwater, the Cuvelai supports more people per unit area than most other rural areas in southern Africa (Mendelsohn & Weber 2011). The Cuvelai Basin indirectly supports close to half of Namibia's population, with most inhabitants obtaining their food from crops and livestock (Mendelsohn & Weber 2011) supported by the water in the Basin. As elsewhere in the world, and observed by Wheater & Evans (2009), human activities appear to have altered the hydrology of the Cuvelai with the result being more recurring flooding, than noted in the past.

1.2 OVERVIEW OF THE CUVELAI BASIN

The Cuvelai Basin is a shared hydrological resource between Namibia and Angola (Figure 1.1). It lies between the Kunene and Okavango River Basins along the western edge of the Kalahari Basin (Figure 1.2).

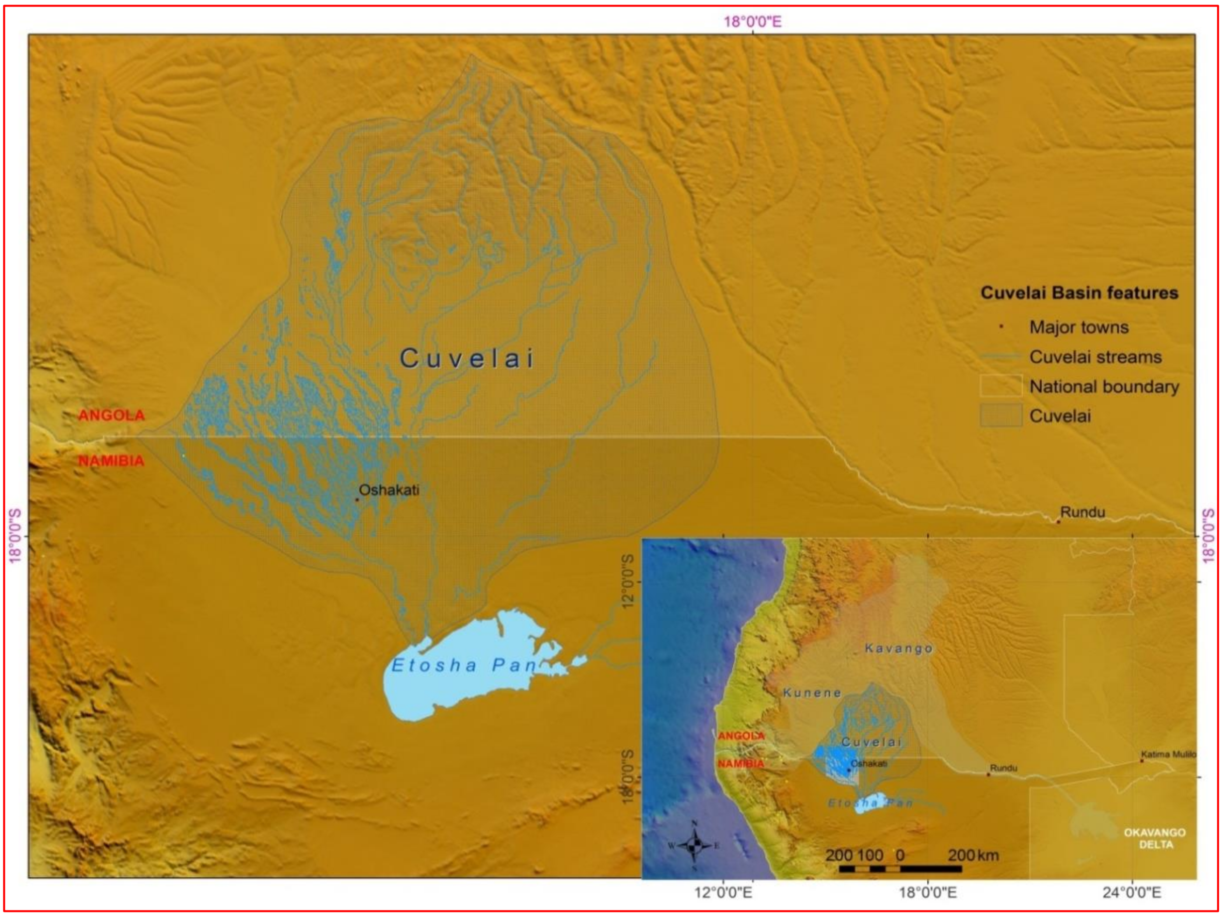


Figure 1. 1 The Cuvelai Basin between Namibia and Angola

Water flows in the Cuvelai drainage system originate from highlands in Angola and local rainfall that converge in channels called *iishana*. Its streams flow seasonally, sometimes emptying their waters into the Etosha Pan, in seasons of particularly high flows (Mendelsohn & Weber 2011). Formed and moulded by floods, rains, and contributing flows from rivers, the Cuvelai Basin is filled with deep sediments varying in quality. Sandy, infertile soils characterise the east, while water-borne sediments make up substantial areas of the central and western zones thereby dictating where local communities settle. During periods of dry conditions and relatively reduced flows, the wind-blown dune sands choke the Basin with sands resembling those of the present southern Kalahari semi-desert. It is the combination of flooding and deposition of these sediments that made the Cuvelai most habitable. The cycles of high and low rainfall and flows have shaped the topography and drainage patterns of the Cuvelai, the characteristics of the soils, the availability of shallow fresh ground water and density of people (Mendelsohn 2013).

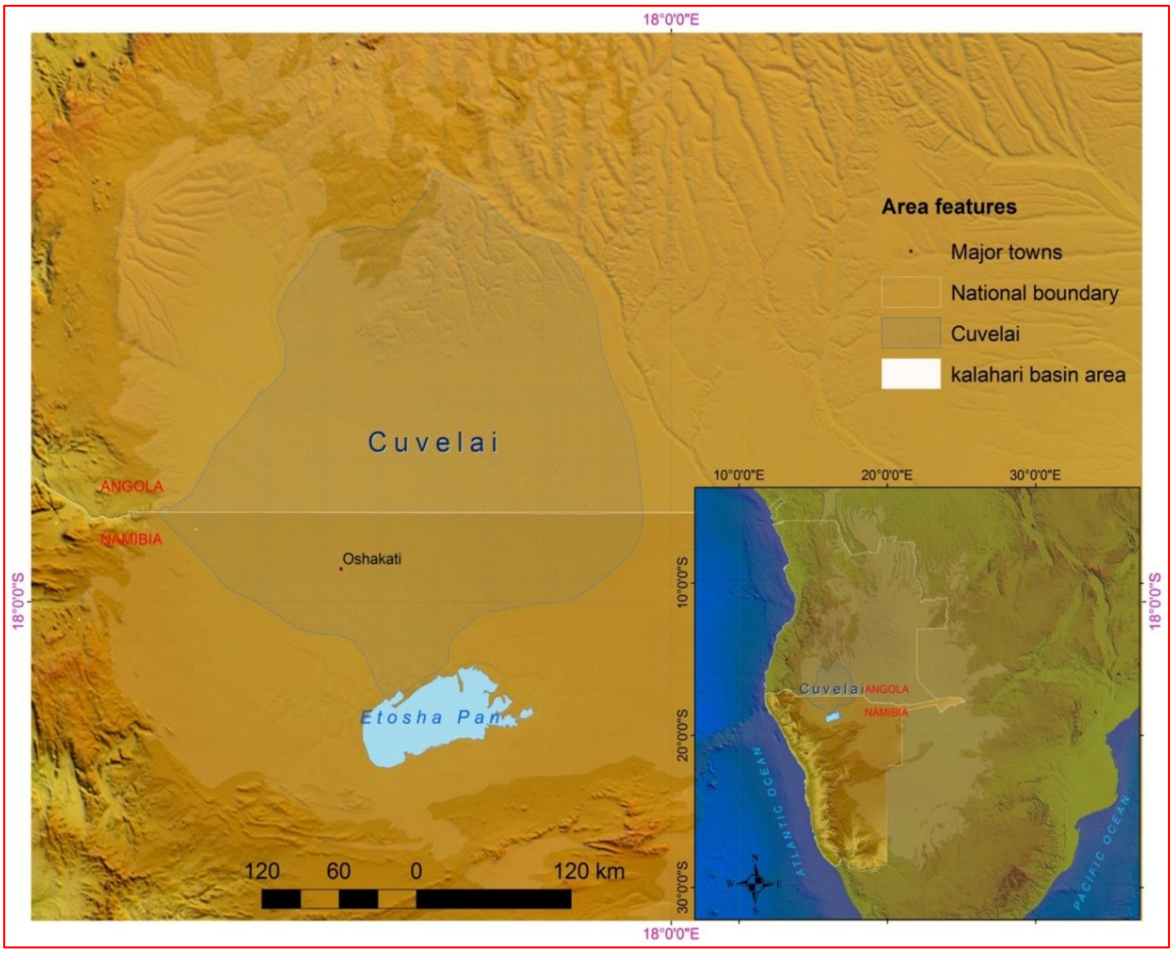


Figure 1. 2 The Cuvelai Basin in context (notice the larger Kalahari Basin underlying the Cuvelai Basin and most of Namibia N-NE-W and Angola)

According to Mendelsohn (2013), the occurrence, distribution and quantity of surface water are seasonal, variable and dependent on where rain has fallen. Local heavy rains in the

Namibian part of the Cuvelai generally may cause localised flooding. Widespread flooding is usually due to extensive heavy rain in higher altitude and higher rainfall areas upstream in Angola. Normally the surface waters are short-lived, evaporating, or seeping away over a period of weeks or months; depending on the depth of water and the permeability of the soils**.** Figure 1.3 illustrates the Cuvelai basin in flood with households, shown by red arrows, trapped by flood waters.

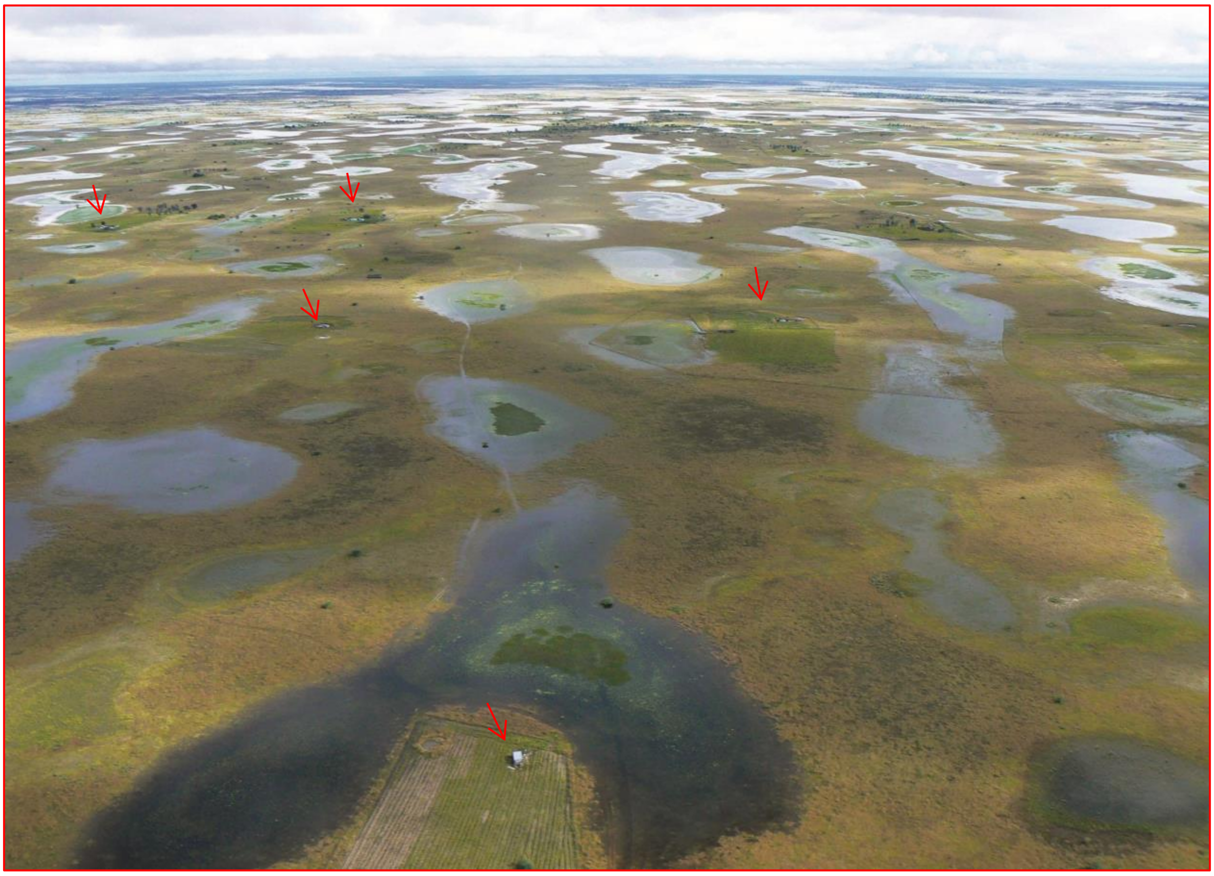


Figure 1. 3 Households surrounded by flood waters in the Cuvelai basin

The Kalahari sands and the Cuvelai floods make most life possible in the Basin. This is due to the alternating impacts of these two factors: (1) floods during wet cycles and (2) winds during dry seasons. Since the northern parts of Namibia in the Cuvelai Basin are prone to flooding, this is likely to cause damages and losses if effective mitigation mechanisms are not put in place. As such, this study focuses on the rural areas of the Cuvelai Basin in northern Namibia to assess the socio-economic consequences of flooding, as described in the next section. It is crucial to formulate alternative strategies to mitigate the negative consequences associated with floods in rural northern Namibia.

1.2.1 Floods as external shocks

Flood can be seen as an “external shock”. Big floods have the tendency to exceed the coping capacity of households. Local people distinguish the different levels of flooding, as “large”, “moderate” and “small” (Tien 2001). A small flood often does not cause damage to property, houses, crops, livelihood activities and assets. Alternatively, it may affect rural livelihoods in different ways. For example, the rural poor people are likely to lose income from fishing activities as they cannot catch many fish due to low water. Eighteen large historic floods in the Cuvelai have been recorded as from 1941. This is illustrated in Table 4.5.

1.2.2 Historical flooding in the Cuvelai Basin

As existing records show, Cuvelai water levels are highly erratic (Mendelsohn 2013). Apart from the seven relatively bigger, qualitatively recorded floods of 1949, 1953, 1956, 1970, 1976, 1977 and 1995 referred to as in the ‘long past’ for purposes of this study, the Cuvelai experienced four major flood events in recent years: 2008, 2009, and 2011, after years of recorded drought (Mendelsohn 2013).

Due to a high level of discontinuity and gaps in the data (1960 to 1968 and between 1971 to 1974) as it is observed from the years in which no flows were recorded as shown in Table 1.1, there exists a major challenge in assessing historic climatic patterns in the Cuvelai due to lack of sufficient and continuous long-term historic data. Although there are available records of water flows dating back to 1941 (as seen in Table 1.1), there are significant gaps in the data. It should also be noted that even though such information may be extracted from interviews with local people especially the elders who may also have varying perceptions of the flood concept in the area, it gives qualitative estimates of the times of high flooding, but not necessarily the quantities (Tien 2001). Some records of magnitudes shown in Table 1.1 are inferred from qualitative information and are not actual measurements. Information provided in this table is a mixture of ground measurements with qualitative inferences.

Table 1. 1 Flood levels from year to year and implications in long-term flood monitoring and prediction

Adapted from: Mendelsohn (2013: 76)

Year	**Size**	**Year**	**Size**	**Year**	**Size**	**Year**	**Size**	**Year**	**Size**	**Year**	**Size**	**Year**	**Size**	**Year**	**Size**
1941	s	1951	n	1961	0	1971	0	1981	n	1991	m	2001	m	2011	b
1942	s	1952	n	1962	0	1972	0	1982	s	1992	n	2002	n	2012	m
1943	m	1953	b	1963	0	1973	0	1983	m	1993	s	2003	n	2013	n
1944	s	1954	n	1964	0	1974	0	1984	s	1994	m	2004	b		
1945	n	1955	m	1965	0	1975	m	1985	m	1995	b	2005	m		
1946	m	1956	b	1966	0	1976	b	1986	n	1996	s	2006	m		
1947	s	1957	n	1967	0	1977	b	1987	m	1997	m	2007	n		
1948	n	1958	s	1968	0	1978	n	1988	n	1998	s	2008	b		
1949	b	1959	n	1969	n	1979	m	1989	n	1999	m	2009	b		
1950	s	1960	0	1970	b	1980	n	1990	s	2000	m	2010	m		
KEY: 0 (no data)		b (big flood)				m (medium flood				s (small flood)		n (no flood)			

It is of great importance if community responses could be used to verify flood forecasting models and remotely sensed data. The floods shown in Table 1.1 are characterized as big (b), medium (m), small (s), none (n) and no data (0) (Tien 2001). In the 73 years there were 11 big floods, 18 medium floods and 12 small floods with 19 years of dry periods and 13 years with no data. During the twenty years between 1991-2000 and 2001-2010 sixteen floods were experienced, five of which were characterized as big (Table 1.2).

Table 1. 2 Summary of floods per decade

Flood Magnitude	**1941-50**	**1951-60**	**1961-70**	**1971-80**	**1981-90**	**1991-2000**	**2001-10**	**2011-13**	**Total**
Big (b)	1	2	1	2	0	1	3	1	11
Medium (m)	2	1	0	2	3	5	4	1	18
Small (s)	5	1	0	0	3	3	0	0	12
None (n)	2	5	1	2	4	1	3	1	19
no data (0)	0	1	8	4	0	0	0	0	13

1.2.2.1 The impact of flood damage in the Cuvelai Basin post-2008

In the period post-2008 (referred to as ‘recent past’ with three big floods), floods disrupted the local economy and economic interactions for approximately three months annually (Post-Disaster Needs Assessment PDNA 2009). Six regions (Ohangwena, Oshikoto, Omusati, Oshana, Caprivi and Kavango) in the north and north-eastern parts of the country were affected, with the first four, commonly known as the 4-O regions, being the hardest hit. It is also in these 4-O regions, where one third of Namibia's poorest population lives, with the majority of these residents heavily relying on subsistence farming (Mendelsohn & Weber 2011). See Table A.1 for figures on the decadal Namibian population censuses of 1991, 2001, and 2011. The table is adapted from Mendelsohn & Weber (2011).

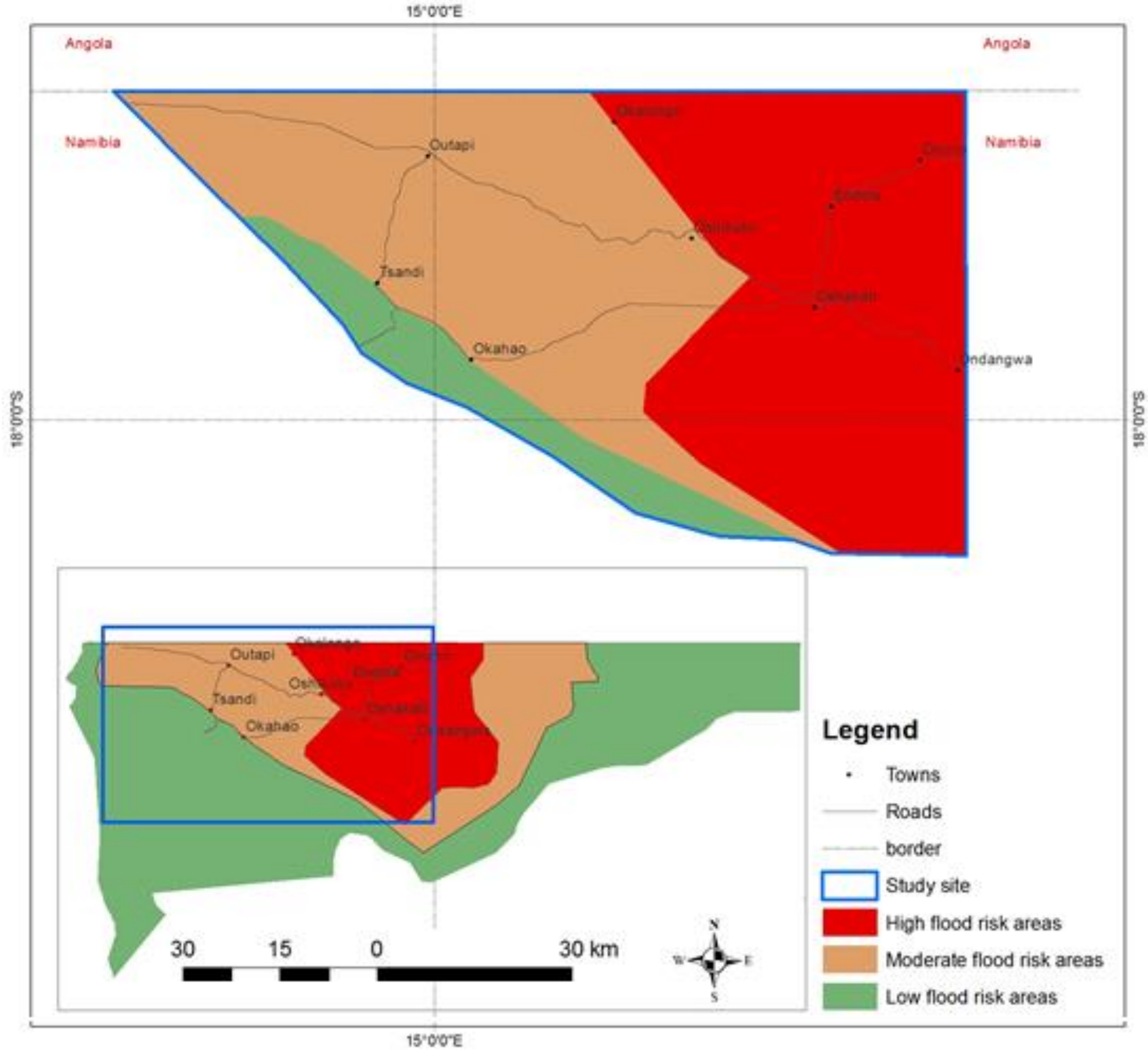
The Directorate Disaster Risk Management (DDRM) (DDRM 2011) outlined that floods come with both positive and negative impacts to persons living in the impact location, the environment, infrastructure, and livestock in the affected areas. However negative impacts as determined through the 2009 rapid assessment as it will be discussed later on in this section were too severe, outnumbering the positive consequences. Positive consequences include increased fishing, agricultural production and recharge of sub-surface water aquifers in some areas. A more detailed assessment of the positive consequences of flooding is discussed in detail in Section 7.4.1.

Negative impacts on the population include, relocation and loss of shelter, human and livestock drowning, closure of hundreds of schools and disruption of education for thousands of pupils, affected potable water and sanitation and infrastructural damage. These negative impacts may contribute to the notable reduction in the 4-Os representative population percentage from 44.1% in 1991 to 42.6% and 40.1% in 2001 and 2011 respectively as many people flock to the capital city and other larger urban areas for jobs and similar opportunities. The devastating effect that these floods in the 'recent past' have had on infrastructure, humans, health, agriculture and education are highlighted next, with the 2011 flood causing most damage as DDRM (2011) reveals.

Flood waters overtopped and washed out local roads and tracks. This disrupted commercial and industrial activities, and hindered access to healthcare facilities and schools. Some parts of the hard-hit regions of Omusati and Ohangwena were still difficult to access by mid-2011 (DDRM 2011) following the 2011 flood. In urban areas, sewage stations were also inundated and systems overflowed. Electricity provision in the areas was disrupted.

To highlight the severity of flooding in the Cuvelai as compared to the rest of the country, 110 out of the 111 drowning cases reported in the 2011 flood were in the Cuvelai (DDRM 2011), while approximately 100 drowning cases were reported in each of the big floods (2008, 2009 and 2011). According to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), flooding also led to thousands of people being re-located temporarily to higher grounds (UNOCHA 2009). The most severe impact of flooding affects poor and vulnerable citizens (Mendelsohn & Weber 2011; Gumbo 2006; Vlachos 1995).

In addition Tamayo Milanés et al. (2011) established that close to one million residents of northern Namibia were affected by floods. In the 4-O regions 730 916 people were affected by flooding with 64.1% living in areas of *high flood risk*. While 26.5% were from areas in *moderate flood risk* and 9.4% from the *low flood risk* zone. View Figure 1.4 showing flood affected areas and the level to which they are vulnerable to floods. The detailed statistics of the affected areas are summarized in Table A.2.



Adapted from: Tamayo Milanés et al. (2011)

Figure 1. 4 Flood vulnerability map

Many residents lost their homes, with traditional houses being washed away by the flood, and many became homeless (PDNA 2009). In 2008 a total of 215 257 people were affected (DDRM 2008). Omusati region experienced the worst impact of the flood disaster with all 12 constituencies affected in one way or another. In the 4-O regions, over 166 359 people were affected in Omusati region (77% of the 2008 affected population) 40 409 people (19% of the affected population) in Oshana region and 5645 in Ohangwena (3% of the affected population). In the Caprivi region 2240 (1%) were affected, 864 (0.4%) in Oshikoto and 900 people (0.42%) in Kavango region (DDRM 2008). Refer to Table A.3 for a summary of the negative impacts of flooding in the Cuvelai Basin.

The 2011 floods were rated as the biggest floods in recent years. By late 2011, 16 559 of the relocated people had already moved back to their homes after approximately three months in relocation camps, with 996 people in all the affected regions being left in camps. Of the people left in camps, 849 were from Kavango region, and were primarily waiting for completion of reconstruction of their homes until the end of July, before they could be repatriated (DDRM 2011).

Floods are also associated with outbreaks of disease. According to the European Space Agency (ESA)'s Disasters Charter (ESA 2008), the 2008 floods in Namibia's northern and north-eastern regions were accompanied by an outbreak of cholera. This outbreak was primarily attributed to insanitary conditions with increased floodwaters submerging pit latrines and overflowing sewerage systems (Hugh & Matjila 2008). The outbreaks of other diseases were exacerbated by the closure of health facilities submerged by flood water. This was also the case in both 2009 and 2011 when health facilities were affected by hospital closure (five in 2009) and the suspension of outreach services and clinics. Refer to Table A.3 for a detailed view on the figures of closed hospitals and outbreaks of epidemics.

One of the hardest hit sectors in the recent floods was agriculture which reported losses due to inundated crop fields which subsequently led to a shortage of food and inadequate nutrition (DDRM 2011). In each of the floods, domestic livestock deaths were reported (DDRM 2008; DDRM 2009 and Flood Emergency Management Committee FEMCO 2011).

Reporting for Namibia Early Warning and Food Information Unit (NEWFIU), Ndjodhi (2008) briefed that heavy and constant rains received between mid-January and early February 2008, especially in the north central and Caprivi regions, resulted in water logging and leaching, which led to poor germinations and stunted growth of crops. The same floods were responsible for lower than expected cereal harvest that year (United Nations Children's [Education] Fund (UNICEF) 2008). Annual harvest and livestock farming were interrupted and supply of agricultural items was cut short. The impact of the flood disaster was more severe on food security in 2008, as the country was still experiencing the impact of the 2006-2007 droughts. An outbreak of army worm colonies, experienced in the early months of 2013 as well (Shaanika 2013), compounded the precarious food security by destroying crop fields at the same time of the flood disaster (DDRM 2008).

In 2008 education for 32 050 learners from 100 schools was disrupted (DDRM 2008). In 2011, a total of 166 schools closed temporarily during the high flood waters, disrupting education for over 100 000 pupils (FEMCO 2011).

As a result of the PDNA (2009) assessment, damages and losses amounting to NAD962.1 million were compiled. Cumulative damages for roads, commerce and industry, as well as housing contributed to 86% of the total damages, with the environmental damages receiving the remaining 14%. Although the health and education sectors did not account for major financial losses and direct damages, these sectors were not spared from the consequences of flooding, and this was especially the case in rural areas. Approximately 15% of the Namibians are living with HIV/AIDS. Thus they rely on medication and access to health facilities for their survival (PDNA 2009; Church Alliance for Orphans (CAFO 2011). Hence, access to health care is crucial in times of flooding for vulnerable communities. Recorded, damages and losses for 2009 were also attributed primarily to the private, urban based sector, leaving a lot yet to be investigated on flood impacts in rural areas (PDNA 2009).

1.2.2.2 National response to floods: the current situation

The 2008, 2009, and 2011 flood aftermath saw the Namibian government declaring a state of emergency, with 2009 seeing a commissioning of the PDNA to assess the level of damage and losses, and to provide recovery as well as reconstruction measures in favour of the affected populations as a result of the flood (PDNA 2009). However, these recovery and reconstruction measures are aimed at the generic benefits of restarting production and reconstructing the most critical assets of development in an integrated manner. The process focuses on another factor crucial for this particular project as well, and that is the protection of the most vulnerable residents.

As highlighted in the PDNA (2009), the poor stakeholder coordination experienced during the initial response phase caused delays and duplication of response activities by assisting organizations. Regional Councils (RCs) had no contingency plans including resources for effective response during the initial phase of the flood disaster. The affected regions also lacked emergency response guidelines. There was no standard format for registration of people affected by the flood disaster by regions during the initial phase of the flood disaster. During the flood disaster registration figures received from the relocation centres continued to change causing problems in provision of relief supplies. The mandates of the RCs and Local Authorities in urban areas during emergencies were not clear, which further complicated the response phase. Against this background, it is critical that households heavily affected by floods are mapped out and that their needs are identified beforehand, leading to this project attempting to determine vulnerability status at household level.

- Rapid assessment

As is alluded to in the previous section, rapid assessment can take many days, and thus delays response and timeous assistance to flooded communities. Using an example of the 2008 as outlined in DDRM (2008), the Government of the Republic of Namibia (GRN) first conducted an initial aerial assessment of the situation in the northern central regions of Namibia's affected regions for two days (2-3 February 2008). This was followed by the inspection of the affected regions by the President for another day (4 February 2008). During the same period, a delegation led by the Permanent Secretary (PS) in the Office of the Prime Minister (OPM) and the DDRM, then known as Directorate Emergency Management (DEM), visited the affected areas to assess the flood situation. A joint GRN, United Nations (UN) and Namibia Red Cross Society (NRCS) then conducted a rapid assessment for another nine days (4-12 March 2008). By this time the affected residents on the ground had not yet been assisted. There are many formal procedures involved, simultaneously with the disaster taking place; however, this situation denies the local communities an opportunity to be assisted as soon as possible in order to minimize the negative impact of the disaster. The research asserts that practical adaptive mitigation strategies need to be formulated to reduce the impact during the waiting period, with or without assistance from central government.

Depending on the number of people affected as determined through the rapid assessment, and the life threatening situation of the flood disaster, the GRN President declared a 'state of emergency' (5 March 2008, 29 March 2011). Until a flood event is declared a "national-disaster" by Cabinet, organizations may not react and coordinating bodies may not act to assist the affected people. The NRCS is an organization which does not have to wait on for Cabinet to declare a flooding event a national disaster. NRCS has a high number of volunteer-staff based in the regions that inform the organization of the situation at hand. This enables them to deploy services right away even before and during the rapid assessment phase to the communities needing assistance (Kwenani 2012, *pers com*).

- Initial response

Should a flood event be declared a national disaster, organizations are compelled to start assisting the local victims. In earlier flood events, the initial response partially rested with the affected RCs with support from DEM and NRCS. The response involves emergency evacuation of the flood affected local residents to relocation centres, and provision of relief items (such as food, tents, blankets, mosquito nets, water treatment tablets and other essentials). OPM then authorizes Regional Emergency Management Units (REMUs) to procure emergency supplies needed by the flood victims. Receipts of purchases must be forwarded to OPM for payment, another lengthy step causing delay in the process of assisting the victims on the ground. The regional authorities are also advised to develop budgets for humanitarian interventions for submission to the OPM (PDNA 2009).

In recent floods, FEMCO, a temporary on-site coordination body was re-activated to coordinate mitigation efforts in the 4O- regions of Ohangwena, Oshana, Oshikoto and Omusati (DDRM 2011). Other regions outside the FEMCO's mandate received direct assistance from DDRM in the OPM, as well as from the National Emergency Disaster Fund (NEDF) (DDRM 2011). FEMCO's logistical, financial as well as technical support mainly comes from the DDRM together with other stakeholders of the public and private sector and a wide range of donor UN agencies and the NRCS (DDRM 2011). International funding has consequently created dependency among the residents.

1.2.2.3 Donor dependency

As the floods progressed, so dependency of local population on the government, and government on external donations increased. In its 2011 report, UNOCHA pointed out that the Namibian Government identified food, health and logistics as its primary areas of intervention. Other urgent areas of need for displaced populations include water, sanitation and hygiene services and non-food items. In 2011, in response to flooding caused by the heaviest recorded rainfall ever in the country, UN's Central Emergency Response Fund

(CERF) allocated US$1.2 million (NAD 11 745 245) for humanitarian response in Namibia. The donor funding was distributed via four main UN organizations. World Health Organization (WHO) received US$500 000 (NAD 4 893 852) to bolster emergency response in the areas of health and nutrition. US$350 000 (NAD 3 425 696) was allocated to UNICEF for the strengthening of emergency response in the water, sanitation and hygiene and education sectors. United Nations Population Fund (UNFPA) used US$250 000 (NAD2 446 926.17) for emergency response in the protection sector, and the World Food Programme (WFP) received US$65 000 (NAD 636 200) to strengthen emergency of the food distribution scheme. Further examples in this regard are given in the Table A.4 adapted from UNOCHA (2011).

This also gives an insight into how Namibia is overly donor dependent. It also indicates short comings of the response- oriented approach to floods in Namibia. This further validates the need for Namibia to build resilience towards disasters, and communities need to be involved in formulating adaptive strategies in which to deal with floods and other disasters.

1.3 RATIONALE OF THE STUDY

Considering the perceived increase in recent flooding frequency and magnitude alluded to earlier, GRN has identified several areas of intervention by which to deal with the impact of flood disasters, through the building of 'flood resilient amenities' for the affected flood victims (PDNA 2009). These interventions revolve around five major areas: (1) *housing*, (2) *social affairs*, (3) *roads*, (4) *water/sanitation*, and (5) *the agricultural sector* (PDNA 2009). It becomes necessary to incorporate Disaster Risk Management (DRM) efforts into economic planning via National Development Plans (NDPs) in order to build resilience against disasters. This will enable legislation and strengthen institutions for Disaster Risk Reduction (DRR) and strengthen risk assessment. The recovery and reconstruction efforts are focused on solutions to urban problems, leaving rural areas ignored. For example the PDNA (2009) proposal of flood resistant or flood proof building material for house construction is expensive and not suitable for poor and rural residents mostly depending on natural matter for construction of their houses. PDNA also recommended that houses in highly flood prone areas should be relocated to higher ground, which is impractical due to land availability. In addition, construction of flood mitigation dykes in urban areas may deflect flood water to the peripheries of rural areas thereby compounding the flood risk. It is therefore important that inexpensive alternative adaptive strategies are developed with local rural residents involved. To accomplish this, local rural residents need to be engaged.

Involving proposals for faster growth in the trade and manufacturing sectors, long term initiatives may require large amounts of capital. The money factor in the mix denies rural areas where non-tax paying residents reside, a chance to accelerated disaster mitigation strategies. Infrastructure investment in rural areas is often perceived as low. This leaves rural residents not well catered for in the disaster risk management development efforts. This validates the need for consultation with rural local residents on strategies that would work in areas in which they reside.

With increasing trade between neighbouring countries such as South Africa and Angola, Namibia is moving towards improved socio-economic development (PDNA 2009). In recent years, the Cuvelai Basin has experienced serious flooding which caused loss of human life, homesteads, crops, livestock and infrastructure. These events have heightened the need for preparedness and mitigation, especially since it is the most economically vulnerable people who are generally hard hit by floods. Moreover, climate change is only expected to worsen the [climate and] weather patterns, placing additional strain on the Basin's socio-economy, as revealed by the Desert Research Foundation of Namibia (DRFN) (DRFN 2010; PDNA 2009). It thus becomes important to assess and analyze the risks and consequences being faced by vulnerable people that are heavily affected by flooding.

1.4 SIGNIFICANCE OF THE STUDY

As the current situation stands, the impact of flood damage as determined by the estimated capital loss is primarily emphasizing mitigation efforts in the urban areas. Against the background described in the previous sections, a variety of measures for reducing the negative impact of flooding, especially in rural areas, need to be formulated and possibly legislated. By investigating and describing the risk and consequences of flooding to a vulnerable population, this research can assist in the development of mitigation measures and contribute towards disaster risk management policy enforcement.

1.5 THE PROBLEM

1.5.1 The causative problem

Coinciding high rainfalls during four of the past ten years in upstream countries such as Angola, Zambia and Namibia have led to major flood events in the north and north eastern

Namibia. These floods have posed various negative consequences to the livelihoods and welfare of rural residents for whom farming is one of their important sources of wealth and nutrition. Flooding has had a substantial impact on the Namibian economy, with estimates suggesting that up to roughly 1% of the country's 2009 Gross Domestic Product (GDP) has been used to deal with the consequences of flooding (Carret 2011, *pers com*; PDNA 2009). Estimated losses in excess of US$200 million (NAD1 billion) in direct damage and indirect losses were experienced.

Flooding has also led to thousands of people being re-located temporarily and permanently in some areas to higher ground (UN 2009). The most severe effects of flooding were on poor and vulnerable populations (Mendelsohn & Weber 2011). Other consequences include destruction to infrastructure, especially roads, buildings and canals. A detailed report of the flood damage impact can be viewed in Table A.3.

1.5.2 The research problem

The majority of rural residents in the Cuvelai Basin live on small farm holdings that typically cover several hectares. The farm holdings (locally known as *ekove* (singular) or *omakove* (plural)) are allocated by local headmen or headwomen. Many of the *omakove* that have been occupied over many decades are typically on higher ground where the soils are also more suited to crops than those in low-lying areas which are also susceptible to floods. As most areas on higher ground are almost fully occupied, people wanting to establish new homes are allocated land in low-lying areas where their *ekove* are often smaller than older, well-established farms on higher ground. As a result, households that are most likely to be flooded have small areas of crops on poor quality soils, and they are also the most vulnerable socio-economically. This has led to a need to develop practical adaptive strategies and methods, together with communities and local Traditional Authorities (TAs), which could reduce the impact of flooding at the village and household level.

1.6 AIM

The study aims to assess vulnerability and socio-economic impacts of flooding on local residents in order to suggest ways in which to counteract the consequences of flooding in rural areas of the Cuvelai Basin while seeking practical ways to adapt to floods and garner support at the policy level.

1.7 OBJECTIVES

In order to achieve the stated aim, the following objectives have been identified. The study specifically intends to:

i. Assess the impacts of flooding in the study area,
ii. Assess the geographical or physical circumstances that place residents at risk and to assess socio-economic conditions that lead to vulnerability,
iii. Assess whether headmen and village residents can use flood risk maps to plan ways of reducing flood vulnerability,
iv. Assess the impact of floods to sustainable rural livelihoods of the local residents,
v. Assess the impact of land-use and allocation on vulnerability of rural residents to floods,
vi. Recommend alternative practical adaptive strategies and household level mitigation strategies to flooding in consultation with local village headmen and residents.
vii. Assess and document technical and indigenous knowledge that can serve as a knowledge base that can be compiled and integrated into an effective village friendly flood early warning system and to garner support at the policy level.

With many studies concentrating on international study areas, local research which investigates socio-economic vulnerability in the Cuvelai Basin is limited to a few sources, like those of Mendelsohn (2013), DDRM (2008, 2009, 2011) and Tamayo Milanés et al. (2011). In this chapter, the impact of flood on agriculture was reviewed, and strategies to remedy the flood consequences have been reviewed at international scale and compared to local scale. The chapter also reviews that human activity has a major impact on the occurrences of flood events, and related arguments are discussed in the following chapter.

CHAPTER 2: DISASTER VULNERABILITY ASSESSMENT

The term "vulnerability" has been applied in several broad ways: in the hazard literature, and through various political/economic perspectives. Various definitions have been offered including the following. According to Turner et al. (2003), vulnerability refers to the susceptibility of a human society to damage, given a certain hazard event, and can vary so widely between societies, or between social groups within a society. This also means that how societies are organized is a major determinant of how much impact a disaster will cause (Smith 2006). Apart from the geography of space, how people are organized in society can be attributed to poverty, colonialism, or even government corruption (Smith 2006). Vulnerability can broadly be classified into three tenets of research: the identification of conditions that make people or places vulnerable to extreme natural events (Burton et al. 1993; Anderson 2000); the assumption that vulnerability is a social condition, a measure of societal resistance or resilience to hazards (Blaikie et al. 1994; Hewitt 1997); and the integration of potential exposures and societal resilience with a specific focus on particular places or regions (Kasperson et al. 1995; Cutter et al. 2000, 2008, 2009). Yohe et al. (2006) similarly classified vulnerability into three parts; exposure, resistance as well as adaptive capacity.

2.1 EXPOSURE AND GEOGRAPHIC VULNERABILITY

Cutter et al. (2000) maintains that vulnerability can be highly differentiated spatially as the causes of vulnerability differ systematically from place to place. Geography should thus be given clear cognizance when conducting vulnerability studies. The geography component of vulnerability assessment is commonly known as 'exposure', and it questions whether the hazard event intersects with the human systems in question (Cutter et al. 2000).

According to Cutter et al. (2009) 'exposure' encompasses biophysical vulnerability and the so-called 'hazard-of-place' approach is amenable to empirical testing and the use of geospatial techniques. The importance of geography was highlighted in an analysis of 'disaster hotspots' by Dilley et al. (2005). Hazard exposure is combined with historical vulnerability in order to identify geographic regions that are at risk from a range of geophysical hazards. 'There are thus geographically distinct levels of vulnerability' and the risk to life tends to vary greatly over space, more than other forms of vulnerability (Cardona et al. 2012:78).

'Exposure is a function of the geographic location of the elements' (UNDP 2004:146). Some researchers maintain that people are vulnerable to floods because of where they live and vulnerability can be defined spatially. Exposure is thus part of geographic vulnerability but in itself cannot define geographic vulnerability. While taking cognizance of the existing terminology commonly used in vulnerability studies, 'geographic vulnerability' is used more predominantly than 'exposure' in this paper. This is intentionally done so that the language is simplified and that the case study speaks directly to the affected people in ways they can easily relate to (Yin 2003b).

2.2 RESISTANCE AND ADAPTIVE CAPACITY / RESILIENCE [SOCIO-ECONOMIC VULNERABILITY]

Nevertheless not all vulnerability can be expressed spatially (Danielson 2009). Social differences at a given place can make some people more vulnerable even than members of their own immediate household. For instance, a resident with a physical disability may have much less resistance with respect to a disaster than someone without a disability because the physically challenged person cannot move around easily to evade the immediate consequences of a disaster until such time that the event has passed. Danielson (2009) further explains that poor residents for instance are often more vulnerable to floods because they can only afford houses close to risky places such as streams and dumps, whereas the rich can live on the high lying areas. These factors are further detailed under Section 2.2.3 on the socio-economic vulnerability of the Cuvelai Basin.

2.2.1 Resistance

According to Cardona et al. (2012: 72), lack of resistance leads to sensitivity (*susceptibility/ fragility*) and that a community can either be resistant or susceptible to damage. "*Physical predisposition of human beings, infrastructure, and environment to be affected by a dangerous phenomenon due to lack of resistance and predisposition of society and ecosystems to suffer harm as a consequence of intrinsic and context conditions making it plausible that such systems once impacted will collapse or experience major harm and damage due to the influence of a hazard event"*. Advocating for the usage of the term resistance in vulnerability studies, Geis (2000: 152) wrote that *"resistant is the most fitting connotation* [to use in vulnerability studies]. *We want to keep 'natural hazards' from becoming 'natural disasters', therefore, resisting a disaster. We want our communities to be hazard resilient and disaster resistant. Along with that consideration, and in our time-byte society, the disaster resistant term has more of an impact (attracts more attention), and is,* *therefore, more marketable. Marketable in the sense that most people probably prefer to 'feel' resistant to disasters, not just resilient to them".*

Yohe et al. (2006) maintains that certain human systems can resist damage from a hazard more easily than others. Yohe et al. (2006) study on Southern Californian residents revealed that residents or households with tile roofs were less resistant to fire events than wooden shingles that were found to be more vulnerable due to their inability to resist fires. This study found that residents of the Cuvelai with mud houses were more susceptible to flood damage than those houses made of cement walls. Construction efforts as attributed to flood impact are detailed in Section 5.3.2. Yohe et al. (2006) also wrote that those households that planted a drought-tolerant strain of sorghum had more resistant crops to a drought event and thus increased their resistance to a disaster than those who planted a variety of maize that required a lot of water. Construction material as well as crop yield are also some of the socio-economic factors used in this study to determine households that are socio-economically vulnerable in the Cuvelai study area as it can be seen in Table 3.2.

2.2.2 Adaptive capacity and resilience

Another component of social vulnerability is adaptive capacity. This refers to a person or group's ability to deal with and bounce back from adversity (Yohe et al. 2006). Income or savings may be one important source of adaptive capacity, allowing victims of a hazard to rebuild their lives. Someone who lacks such sources of money would be less able to adapt to the hazard, and thus more vulnerable to it (Danielson 2009).

Resilience has become a useful concept in the study of environmental hazards. As literature has it, the term "resilience" first originated from the ecological discipline. Holling (1973:17) defines resilience as "a measure of the ability of the systems to absorb change of state variables, driving variables and parameters and still persist". This concept focuses on the capacity of an ecological system to absorb changes but still maintain its core function. In flood risk studies, resilience is defined by (Bruijn 2004:1999) as "the ability of the system to recover from floods". In a social system, Adger et al. (2002:358) define social resilience as "the ability of a system to absorb external changes and stress, while maintaining the sustainability of their livelihoods". A system in this context may be a region, a community, a household, an economic sector, a business, a population group, or an ecological system, (Brooks 2003). Buckle (2006:91) refers to resilience as the "capacity to withstand loss". Norris et al. (2008:130) define resilience as "a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance". The concept of resilience has also been linked in social and ecological systems (Folke et al. 1998; Adger 2000; Folke 2006). The resilience concept is concerned with the capacity for renewal, reorganization and development (Folke 2006), creativity (Adger 2000; Maguire & Hagan 2007), and transformation in a social-ecological system (Walker et al. 2004), as well as capacity to maintain its identity (Cumming et al. 2005).

Resilience is difficult to measure directly (Carpenter et al. 2001), and certain factors have to be taken into consideration when attempting to operationalize resilience - a gap which this paper attempts to narrow. For this paper, the state of a system before and after major flood events including its ability to withstand floods was established through the Cuvelai Basin residents' interviews at household level.

Although there are various definitions of resilience from different disciplines, three common properties of resilience dominate in resilience literature (Carpenter et al. 2001). The first property is about the speed of recovery at which a system can recover after disturbance. Natural hazard researchers attempt to observe the speed of recovery after disasters as a measure of resilience (Bruijn 2004). The second is the magnitude of a disturbance relative to a threshold that can be absorbed before a system changes its structure by changing the processes and variables that control it (Colding et al. 2003). Magnitudes are rather given descriptively in this paper from *low* to *high* ranking scale as expressed in Section 4.4.3. The final property is about the capacity to learn from and to create new things from disturbance, and to transform (Folke et al. (2002); Berkes & Seixas (2005)), as reflected in Section 4.6 and Section 4.7. Even though, the conventional approach to measure resilience as the speed of recovery may not capture its full dimensions, this project aims to start the debate at basin level and set a basis on which further research in this area may build.

Resilience of the system is dependent on several factors such as demographic, social, cultural, economic, political, type of disasters, and geographical setting of the place (Gaillard 2007). However, these factors vary at different levels of analysis as described by Buckle (2006). At household level, access to agricultural land, diversity of income sources and good housing quality create essential resources for households to cope with annual flood events in Bangladesh and climate change in the coastal province of Vietnam (Adger 1999; Brouwer et al. 2007). Learning to live with change and uncertainty, nurturing learning and adapting, and creating opportunities for self-organization were found as the important factors for enhancing household resilience in the Cambodian context (Marschke & Berkes 2006).

At the community level, Norris et al. (2008) identified four primary sets of capacities that enhance community resilience, including economic development, social capital, information and communication, and community competence. Economic development refers to economic growth, stability of livelihoods, and equal distribution of resources within the population (Adger 1999). Social capital refers to networks of social supports, bonding within community, bridging between communities, and networking between communities and government bodies (Adger 2003; Pelling & High 2005; Mathbor 2007). Information and communication refer to the system and infrastructure for informing the public because people need accurate information about danger and behavioural options for them to act quickly. Community competence refers to the capacity of the community to learn, work together, and solve problems creatively. These contributing factors are measurable in the practical context and are further detailed under Section 2.4 and Section 5.1.2.8 of this paper.

Many researchers attempt to define the concept of resilience, but very little research operationalizes it in practice. Cumming et al. (2005) noted that resilience is a multidimensional concept, difficult to operationalize in practice. Coping with this problem, they developed a “surrogate approach” as an indirect way of measuring resilience (Carpenter et al. 2005: 967). Marschke & Berkes (2006) adopted the surrogate approach to operationalize resilience from livelihood perspectives in rural Cambodian villages using a subjective well-being approach. However, Marschke & Berkes (2006) only explore the well-being of households and communities in a qualitative manner and they do not attempt to quantify resilience indicators at a household level. It is documented that well-being is what people think and feel about their life or subjective well-being (Copestake & Camfield 2009). The subjective well-being approach was widely accepted in poverty and livelihood studies in developing countries (Narayan et al. 2000). However, little is known about different dimensions of households’ resilience to floods in a real “living with floods” context. Knowledge of the ability of households to cope with, adapt to, and benefit from floods reflects their resilience, but there exists no study that operationalizes the concept of resilience in the Cuvelai Basin.

As reviewed in Section 1.2.1, resilience is referred to as the capacity of a system to cope and recover from an external shock or stress. Some researchers may argue that flood events in the Cuvelai are not external shocks because people have experienced the floods every year for many years. However, large flood events such as the historic floods between 2008 and 2011 can be seen as external shocks because they exceed the coping capacity of many rural residents. Some people could cope well with floods, but many people were vulnerable to those floods. Therefore, statements used in this approach to measure households' resilience to floods are related to their coping capacities in those big floods. The statements related to confidence in securing food, income, and health of family members during historic flood events, and safe evacuation in future extreme flood events due to climate change, recovery after the flood if they are affected, confidence in securing homes in a large flood events, and their interest in learning and implementing new ways of living with floods (flood-based livelihoods) are some of mechanisms ensuring resilience at Basin and household level. In this analysis, most of the items focus on experiences or perceptions of households in coping with floods in the past rather than the capacity to cope with future flood events in the context of local climate change scenarios. Therefore, further studies should be carried out to incorporate possible changes in the flood regimes into measures of resilience at basin level.

2.2.2.1 Resistance and adaptive capacity/ resilience nexus: an integrated approach to socio-economic vulnerability assessment

Le Roux & van Huyssteen (2010) indicated that critical aspects related to the spatial manifestation of socio-economic development dynamics in order to enable an exploration of the range of relationships and interactions between socio-economic development and the natural environment should be done in an integrated approach. Danielson (2009) alleged that resistance is heavily dictated by adaptive capacity, and that adaptive capacity is directly proportional to resistance. It is therefore useful that resistance and adaptive capacity (collectively referred to as socio-economic vulnerability in this paper) are not assessed in isolation.

'Socio-economic vulnerability' has been heavily utilised at international and continental level. Published in the South African Risk and Vulnerability Atlas (SARVA) by the Department of Science and Technology, Le Roux & van Huyssteen (2010) have reprinted mapped out areas in South Africa characterised by 'high socio-economic vulnerability' in terms of their dependency on the economically active population, as well as high ratios and absolute numbers of unemployment in the Eastern Cape, KwaZulu-Natal as well as North West and Limpopo provinces. For this and other similar reasons given above, this study will adopt usage of 'socio-economic vulnerability' as a nexus between resistance and adaptive capacity.

2.2.2.2 Challenges underlying socio-economic vulnerability assessment

Due to a wide variety of views and meanings attached to vulnerability, there are multiple definitions, concepts and methods to systematize this terminology. Ciurean et al. (2013) loosely define vulnerability as the inability to withstand the effects of a hostile environment. Ciurean et al. (2013) further wrote that the term vulnerability can have many meanings, and the definition of vulnerability depends on the purpose of the study, differentiated mostly by the vulnerable entity studied, and the stakeholders of the study. The design of an assessment has to respond to the needs of the particular stakeholder who might use it. Various schools of thought proposed different conceptual models with the final aim of developing methods for measuring vulnerability. However, there is no universally agreed upon model of assessing socio-economic vulnerability. An integral part of vulnerability assessment therefore is the collaboration with its stakeholders. Thus, the specific definition and the method of vulnerability assessment remains specific to each study (Ciurean et al. 2013).

Saldaña-Zorrilla (2007) defines 'socio-economic vulnerability' as the susceptibility of an economic agent to absorb external shocks (hazards) negatively, given its assets possession and entitlements system (coping capacity), as well as its implemented risk management and protection measures (adaptive capacity). However, according to Saldaña-Zorrilla (2007), being poor does not necessarily imply being vulnerable, poverty makes individuals relatively more vulnerable to a given hazard. Adverse economic conditions make individuals less able to invest in all items, including those needed to manage risk and increase disasters protection.

As Cannon (1994) further illustrates, what turns a natural hazard into a disaster is not simply a question of money, but also of economic and political system. The way countries structure societies determines that similar hazard lead to very different impacts among societies.

Developing countries have historically experienced more flood damage, relative to developed countries (Benson & Clay 2000). In absolute terms, total economic losses tend to be higher in rich countries, but compared to economy value, losses are much higher in developing countries (Freeman & Mechler 2001). According to Saldaña-Zorrilla (2007), a given natural hazard with identical intensity can hit in different degrees two distinct countries or societies. Differences in civil protection system, health facilities and public financial ability such as for reconstruction make countries or societies to absorb hazards differently. For instance, the same hurricane that hit the Dominican Republic and Haiti in 2004 caused economic losses fivefold higher in Haiti. It reflects differences in development stages among these two countries as well (Saldaña-Zorrilla 2007). Although Namibia's per capita income of US$5610

(NAD59 823) places the country in the World Bank's upper-middle income grouping, average income paints a misleading picture since Namibia's income distribution is among the most unequal in the world, with a Gini coefficient estimated at 0.5971 (World Bank 2014). Consequently, the majority or residents in rural areas remain poor and unable to invest in flood mitigation measures, thus practical adaptive strategies have to be tailored for them and in collaboration with the affected rural communities, an alternative which this paper thoroughly investigates.

Le Roux & van Huyssteen (2010) indicated that risk implications and vulnerabilities within social ecological systems tend to be higher in areas characterised by increasingly high development pressure on the natural environment, and in areas characterised by 'high socioeconomic vulnerability'. Resilience, especially in the context of developing countries such as Namibia and most African countries, is not only influenced by the geographic concentration of people, but also related to poverty, high levels of income and other inequalities. Most affected people in the Cuvelai live in poverty and are unable to get sufficient monetary capital to upgrade their structures and technologies to better adapt to the consequences of flooding.

2.2.3 Socio-economic vulnerability indicators

Mileti (1999) documents that little information is known about the social aspects of vulnerability. Socially created vulnerabilities are largely ignored, mainly due to the difficulty in quantifying them. This can also explains why social losses are normally absent in after-disaster cost/loss estimation reports. There is very limited information in Namibia's PDNA (2010) report on social vulnerability and social indicators of vulnerability have not been quantified before at country level, a gap which this study intents to fill. In addition, to date, there has been little research effort focused on comparing the social vulnerability of one place to another.

According to Cutter et al. (2000), there still is no consistent set of metrics used to assess social vulnerability to environmental hazards, although there have been calls for such an index. There is however, according to Cutter et al. (2000), a general consensus within the social science community about some of the major factors that influence social vulnerability. These include among other factors: lack of access to resources (including information, knowledge, and technology); limited access to political power and representation; social capital, including social networks and connections; beliefs and customs; building stock and age; frail and physically limited individuals; and type and density of infrastructure and lifelines. As a consequence, disagreements often arise in the selection of specific variables to represent these broader concepts. Gender, race, socioeconomic status, special needs populations or those that lack the normal social safety nets necessary in disaster recovery, such as the physically or mentally challenged, immigrants, the homeless, quality of human settlements (housing type and construction, infrastructure, and lifelines) and the built environment are some of the other many factors a researcher may choose to use to measure socio-economic vulnerability, especially as these characteristics influence potential economic losses, injuries, and fatalities from natural hazards (Cutter et al. 2000).

There are other indicators used to assess socio-economic vulnerability, which should be determined by the familiarity of the researcher with local conditions as well as the orientation and perspective of the study (Danielson 2009). Like Le Roux & van Huyssteen (2010) and Cutter et al. (2000), Danielson (2009) also proposes that vulnerability commonly correlates with the major axes of inequality in a society. To a greater extent, differences in vulnerability are a significant way that axes of inequality can be reinforced and maintained. Being forced to frequently deal with bad risks can prevent a group from achieving equality. Aspects of vulnerability that derive from various other axes of inequality will vary spatially along with those axes of inequality.

Danielson (2009) further gave an example that if people of colour are more vulnerable to a hazard because a history of racism has limited the reach of their social networks, and thus reducing their adaptive capacity, then vulnerability will be higher in neighbourhoods with high concentrations of people of colour. For example in 1951 as O'Malley (2005) documents, the South African government decided that each African tribe should have its own 'Bantustan' or homeland and set aside only 13.7% of the land in the country to be used for such purposes. Most of the allocated farmland was poor quality and there were very few jobs inside the Bantustans. Some of the Bantustans were very overcrowded and the people generally lived in very poor conditions. Africans living in the Bantustans also lost the few rights that they had in South Africa. Le Roux & van Huyssteen (2010) wrote that the apartheid history ensured that settlement landscape not only bears witness that the challenges of concentration and inequalities are not limited to metropolitan areas and cities, but are also rife in areas characterised by densely populated and highly dispersed settlements in some former Bantustans. High concentrations of poverty, limited access to employment, livelihoods and socioeconomic services, as well as dependency burdens are posing significant threats to the resilience of these regions and the socio-ecological systems of which they are part. Le Roux & van Huyssteen (2010) concluded that increased population pressures are exacerbated by the high number of people living in poverty, as evident in the metropolitan areas and the former Bantustan areas, revealing two contrasting classes of places with high poverty levels and increasing vulnerability.

When geography (exposure) and socio-economic factors (resistance and adaptive capacity) coincide for a particular residence, vulnerability exacerbates. One of the harms inflicted on people on the disadvantaged end of an axis of inequality may be confined to more vulnerable places. For example, Wisner et al. (2004) found that the poor in Guatemala City can only afford to live on the steep hillsides around the city, which are highly susceptible to landslides in the event of an earthquake.

2.2.4 Socio-economic vulnerability indicator based analysis

An indicator here is defined as a 'variable which is an operational representation of a characteristic or quality of a system able to provide information regarding the susceptibility, coping capacity and resilience of a system to an impact of a defined (in some cases an ill-defined) event linked with a natural hazard' (Cutter et al. 2003). Social and environmental indicators research is common in the field of sustainable science. For example, United Nations Development Program's (UNDP) Human Development Index (UNDP 2012), proposes a composite indicator of human well- being, as well as gender disparity and poverty among nations. Similarly, the World Bank develops indicators that stress the links between environmental conditions and human welfare, especially in developing nations, in order to monitor national progress toward a more sustainable future (Cutter et al. 2003). In natural hazards risk management framework, many of the indicator based vulnerability studies are relying on measuring attributes or factors influencing vulnerability rather than understanding relationships or processes between such factors (Consortium CapHaz-Net 2010).

Ciurean et al. (2013) iterated that the composition and selection of vulnerability indicators is just as complex as socio-economic assessment itself. Indicator based methods should however be used to measure socio-economic vulnerability. A factor analysis is used for combining related variables into 'composite' variables for conceptualizing components of household resilience to floods (De Vaus 2002). Factor analysis helps us to identify patterns in responses to a set of questions (De Vaus 2002). The purpose of this technique is to reduce the large amount of variables to a smaller set of underlying variables by creating factors (Kim & Mueller 1978). There are a number of methods involving rotation variables including the quartimax method, the equamax method, and the varimax method (Kim & Mueller 1978).

One of the most frequently used methods is the varimax method, which aims to minimize the number of variables that have a high loading on a factor. This approach was widely used when identifying the factors of the vulnerability analysis (Cutter et al. 2003; Fekete 2009). By identifying underlying factors in measuring social vulnerability to natural hazards (Cutter et al. 2003), each item response was coded before conducting a factor analysis, and for this paper SPSS and STATISTICA software were used to code factors or indicators as a first step in determining socio-economic vulnerability.

2.3 PHYSICAL/ STRUCTURAL VULNERABILITY ASSESSMENT

According to Ciurean et al. (2013:15), "if in social vulnerability assessment the focus is on determining the indicators of societies' coping capacities to any natural hazard and identifying the vulnerable groups or individuals based on these indicators, in physical (or technical) vulnerability assessment the role of hazard and their impacts is emphasized, while the human systems in mediating the outcomes is minimized". Physical vulnerability as Ciurean et al. (2013) note, aims to represent the degree of loss/potential damage of the element at risk. Even though evaluation of vulnerability and the combination of the hazard and the vulnerability to obtain the risk differs between natural phenomena, physical vulnerability mostly remains dependent both on the acting agent (physical impact of a hazard event) and the exposed element (structural or physical characteristics of the vulnerable object) (Ciurean et al. 2013). Vulnerability curves (stage-damage functions), fragility curves, damage matrices and vulnerability indicators described by Kappes et al. (2012) are some of the main ways in which physical vulnerability for different types of disasters can be expressed. This paper utilises the vulnerability indicators method by using information that was gathered from the Cuvelai residents on the state of before, the onset on the flood events and after the floods had passed. The study however encourages more research into technical flood vulnerability modeling and analysis at village level so that guidelines in reducing structural vulnerability are enhanced. This will also better spatial planning at village level in the future, as slightly described in Section 5.2 and Section 5.4 of this paper.

Two main strategies of assessing physical vulnerability are discussed by Ciurean et al. (2013). The first strategy focuses on the economic damage and is essentially a quantification of the expected or actual damages to a structure expressed in monetary terms or through an evaluation of the percentage of the expected loss. The estimated losses in monetary values was gathered at household level in the Cuvelai, with residents giving the amount of money they had spent on either putting back similar structures after the event has passed, or how much money has been lost in structures that were irrecoverable after floods. The second strategy deals with the physical vulnerability of individual structures and on the estimation of the likelihood of occurrence of physical damages or collapse of a single element (in this case, for example the number of ruined huts and the extent to which they were destroyed).

The second strategy shapes itself around two methods, the empirical and the analytical methods, as described by Apel et al. (2004). While the analytical methods utilise computer based models and simulations such as hydrological and hydraulic modelling which are beyond the scope of this paper, the empirical methods make use of real data and are based on the analysis of observed consequences and collection of actual flood damage information after the event through the use of interviews, questionnaires and as well as field mapping, which have been utilised in this paper to gather information from the rural residents of the Cuvelai.

Several ways of classifying physical/structural/technical vulnerability are outlined in the literature. However, as expressed in Section 5.4.3, to assess structural damage or physical vulnerability thereof, of the Cuvelai, this paper further adapts the classification method used by Papathoma-köhle et al. (2011) as published in their research paper documenting the "physical vulnerability assessment for alpine hazards". The method classified damage intensity into three classes namely *low* (persons barely at risk and only low damages at buildings or disruption expected), *medium* (persons outside of buildings are at risk and damage to buildings occur while persons in buildings are quite safe and sudden destruction of buildings is improbable), and *high* (persons inside and outside of buildings are at risk and the destruction of buildings is possible or events with lower intensity occur but with higher frequency and persons outside of buildings are at risk). The three classes are replicated in Figure 5.30 in the results chapter.

CHAPTER 3: THE IMPACT OF FLOODING ON RURAL LIVELIHOODS

A livelihood "comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base" (Scoones 1998:5). Many rural livelihoods are reliant to a considerable degree on the environment and the natural resource base (Scoones 1998), and extreme climate events can impact severely on the agricultural sector (Saldaña- Zorrilla 2007).

According to Cardona et al. (2012), vulnerability deals with the role of regulating ecosystem services and ecosystem functions, which directly impact human well-being, particularly for those social groups that heavily depend on these services and functions due to their livelihood profiles. In developing countries especially, Cardona et al. (2012:77) documents that "poorer rural communities often entirely depend on ecosystem services and functions to meet their livelihood needs". The importance of these ecosystem services and ecosystem functions for communities is also documented in the 2009 and 2011 Global Assessment Reports on Disaster Risk Reduction (UNISDR 2009a, 2011) as well as by the Millennium Ecosystem Assessment (MEA 2005). The degradation of ecosystem services and functions can contribute to an exacerbation of both the natural hazard context and the vulnerability of people. The erosion of ecosystem services and functions can contribute to the decrease of coping and adaptive capacities in terms of reduced alternatives for livelihoods and income-generating activities due to the degradation of natural resources (Cardona et al. 2012). Additionally, a worsening of environmental services and functions might also increase the costs of accessing these services.

3.1 SUSTAINABLE RURAL LIVELIHOODS

Though the focus of this paper is on rural areas, urban and the rural are inextricably linked. Inhabitants of rural areas are often dependent on cities for employment, as a migratory destination of last resort, and for health care and emergency services. Cities depend on rural areas for food, water, labour, ecosystem services, and other resources. All of these (and more) can be impacted by climate-related variability and extremes including changes in these associated with climate change. In either case, it is necessary to identify the many exogenous factors that affect a household's livelihood security. Rural communities are however potentially more vulnerable to disasters than urban areas, since urban areas have considerable resources for dealing with hazards and disasters (Cross 2001) and smaller settlements and villages are often of lower priority for government spending. Sustainable livelihoods research suggests a number of ways of analysing and understanding rural development processes but with a consistent focus on poor households and the decisions people take about how to achieve successful sustainable livelihoods (Scoones 1998).

Sustainable livelihoods research differentiated the notion of sustainable livelihoods from most definitions of poverty, wellbeing or equity in the sense that sustainable livelihoods included key concerns with dynamic processes, livelihood systems, incorporating social institutions, and vulnerability or resistance (Scoones 1998). Sustainable livelihoods therefore marks a move away from static measurements of livelihoods derived from calculations of absolute (positive or normative) levels of poverty and well-being, towards a concern with how poor people make a living, and whether their livelihoods are secure or vulnerable over time (Scoones 1998).

3.2 THE IMPACT OF CLIMATE CHANGE ON FLOODS FROM AN ANTHROPOGENIC PERSPECTIVE

DRFN (2010) predicts with a high degree of certainty that Namibia will become hotter in coming years, with a predicted increase in temperatures of between 1°C and 3.5°C in summer and 1°C to 4°C in winter in the period 2046 - 2065. DRFN (2010) asserts that maximum temperatures have been getting hotter over the past 40 years, as observed in the high frequency of days exceeding 35°C. Equally, the frequencies of days with temperatures below 5°C have been getting less, suggesting an overall warming.

Namibia has experienced recurrent [recorded] floods since 2008. According to Allan (2011), intense rainfall is inherently local [at basin rather than country level in this case], but it is fuelled by the supply of atmospheric moisture from further afield that may otherwise have contributed to more moderate rainfalls elsewhere. This implies that the increase in rainfall intensity, duration, and frequency in one region may mean reduction in another. This argument is also projected in various climate models through 2-3°C global increase in temperature, as well as increase in rainfall intensity in wet regions and diminishing rainfalls in dry areas.

With its high spatial heterogeneity in terms of climate, Namibia is an arid country with highly variable and erratic rainfalls and resulting surface water (Mendelsohn 2013), which according to DRFN (2010) makes detecting trends in rainfall typically more difficult. Being the driest country in Sub-Saharan Africa, Namibia's rainfall (October - April) average mean is 270 mm and range from below 50mm in the coastal areas to 350mm in the central areas to above 700 mm in the north-east (Du Pisani 2001). Exacerbating the impact of dryness, the country is very sunny with 300 days of sunshine per year and average monthly summer temperatures ranging from 20°C to 34°C with daily temperatures exceeding 40°C. Average minimum winter temperatures range between 6°C and 10°C and average maximum winter day temperatures between 18°C and 22°C (Du Pisani 2001).

Although intensity is likely to increase as far as predictions for the future are concerned, it has not been clearly established whether Namibian rainfall will be reduced (DRFN 2010). Allan (2011) explains that this predicting gap in modeling and simulations is due to the fact that certain climate models do not have the sufficient resolution to effectively model formations at cloud level posing considerable variations in simulated relationships between high rainfalls and warming. Another shortcoming is that such models may at the same time lack anthropogenic data. However, the gap can be remedied by the use of detailed high-resolution climate models such as the ones explained in Min et al. (2011) and Pall et al. (2011) that combine robust physics with carefully constructed observing systems. These two papers have clearly established that global warming resulting from global emissions of greenhouse gasses as a result of human activity may have compounded the effects of natural fluctuations in atmospheric circulation systems on rainfall distribution, and that frequency of intense rainfall events is likely to increase with anthropogenic greenhouse gas induced warming (Allan 2011). Myers (1993) and Parry et al. (2007) have supplemented that on-going anthropogenic activities such as urbanization, population and economic development contribute to increasing shift in climate patterns and thus exacerbating flood vulnerability.

3.3 THE IMPACT OF FLOODING ON PLANT AND CROP COMMUNITIES

Some plants such as water lilies and rice grow well in an abundance of water and are adapted to do so. However, in drier areas such as fields or pastures, the presence of excessive amounts of water can cause the plants to become stressed and even die (Ransom 2013). Apart from supporting life, as suggested by Huber, Jacobs & Visser (2009); Van de Steeg & Blom (1998); Van Eck et al. (2004) and Voesenek et al. (2004), periodical flooding in floodplains can be considered as an environmental concern in the affected areas. The clogging of soil pores by water deprives roots of adequate oxygen subsequently leading to root and plant stress (Banach et al. 2009; Schipper et al. 2011). This also affects soil pH and nutrient base, influencing the distribution of plants across space (Beumer et al. 2008). In the Cuvelai and since the on-set of floods, 94% of the local population has experienced continuous crop damage that has led to enormous food shortages in the areas (DDRM 2011).

With many of the Cuvelai residents being subsistence farmers, with pearl millet (*mahangu*) being the main staple food in the basin, it is imperative that the impact of floods on plant communities is not overlooked. Ways in which floods can impact on plant communities are many, but all revolve around waterlogging.

Excessive moisture in the soil decreases oxygen levels. This inhibits respiration (where energy is released from sugars) in the roots leading to the build-up of carbon dioxide, methane and nitrogen gases, subsequently causing the roots to suffocate and die. Toxic compounds such as ethanol and hydrogen sulphide can also build up in the soil and damage plants (Ransom 2013).

Waterlogging (flooded/ponded/saturated soils), as referred to by Ransom (2013), affects a number of biological and chemical processes in plants and soils that can impact crop growth in both the short and long term. The primary cause of waterlogging in crop plants is oxygen deprivation or 'anoxia' as excess water itself does not react chemically with the plant. Plants need oxygen for cell division which is central for growth of all multi-cellular organisms. Oxygen is also vital for the uptake and transport of nutrients by the plants. Because Oxygen diffuses much more slowly through undisturbed water than through a well-drained soil, its requirements by plants rapidly exceed what is available when soils are saturated (Ransom 2013). The rate of Oxygen depletion in saturated soil is impacted by temperature and the rate of biological activity in the soil. Faster oxygen depletion occurs when temperatures are higher and when soils are actively metabolizing organic matter. The longer that excessive water is present the more likely that damage to plants will be fatal. Generally, the oxygen level in a saturated soil reaches the point that is harmful to plant growth after about 48-96 hours (Ransom 2013). In an effort to survive, tissues growing under reduced oxygen levels use alternate metabolic pathways that produce by-products, some of which are toxic at elevated levels.

Secondly, if leaves and stems are submerged, photosynthesis (absorption of energy from the sun to produce sugars) can be inhibited and plant growth can slow or even stop subsequently weakening and killing the plant (Cannell & Jackson 1981). Thirdly, plants that are suffering from excessive-water stress are more prone to infection by disease-causing organisms such as fungi or insects as excessively wet soil tends to favour the growth of soil-microbes such as

Fusarium spp., *Phytophora* spp. and *Rhizoctonia solani*, which can infect plant roots leading to diseases such as root and crown rot (Cannell & Jackson 1981). Fourthly, the deposition of soil and rocks onto plants during flooding increases erosional friction subsequently exposing the plant roots and damage plants in the process as the protective layer is removed. This impact has a general tendency of extending through to the dry period even after the flood waters have receded, rendering the damaged plants more vulnerable to other stresses as plants with substantial root damage are more likely to be uprooted in windy conditions for instance (Cannell & Jackson 1981).

Crops can differ in their tolerance to waterlogging and the damage caused to plants by flooding depends on the type and growth stage of the plants as described by Ransom (2013). Established healthy plants have established good firmness and rigour and are thus generally more tolerant than young or very old plants which are less firm and less rigorous. Crops like small grains and corn tend to be more sensitive to waterlogging most especially when their growing point is still below the surface of the soil (before the 5-6 leaf stage). Germinating seeds/emerging seedlings are very sensitive to waterlogging as their level of metabolism is high, and can be killed if soils are saturated beyond 48 hours and soil temperatures exceed 65 ^{o}C, while late planted crops look much worse than earlier planted crops. Early planting of crops has been outlined by the Cuvelai residents in Section 6.3.9 as an adaptive strategy to counteract the consequences of flooding on crop agriculture in the area.

Even once the flood waters recede it can take weeks for the soil to dry out with plants continuing to suffer damage in the meantime. Waterlogged conditions can reduce root growth and can predispose plants to root rots, so the ultimate effect of excess moisture may not be known until late in the season. Waterlogging can also indirectly impact crop growth by affecting the availability of nitrogen in the soil. Excessive water can leach nitrate nitrogen beyond the rooting zone of the developing plant, particularly in well-drained lighter textured soils. In heavier soils, nitrate nitrogen can be lost through denitrification. The amount of loss depends on the amount of nitrate in the soil (the most fertilizer applied N is in the nitrate form), soil temperature, and the length of time that the soil is saturated. Adding N to the crops while they are still young as it is recorded by residents in some parts of the Cuvelai may however overcome this consequence and assist in increasing crop yield.

3.4 THE IMPACT OF FLOODING ON LIVESTOCK

Livestock is of utmost importance for status, income, livelihoods, as well as survival of populations and cultures that are relying on livestock production. One of the fastest growing agricultural subsectors in developing countries with an agricultural GDP share of 33 percent, (Thornton et al. 2006), and covering approximately 30 percent of the surface area of land (Steinfeld et al. 2006), livestock systems are a significant global asset with a value of at least US$1.4 trillion, employing 1.3 billion people and directly supporting the livelihoods of 600 million poor smallholder farmers in the developing world. Though there are very large differences between rich and poor countries, on a global scale, livestock products contribute 17 percent to kilocalorie consumption and 33 percent to protein consumption, making livestock a key component of world agriculture (Rosegrant et al. 2009). Thornton et al. (2006) supports that livestock are important providers of nutrients and traction for growing crops in smallholder systems and livestock keeping thus is an important risk reduction strategy for vulnerable communities.

Of all the factors influencing livestock production, climate and location are undoubtedly the most significant (Lammy et al. 2012). In fact, climatology characteristics such as ambient temperature and rainfall patterns have a great influence on pasture, food resources availability cycle throughout the year, and types of disease and parasite outbreaks among animal populations. The impact of flooding on livestock in the Cuvelai is documented in detail in Section 5.3.2.3 of this paper.

Diseases that reduce production, productivity, and profitability are associated with the cost of their treatment, disruption of local markets, international trade, and exacerbate poverty on rural, local, and regional communities (Lammy et al. 2012). At the biological level, pathogens compete for the productive potential of animals and reduce the share that can be captured for human purposes (Food and Agriculture Organization (FAO) (FAO 2009); Rushton 2009). Apart from the impact of floods and associated direct consequences on agriculture, the impacts may as well be exacerbated by the levels of involvement of decision makers before, during, and after the flood disaster.

3.5 RISK FACTORS

A combination of risk factors associated with above normal rainfall, both local and rain that has fallen elsewhere upstream such as in southern Angola and Zambia, exacerbates Namibia's flood conditions. Risk factors include but are not limited to: uncontrolled urban developments, human habitation of flood prone areas, vulnerable and poorly maintained physical infrastructure such as blocked culverts and storm drains, weak risk mapping information systems as well as insufficient integrated early warning systems (DDRM 2008).

There are two categories into which flood mitigation approaches can be classified, structural and non-structural approaches (Thampapillai & Musgrave 1985; Smith 1996). While structural approaches are generally based on engineering interventions to control floods and to protect human settlements from flooding by building walls, levees, channels, and revetments, non-structural approaches are associated with adjustment of human activities and communities to mitigate flood damage with measures such as directing land use away from flood prone areas, communicating mitigation information, protecting sensitive areas, and as it is the case in the Americas, insurance schemes (Alexander 1993; Few 2003). The mitigation approaches may be used independently or in a mixed fashion, depending on the circumstances of the flooded areas and the populations affected (Brody et al. 2009).

3.5.1 Structural mitigation control measures

According to Danielson (2009), attempts to prevent risks have traditionally focused on the hazard event itself. Engineers worked to stop natural events through strategies ranging from high levees to block floodwaters for instance. There is however a disadvantage with this hazard-specific approach in that it requires a significant amount of somewhat excessive arrogance to imagine that human efforts can fully control hazard events. In addition, a hazard-focused approach often backfires. Burton et al. (1978) stated that the many levees built around the United States by the US Army Corps of Engineers have lulled the public into a false sense of security. As a consequence, dense housing developments sprung up on the now-safe land just behind the levees. Eventually, the levee would fail if there was a storm big enough or the levee maintenance was not kept up. The resulting floods were even more damaging than ordinary floods would have been, because a much larger population was now exposed to the hazard (Burton et al. 1978). Thus, an important trend in contemporary policy regarding risks should rather focus on reducing vulnerability via several non-structural disaster management efforts that foster and build society’s resilience to disasters that are also explored at Basin level of the Cuvelai in this paper.

Alexander (1993) listed flood control work structures such as levees, floodwalls and fills as examples of structures that alter or modify the built-environment to mitigate flood damage. *Channel phase* and *land phase* are two ways to describe how structural flood control works. While the *land phase* methods include gully control, modified cropping practices, soil conservation, revegetation, as well as slope stabilization, methods such as dams, dykes, reservoirs and systems for accelerating or retarding flows, reducing bed roughness and deepening, and straightening or widening channels make up the *channel phase* structural techniques (Alexander 1993).

According to Alexander (1993), structural flood mitigation, even though effective over time, have several associated shortcomings. Unlike developed countries such as the United States of America (USA) where flood mitigation history has been dominated by structural techniques, which have been utilised since the 1927 Mississippi floods (Birkland et al. 2003). Namibia, being predominantly rural and less-industrialized, has relied on non-structural techniques to deal with the impacts of flooding over the flood-cycle years. If not well planned or maintained, flood mitigation structures stand a chance of failing to protect against flooding, subsequently worsening the impact on the unsuspecting residents. Excessive flooding may exceed the design capacity of a structure resulting in significantly higher flood damages than if the area had been unprotected (White 1945; White 1975; Burby et al. 1985; Stein et al. 2000; Larson & Pasencia 2001).

A well-known global example is in the American city, New Orleans in the state of Louisiana. New Orleans endured Hurricane Katrina, where large areas of the city were destroyed because of the failure and breaches of the levees and flood walls protecting the city (Birkland et al. 2003). Birkland et al. (2003) added that flood mitigation structures may constrict the channels as well as flood plains, subsequently leading to the rise in water level and increase of the flood intensity downstream. According to White (1936) and Dalton & Burby (1994) structural mitigation has the capability to instill a false sense of safety and security in residents. This promotes negligent development in the area, creating perceptions that such areas are completely safe, subsequently increasing the risk of mortality and property loss in the associated floodplains initially deemed safe by residents (Burby et al. 1985). Apart from high financial and environmental costs involved in erecting structural mitigation control measures as pointed out by Stein et al. (2000), construction of dams and other flood control structures exacerbate adverse environmental impacts, such as the decline of fish and associated wildlife habitats, water quality, as well as function of hydrological systems (Abell 1999; Birkland et al. 2003).

Unstable systems can also accelerate the effects of floods. Though partly contained by levees, because the river had been choked with sediment, any significant increase in its volume will cause flooding of the surrounding areas (Questia 2004). An example is the disastrous Chinese Yellow River, with floods killing approximately 1 000 000 and 4 000 000 people in 1987 and

1931 respectively (Questia 2004; Frater 2007). The two separate disasters were ranked as the top two, most deadly natural disasters in history, according to Frater (2007).

3.5.2 Non-structural adaptation approaches

Vulnerability reduction strategies are hugely diverse. These may include examples as enforcing policies and formulating legislations that prohibit residents to build in flood prone areas as well as instilling awareness in especially those who are most affected by particular disasters (Danielson 2009).

In many cases however, the causes of vulnerability are so deep-rooted that can be addressed in the short term during which time more hazard events will strike, and the costs of trying to reduce vulnerability may be much greater than the costs of preventing the hazard event. This debate has been particularly intense in the field of climate change, where the terms 'mitigation' and 'adaptation' are typically used for what has been referred above as management of the hazard event and reduction of vulnerability. Most climate scientists hold that mitigation is usually the more cost-effective strategy, though it is becoming clear that some degree of climate change is inevitable and thus must be adapted to (Metz et al. 2007), but some thinkers disagree (Lomborg 2001). Emerging, small-scale and resource-poor farmers are particularly vulnerable to climate change and variability because they have fewer capital resources and management technologies at their disposal. Small scale subsistence farmers often do not have the ability to adapt or sufficient means to deal with and recover from extreme events such as floods and droughts (Lötter 2010).

Due to the high negative impact of structural approaches to flooding, it becomes worthwhile to look at non-structural ways of mitigating the impact of flooding in communities. Land use planning tools as well as education and awareness campaigns are some examples of non-structural flood mitigation strategies discussed by Brody et al. (2009). Some of such non-structural mitigation strategies include insurance programmes as well as spatially targeted land-use planning, public education awareness campaigns, flood warning and forecasting strategies and organizational capacity, as discussed in detail below and in greater detail in Chapter 6.

In highly urbanized countries such as the USA, strategies may extend to insurance programs such as the [American] National Flood Insurance Program (NFIP) established in 1968 as an attempt to stem rising flood losses in the USA. The NFIP is responsible for providing insurance to those living in vulnerable areas as long as local jurisdictions adopt some minimum level of protection. Effectiveness of the NFIP has however been repeatedly criticized in Godschalk et al. (1999) and Platt (1999) for encouraging floodplain development and generating repetitive losses with high financial costs, and should perhaps be discouraged.

What has been referred to as 'spatially targeted land use planning policies' by Brody et al. (2009), and aimed at addressing rapidly expanding urban and suburban development patterns that can place residents in areas vulnerable to flooding, have been adopted by various communities across the globe. Emphasizing the importance of integrating Disaster Risk Management (DRM) into National Development Plans (NDPs) and integrating hazard mitigation into land use planning frameworks has a long history (PDNA 2009). Writers such as White (1936); Burby et al. (1985); Burby et al (1999); Godschalk, Brower & & Beatley (1989); and Brody et al. (2009) have argued that the negative impact of flooding could be minimized through effective and proactive land use planning. Policies and regulations such as development restrictions, clustering, density bonuses, and transfer of development rights will not only reduce the negative impacts of flood events by directing growth away from susceptible areas, but also protect critical natural habitats and water quality. *Clustering* here entails formulation of policies and regulations that promote residents and developments to be clustered in areas on low risk. Whipple (1998) also adds that by reducing artificial and impermeable/ impervious surfaces in the areas will have minor negative effects on the area's hydrology.

Just like in the Cuvelai and other parts of Namibia, land use planning as a flood mitigation more sophisticated measure has been taken for granted by authorities elsewhere in the world. Local governments in developing countries tend to primarily resort to structural strategies as opposed to non-structural policies (Burby & French 1981; Burby et al. 1985; Olshansky & Kartez 1998) involving land acquisition, financial incentives, or public facilities. Structural strategies are said to exacerbate the flood impact upon failure, as compared to when there were no structures in place (Brody et al. 2009). Similar sentiments are also expressed earlier by Burton et al. (1978) in Section 3.6.2. To place flood risk in context, it is worthwhile to review the process of land acquisition in Namibia's communal areas.

3.5.3 Intentional residence in disaster prone areas

A given society or social group may be especially vulnerable to a hazard because they are forced into harm's way (Cutter et al. 2000). However, sometimes residing in disaster prone areas is out of informed decision making and not necessarily due to lack of knowledge of the area and its geography thereof. For example Yohe et al. (2006) found that a group of residents may voluntarily move into harm's way because they're seeking out other benefits when he studied rich southern Californians who knowingly buy homes in beautiful but fire-prone suburbs (Yohe et al. 2006). Some farmers achieve good yields after every flood season due to the water and sediment that is brought by floods (Tien 2001), as documented in this paper in Section 5.3.2.

Traditionally, people relied on floods for building their livelihoods in the flood prone regions of the deltas (Biggs et al. 2009). More recently, farmers can develop flood-based livelihoods to improve household income during several flood months (Nguyen 2007). Just like in the Cuvelai Basin (Mendelsohn 2013), some residents along the Nile (Tanner 2005) and those of the Mekong river delta (Nguyen & James 2013) have intentionally settled in these low lying areas due to good fertile soils and optimum conditions for agricultural purposes, decisions which in turn render residents highly prone to flood impacts.

3.6 LAND USE AND ALLOCATION IN NAMIBIA'S COMMUNAL AREAS

According to the Government of Namibia (2002) in its Communal Land Reform Act (Act No.5 of 2002), all land and natural matter on, above and below it, belongs to the GRN state. Furthermore, the Act states that all communal land in Namibia should be free of charge and reserved for the country's rural poor for residence, household farming, and grazing purpose. In addition, the TAs, and as it is confirmed in the Traditional Authorities Act (Act No. 25 of 2000), are entrusted with all communal land by the GRN for the communal residents they represent (Government of Namibia 2000). This also implies that the TAs bears a large responsibility in land allocation in rural areas. In some cases the TAs have a final objection on the choice of habitable spaces in the villages. Since there is no land use planning at village level, it is vital that such conditions are looked at in this study. This section also provides a detailed review of how the TAs function in Namibia. The box insert in Table A.5 provides insight into the land situation and acquisition in the rural areas of Northern Namibia adapted from Mendelsohn (2008).

Namibia has approximately 46 recognized Traditional Authorities (TAs) with varying spatial, household sizes and historical differences. All TAs have similar operational structures, ranging from the local authority, a village head, councillors, senior heads, and then chiefs. There are many TAs without communal land. This is especially true among the Topnaar, /Khomanin and Hai-//Om communities, with their communal land being housed inside other TAs (Mendelsohn 2008). Another instance pertaining to TAs lacking communal land is the influence of urban expansion. This primarily affects rural areas or villages located within certain distances from urban centres, land which currently is classified as town land, but with rural residences and activities. Examples of TAs who have lost ownership to communal land due to urban expansion include Kai-#Kaun, Afrikaner and !Gobanin. In such cases the TAs appoint councillors living in the towns to represent their local communities and their ideals (Mendelsohn 2008). This paper investigated this phenomenon with regards to flood risk management and it is documented in Section 6.3.3.

Mendelsohn (2008) documented that older TAs including those of the Owambo in the Cuvelai, as well as those of Caprivi and Kavango, date back to the 19th century. TAs evolved for many hundreds of years and is thus well established in terms of customary laws, leadership, and political affiliations. Most of the older and bigger TAs have relatively well established facilities such as substantial buildings which provide offices, storage space and areas in which public meetings and other community events can be held. Some offices are equipped with computers, fax machines, filing cabinets, chairs, desks and other furniture. These offices are known to function in an orderly fashion, having filing systems, record books and several staff members appointed to perform defined functions. However, other, relatively younger TAs being formed for approximately only two decades ago, are associated with more political unrest and other poorly distributed boundaries. Such TAs are known to lack these facilities and most administrative information is therefore retained only in the memory of secretaries and chiefs. Each TA has a secretary who is fully or partially paid with funds provided by the Ministry of Regional & Local Government & Housing (MRLGH). Most secretaries work as administrative or clerical assistants, and are thus proficient at only basic tasks. Some other secretaries, including notably all those in Kavango, are influential and competent members of the TAs administration. The largest TAs, for example Ondonga and Uukwanyama, have tens of thousands of families on communal land, whereas the smallest TAs, such as !Gobanin and Afrikaner, are responsible for less than one hundred communal households (Mendelsohn 2008). The influence of TA on land allocation and acquisition is discussed in Section 6.1.2.

3.7 INVOLVEMENT OF DECISION MAKERS

The greatest opportunity to reduce the risks to and impacts of chronic flood hazards rests in the hands of [local] decision makers. But whether risks are decreasing or becoming more widespread as per the ongoing debate in the literature (Danielson 2009; Beck 1992), trust of decision makers by the local residents seems to be more important. The level of trust by residents in the Cuvelai toward agencies responsible for early warning systems in comparison to communities' indigenous knowledge is expressed in Section 6.3.8.

3.7.1 Trust and the risk society

According to Beck (1992), the distribution of risks has become an important source of conflict in society. In the past, the main conflict was the distribution of socially-produced goods. According to Danielson (2009), in today's risk society, an increasing source of conflict is over who should have to bear the risks that occur. Some literature documents that the increasing commotion is no longer that risk is increasing, but rather that of trust of residents to trust officials in charge of managing the risks (Yohe et al. 2006).

In disaster risk management, Yohe et al. (2006) asserts that, trust can be defined as reliance on the actions of another in a context of uncertainty. Studies have shown that trust in the people responsible for managing a risk strongly shapes how concerned people are about that risk (Cvetkovich & Löfstedt 1999). Substantial research has been dedicated to investigating the reasons why people trust or distrust certain people or institutions to manage risks, and why they would trust or distrust information about risks that they receive from certain people or institutions. This phenomenon is also documented in Section 6.3.8. There are two basic approaches to understanding trust: cognitive and cultural. These are not necessarily competing explanations; both types of factors may be at work in shaping whether a person trusts another or not (Cvetkovich & Löfstedt 1999).

The cognitive approach is based on the idea that people decide whether to trust a person or institution (the "trust object") by weighing a combination of factors about the trust object. Researchers differ on the specific list of factors that are involved, but one paper lists them as commitment, competence, caring, predictability and openness (Kasperson et al. 1992). That is, to be trusted, a trust object should show that they're *committed* to doing what they're being trusted to do, that they have the *competence* to actually do it well, that they *care* about the source of truster's well-being, that their handling of the situation is *predictable*, and that they are *open* about what they're doing and why.

The cultural approach is based on the idea that people trust 'trust objects' that are culturally similar to them and share similar values (Earle & Cvetkovich 1995). Thus, a person with a strongly hierarchical disposition, who values maintaining order and respecting expertise, would likely trust a bureaucratic institution. However, someone with a more egalitarian disposition would be more likely to trust an environmental activist group for example.

Similarly and as investigated in this paper, a village resident may opt to trust the village headmen over a government official. This paper dissects trust of technical early warning information of the Cuvelai in comparison to indigenous knowledge and word of mouth to a lesser extent.

3.7.2 Role of institutions organizational capacities in flood risk management in Namibia

Apart from ill-land use planning mechanisms that exist at local level, lack of information awareness is another crucial factor hindering the flood mitigation process. Educating the public with regards to floods will not only help residents have a better understanding of the flood concept with reference to their local circumstances, but will also alter the perceptions of floods by rural residents and subsequently impact ways in which residents respond to floods. However, changing the mind-set of human beings is a complicated process, which may be effectively attained through localized public education. Printed materials, websites, training workshops, community meeting are media examples in which public education may be transmitted (Brody et al. 2009).

According to Brody et al. (2009), fiscal strategies can involve a referendum to dedicate funding for flood mitigation programs or to acquire lands that are particularly sensitive to flood damage. In the USA, obtaining government funding, is another type of fiscal flood mitigation strategy, according to Brody et al. (2009). For example, through the Community Block Grant Program, federal funds can be allocated to local jurisdictions for specific flood mitigation initiatives.

Commonly used by local governments to gather data, assess structures, and predict the consequences of flood events, flood warning and forecasting is not a new concept to the Namibian context, Namibia Hydrological Services (NHS) (in PDNA 2009). Though various computer models and assessment software can help guide communities looking at riverine flooding, retention, and storm drainage, technical modeling capability is however not well established in the NHS, and flood modeling only became a concern after the large floods in recent years, specifically as a recommendation by PDNA (2009). Flood warning is also as a consequence limited to the simply warning of regional councils with no follow up on the effectiveness of the strategy or analysis of the flood associated consequences with regards to forecasting and warning on affected communities. Many response organizations in Namibia lack the necessary capacity to coordinate events before, during, and after floods. The DDRM does not have enough authority to deal with disasters and the delegation of duties and lead agencies is seemingly unclear, and recommended that further mainstreaming of disaster response and risk reduction is required. This leads to the role of organizational capacity in flood mitigation.

Brody et al. (2009) wrote that the extent of both structural and non-structural flood mitigation policies is thought to be influenced by the capacity of the organization implementing the adopted strategies. According to Honadle (1981) and Brody et al. (2009), organization capacity with reference to flood mitigation can be conceptualized as the ability to anticipate flooding, make informed decisions about mitigation, and implement effective policies as well as the ability of individuals within a unit to work together to achieve a common goal. Factors such as financial resources, staffing, technical expertise, communication and information sharing, leadership, and a commitment to flood protection are key characteristics of effective organizational capacity in flood mitigation (Hartvelt & Okun 1991; Grindle & Hilderbrand 1995; Hartig et al. 1995; Handmer 1996). This implies that organizational capacity is seen as a foundation on which strong flood mitigation programs may rest. Some of the factors influencing organizational capacity include staffing, mandate and budget (Burby & May 1998), level of staff commitment (Handmer 1996) and the organization's flood mitigating approach (Holling 1996).

Burby & May (1998) have documented, that an increase in the planning staff numbers as well as funding for related programs will lead to higher quality mitigation policies. Furthermore, the higher the planning agency's capacity for a given jurisdiction, the more the technical expertise and the more personnel can be devoted to implementing flood mitigation techniques (Olshansky & Kartez 1998; Brody 2003b; Laurian et al. 2004). According to the interviews conducted with various institutions involved in DRM in Namibia, by the researcher and another colleague in 2012, Namibia's DDRM, in its coordinating role, employs 34 staff and has an annual budget of NAD5 000 000 and access to a contingency reserve of NAD20 000 000. Contingency planning in Namibia takes place in the form of regional 'all hazards' plans. Early warning for severe weather systems falls to the meteorological services in Namibia. The Meteorological services have shown a significant decline in the number of operational weather stations after [the country's independence in 1990]. Before independence there were over 1000 weather stations across the country, which has decreased to approximately 400. In total the meteorological services employs 52 staff members, of which, seven are forecasters. Hydrology Division is responsible for flood monitoring and warning. The division employs 11 hydrologists and seven hydrological assistants. UN agencies appear not to have contingency plans for disasters in the country, but advice on the contingency plans set out by government.

In most cases especially in the GRN bodies, allocated budgets are insufficient to cater for more extensive engineering approaches towards mitigation or community-wide programs to prepare residents for flooding events. The NHS for instance that deals with flood and hydrological drought monitoring, forecasting, and warning, and in which the researcher works, has its majority of the on-going projects and work being supported by international bodies such as the National American Space Agency (NASA), European Space Agency (ESA), and the World Bank among many others, for financial and or technical assistance including capacity building. At a country level, even when money is available at times, it is invested in response-based DRM initiatives such as provision of emergency food relief and other response initiatives that rather build-up high levels of dependence and add no value to building resilience towards disasters in the at-risk communities (NHS 2010).

Brody et al. (2009) iterates that merely having sufficient number of staff and budget is not a guarantee that mitigation measures worked on will be effective enough. The level of commitment is just as an important factor underlying a strong local flood management program. Handmer (1996) and Ivey, Loe & Kreutzwiser (2002) support this by saying that even though local authorities, elected officials, and staff may have the resources to develop a flood mitigation program, but lack the necessary commitment, failure in the implementation of policies is evident. In fact, studies by Dalton & Burby (1994); Berke et al. (1996); Burby et al. (1997); Brody (2003a) and Brody et al. (2009) have revealed that local governmental commitment associated with natural hazards, such as floods is a key factor in the implementation of mitigation strategies. These scholars further recommended that strong organizational commitment to flood protection should lead to the implementation of more flood mitigation strategies as agencies to emphasize the importance of reducing the adverse impacts of floods during the planning processes.

Since the capacity of the organization influences adoption of both structural and non-structural mitigation policies (Brody et al. 2009), mitigation strategies need to be robust and dynamic, designed in an experimental fashion, adaptive enough to the changing local conditions. They should also be able to respond to changing local conditions, shifts in local interests and activities as well as to new and changing information. Measures should also be geared towards possibilities of uncertainties, and should carry reasoned expectations about how existing conditions will respond to management actions (Holling 1996).

Various strategies applied by other researchers to assess socio-economic consequences on communities as a result of floods are reviewed in the next chapter. At the same time, specific processes employed for purposes of this particular study are also outlined.

3.8 PURPOSIVE (NON-PROBABILISTIC) SAMPLING

Purposive sampling is a deliberate informant selection tool which does not need underlying theories or a set number of informants (Tongco 2007). Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Bernard 2002; Lewis & Sheppard 2006). Informants may also be chosen out of convenience or from recommendations of knowledgeable people (Lopez *et al*. 1997; Seidler 1974; Smith 1983; Zelditch 1962), such as the village headmen of the Cuvelai as it in this paper.

As opposed to non-probabilistic sampling such as purposive sampling, random or probability sampling is generally recommended as a means of informant selection because of two main reasons that ensure external validity of the data and results gathered. First, randomization reduces biases and allows for the extension of results to the entire sampling population (Godambe 1982; Smith 1983; Snedecor 1939; Topp et al. 2004). Second, results may be applied beyond the community studied (Bernard 2002; Godambe 1982; Karmel & Jain 1987).

However, random sampling is not always feasible, and not always efficient. Disadvantages of random or probabilistic sampling vary from factors such as higher costs for a researcher induced by high dispersion of samples (Alexiades 1996; Bernard 2002; Snedecor 1939), and missing data, which is common in field situations, also renders random samples invalid for traditional probabilistic statistical inference (Godambe 1982). This often occurs because not everybody is willing to participate or may be absent during sampling (Alexiades 1996). One example comes from Gomez-Beloz (2002) who opted for purposive sampling after the randomly chosen interviewees who were initially willing to participate suddenly became absent during the survey, with some respondents not completing all items in questionnaires.

Non-probability methods can be as effective as probability methods in some situations. When a sample is representative, it becomes valid over the realm it represents, providing external validity, which is a benefit of probability sampling. However, when a sample is measured correctly, it becomes valid for the sample, thus providing internal validity which is an advantage of purposive sampling (Tongco 2007).

Advocating for the use of purposive sampling, Zelditch (1962) alleged that insisting on randomized samples every time increases the danger of losing efficiency, and accelerates failing to recognize the existence of different types of information which can be extracted from a community in more than one way. Purposive sampling is a practical and efficient tool when used properly, and can be just as effective as, and even more efficient than random sampling (Tongco 2007). Despite its inherent bias, purposive sampling can provide reliable and robust data. The strength of this method actually lies in its intentional bias (Bernard 2002; Lewis & Sheppard 2006; Poggie 1972; Tremblay 1957). Campbell (1955) also conducted a study where he took purposive samples and compared these with a survey of all crew members regarding morale. Results of both methods were highly correlated using Spearman rank order correlation by other researchers. Karmel & Jain (1987) compared the results of a purposive sampling method and a random sample with the intention of advocating random sampling, but they found that the purposive method did better than the random method, encouraging statisticians to look beyond probabilistic sampling designs.

3.9 CASE STUDY INQUIRY

For many years, case study research has been applied by primarily social researchers across varied disciplines to understand complex issues or objects. Yin (2003b) defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used. Although interviews are the most common source of data in case study research (Merriam 1998), other sources such as documentation, archival records, direct observations, participant observation and physical artifacts may also be utilised (Yin 2003b). A case study emphasizes detailed contextual analysis of a limited number of events or conditions and their relationships, focusing on a holistic description and explanation (Merriam 1998).

Certain critics however believe that the study of a small number of cases is of insufficient precision (quantification) and can offer no grounds for establishing reliability or generality of findings. Others feel that the intense exposure to study of the case biases the findings and limits objectivity, and some regard case study research as a less rigorous method that is useful only when utilised as an exploratory tool (George & Bennett 2004). Stake (1978) also observed the negative bias towards the case study approach by writing that "the more episodic, subjective procedures, common to the case study, have been considered weaker than the experimental or co-relational studies for explaining things" (Stake 1978:6). He further concluded that when the aims of the study involve understanding, extension of experience, and increase in conviction in that which is known, the disadvantage of case study research often disappears" (Stake 1978:7).

In addition to Stake's (1978) defense in favour of case study research, Yin (2003b) and Brown (2008) emphasized that a case study should be regarded as a design, a methodology, a particular data collection procedure, and as a research strategy. Flyvbierg (2006) adds that case studies have a benefit of providing 'context-dependent' (practical) knowledge rather than 'context-independent' (theoretical) knowledge which social science has difficulty with. Flyvbierg (2006) clarified further that 'predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent (practical) knowledge is, therefore, more valuable than the vain search for predictive theories and universals'. While looking at the theoretical knowledge that exists elsewhere, this paper predominantly seeks to document and expand more on practical knowledge as gathered from the Cuvelai residents.

Yin (2005) reaffirms the efficiency of case study approach by stating that gathering a lot of statistics is one way to start an inquiry, but statistics is not what real life is really about. He further added that to enable for a better understanding of the world may as well mean bringing to life what occurs in the system and how it is connected to a greater display of real life. By providing both 'descriptive richness' and 'analytic insight' into people (which Flyvbierg (2006) described as the high degree of 'conceptual validity'), events, and passions as played out in real-life environments, case studies can be a necessity to fill this gap. Yin (2003b:1) introduced his often quoted description of the choice of the case study as the 'preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context'. Case studies are also epistemologically in harmony with the reader's experience, offering a natural basis for generalization (Stake 1978) and thus resembling understanding of the naturalistic world through personal experiences (Brown 2008).

In fact, researchers continue to apply the case study research approach with success in studies of real-life situations, issues, and problems, and reports on case studies from many disciplines are widely available in the literature. Social researchers such as Yin (1981, 1999, 2003a, 2003b, 2005); Stake (1978, 1994, 1995, 2005, 2008); and Merriam (1998) among many other case study researchers have made wide use of this research method to examine contemporary real-life situations and provide the basis for the application of ideas and extension of methods. For this particular study, the case study approach yielded valuable results as presented in Chapter 5 and 6 of this thesis.

The use of multiple sources of evidence, the creation of a case study database, and the maintenance of a chain of evidence are three main benefits of case study data collection. The case study database such as the example previewed in Figure 4.12 and Figure 4.13 under Section 4.2.8.1 enables the researcher to organize and maintain raw data, subsequently increasing the reliability of the case study (Yin 2003b) and thus overcoming validity and rigour concerns expressed earlier by George & Bennett (2004).

A case study is an appropriate research approach for 'appreciating the complexity of organizational phenomena' (Yin 2003b), which is effective for this paper. Firstly, new theories are constructed and some were tested and exploited. Secondly, a case study database with raw data as in Section Figure 4.12 and Figure 4.13 under Section 4.2.8.1 has been created to advance theoretical ideas and to a greater extent document practical knowledge. New information can stimulate new theoretical thinking. Thirdly, formulation and provision of practical knowledge ('context-dependent' as in Flyvbierg (2006)) which is also outlined in Objective VI of this thesis further validates the use of the case study approach.

Primarily regarded as a qualitative approach, a case study method could also be used with quantitative evidence (Yin 2003b), analytically or holistically, through measures or by interpretation. However, the critical factor is that the case is a system with boundaries, and with certain features inside those boundaries (Stake 2005, 2008).

CHAPTER 4: RESEARCH METHODOLOGY REVIEW AND METHODS APPLIED

Emanating from the literature review and Section 3.8 and Section 3.9 in particular, approaches used by other researchers to conduct flood vulnerability and socio-economic studies are reviewed here. Methodologies employed vary from qualitative to quantitative, mixing these methodologies to assess the impact of human activity on flood vulnerability. The research methods and steps followed for this specific study, including sampling and delineation of the study area, are provided in the research methods section. The research methodology is summarized in the research design at the end of the chapter.

4.1 RESEARCH METHODOLOGY

This section reviews methods that have been applied in related studies, highlighting some expected results which provide justification for the use of similar methods. This study not only makes use of qualitative data collected through focus groups and in-depth interviews, but statistical analyses are also performed in order to gain an in-depth understanding of human behaviour and the reasons that govern such behaviour. This study is therefore exploratory in nature and will contribute to understanding the consequences of flooding in the Cuvelai Basin and associated mitigation strategies, especially at local level. Assumptions and limitations are emphasized in the description of each research method in Section 4.2.

Combining qualitative and quantitative approaches, Brody et al. (2009) investigated organizational capacity and local flood mitigation strategies by using survey information of floodplain administrators and planning officials to build statistical models to compare flood mitigation techniques. By correlating individual measures of organizational capacity with flood mitigation techniques, and using multiple regression analysis to isolate the effects of organizational capacity on the implementation of structural and non-structural mitigation techniques while controlling for geophysical and socioeconomic control variables, the authors were able to conclude to what extent organizational characteristics and specific local conditions influence the degree to which flood mitigation is occurring at the local level (Brody et al. 2009). This is an important finding for the design of this study, as systematically evaluating flood mitigation at the local level also provides policy signals to decision makers on how best to craft a program that can most effectively reduce the adverse impacts of floods over the long term. It is the better understanding of the local conditions under which flood mitigation is most likely to take place which fosters the development of more flood-resilient communities in the future (Brody et al. 2009).

In Namibia, specifically in the Cuvelai Basin, there is a lack of historic data, in particular regarding the timing and consequences of flooding. The effect of anthropogenic change on rainfall patterns and associated floods (Min et al. 2011; Pall et al. 2011) has not been quantified. Allan (2011) found that the frequency of intense rainfall events is likely to increase with anthropogenic greenhouse gas induced warming, while Myers (1993) and Parry et al. (2007) have supplemented that on-going urbanization, population and economic development contribute to increasing vulnerabilities. In order to build up a record of change and effects, this study has invested in an extensive socio-economic data collection about the area with reference to floods, from which vulnerability relationships can be deduced. Furthermore, and due to the future implications [faced by the country] as a result of flooding and drought, it becomes vital to establish a physical baseline for the Cuvelai Basin.

At basin level, Mendelsohn & Weber (2011) and Tamayo Milanés et al. (2011), divided the Cuvelai into three main flood risk zones, high, moderate and low, determined by the level of the risk of the flood. The *high risk zone* encloses areas that are located in flood prone areas and thus highly vulnerable. The *moderate risk zone* houses areas that are low lying and that are affected by rainfall levels thus moderately vulnerable. The *low risk zone* includes areas that are located on higher elevation or low lying areas with reduced to no vulnerability. Elevation per household point was determined using a Digital Elevation Model (DEM) and classifications were verified with aerial photographs (Mendelsohn & Weber 2011). In contrast, DDRM (2011) used qualitative surveys to determine the total affected population for purposes of providing relief assistance to the victims. Similarly, Tamayo Milanés et al. (2011), were able to outline several areas affected by 2011 floods by choosing areas that coincide with the three flood risk zones, but these numbers are seen as an over estimation. It is against this background that the pilot sites to the study were selected and re-enforces the motivation for the particular study site as shown in Section 4.2.1 and Section 4.2.2.

For their case study, Nguyen & James (2013) employed both qualitative and quantitative research approaches to conceptualize household resilience to floods in three communes in Vietnamese Mekong River Delta. They conducted ten in-depth interviews in each commune and also made use of field observations to gather field data covering a range of social classes and gender. The study used a multiple items approach to design questionnaires for measuring household resilience. As noted by De Vaus (2002), it is beneficial to use multiple indicators to measure the complexity of a concept. Multiple items also help to increase reliability and precision of the measure. The multiple item approach was widely accepted in measuring individual resilience to stresses in psychological disciplines (Wagnild & Young 1993; Connor & Davidson 2003; Yu & Zhang 2007; Baek et al. 2010; Wang et al. 2010), and individual resilience to institutional changes (Marshall &Marshall 2007). As rural households in the Cuvelai Basin have experienced the impacts of annual flood events for the past years, it becomes reasonable to use the wide array of purposive approach methods and strategies in order to identify the ability of households to cope with, adapt to, and benefit from floods. Details of non-probabilistic research methods are reviewed under Section 3.8.

Das & Dey (2011) used questionnaire surveys by interviewing 22 households in a flood affected village of Barak Valley in India, to identify the impacts of recurrent floods on the socio-economic structure of the households. The results reflected various socio-economic aspects of the representative households, hence help in maintaining a clear picture of the prevailing social and economic conditions. They used Microsoft Excel for data processing and analysis and primary and secondary data were analysed both quantitatively and qualitatively. In this paper, Microsoft Excel is utilised to build a socio-economic database alluded to earlier in Section 2.2, and data was also both quantitatively and qualitatively analysed.

In Central Java, Indonesia Ariyanto & Asai (2012) made use of interviews and discussions with key informants to determine the 'level of flood vulnerability based on socio-economic indicators of income, occupation, period of stay, number of family members, gender, age and education. Most such factors are among several other indicators that have been used in this paper to determine the socio-economic vulnerability of the Cuvelai rural residents.

Haque & Uddin (2014) applied a case study approach which employed participatory rural appraisal tools, such as focus household interviews and key informant interviews, in two coastal communities of Bangladesh severely affected by Cyclone Sidr. This data was procured and analysed from a total of 162 randomly selected households distributed across eight villages. Details of case study research methods are reviewed under Section 3.9.

Childers (1999) conducted an exploratory study to investigate the impact of income on elderly female-headed households in New Orleans. The research concluded that elderly female-headed households are more socio-economically vulnerable than other households. Another similar study used purposive sampling to interview 220 respondents to investigate the impact of floods on natural resource dependent communities in Northern Ghana (Armah et al. 2010). The data found that widows are prone to damage, loss and suffering in the context of the frequency and magnitude of the floods.

By using both quantitative and qualitative approaches, Mwape (2009) assessed the flood impacts on the socio-economic livelihoods of the Sikaunzwe community in Zambia. He found that other households had a diversity of livelihoods (crop production, trading, beer brewing, fishing and charcoal burning) as opposed to the single, divorced, separated and widowed household heads.

Shah et al. (2013) used a field based observational research to identify the major causes of damages to the mud houses in the wake of torrential floods in Pakistan. This has also identified the need for collaborative efforts for better design and construction of mud houses to mitigate any such damages in the likely future floods.

4.2 RESEARCH METHODS

In this section the study site selection and applicability of methods based on the results from the pilot study are discussed and the data collection methods are described. The study employs a case study research approach which is reviewed in Section 3.9. The research methods section concludes with a schematic of the research design outlining all steps undertaken.

4.2.1 Study site

The research was carried out in the Cuvelai Basin, previewed in Section 1.2. The study area was selected to concentrate on areas with defined drainage lines and where flooding is known to occur regularly. See Figure 4.1 of the initial study site with the reduced study portion of the study site.

The Cuvelai Basin (also referred to as ‘the Basin’) is shared between two countries, almost split in half by Angola and Namibia. The floods occurring in the Southern part of the Basin which lies in Namibia are generated high up in the catchment in the Angolan highland. See Figure 1.1 and Figure 4.1 showing the network of the flow of water and streams from Angola’s highlands into Namibia.

The pilot study described in Section 4.2.2 was conducted across the initial predetermined study area shown in Figure 4.1. However, due to reduced stream network and density especially in the area west of 15°00′ 00″ E, and 18°00′ 00″ S as well as immediately to the west of the study area, and reduced population density elsewhere, the study area was reduced to focus only on the area mostly with well-defined and increased stream density which experiences serious flooding and consequences thereof, and which is also the most densely populated part of the Basin.

4.2.2 Pilot study

To test the applicability of the research methods to the study area, a pilot study was carried out along and around three transects as outlined in Section 4.2.3 and Section 4.2.4. Roads being one of the main population growth nodes apart from powerlines and streams, transects were based on the two main roads of Engela-Okalongo-Uutapi, Oshakati-Okahao, and around areas of Uuvudhiya and Ombuga.

Two villages were then taken from each of the three transects, giving a total number of six villages. From transect 1 (Engela-Okalongo-Uutapi) villages Etayi and Engela were chosen. From Transect 2 (Oshakati-Okahao), Othingo and Oshihenge were chosen. Omapopo and Uuthilindi were chosen from Transect 3. Marked by red asterisks on Figure 4.2, villages interviewed during the pilot study are also shown in greater detail in Figures 4.3 to 4.8. For purposes of clarity, note that a 'region' in Namibia referred to hereafter, is understood in the same light as a 'province' in the neighbouring South Africa.

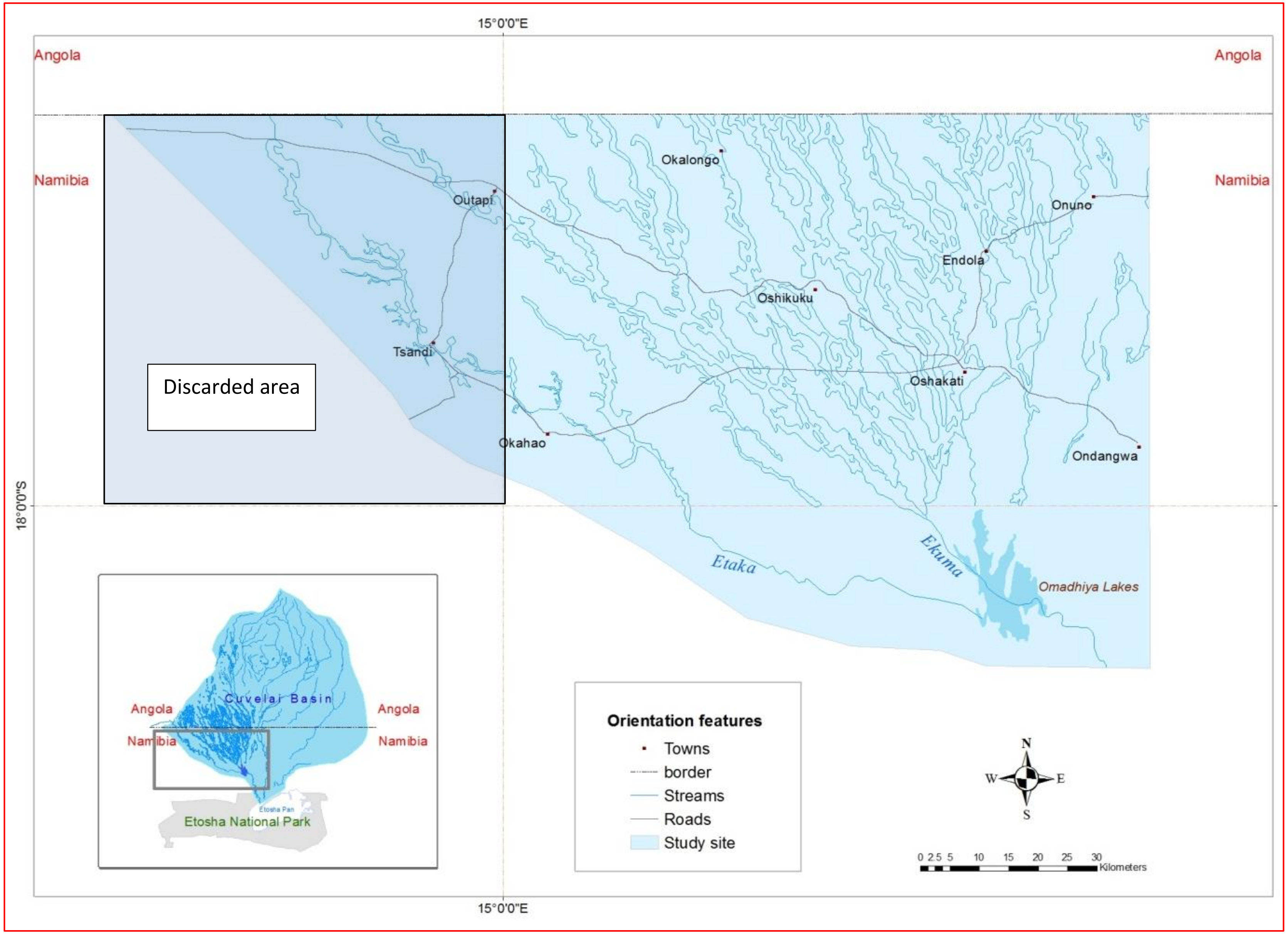


Figure 4. 1 The study area within the broader drainage basin of the Cuvelai Basin

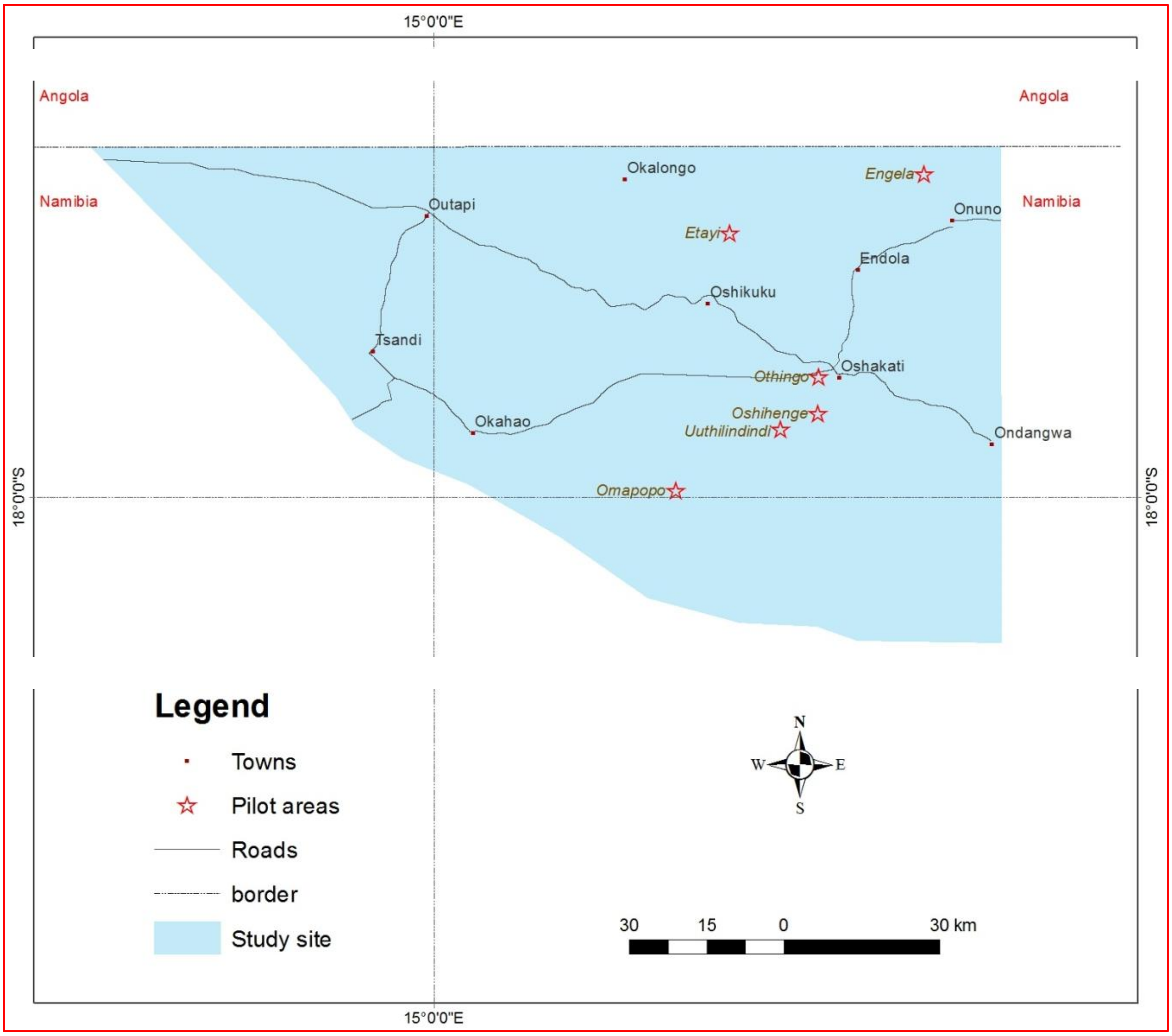


Figure 4. 2 Villages interviewed during the pilot study

4.2.2.1 Etayi

Situated in the Omusati Region, Etayi in Figure 4.3 is a district capital of the Etayi electoral constituency in northern Namibia. The village is home to approximately 35 130 inhabitants (Tamayo Milanés et al. 2011).

Figure 4. 3 Etayi pilot village

4.2.2.2 Engela

Being closer to the Angola-Namibia border and in the Ohangwena Region, a substantial number of residents have come from Angola in relatively recent years, settling in some of the flood prone areas. These make up a larger portion of the flood victims in this area. Engela is shown in Figure 4.4.

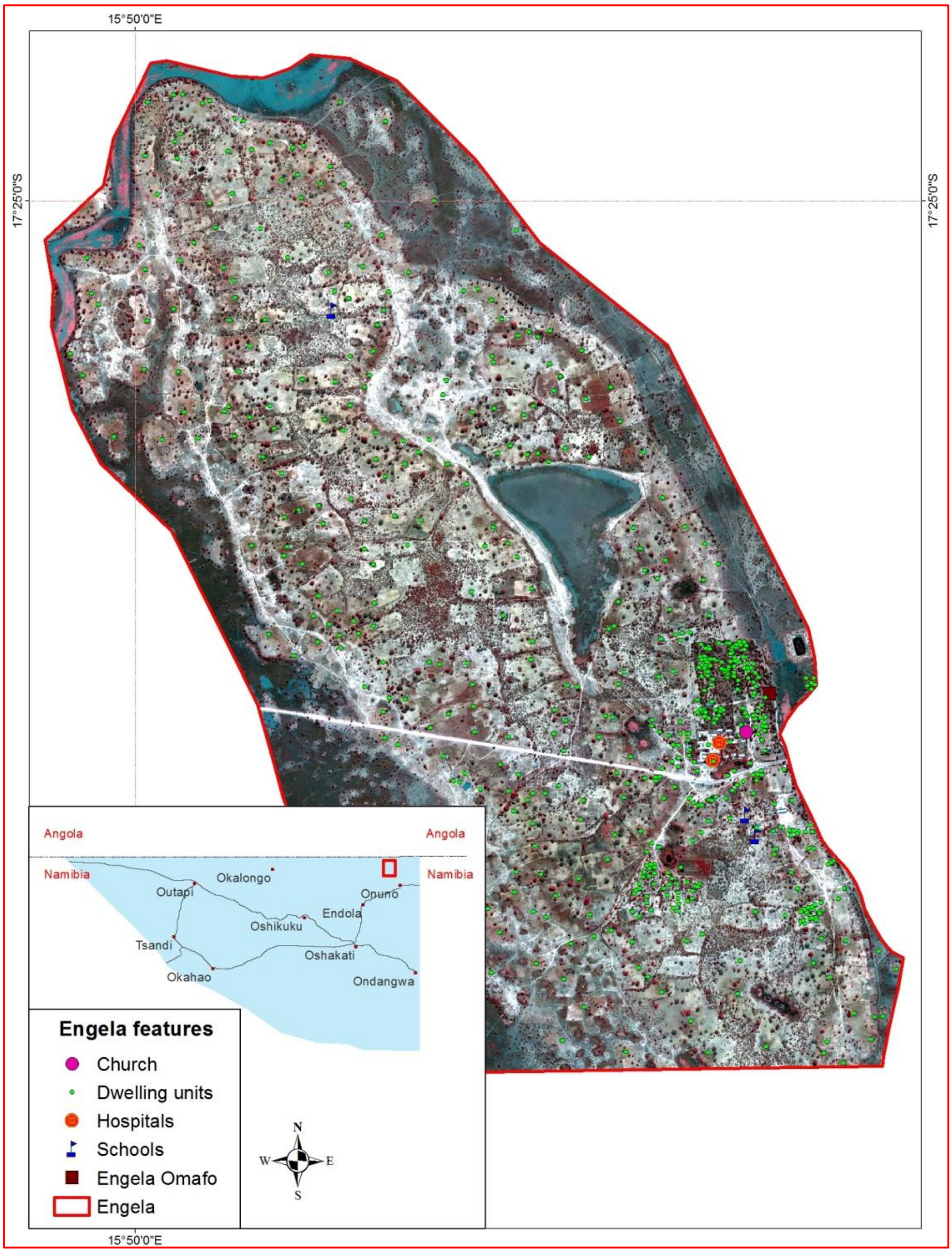


Figure 4. 4 Engela pilot village

4.2.2.3 Othingo

Being on the peripheries of the Oshakati town, Othingo shown in Figure 4.5 is an example town of which some of its impacts are accredited to urban consequences. The urban dyke though working in many instances by protecting the urban residents from flooding, it also creates a built up on the opposite side, deflecting the waters to the nearest fields. It is also in this village where the town municipality has a landfill as well as municipal cemetery nearby rural homes, sites which have been heavily associated with increased flooding in the village. Being a very low lying area, the great part of the village is also highly geographically vulnerable.

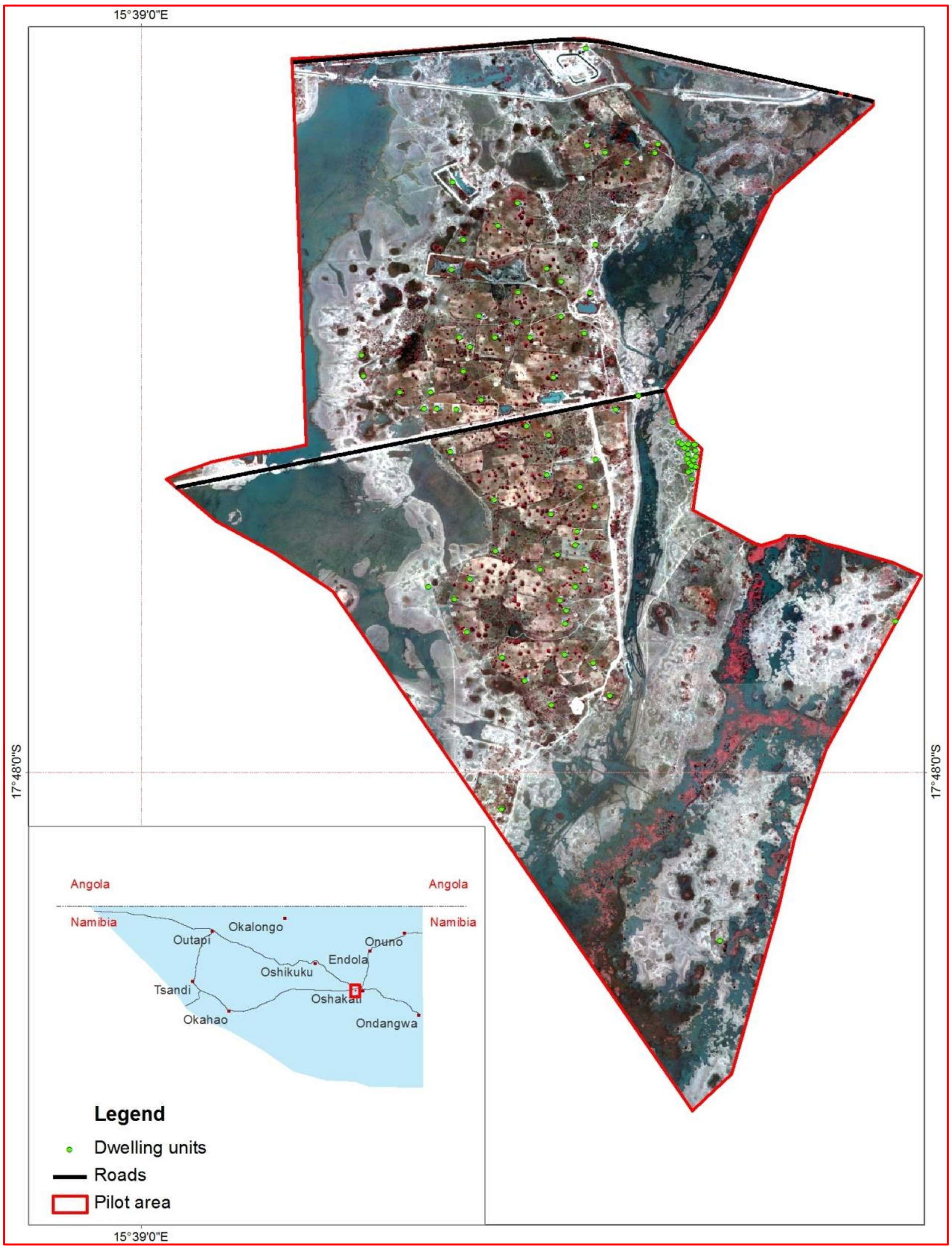


Figure 4. 5 Othingo pilot village

4.2.2.4 Oshihenge

Oshihenge, shown in Figure 4.6, translates into a local name for soils with a high content of Kalahari sands, and suffers from increased seepage. Though an extremely low lying area with few patches of relatively high land, in this case the geography becomes somewhat irrelevant for those on relative high land when determining vulnerability of households to floods as all households seem to be equally affected as a result of either direct surface flooding or seepage.

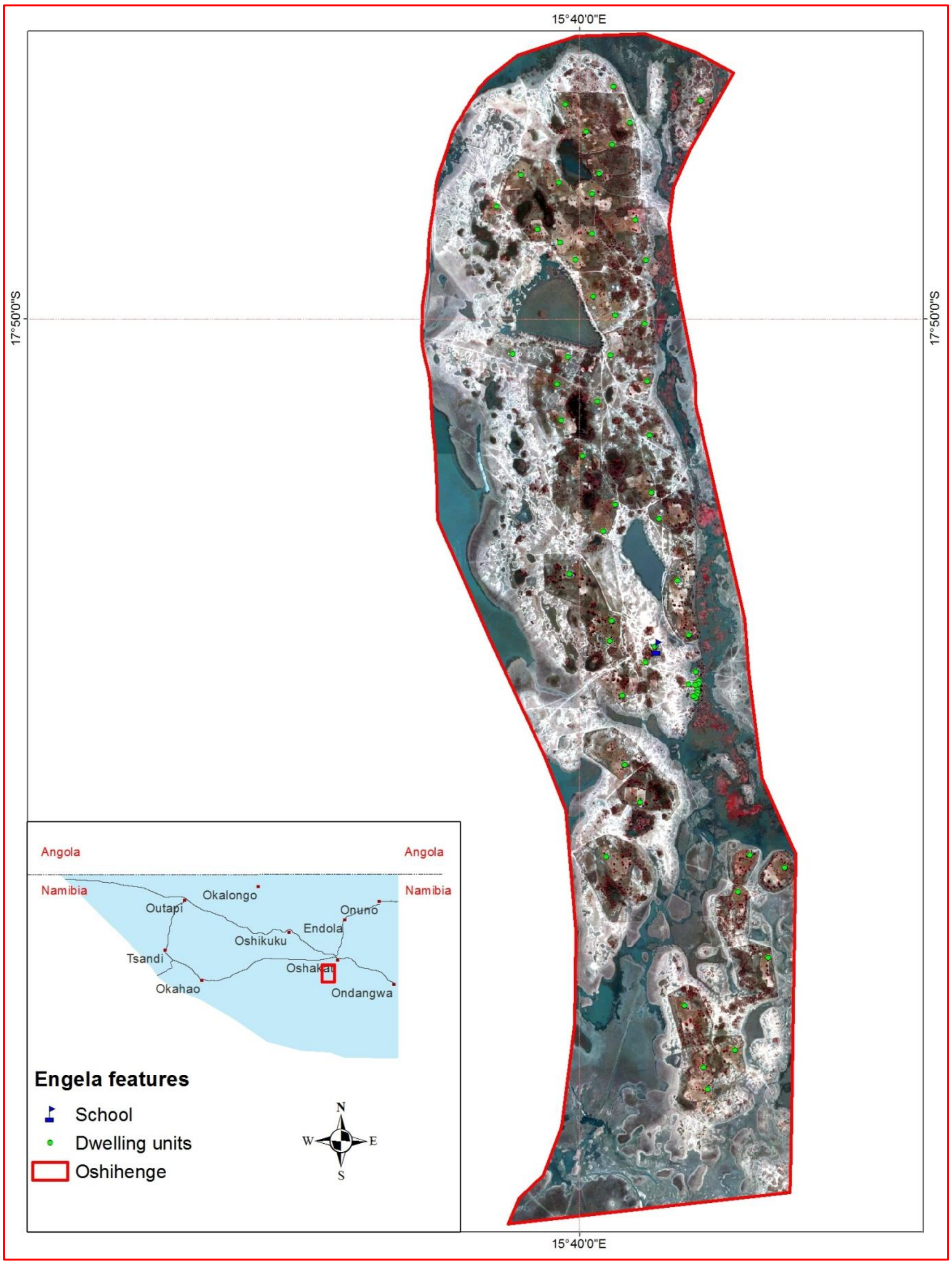


Figure 4. 6 Oshihenge pilot village

4.2.2.5 Omapopo

This area is dominated by small pans and the channels are not properly defined as it is visible in Figure 4.7. The floods in this area are thus primarily fed by local rains, and no matter where one may choose to reside, geographic vulnerability does not differ much as the whole area is generally flat.

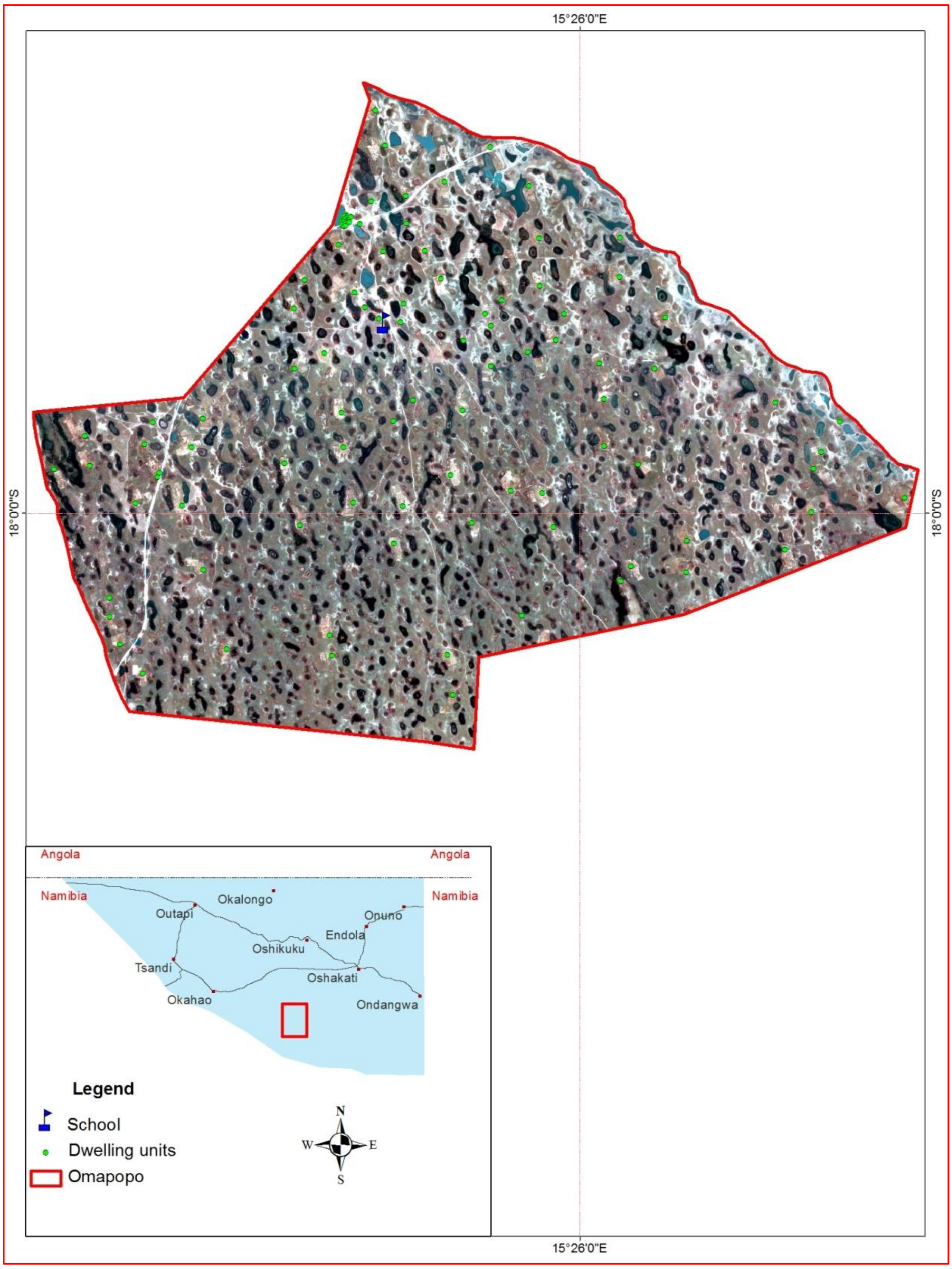


Figure 4. 7 Omapopo pilot village

4.2.2.6 Uuthilindindi

This area consists of a mixture of local pans in the South-West with interconnected *iishana* channels in other parts of the village, and high contents of Kalahari sands as it can be seen in Figure 4.8. Where the channels are well defined, geography becomes crucial and a resident is vulnerable depending on their proximity to the water source.

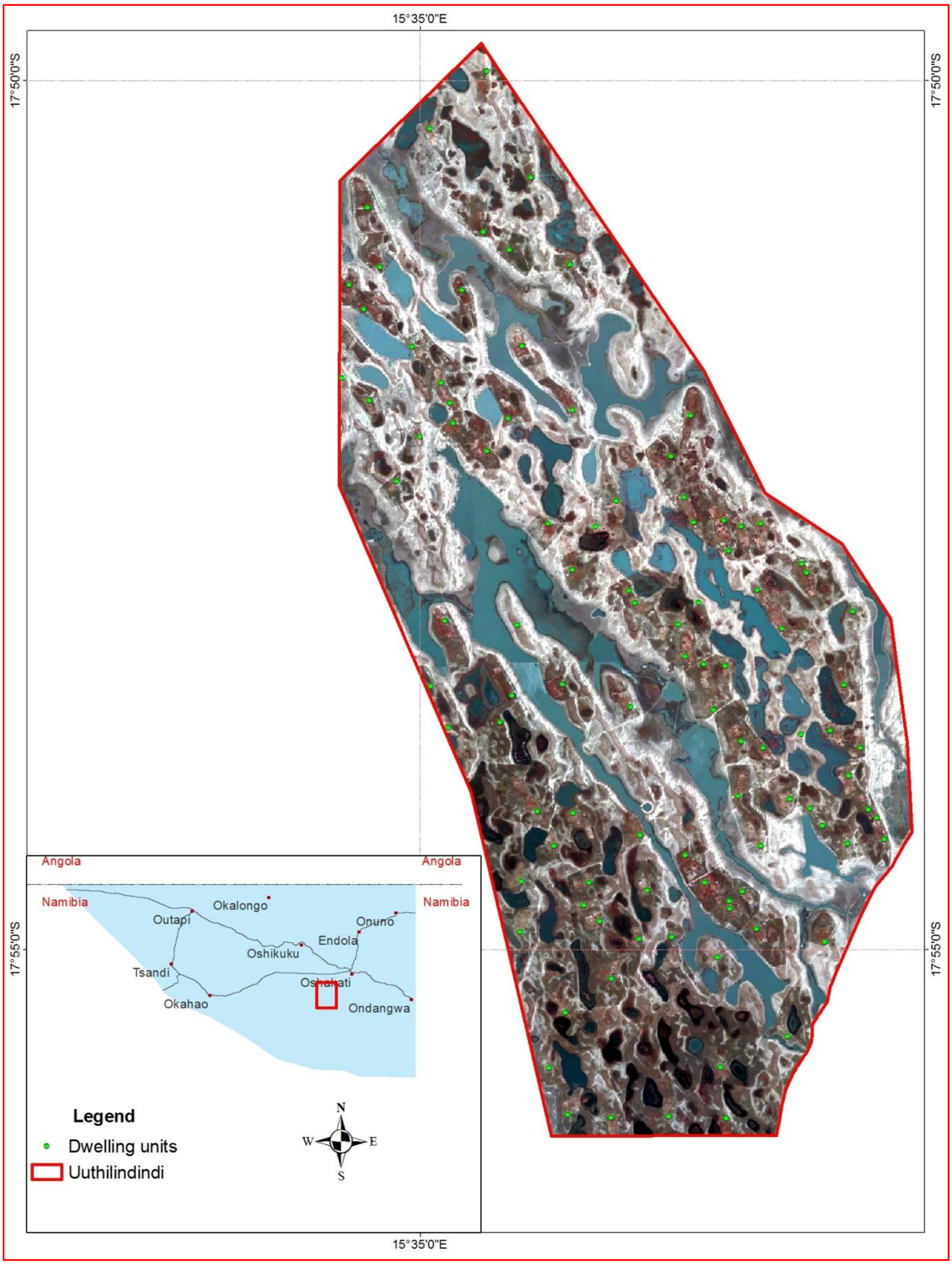


Figure 4. 8 Uuthilindindi pilot village

The pilot study was used to test the robustness of the data collection methods and instruments. These included determination of such factors as: the sampling transects and spatial extent thereof, timing of the data collection process with regards to accessibility of the sample areas, sample areas, target interviewees in the sample areas, adjustment of the interview questions, length of a specific interview session, cost analysis and budget issues, transportation and trip authority, and man power. The factors listed are described below in detail.

4.2.3 Determining the spatial extent of the sampling transects

According to FEMA (2014), the dynamics of riverine flooding vary with terrain. The elevation is not uniform over the Cuvelai. The downstream course, just like any other basin, has lower elevation than the upstream course which generally tends to be relatively steeper. In relatively flat floodplains, areas may remain inundated for longer durations (FEMA 2014). Between the upstream course and the downstream course of the Basin, lies a smooth transition commonly referred to as the midstream course. Though considering the Cuvelai Basin as a whole, its upstream course typically lies in Angola, while the downstream is situated in Namibia, with the midstream situated at the transition of the two hydrological courses. However, since the study only concentrates on Namibia, the three main hydrological courses were determined at such local scale. Transect One, Transect Two and Transect Three are thus envisaged to sufficiently represent the upstream, the midstream, and the downstream river courses of the Basin as the elevation drops in the north-south or upstream-downstream direction.

In addition to variation in elevation, is the variation in population distribution and density across the study site, which equally plays an important role in determining the sampling transects. Therefore taking three east-west transects straddling the basin is sufficient to take the varying population distribution as well as elevation and other topographic features into consideration. This gives any area falling within the transects equal chance of being included in the study. Expert knowledge on past floods in the area, from the Basin hydrologist and the researcher was also incorporated in making a final determination of the pilot area.

To determine the sample of the study area, three sampling transects were overlaid on the study site at equal intervals as shown in Figure 4.9. The greatest north-south extent of the study site is in its most eastern direction, and is roughly 96 km which is divided between three selected transects. This means that each of the three transects would cover 32 km in a north-south direction. The horizontal extent is limited to the boundaries of the study site in each transect in both west and east directions. The first centerline of the first transect (Transect 1), is located 16 km from the northern-most boundary of the study site (half of 32 km) and from Angola. The centerlines of all three transects were then placed 30 km from each other. The centerlines were transformed into 20 km wide polygons by buffering the centerlines by 10 km on each side. This means that the transects are each 20 km wide, and are roughly 8 km apart, with the first transect being roughly 4 km from the starting point and from Angola.

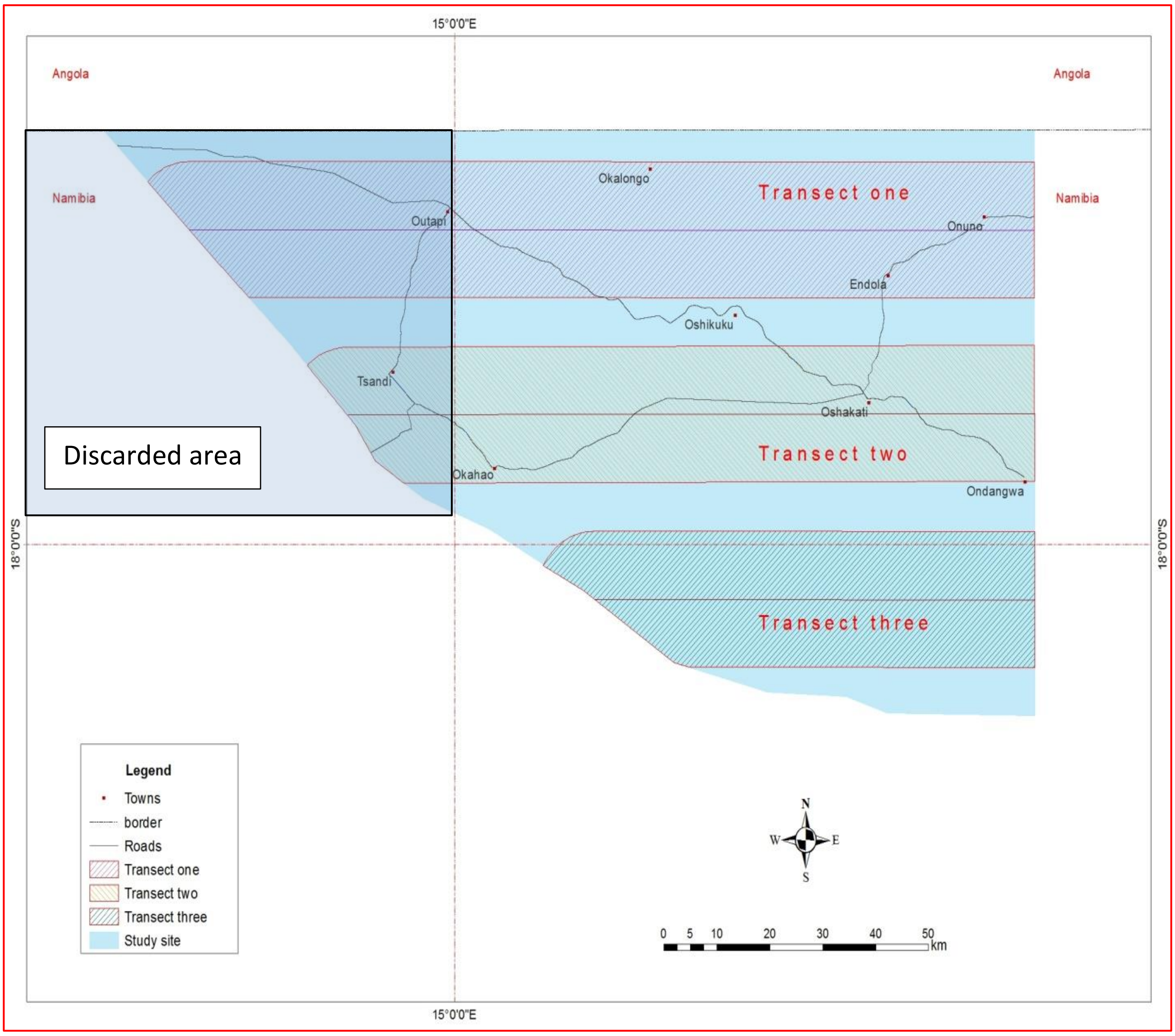


Figure 4. 9 Three sampling transects overlaid on the study area

The entire study site is then covered by the transects stretching in the east-west direction and sloping down the southern direction, giving all areas in the study site equal chances of being involved in the study.

4.2.4 Accessibility of the sample areas

As shown in Figure 4.9, Transect 3 is quite difficult to access based on the fact that there are no major roads in the area as compared to Transect 1 and Transect 2. However, tracks and other small roads are available across the study site. These tracks are in most cases only accessible during the dry season or when there is not much standing water. This validated the timing of the data collection process which ranged between the months of August to November when most areas were dry. In few parts however, especially those that are surrounded by big channels such as those in *Ombuga* area in Transect 3 and also Transect 2 were still difficult to access.

4.2.5 Determining the sample of the study

Selection of the sample was largely informed by the pilot study conducted a few months before the main study commenced. In order to determine the households and interviewees to be selected depended on the researcher's expert judgment and primarily on the advice from the local TAs on which would be most useful sample to answer the research questions. This sampling technique is referred to as 'purposive' sampling or 'judgment' sampling Tongco (2007).

By using spatial data obtained from the Namibia Statistics Agency (NSA), the researcher was informed that the study site contains approximately 1324 villages (Figure 4.10). With villages not accurately represented in the dataset for localities as it was observed on the ground, this figure is an underestimation, more so than an overestimation of the available localities in the study site. There are also observed villages that are not registered in the dataset. Of these 1324 localities, 476 fall in Transect 1, 387 in Transect 2, and 96 in Transect 3. This brings the population of the study site to 959 villages, a number which excludes a total of 365 villages within the entire study area from sampling. The number of villages in each transect gives an approximate indication of the size of the villages and the fields, varying across the north-south profile, with smaller villages in the north and larger in the south direction (also see Figure 4.11). Larger villages may be seen as an adaptation strategy to compensate for poor soil quality, soil fertility and thus reduced crop productivity in the grass dominated southern parts of the Basin.

Though the high number of localities/ villages per transect may translate into an increased number of households or population in such villages, the number of randomly selected villages should not be regarded as a pre-determinant of the number of households included in the study. This is due to the following factors which are the role of the TA and relief as well as soils of the area. Firstly, the study area is comprised of more than thirteen recognized TA structures that operate differently. It is thus important that TA advice is taken into consideration when selecting the sample households for the study. Secondly, the elevation is not uniform across the Basin, and low-lying households are more prone to floods than high-lying households across transects. In addition to elevation, some soil may be more susceptible to seepage impacts than those in other areas, and would need local guidance in determining which households become parts of the sample. Though the villages themselves were randomly selected, the households were selected with advice by the TA representatives. Some villages were fully flood prone, while others were primarily unaffected by floods. In other areas where certain characteristics and answers were considered to have reached a certain level of homogeneity, fewer households were picked and partially in accordance with TA representatives 'commands' and advice. TAs have the authority to grant or deny a researcher some access to their villages. This is especially true when certain preferred procedures are not followed. This sensitivity factor had to be taken into consideration when certain methods have to be opted for, as in Bernard (2002) and Lewis & Sheppard (2006).

It is therefore important that the impact of land allocation by the TAs at indigenous level as well as the local conditions in which the study was undertaken are taken into consideration when trying to comprehend the type of methods used for this study. It is thus important that the study is placed into the local context in which it was conducted, taking into consideration that TA structures and setup and geophysical characteristics may vary across the three transects.

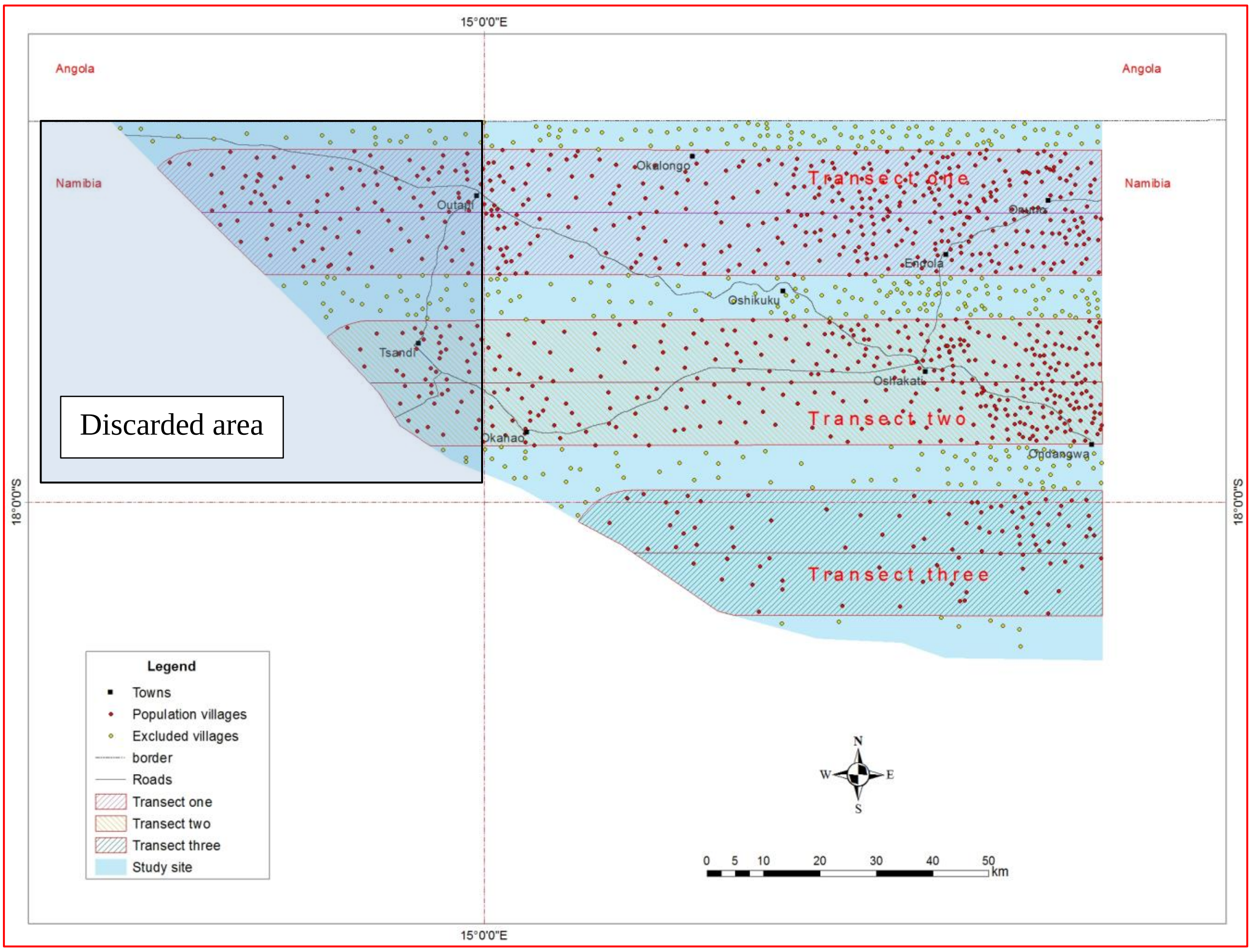


Figure 4. 10 Population villages from which sample villages were drawn

As shown in Figure 4.10, the villages that fall within the three transects are indicated in red points. Villages outside transects are indicated in green. From each of the three transects, 15 villages were selected. Considering the homogeneity of the responses by the interviewees and advice from the local TA mainly during the pilot study previewed in Section 4.2.2, a total of six to ten households were drawn from each of the 45 villages, giving a total of 314 households that were included in the study. It is on these 314 households that the interviews were conducted. Out of the 314 interviewed households, 75 per cent (n=237) were flood victims, 13 per cent (n=42) were community leaders or representatives of the TA, and 11 per cent (n=35) were non-affected residents households.

4.2.6 Spatial distribution of interviewed households in the study areas

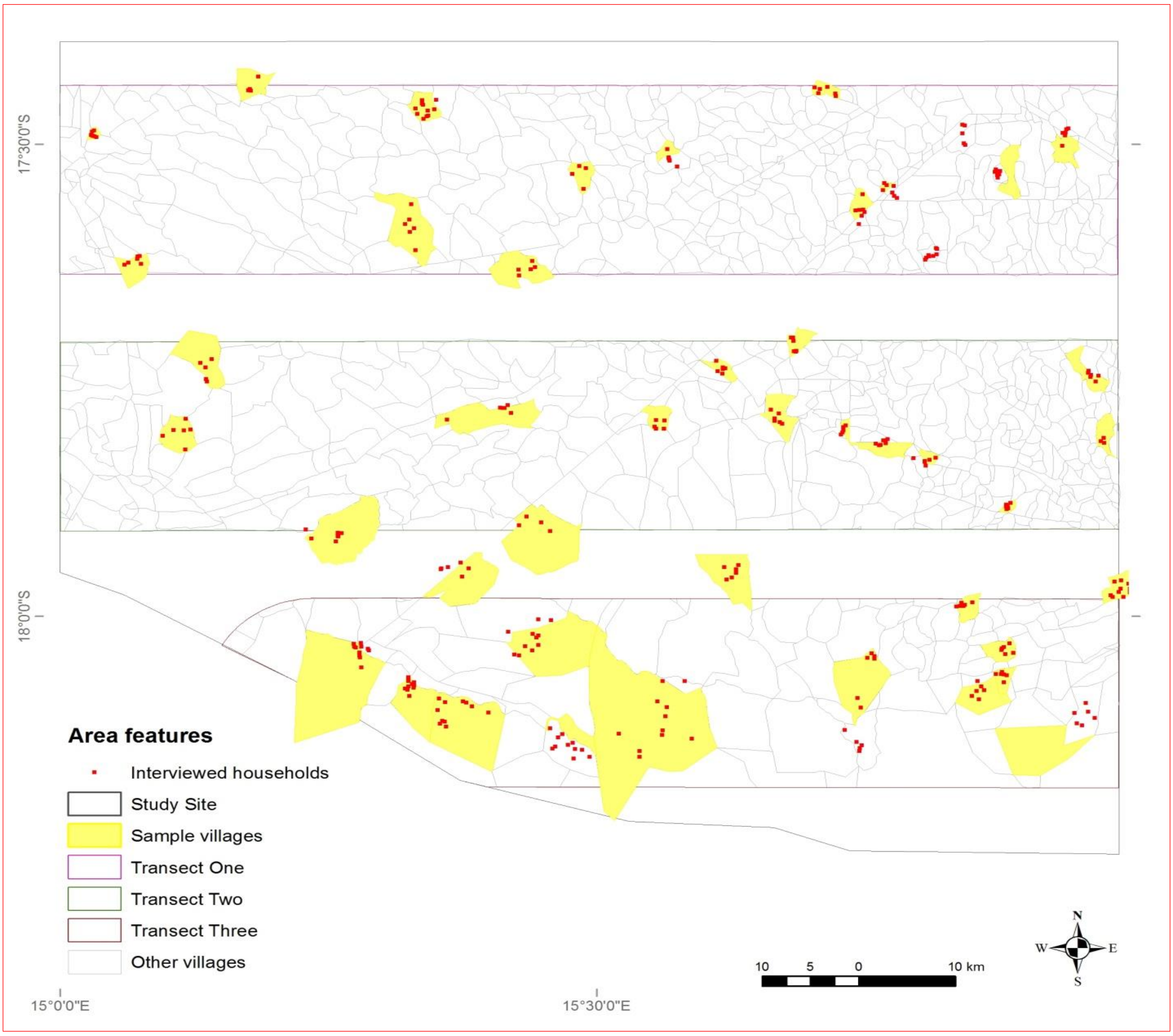


Figure 4. 11 Spatial distribution of interviewed households overlaid on the 45 sample villages

Most of the villages in the Cuvelai are surrounded by *iishana* which often serve as borders between the villages (See Section 1.2). Just like all natural phenomena, *iishana* are not straight line pre-defined boundaries. The linear sampling transects cut through many villages, especially at the transition between Transect 2 and Transect 3 in Figure 4.11 which have relatively large villages. Some of the sampling villages therefore seem to appear outside the sampling transects. The interviewees are spread across the entire village, regardless of whether the village is completely enclosed within a transect or not.

4.2.7 Type of enquiry

The study is both quantitative and qualitative in nature and employs a case study research approach for its investigations. The qualitative component includes interviews with non-affected local residents providing their views and opinions on the impact of flooding in their villages. The researcher interviewed the Headmen as responsible for land allocations, the non-affected local residents as well as the flood-affected residents that are directly affected by floods. For this reason, the interview schedule is comprised of three main sections: Part 1 (Appendix A.1) has questions intended for the village Headman, part 2 (Appendix A.2) has questions for non-affected local residents, not directly affected by flooding and part 3 (Appendix A.3) has questions for the flood-affected local residents.

The sets of questions provide qualitative information as well as quantitative data that is analysed statistically. The two types of data were mixed during the interviews and applied to the same people in each village. Responses to many of the questions posted are given scores, statistical codes or counts for quantitative analysis purposes.

Qualitative information also provides common-sense answers, which helps to interpret the significance and validity of the statistical information (Flyvbierg 2006; George & Bennett 2004). Furthermore, qualitative information betters the understanding of local dynamics among residents, feelings towards flood-affected residents and attitudes of traditional leaders during the data collection process and addresses several perceptions of flooding by local residents, in accordance with arguments by Stake (1978) and Yin (2003b).

The responses were processed using statistical packages such as Microsoft Excel, Statistical Package for Social Sciences (SPSS) and STATISTICA. While some responses were captured, coded and then quantitatively analyzed to derive quantitative results that are ultimately necessary to validate the arguments made qualitatively, some responses were expressed in a rather descriptive manner. Being a field research study, most of the findings predominantly draw from the analysis of primary data.

4.2.8 Data collection, capture, and manipulation

4.2.8.1 Data collection

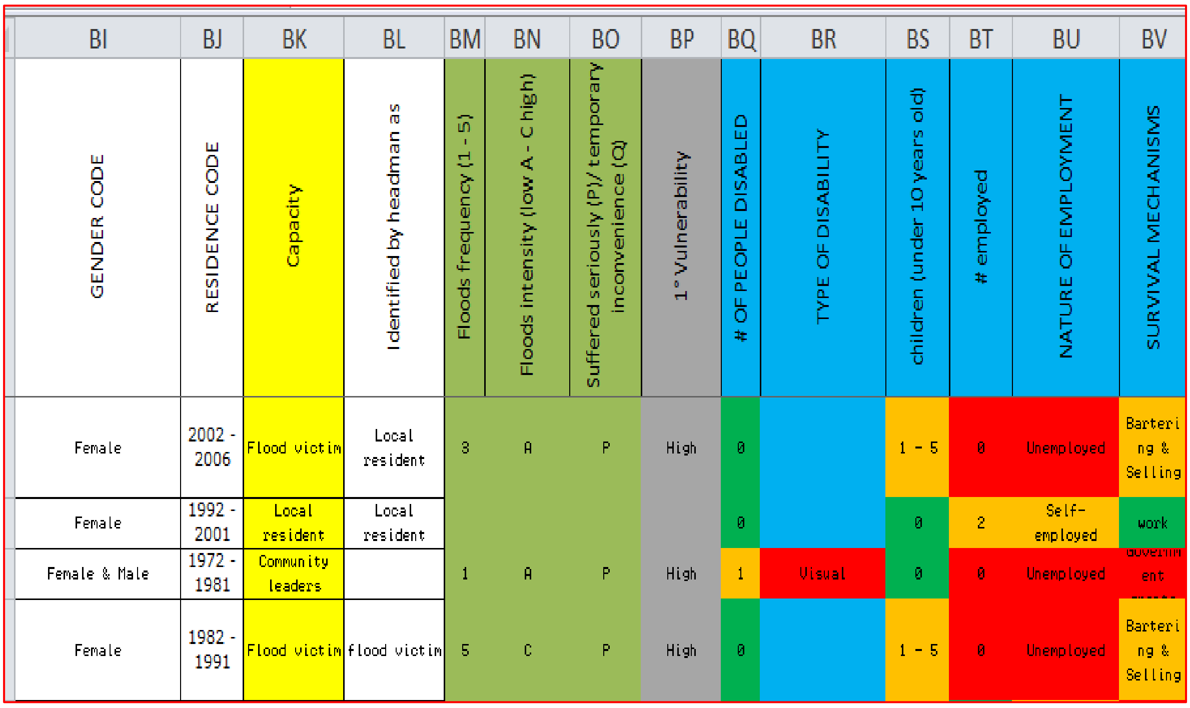
As maintained by Yin (2003b), using multiple sources of evidence during data collection, creation of a case study database, and the maintenance of a chain of evidence ensure validity and reliability and instills rigour in case study based methods. Stretching over a cumulative period of nearly four months (August, September, October, November 2012), the data collection process covered the 4O-Regions, namely: Oshana, Ohangwena, Omusati, and Oshikoto. The process entailed:

1. identifying the villages of concern;
2. locating the household of the village headman;
3. speaking with the village headman and build rapport to get consent to enter the villages for purposes of interviewing the local residents. The headman recommended a local field assistant to the researcher, mainly for direction and guidance. The headman also recommended the approach of to be followed that may be tailored to that specific village or area, including giving permission to interview certain households and not others in some cases;
4. interviewing the headman;
5. interviewing the villagers, including non-affected residents as well as flood-affected residents.

All interviewees provided informed consent to participate in the study in accordance with the headman of the village or area and the local TA. All interviews were anonymous and no sensitive information regarding the respondent was transcribed.

4.2.8.2 Data capture

Data capture involved recording all the information received from local residents (headmen, non-affected local residents and flood-affected residents) from questionnaires into Microsoft Excel format shown in Figure 4.12 for further manipulation. The capturing process occurred over seven months, from September 2012 until March 2013. The lengthy duration of data capture is attributed to the large amount of information that was collected in the field as well as the large sample size to properly represent the entire study site. All data had to be recoded to enable quantitative analysis of the information.

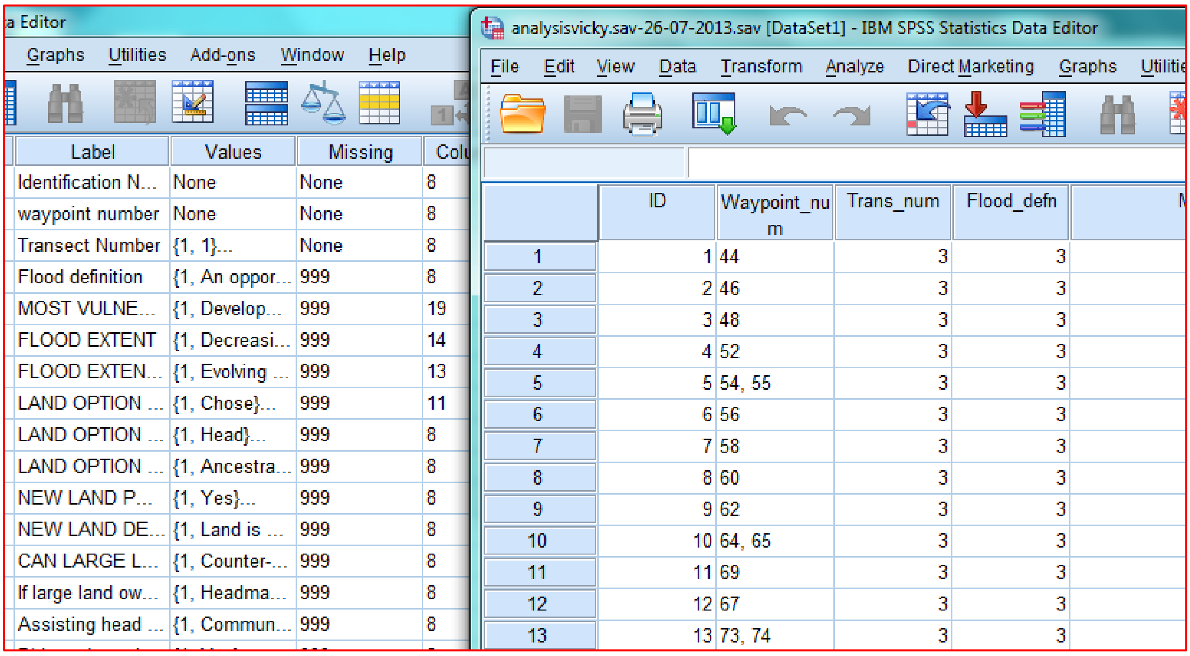


BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS	BT	BU	BV
GENDER CODE	RESIDENCE CODE	Capacity	Identified by headman as	Floods frequency (1 - 5)	Floods intensity (low A - C high)	Suffered seriously (P)/ temporary inconvenience (Q)	1° Vulnerability	# OF PEOPLE DISABLED	TYPE OF DISABILITY	children (under 10 years old)	# employed	NATURE OF EMPLOYMENT	SURVIVAL MECHANISMS
Female	2002 - 2006	Flood victim	Local resident	3	A	P	High	0		1 - 5	0	Unemployed	Bartering & Selling
Female	1992 - 2001	Local resident	Local resident					0		0	2	Self-employed	work
Female & Male	1972 - 1981	Community leaders		1	A	P	High	1	Visual	0	0	Unemployed	Governm ent
Female	1982 - 1991	Flood victim	flood victim	5	C	P	High	0		1 - 5	0	Unemployed	Bartering & Selling

Figure 4. 12 A screenshot example of the data capture and coding process in Microsoft Excel

4.2.8.3 Data manipulation and analysis

Data entered into Microsoft Excel (Figure 4.12) for coding was then transferred to SPSS, shown in Figure 4.13, for further coding and univariate statistical analysis. An example of coding is illustrated using Figure 4.13, where a certain flood definition category is allocated a certain number, in this case a 3.



Label	Values	Missing	Colu
Identification N...	None	None	8
waypoint number	None	None	8
Transect Number	{1, 1}...	None	8
Flood definition	{1, An oppor...	999	8
MOST VULNE...	{1, Develop...	999	19
FLOOD EXTENT	{1, Decreasi...	999	14
FLOOD EXTEN...	{1, Evolving ...	999	13
LAND OPTION ...	{1, Chose}...	999	11
LAND OPTION ...	{1, Head}...	999	8
LAND OPTION ...	{1, Ancestra...	999	8
NEW LAND P...	{1, Yes}...	999	8
NEW LAND DE...	{1, Land is ...	999	8
CAN LARGE L...	{1, Counter-...	999	8
If large land ow...	{1, Headma...	999	8
Assisting head ...	{1, Commun...	999	8

	ID	Waypoint_num	Trans_num	Flood_defn
1	1	44	3	3
2	2	46	3	3
3	3	48	3	3
4	4	52	3	3
5	5	54, 55	3	3
6	6	56	3	3
7	7	58	3	3
8	8	60	3	3
9	9	62	3	3
10	10	64, 65	3	3
11	11	69	3	3
12	12	67	3	3
13	13	73, 74	3	3

Figure 4. 13 An example of the data capture and manipulation in SPSS in variable view on the left, and data view (coded) on the right window.

Further analysis was also done by using STATISTICA as shown in Figure 4.14. The results are described in Chapter 7 and Chapter 8.

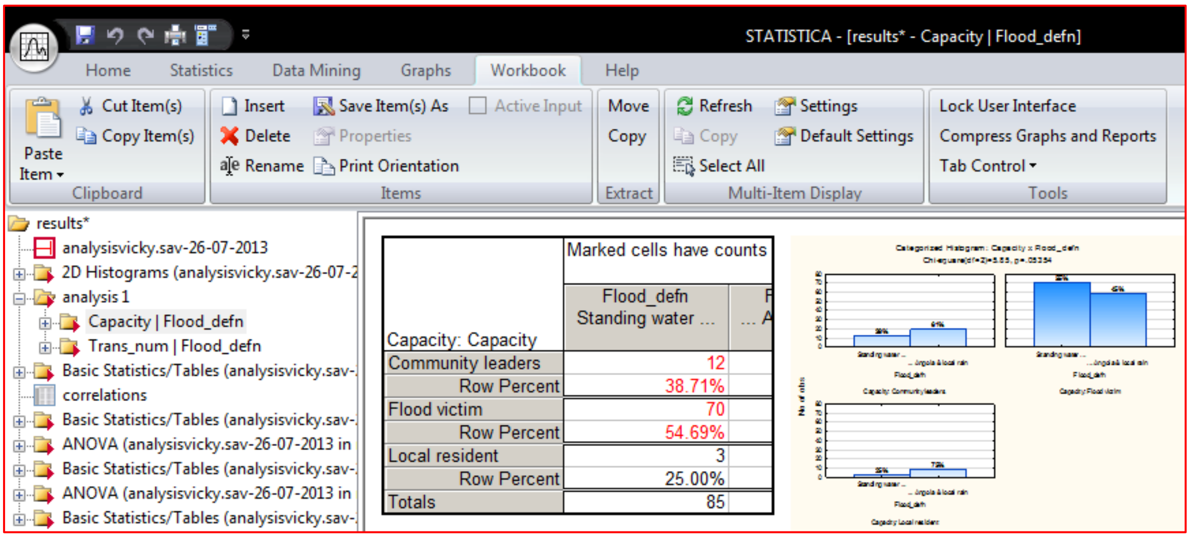


Figure 4. 14 An example of the data manipulation in STATISTICA

Geographic analyses such as spatial statistics were used to determine hot spots in ArcMap (Figure 4.15). Spatial statistical analysis proved unsuccessful at Basin level as the data is clustered at village level yet random at Basin level.

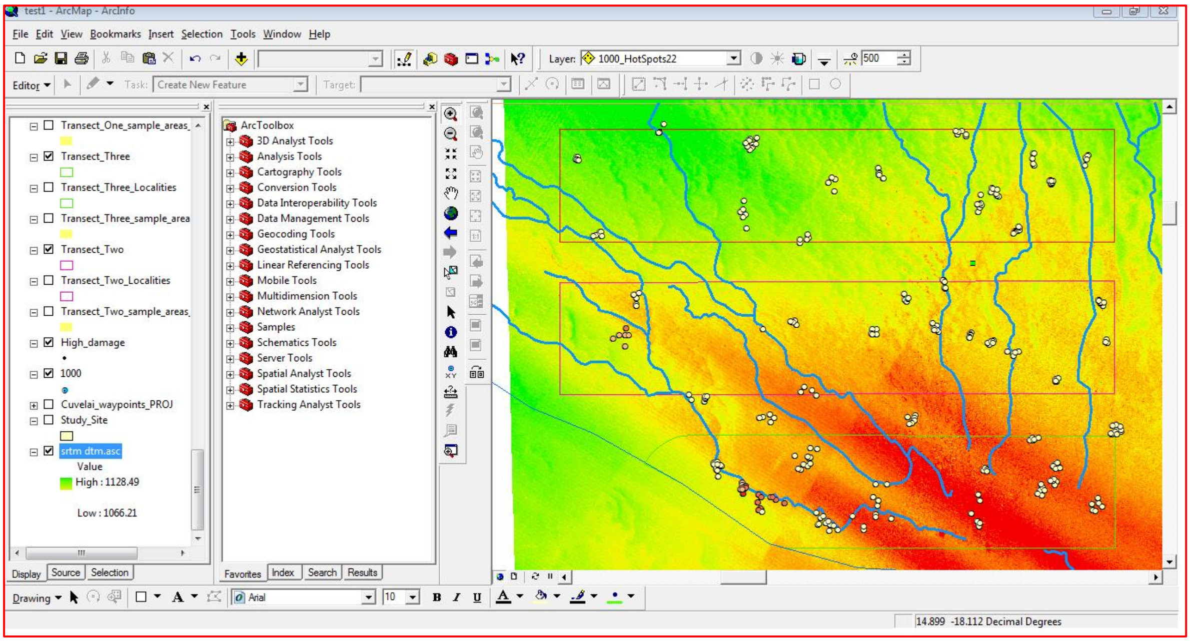


Figure 4. 15 An example of the geographic data manipulation in ArcMap, here showing unrealistic HotSpots representation for flood-affected residents.

Broadly speaking, there is a significant and roughly similar risk of inundation across that whole study area because of the hundreds of channels that flow across the area. Although each village is unique with distinctive composition and structure, questionnaires were focused on flood-affected residents, therefore already clustered at village level. This made the HotSpot and other spatial statistics non-beneficial for purposes of this study.

4.2.9 Determining vulnerability indicators/ factors

In order to clearly define flood-affected residents and the extent to which they have been affected, three categories of assessing vulnerability as justified in Chapter 2 were developed. These include geographic vulnerability largely comprising of exposure, socio-economic vulnerability which is at the resistance and resilience nexus (Ciurean et al. 2013; Saldaña-Zorrilla 2007; Cutter et al. 2000; Le Roux & van Huyssteen 2010), and physical/ structural/technical vulnerability which is evidence of the impact or actual damage as observed or narrated by the interviewees (Ciurean et al. 2013; Kappes et al. 2012; Papathoma-köhle et al. 2011; Appel et al. 2004). Used interchangeably in this thesis, the three vulnerability assessment categories are also respectively loosely referred herein as primary (1°) vulnerability, secondary (2°) vulnerability, and tertiary (3°) vulnerability elsewhere especially in the case study databases in Figure 4.12 and Figure 4.13. These classes were used in the re-coding of the captured data and used extensively in the quantitative analysis of the results. A colour coding scheme was used to depict the degree or level of vulnerability: red for high, yellow for medium and green for low vulnerability in each of the specific categories. For each category of vulnerability a table matrix was developed and used to re-code the data collected via interviews.

4.2.9.1 Geographic vulnerability (exposure)

Geographic vulnerability assesses vulnerability influenced by geography or locational factors. Three determining factors were taken into account in order to develop the table matrix shown in Table 4.1, on which classification of different degree levels (*high*, *medium*, *low*) of geographic vulnerability was built. Due to associated short memory of flood disasters, the flood frequency factor was applied to the matrix in a lenient manner. It should however be taken into consideration that this matrix has been formulated specifically for this study, and note should be taken when interpreting results of a similar nature that have employed different vulnerability rating methodologies.

Table 4. 1 Geographic vulnerability score

Flood intensity	Flood frequency 1	2	3	4	5	Level of Inconveniance
A	AP	AP	AP	AP	AP	**P**
B	BP	BP	BP	BP	BP	**P**
C	CP	CP	CP	CP	CP	**P**
A	AQ	AQ	AQ	AQ	AQ	**Q**
B	BQ	BQ	BQ	BQ	BQ	**Q**
C	CQ	CQ	CQ	CQ	CQ	**Q**

Degree level of vulnerability	
(red)	High
(orange)	Medium
(green)	Low

Three determining factors					
Flood frequency (years flooded)	**1**	**2**	**3**	**4**	**5**
Flood intensity	**A** Low	**B** Medium	**C** High		
Level of inconvenience	**Q** Temporary inconvenience	**P** Permanent inconvenience			

Degree of factor influence: *low - high* →

Despite the fact that this household location factor was welcomed by communities, in some cases, villagers felt that an additional level should have been added to address those residing at the village peripheries, which in their estimation suffer more floods than those in the centre.

4.2.9.2 Socio-economic vulnerability (resistance and adaptive capacity/ resilience)

Secondary (2°) vulnerability at household level is based on 17 socio-economic factors that include variables such as income, number of people with disabilities, number of inhabitants, number of elderly and Orphans and Vulnerable Children (OVCs) gathered from primary data. Depending on their degree of influence within this particular community based on the researcher's expert knowledge based on indigenous knowledge, the socio-economic factors described in Table 4.2 were ranked in three sub-classes of *high*, *low*, and *medium*, and were used to assess socio-economic vulnerability of each household, as outlined in Section 2.2.3. The sub-class with the highest cumulative ranking is prioritized and is taken as the final score for a particular variable and subsequently for the overall socio-economic vulnerability.

Table 4. 2 Indicators for assessing socio-economic vulnerability

Variable	Description 1	Description 2	Description 3	Description 4	Description 5	Description 6
# of people disabled	0	1	2	3		
Type of disability	Hearing	Mental	Physical	Speech	Visual	Multi
Children (under 10 years)	0	1-5	6-10	11 (and above)		
Employed	0	1	2	3	4	5 (and above)
Nature of employment	Casual labour	Self- employed	Professional	Mixture	Unspecified	Unemployed
Survival mechanisms	Bartering & selling	Mixture	Work	Work & government grants	Government grants	No income
# of pension	0	1	2 (and above)			
OVC spport	0	1	2	3 (and above)		
# of learners	0	1	2	3	4 (and above)	
Elderly	0	1	2	3 (and above)		
Orphans	0	1	2	3	4	5 (and above)
San	0	1	2	3		
Single headed households	yes	No				
Widow(er)	Widow	Widower				
In urban areas	0	1-2	3-4	5-6	7-8	9 (and above)
Inhabitants at home	1-5	6-10	11-15	16-20	21 (and above)	
Total household inhabitants	1-5	5-10	11-15	16-20	21 (and above)	

(red)	High
(orange)	Medium
(green)	Low

For example using Table 4.2, a household with 0 disabled people, 1 – 5 children under 10 years, 3 self- employed persons, 0 pensioners, 2 OVCs support grants, surviving on capital/ work, 0 elderly, 0 learners, 0 orphans, and 0 San, gets a score of 8 *lows*, 2 *mediums*, and 1 *high*. That household will be allocated a low vulnerability score. Where two sub-classes have an equal count, a medium class is allocated.

4.2.9.3 Physical/ structural (technical) vulnerability (Impact of actual flood damage)

This is a measure of severity of damage or level thereof, physical evidence of flood damage, or impact as a consequence of floods (Kappes et al. 2012). The method used to determine the stage of vulnerability is similar to the one described for all indicator based vulnerability assessments above as supported by De Vaus (2002) and Kim & Mueller (1978). The sub-class (*high*, *medium*, *low*) with the highest ranking retains the vulnerability score for a particular household (Papathoma-köhle et al. 2011)). Using the physical vulnerability indicator approach described in Kappes et al. (2012), all variables gathered from the field survey, observations and interviews are taken into consideration for each household and for purposes of consistency and comparison, as shown in Table 4.3.

Table 4. 3 Indicators for assessing the impact to floods

Variable	Description 1	Description 2	Description 3	Description 4	Description 5	Description 6	Description 7	Description 8	Description 9	Description 10
House damage?	no	yes								
Damages	No damage	Standing water (damaged items)	Cement walls dismantled	1 hut destroyed	Unspecified	*Mahangu* storage destroyed	Natural material huts dismantled	Dismantled house		
Recovery cost (N$)	Not replaced	Own labour	Unpaid labour	Less than 1000	1001 - 2000	2001 - 3000	3001 - 4000	13000 - 14000	14001 - 15000	Paid labour (unspecified)
Crops damage?	no	yes	no harvest							
Cash crops/ personal use?	personal use, cash crops	personal use	no harvest							
Income loss (%)	71	96	100							
Reduction in crop productivity (%)	20	25	100	-1 - 20	-21 - 40	-41 - 60	-61 - 80	-81 - 100		
Livestock affected?	no	yes	no livestock							
Reduction in livestock (goats and sheep) %	0	1 - 20	21 - 40	61 - 80	81 - 100	undisclosed				

	High
	Medium
	Low

The method used in this paper to assess technical vulnerability is fully documented in the literature. As is Table 4.3, two main strategies of assessing physical vulnerability discussed by Ciurean et al. (2013) are employed. The first strategy focuses on the economic damage and is essentially a quantification of the expected or actual damages to a structure expressed in monetary terms or through an evaluation of the percentage of the expected loss. To derive the factors such as income loss, reduction in crop and livestock productivity in the absence of real figures and based on questionnaire responses, the formula listed below in Equation 1, Equation 2 and Equation 3 respectively have been used. The equations derived are unique to this paper tailored to fit local conditions.

$$\textbf{Income loss } (\%) = \textit{mahangu} \text{ barrels sold pre floods} - \textit{mahangu} \text{ barrels sold during flood years}$$

Equation 1

*average cost of Pearl Millet (*mahangu*) per 1 barrel equivalent to 20 litres = N$70.00

$$\textbf{Reduction in crop productivity}\ (\%) = \text{amount of } \mathit{mahangu} \text{ harvested pre floods} - \text{amount of } \mathit{mahangu} \text{ harvested during flood years}$$

Equation 2

*average cost of Pearl Millet (*mahangu*) per 1 barrel equivalent to 20 litres = N$70.00

$$\textbf{Reduction in livestock}\ (\textbf{goats and sheep})\% = \text{number of livestock pre floods} - \text{number of livestockduring or post floods}$$

Equation 3

*number of livestock during or post floods (livestock deaths)

For example using Table 3.3, a household that was damaged by floods at some point, completely dismantled and cost N$15 000.00 to rebuild, experienced crop damage, harvest crops for personal use only, experienced a 50% reduction in crop productivity, and no livestock, gets rankings of 1 *medium* and 6 *highs* and will be associated with a *high* flood impact.

4.2.10 Research design

The study is based largely on interviews with residents to gain their views and opinions on flooding and impacts of flooding. Fieldwork is the main component and starting point of the study, therefore it allowed for the collection of both spatial and non-spatial data. The spatial data together with other ancillary data for geographic analysis was captured into GIS using ArcGIS.

The qualitative data are coded for purposes of analysis in SPSS. To help assess the impact of geographical location of households to flooding, Landsat images were used for the classification of water bodies in the area. Processing and classification of the images was done in ENVI. Water bodies were analysed together with a 50m DEM for vulnerability analysis. The steps and processes followed to complete this research are graphically outlined in Figure 4.16.

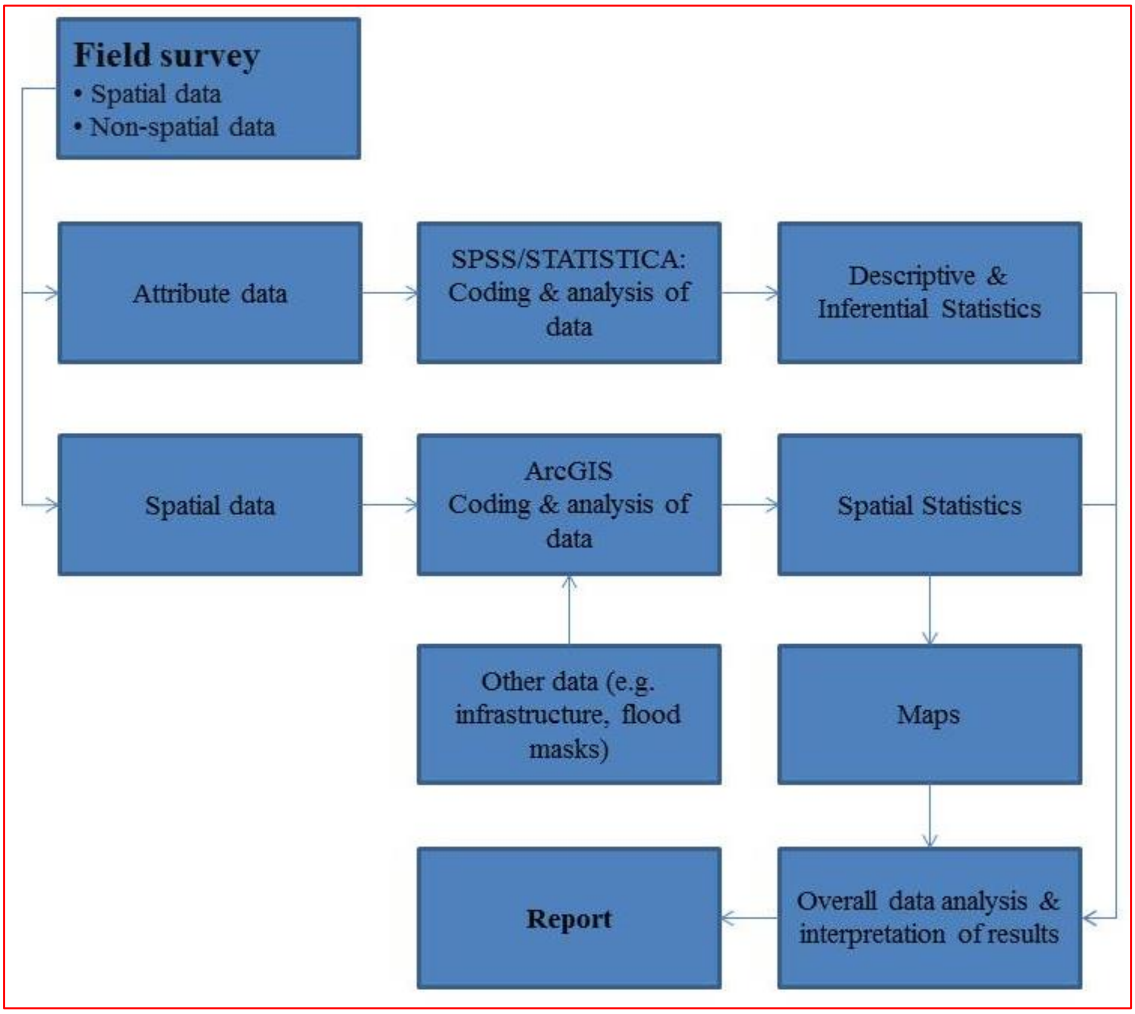


Figure 4. 16 Research design

CHAPTER 5: FLOOD IMPACT AND VULNERABILITY OF THE CUVELAI BASIN

In this chapter the results of the data with regards to the flood impact and flood vulnerability of the Cuvelai Basin as collected in Chapter 4 are presented. The data were collected and then processed in response to the problems raised in Chapter 1. Four fundamental objectives drove the collection of the data and the subsequent data analysis. Those objectives were to assess the impacts of flooding in the study area, to assess whether headmen and village residents can use flood risk maps to plan ways of reducing flood vulnerability, to assess the geographical or physical circumstances that place residents at risk and to assess socio-economic conditions that lead to vulnerability, and recommend alternative practical adaptive strategies to flooding in consultation with local village headmen and residents. The findings presented in this chapter demonstrate that these objectives were accomplished.

For this case study qualitative data was collected using questionnaires for in-depth interviews and focus group discussions as described in Section 3.9. The qualitative data was recoded and some of it coded as stated in Section 4.2.8, to enable statistical analysis of the results. The results from the analysis of the qualitative and quantitative data are provided in this chapter and later in Chapter 6. Qualitative responses are in turn partly used to substantiate the quantitative results. The chapter starts with a description of the households interviewed, then addresses the assessment of the usage of village tailored flood vulnerability maps by rural communities to help plan ways of reducing flood vulnerability (objective three). The bulk of the chapter covers the understanding of flood concept by rural communities, as well as several positive and negative consequences of flooding in the Basin. This addresses objectives one and two by evaluating the geographic and socio-economic vulnerabilities of respondents. Various flood adaptation strategies between ‘long past’ floods and ‘recent past’ floods are discussed in Chapter 6 highlighting the communities’ response to floods. The chapter also makes recommendations to counteract the consequences of flooding at household level.

5.1 INTERVIEWEES

The interview process started off with having to travel to the sample villages and identify the residence of the village headmen. A consultation with the headmen was held and the purpose of the visit outlined. After having an understanding of the project, the headmen gave consent to give an account of their villages with regards to flood disasters, how they cope with floods, and how the villages’ residents are impacted upon. The worst and least affected residents’ households were identified by the headmen from the village maps and their vulnerability status classified from least to worst affected as supported by purposive sampling methods (Lopez *et al*. 1997; Seidler 1974; Smith 1983 and Zelditch 1962. For purposes of better navigation and to ensure trust in the researcher by local residents, the village headmen allocated an assistant to the research team. To make the residents more at ease and to gain the interviewer's trust, it becomes the village assistants' duty to introduce the research team to the interviewees and ensure the interviewees that permission was granted from village leadership for studies to be carried out in the village.

The village assistants vary from villages. In some cases assistants were members of the village committee, in some cases residents of the headmen's homes, while in many cases the headmen had to personally join the research team for all activities in the village until the interviews were completed. The magnitude and kind of assistance that the local residents were willing to offer was immense, especially with very limited or sometimes no compensation.

Local residents' perceptions towards government greatly and randomly varied from place to place. Two types of attitudes were identified: the first group contained poor and quite pessimistic residents that had generally lost faith and trust in government and would vent their frustrations first before agreeing to commence with the interview process. In general however, the interviewees and local residents offered their cooperation and assistance to the data collection process, with only one rejected interview of a Transect 2 resident who did not want to be interviewed due to alleged lack of trust in government. The second attitude group was more optimistic in nature, and residents were willing to easily cooperate with or without any immediate benefits from the government.

After completing interviews for Transect 3, and other areas in Transect 1, it was noted that the responses from the residents were becoming overly homogenous. Due to increasing sample homogeneity and community leaders advice, the total number of households visited was reduced to 314 from 495. As can be seen in Figure 5.1, the distribution of respondents per transect were approximately equal with Transect 1 housing 32% of the respondents (99), while Transect 2 and 3 contributed 27% (86) and 41% (129) respectively. Transect 3 had the most respondents. The interview process started with Transect 3, then Transect 1, before finally moving to Transect 2. As the data collection proceeded in each transect, the sample homogeneity increased, explaining the gradual decrease in sample size over time and space.

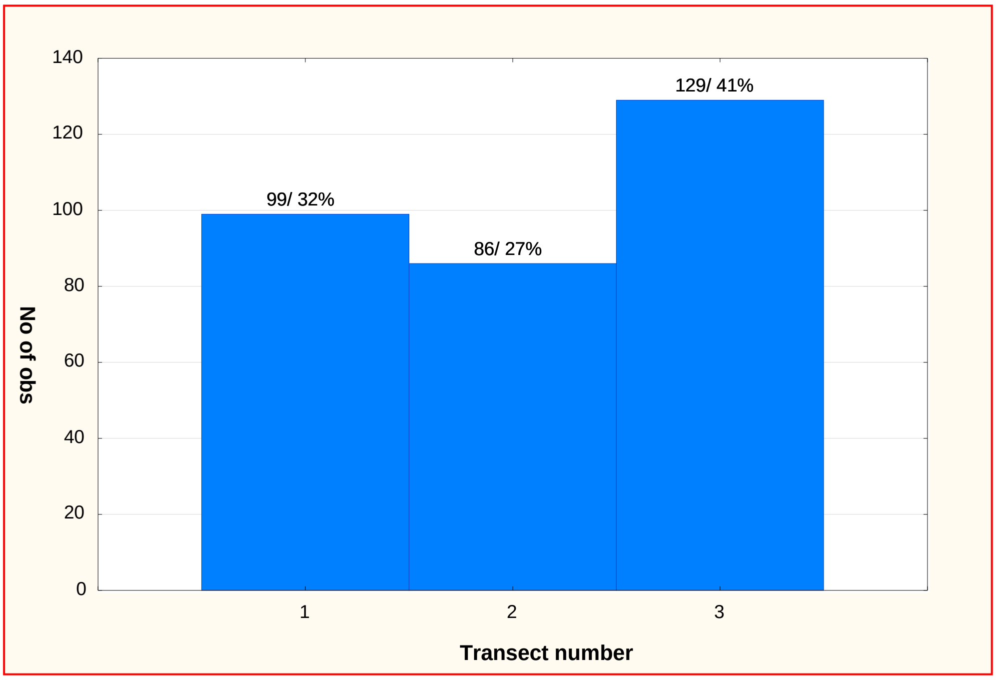


Figure 5. 1 Number and percentage of respondents (n=314)

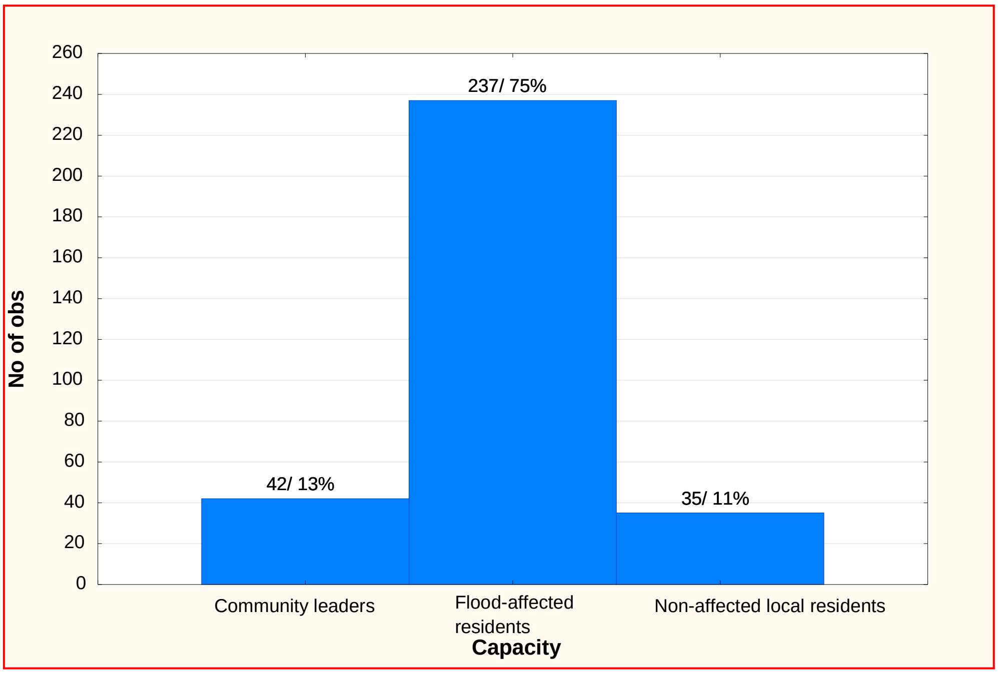


Figure 5. 2 Community respondents in capacity in which they were interviewed

The majority of the selected respondents interviewed, fell in the category of 'flood-affected residents' that were adversely affected by flooding in the past (237 out of 314). This observed homogeneity of the dataset which is expressed earlier in Section 4.2.5 is shown in Figure 5.2 with flood-affected residents making up 76% (n = 237) of the total respondents (n = 314), while community leaders (n = 42) and non-affected local residents (n = 11) make up a cumulative 24%.

5.2 VULNERABILITY MAPS

One of the objectives of this study was to assess whether headmen and village residents can use flood risk maps to plan ways to reduce flood vulnerability. More than 80% of the respondents were able to interpret tailor-made village maps and found the maps useful when provided.

The process of map interpretation started off with confusion as people felt intimidated to look at the map, but after a while features became clearer increasing their confidence and ability to interpret the maps. Assessing the map interpretation skills of local communities employed a very basic criterion. The ranking was based on the number of features the residents were able to identify on the maps with or without any assistance from the interviewer. A reasonable number (n=94) of interviewed community residents that could respond to this particular question (n=215) could fairly (good or very good) interpret maps (Figure 5.3). Those residents that were able to identify their surroundings and homes with little assistance were rated 'good' while 'average' rated respondents could identify general features but not specific to their surroundings and were thus unable to orientate themselves on the map even with additional assistance.

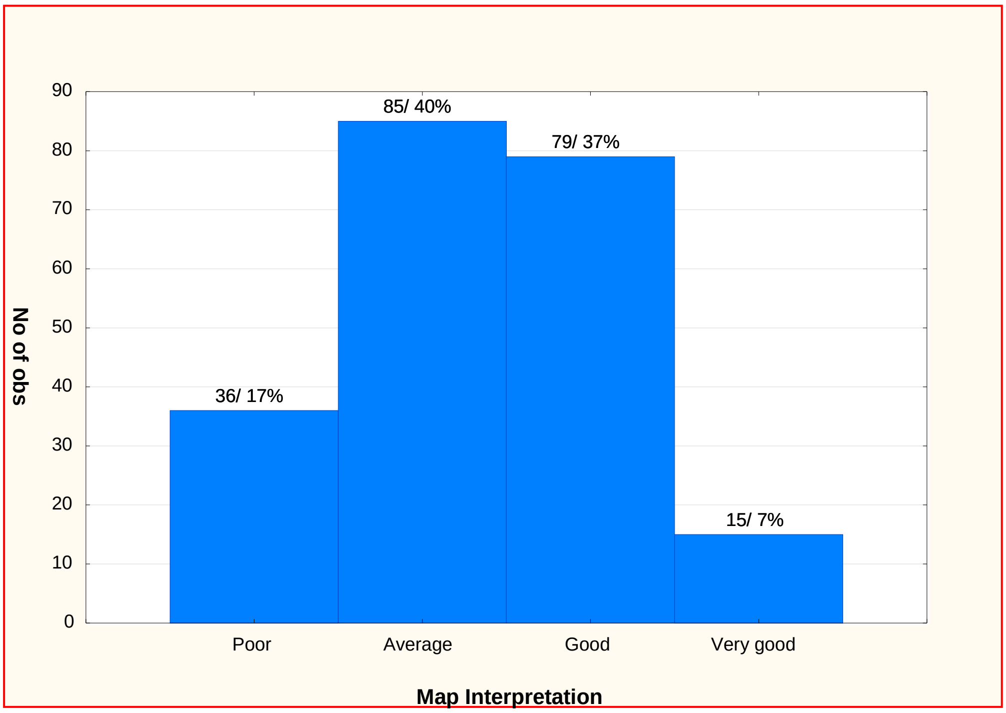


Figure 5. 3 Interpretation of vulnerability maps by local residents

Residents that could not identify features on the maps even with additional assistance (n=36) were rated as 'poor' (17%) in map interpretation. Respondents (=15) in the 'very good (7%)' category were able to identity features as they appeared on the maps right away with no additional assistance. This relatively small percentage were respondents that had been exposed to or directly worked with maps before, e.g. soldiers, students, teachers, and community leaders, which does not make up a large component of rural communities.

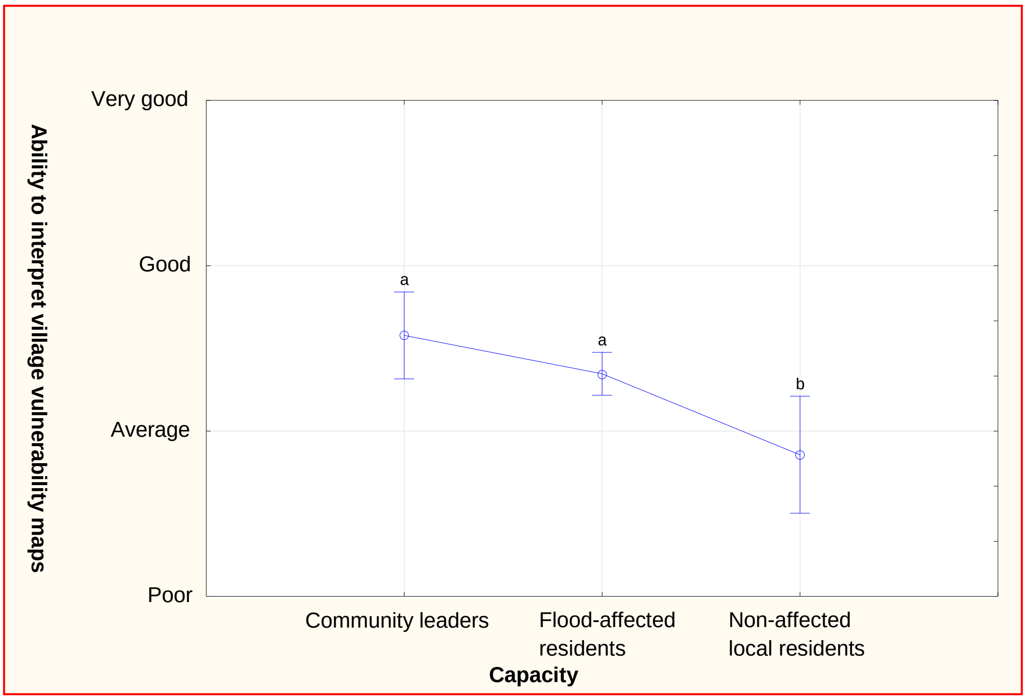


Figure 5. 4 Positive relationship between map interpretation ability and different resident capacities

The ‘good’ to ‘average’ categories (a cumulative of 76%) of residents had knowledge and interpretation of maps by community respondents as shown in Figure 5.4 (Current effect: F(2, 212)=5.2367, p=<0.01 Kruskal-Wallis p<0.01, Effective hypothesis decomposition, Vertical bars denote 0.95 confidence intervals). Figure 5.5 shows villagers trying to locate their household on the map.

Figure 5. 5 Maps attract a lot of interest and attention in local residents

5.3 UNDERSTANDING THE FLOOD CONCEPT

The definition and understanding of flood events by local communities is heavily dictated by residents' experiences and the direct impact flood waters have had on the residents and property. Forty nine percent of the interviewed residents have defined flood as either 'standing water in houses or fields' posing a direct impact on agricultural production and human activities (Figure 5.6). An equal number of community members understand floods as a combination of flood waters coming from the highlands of Angola in combination with local rainfall. Though a small percentage, 2% of the entire population that gave their views on this question (n=174) relates to flood events as an opportunity to get more food either for livestock and human consumption. The advantages associated with flooding at the community level are discussed in Section 5.3.1.

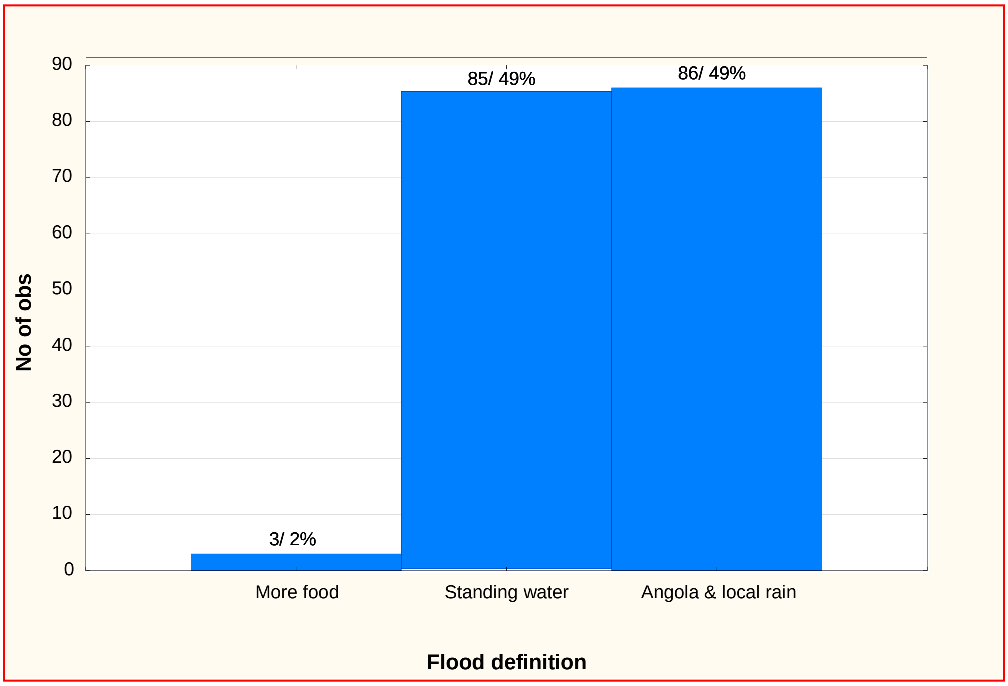


Figure 5. 6 The main definitions and characterizations of flooding used by local respondents

A breakdown of how the different respondents (community leaders, flood-affected residents and non-affected local residents) characterize flooding is given in Figure 5.7. Many of the community leaders (61%) indicated in Figure 5.7 associate local floods as generated elsewhere up in the catchment in Angola while flood-affected residents (55%) are more likely to see floods as standing water associated with direct damages and losses to property. This is understandable seen from the perspective that flood-affected residents mostly experience the impact of flooding at first hand, and the negative consequences thereof. There is thus a strong relationship (Chi-square (df=2) =5.85, p=.05354) between the type of local residents in the village and how they perceive floods.

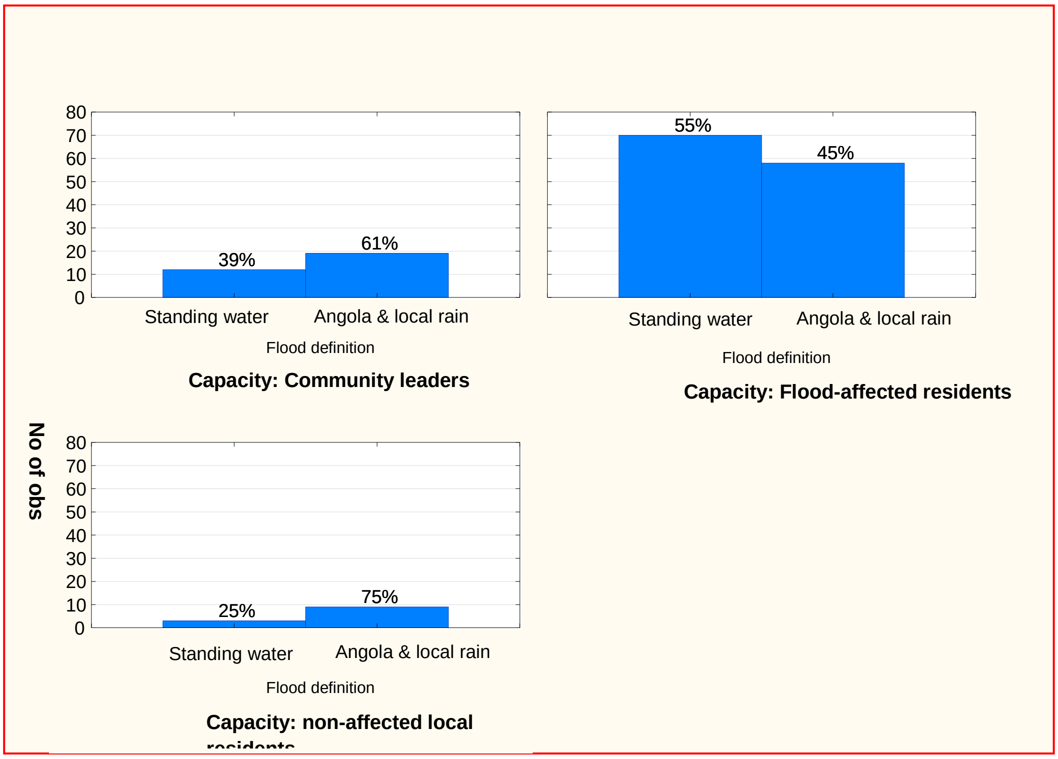


Figure 5. 7 Observed frequencies of how different members of community perceive floods

In addition to indicating the residents' understanding of flood and though statistically insignificant (Chi-square (df=4)=80.98, p=.0000), definitions provided by local residents also indicate a step in the process and flow of flood waters as they progress from upstream to downstream (Figure 5.8). Almost 90% of the residents in Transect 2 perceive floods as 'standing water'.

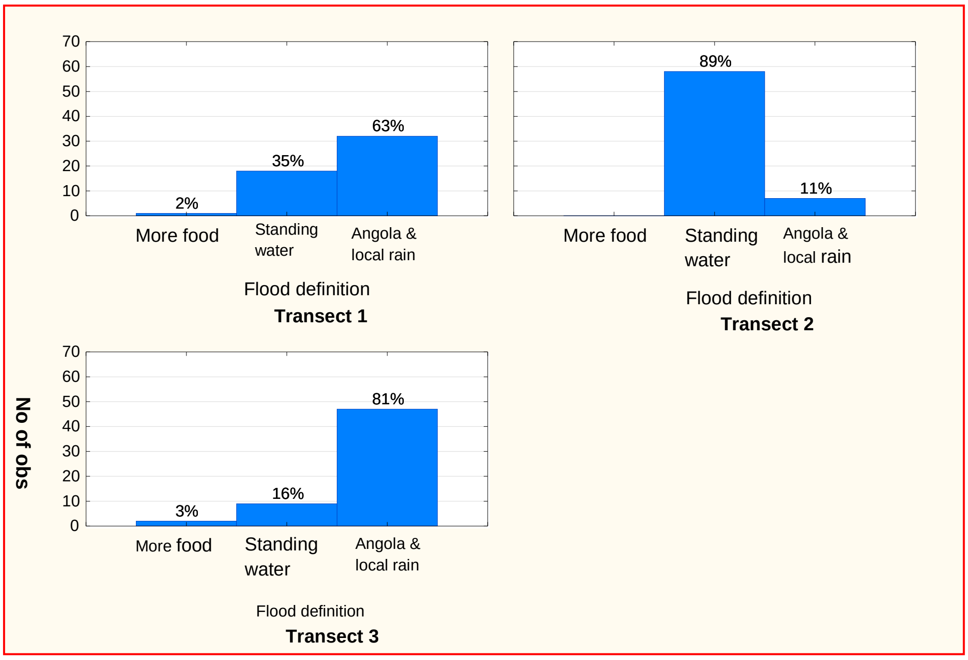


Figure 5. 8 Observed frequencies of flood characterization per transect

5.4 THE IMPACT OF FLOODING ON RURAL LIVELIHOODS OF THE CUVELAI

5.4.1 Cuvelai livelihoods are flood cycle-dependent

Survey results indicate that there are a great number of people that prefer floods since there are long term benefits associated with flood conditions. Scaled down, this is most especially true in very dry areas with low rainfall. Respondents from Transect 3 associated flood waters by definition with increased food production (Figure 5.8). In years with normal rainfall and greatly reduced stream density and as according to local residents, such areas can go for long periods of time without water. The dry situation is reportedly worsened when there is no influx of waters from elsewhere to fill the normal water channels that have to reach crop fields or to recharge temporary water ponds. Flood disasters are regarded as 'a temporary inconvenience' in this area. Though floods may cause many inconveniences, the local communities have reported that they consider that long term benefits of flooding outweigh the short term inconvenience of flooding. Some of the benefits of floods include increased harvest and livestock productivity for drier places, recharge of sub-surface water reserves and aquifers, as well as increased fishing activities and income.

5.4.1.1 Increased agricultural productivity

Even though more than 90% of the respondents have experienced some level of crop damage since the onset of flood events (indicated in Figure 5.9), there are households (5% of respondents) in some areas of Transect 3 that have recorded an increase in crop productivity (Figure 5.10). In drier parts of the Basin especially where waters wouldn't reach under normal circumstances, floods are reportedly preferred over 'no flood situations', and any long period standing source of surface water, often rare, is considered a valuable asset to the livelihoods of the people residing there. Residents also reported that only when floods are big enough to reach areas at the lower extents of the Basin, can residents and livestock temporarily get unlimited access to surface water. Due to lower rainfall and stream density and subsequent poor soil fertility, dry areas are dominated by seasonal grasses and few shrubs, of which grasses are a primary house construction material. Residents have associated high flood waters with blossoming grasses for thatching and for livestock consumption as well as increased catfish for food. After the floods recede, the soil is left moist and plants can grow for a number of months until it eventually dries out again. Some of this water is trapped in ponds for future use by the residents and their livestock after the flood event.

5.4.1.2 Recharge of sub-surface water reserves and aquifers

The Cuvelai river system is an ephemeral system and residents have no access to this water throughout the year. Some residents interviewed also have no access to piped water, and as a result some of the residents depend on surface water during floods and ground water during dry seasons. Responding in favour of floods, some residents felt long standing waters are good as they recharge the underground water sources, from which they can tap during hydrological drought conditions. Potable water availability as per household has not been quantified for this paper.

5.4.1.3 Fishing

Fishing is one of the main sources of income in the Cuvelai Basin reported by the local residents. Fish are caught and sold to the local markets as well as neighbouring Angola and as far as the capital city, Windhoek. Most fish is also dried and reserved for drier seasons, and it is a common delicacy in northern Namibia.

In the distant past, and as the residents report, fishing was more confined to *iishana* such as the traditional seasonal and highly irregular 130km wide *iishana* channel network amalgamation which occurs during times of wide floods. In the recent flood years however, as described by local communities, the fishing area has increased in geographic extent and widened to even include fields and homes within the flood extent zones. While this observation may be true in some areas irrespective of transect, it may not hold as such in others. Though the extent of floods and that of fishing may have increased, the people have started constructing houses and commencing with agricultural activities directly in or closer to old, dry and seemingly safe looking *iishana*, thus increasing vulnerability of residents to floods. Lack of land use planning at village level as discussed earlier in Section 3.6, further exacerbates the residents vulnerability to floods.

5.4.2 Livelihood destruction

Though floods may be necessary for livelihoods to flourish in some parts of the Cuvelai, floods can cause huge destruction to the livelihoods of the local residents in other parts and depending on the times disasters may strike. Following are some of the negative impacts of flooding at household level as outlined by the local communities.

5.4.2.1 Destruction to crops and reduced harvest

The perception of residents of ‘standing water’ (indicated in Figure 5.6, Figure 5.7 and Figure 5.8) is mostly linked with destruction of crops and immovable property. This is also expressed in Figure 5.9 with 94% of the population (n=249) having had to endure the negative impact of crop damage with reduced harvest as compared to years of relatively good rains. A small percentage (< 1%) did not manage to produce any crop during the consecutive flood years due to heavy flooding which caused extensive remodeling and altering of the fields rendering them unsuitable for cultivation. Many fields were either completely submerged by floods or were highly waterlogged which made ploughing impossible or extremely difficult. Even though most of the *mahangu* crops (pearl millet) withstood direct washing away by floods, the resultant grains and flour was reportedly unpleasant to consume due to reported discolouration, unusual yet potent odour and loss of taste. The fields with ‘less firm’ crops suffered the most consequences, with all crops washed away altogether with the flood waters into the *iishana*.

The residents alleged that during flood years most fields undergo extensive flood damage and destruction of crops. According to the information provided only a comparatively small number of less than ten percent did not experience any crop damage associated with floods as the flood impact was very minimal to non-existent in these areas (Figure 5.9). In 2009 and 2011 especially as the survey gathered, there were homesteads that failed to harvest even a single grain from the fields, a situation that created increased dependency on Government and donor food relief as it can be inferred from respondents’ answers.

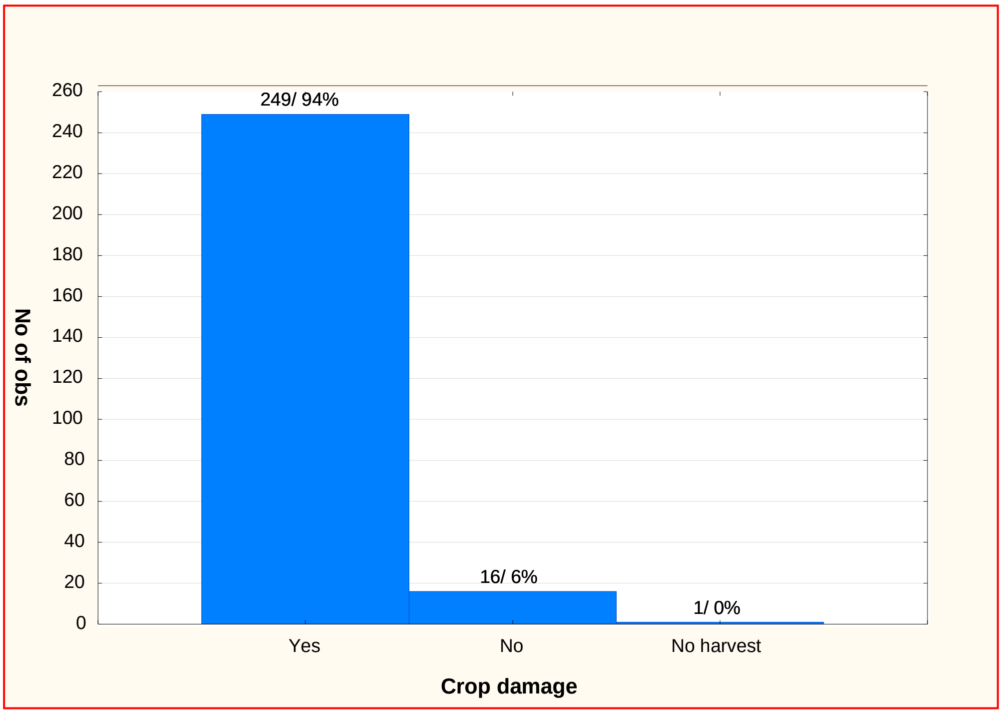


Figure 5. 9 Percentage of local residents who have experienced crop damage as opposed to those who have not experienced crop damage

- Determining reduction in crop productivity

An average of the number of barrels produced per year during the past four flood years (2007, 2008, 2009 and 2011) was calculated and compared to the average quantity of barrels produced during years of no floods. In some cases, this is a generalization. The amount of *mahangu* yielded during flood years was then subtracted from the amount of *mahangu* harvested during non-flood years (*Equation 4*). The resultant difference was then used as a measure of reduction or increment in *mahangu* productivity. A percentage of the difference was then used and computed into 8 classes shown in Figure 5.10.

$$\textbf{crop productivity}\ (\%) = \text{preflood crop yield} - \text{post flood crop yield}$$

Equation 4

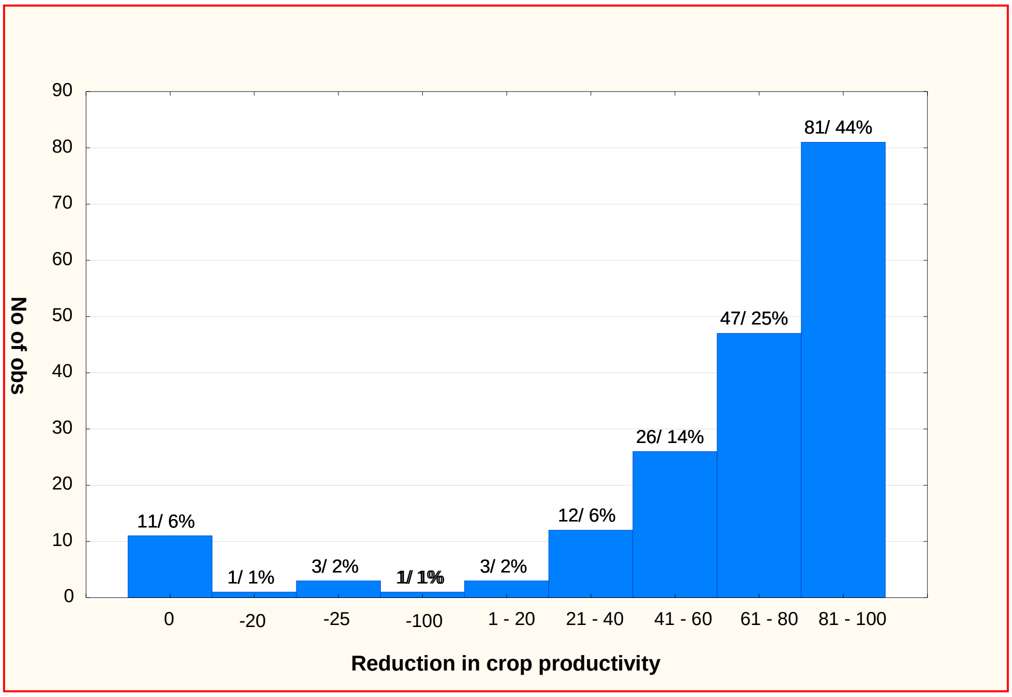


Figure 5. 10 Categorized percentages in the reduction of crop productivity in the area

As a result of crop damage by floods, a cumulative of close to 70% of the population (n=128) reported (Figure 5.10**)** a heavy reduction in crop productivity of 60 to 100%. This did not only indicate an obvious state of food shortages in the area, but also particularly a huge economic setback to the small-holding farms who sell their surplus crops to secure school funding for children and other basic necessities at household level.

- Determining loss of crop income

An insight into the proportion of communal residents (n=20) who sell part of their remaining crops for income (9%) is given in Figure 5.11. Much of the crop produce, not sold, is bartered between those that were not heavily affected by floods, and flood-affected residents in exchange for fish which is in turn a scarce commodity in areas where floods do not often reach.

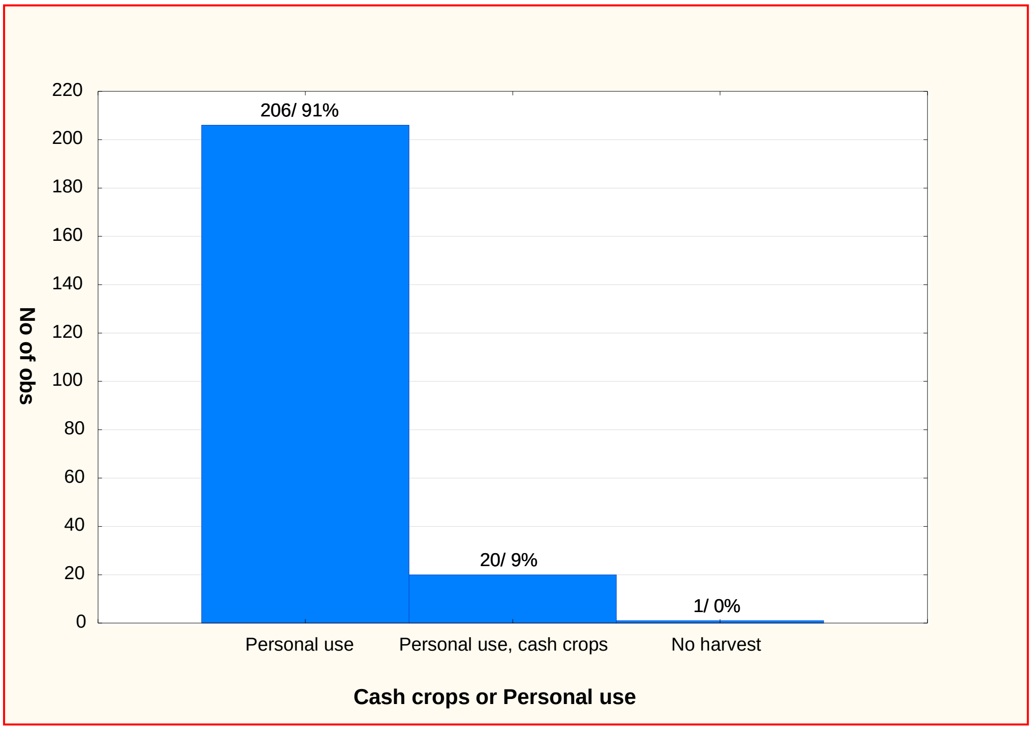


Figure 5. 11 Proportionate usage of crop produce by local residents in the Cuvelai

View the average income loss due to flooding events as shown in Figure 5.12. Reduction in crop productivity has led to affected residents losing between 70 to 100% of their sales since the onset of the recent flood cycle years. As gathered from the local respondents, *mahangu* sales are usually made using an average price measure of NAD70.00 per 20 L (19.2 kg) bucket. However, with different high consumer demand rates in certain parts and seller desperation in other parts, the prices reportedly vary greatly across the area, costing as high as NAD90.00 in some and as low as NAD50.00 in others. To determine the average loss in income due to flooding, the average amount of *mahangu* sold pre-floods is subtracted from the average amount of *mahangu* sold during the cycle of flood years using *Equation 5*. The difference, shown in Figure 5.12 as percentage for the sake of generalization is then taken as an indicator of crop income loss.

$$\textbf{Income loss}\ (\%) = \text{preflood yield income} - \text{post flood yield income}$$

Equation 5

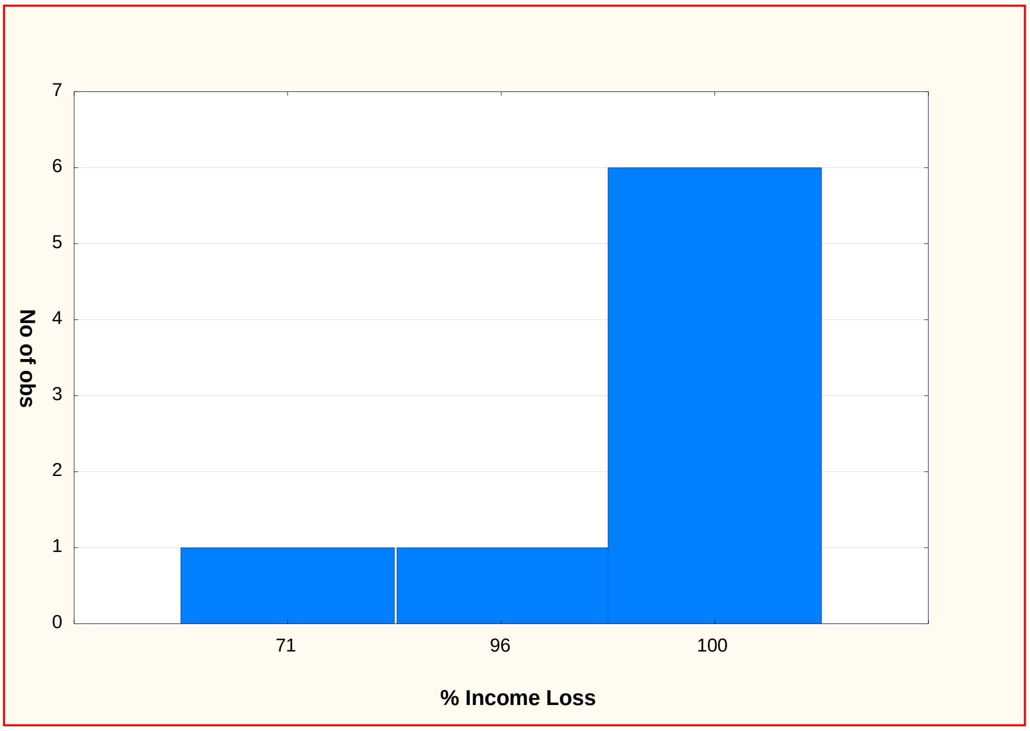


Figure 5. 12 Average income loss since the onset of recent flood cycle

5.4.2.2 Destruction to indigenous fruit trees

Since the recent flood years as per comments made by local residents during interviews, communities have observed a striking reduction in local fruit bearing trees such as various berries and marula trees in the area. In fact, some residents indicated they would not relocate to other areas as expressed through comments such as, '*this is where we get our money, if we relocate it will take longer for indigenous trees to grow there again*', or '*since floods, we no longer sell 'ombike*'. Berry trees in the most waterlogged soils especially begin to wilt and eventually die or reduce in productivity as reported by the residents. This has had a major setback to the economy of the local people, as it had subsequently led to reduced production of the indigenous products for commercial purposes.

5.4.2.3 Impact on livestock

Several cases (n=87) of unhealthy livestock were reported by local residents, with 68% of the households confirming cases of affected livestock (Figure 5.13). The most affected animals were goats, sheep and calves. Relatively, mature cattle were not as badly affected by flooding as small stock and calves. Animal ill-health conditions and symptoms such as 'splitting hooves' and rashes dominated the list of negative impacts that flooding had on the communities. In many cases, no veterinary services visited the affected areas due to inaccessibility of the roads leading to the areas and cut-off by floods. Many cases also went unreported to veterinary services for investigations as it is revealed by the local residents.

The study revealed that in *Ombuga* areas such as Etope, deadly symptoms were experienced in cattle. Affected animals were reported to have succumbed to death within a day of showing symptoms of, in addition to the ones mentioned above, weak joints and inability to give birth unassisted. Some residents reported to have lost close to 100 herds of cattle over the recent flood years

Apart from disease outbreaks, many animals succumbed to death as a result of hunger as much of the grazing land became submerged subsequently reducing grazing and habitat land, a situation that has led to overcrowding, starvation and unhealthy conditions such as diseases and then death. According to the residents, a greater percentage of animals had also died as a direct result of drowning. Affected mostly were small animals like goats. As explained by residents, herders relocated their cattle to better land in time in 2011 as opposed to flood instances in 2008 and 2009. As a result, cattle were not as a badly affected as other animals in the 2011 floods.

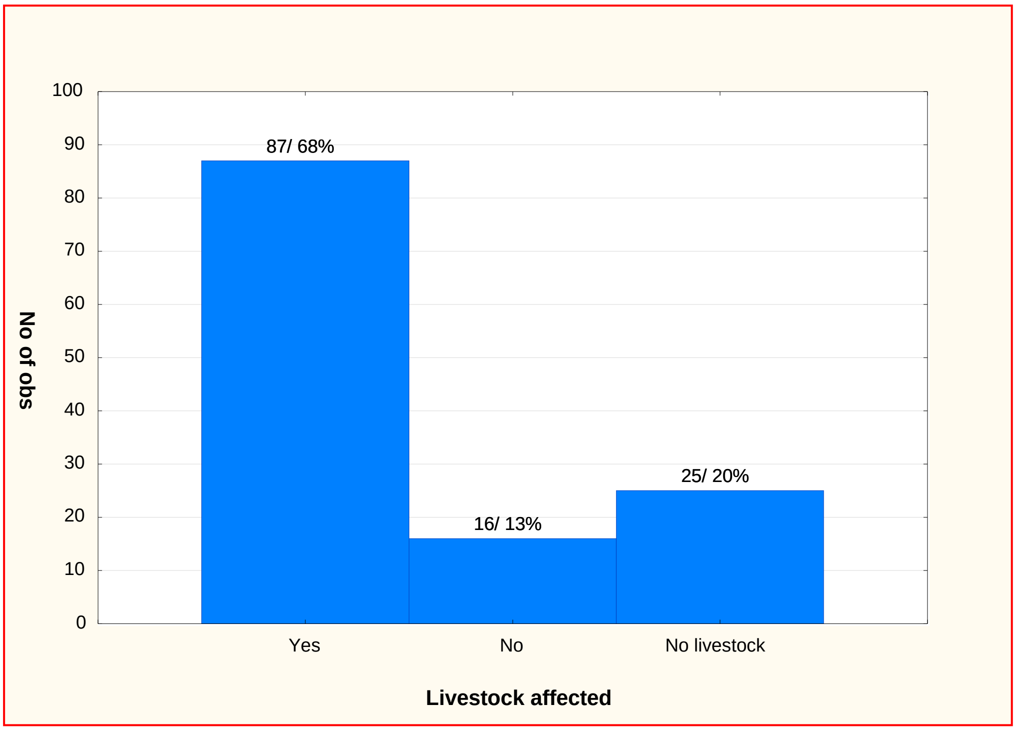


Figure 5. 13 Number of households with livestock affected by floods

- Livestock productivity

Flooding affects livestock productivity in many ways, and local residents have identified some of the associated negative impacts. Some of examples of negative consequences associated with livestock reduction include, *reduced trampling of livestock on field and reduced fertilisers* Figure 5.14 shows the reduction of goats and sheep due to flooding. The figures show that 67% of the population had lost between 60% and 100% of their herds of livestock, and only 2% of the local residents had reported no impact of flooding on their livestock and no losses thereof.

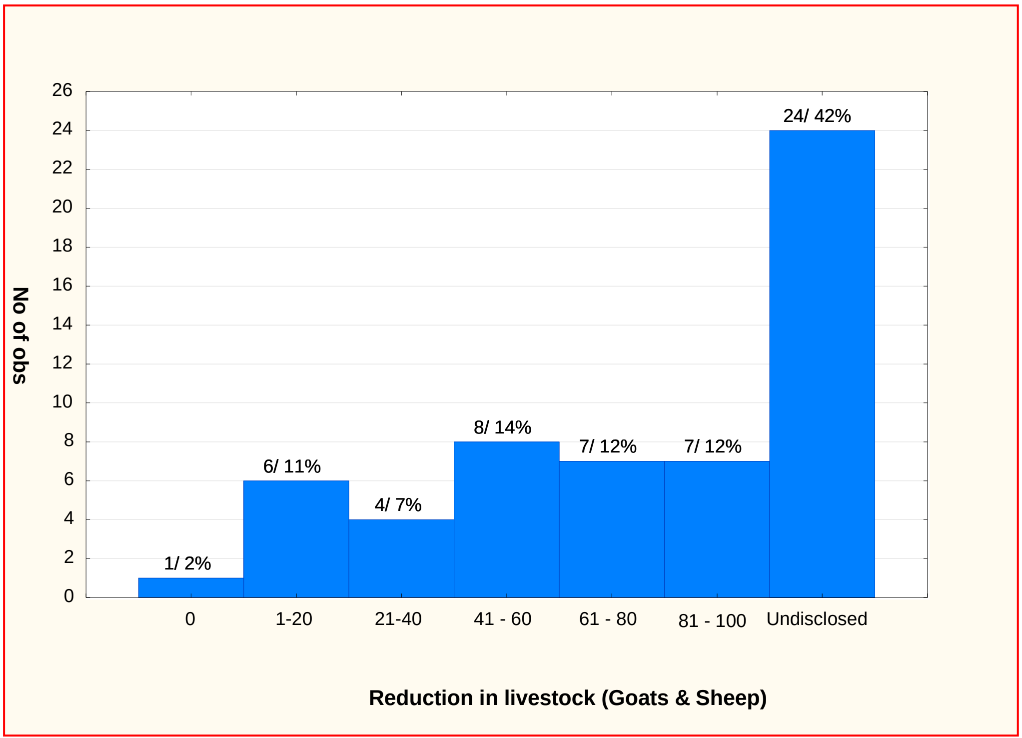


Figure 5. 14 Categorized percentages in the reduction of livestock (sheep & goats) in the area

- Determining livestock productivity

A percentage of the difference (*Equation 6*) was used and computed into 7 classes shown in Figure 5.14. There are some residents (n=24) who decided not to disclose the number of livestock lost to a mere stranger (the researcher).

$$\textbf{Livestock productivity}\ (\%) = \text{pre flood livestock yield} - \text{post flood livestock yield}$$

Equation 6

- Loss of human life

In many situations residents had direct contact with sick animals not only during assistance with cattle labour or in assisting weak animals to keep balance (*okutumba*), but also via direct consumption and handling of carcasses. The residents further revealed that, many of the traits of ill-health depicted by animals had spread to the local human population. Some of those illnesses included, wounds on the body, rashes, and splits in-between fingers which lead to bleeding in some cases and itchiness. The residents also informed the researcher that no medical assistance was sought by affected persons. This was due in large part, because *clinics* *and health facilities were inaccessible and mobile clinics were either limited or not in close proximity* to respective affected communities.

From information gathered during interviews, it was revealed that most residents affected by drowning were *school children who cross vast and deep iishana to and from schools without guidance or assistance of the elders, drunkards who attempt to cross inappropriate sites when drunk as they travel to and from shebeens, old people who fail to maintain balance in slippery or sometimes turbulent waters, and people with special needs such as the disabled, mentally unstable, and weak and vulnerable members of society*. Figure 5.17 indicates additional vulnerable members in the community identified by the local residents. In Transect 3, cattle herders were reported to be another category of flood-affected residents when trapped by flood waters for days in search of cattle or while at cattle posts with no means of communication. Another group of flood-affected residents identified are the people who are new to the area and unaware of safe crossing points.

5.4.3 Other risk factors

There are various physical conditions precipitated by floods that place residents at risk and lead to increased vulnerability. As commonly complained about by the residents, these other risk factors include the danger of *snakes* as well as *accessibility affected by floods*.

5.4.3.1 Snake problem

Another complained about negative consequence associated with flood waters in the Cuvelai by the interviewees, are snakes. Areas along the lower parts of Transect 3 are referred to by the residents as home to various species of snakes, including black mambas and adders that remain a threat to humans. In Transect 1, green mambas are said to dominate and continuously pose a threat to livestock. As the residents narrated, during the flood season and after disruption of their natural habitats, snakes escape to other limited safe places available, including shade trees, in homes and huts and nearby relatively high-lying fields that are not flooded. Residents added that being good swimmers, some snakes stay in the water, causing danger to passers-by like, school children, elderly, the general human population , animals, and others crossing the *iishana*. It has also been reported that during floods snakes are seemingly more easily provoked and quick to attack unlike in dry conditions. Some deaths and skin deformities as a result of snake bites especially in the *ombuga* area covered mostly by Transect 3 and partly by Transect 2 have been reported by the respondents. As the residents recalled, most snake bites took place in the residents' homes including bedrooms while sleeping (see Figure 5.15 of a poorly constructed house), as well as in shade trees inside and outside of homes during resting times. As local residents report, snake bites have also been reported to occur in fields when residents are working, in *iishana* when crossing, as well as in fishing places when the movement of a snake in a fishing basket is confused with that of a trapped catfish.

Figure 5. 15 Homes and bedrooms poorly constructed as this one makes it easy for snakes and flood waters to pass through during flood times

5.4.3.2 Accessibility issues: destruction of roads and other structures

As the residents report, overtopping of roads had hindered local accessibility to a greater extent and cut- off of rural residents to urban centres, places of worship, health facilities, schools and other important spheres of interaction in their lives. As a result, flood-affected residents had to stay for longer periods without basic necessities such as medication and food. Affected badly were the rural residents on Anti-Retro Viral (ARV) and other acute treatments. Though mobile clinics were dispatched to some of the centres in the villages, ARV dependent people could still not get their medication as such medication can only be given out at a hospital by a doctor. This poses long-term health insecurities for the people needing the medication. Home births without professional assistance were also reported, with pregnant women missing ante-natal visits to health centres.

5.5 VULNERABILITY OF FLOOD-AFFECTED RESIDENTS

To get a clear insight into the residents affected by floods (also termed flood-affected residents; n=234) and the extent to which they have been affected, three categories of assessing vulnerability were developed which include geographic vulnerability, socio-economic vulnerability, and physical vulnerability. These three vulnerability assessment categories were used to address the objective of assessing the circumstances (geographical or physical) that place residents at risk as well as the socio-economic conditions that lead to vulnerability (see Chapter 2).

5.5.1 Geographic vulnerability

This assessment of vulnerability is based on the geography or location of the household and its relationship to flooding. It appears as if flood frequency did not play a large role in assessing geographic vulnerability due to the fact that most flood-affected residents seemed to easily forget flood events, and could not establish clearly the number of times they had been affected by floods. The length of time that a household has been established also did not greatly influence geographic vulnerability (Current effect: $F(1, 257)=.14309$, $p=0.71$ Mann-Whitney U $p=0.87$). This indicated that more recently established households are not necessarily more prone to floods. Figure 5.16 shows households submerged by the flood waters.

Source: Mendelsohn (2013).

Figure 5. 16 Households surrounded by flood waters depicting geographic vulnerability

The perception of respondents (n=39 non-affected local residents) of the most vulnerable members of the community to flooding impacts are presented in Figure 5.17. Residents regarded as vulnerable due to residing in close proximity to certain developments that channel flood waters into their homes and fields regardless of geography make up a very small percentage. These would be people residing at the peripheries of urban centres.

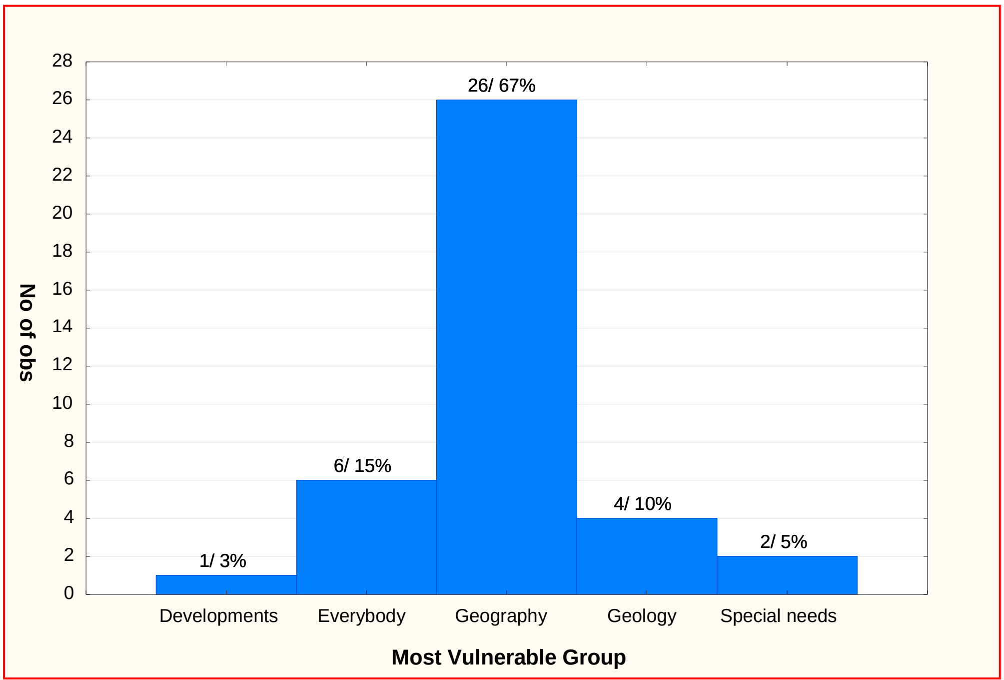


Figure 5. 17 Most vulnerable groups in villages as identified by the local residents

Some residents (n=4) are considered vulnerable because of the type of soil in the area, which is especially prone to seepage (10%). While (n=2) 5% are seen as most vulnerable as they have special needs and struggle to look after themselves. Fifteen percent of the respondents (n=6) were of the opinion that everyone in the village is vulnerable regardless of the geology or geography of the space, while more than 60% (n=26) are considered vulnerable based on location (geography).

Vulnerability due to geology referred to in Figure 5.17 describes the impact of soil type on flood vulnerability and is closely related with geography. Soil surface properties can be the most important influence on runoff in some areas. If water is unable to infiltrate the soil surface, the characteristics of the soil profile below become unimportant. Impermeable surface materials, soil compaction, deforestation, and fire are factors that affect infiltration into the soil profile.

There is a strong link between geographic vulnerability and household location (Chi-square (df=4) =17.45, p=.00158, n=236) as shown in Figure 5.18. These quantitative results are discussed per transect, describing the reasons for the geographical vulnerabilities of flood-affected residents as discussed in detail in Section 7.5.1.

In Transect 1, people residing in low lying areas suffer the most flood consequences. Notice the high geographic vulnerability in Transect 1 (91%) as shown in Figure 5.18. Local residents alleged that the 2008 and 2009 waters also flooded those residing at relatively higher places.

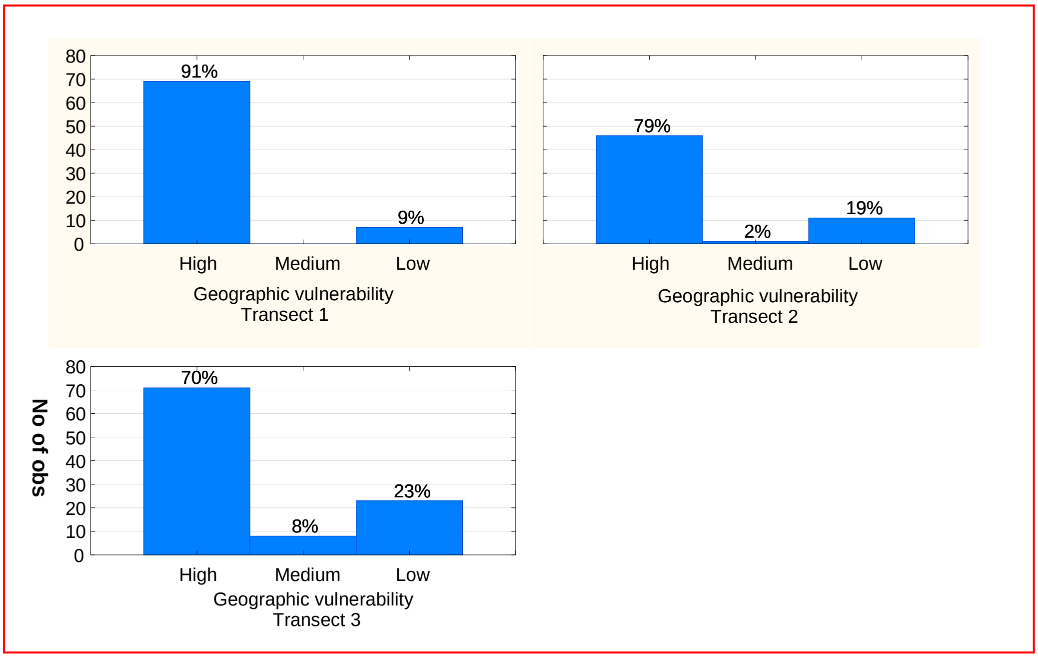


Figure 5. 18 Flood-affected residents victims geographic vulnerability rates per sampling transect

Apart from silting up of the *iishana*, residents reported that new streams can form starting off as minor dongas and gullies in a localised setting then spreading over a less stable and flood prone soil structures (Figure 5.19). They further reported that any weak point, mainly roads, tracks, and passages in-between the plots in the fields, can be a starting point for a new stream to establish itself. Roads especially have been reported to channel flood waters into some homes, and a number of such small streams have been reportedly widening at a relatively high pace.

Figure 5. 19 This eroded area was once part of the field in the far background

Table 5.1 summarizes the vulnerability across various geographic spaces of residence compiled from the information collected from the local residents during the survey and gives insight into the safety of various spaces within the Basin.

As shown in Table 5.1, geographic vulnerability is heavily dictated by the geographic space in which local residents may choose to reside or cultivate. More than 70% of local residents are 'highly' geographically vulnerable to floods in all transects and subsequently across the study area. As expected, residents residing directly in *iishana* are highly prone to floods than those on highland characterized by Kalahari sands, while residents residing on other types of highland are less vulnerable to the flood risk than those on the edges of the *iishana*.

Table 5. 1 Localised vulnerability in the Cuvelai Basin

Geographic space	**In *iishana***	**Highland (characteristics of Kalahari sands)**	**Closer to *iishana* edges**	**Other highland**
Level of associated risk	high flood risk	high seepage risk	low to moderate flood risk	low flood risk
	flat- water stands for longer	relatively gentle	relatively steep- water does not stand	relatively gentle
	flood duration = long**er**, flood intensity = high	flood duration = long, flood intensity = low	flood duration = short, flood intensity = low	flood duration = short**er**, flood intensity = very low
	permanent inconvenience	permanent inconvenience	temporary inconvenience	temporary inconvenience
	food shortages	bad for cultivation during drier periods	good for cultivation even during drier periods	bad for cultivation during drier periods
← **Degree of associated risk**				
SUMMARY POINTS				
	• At high flood risk • Flat – water stands for longer • Flood duration is longer, intensity is higher • Food shortage always • Permanent inconvenience	• At flood risk • Slope is relatively less gentle than inland – flood duration is shorter, intensity is high • Good for cultivation even during drier periods • Temporary inconvenience	• At seepage risk. • Flood duration is longer, intensity is very low • Bad for cultivation during drier periods • Permanent inconvenience	• Low flood risk • Too dry when insufficient rains (bad for cultivation during drier periods) • Preferred by majority, better water holding capacity than Kalahari sands • Temporary inconvenience

5.5.2 Socio-economic vulnerability

Using the factor or indicator based approach to assess socio-economic vulnerability described in Section 2.2.3, socio-economic vulnerability was determined by prioritizing the category (*high, medium, low*) with the highest cumulative ranking across all contributing variables per household. At household level, the majority of the flood-affected residents interviewed are socio-economically vulnerable as indicated in Figure 5.20 (Chi-square (df=4)=9.74, p=.04500) with 72% falling in the medium to high vulnerability class. As expected, community leaders are not very vulnerable, with only 21 % being highly socio-economically vulnerable. An interesting observation from Figure 5.21 is that ~30% of flood-affected residents were not socio-economically vulnerable (low), yet had suffered some flood damage in the past. Socio-economic vulnerability and geographic vulnerability however are not necessarily in direct proportion with each other.

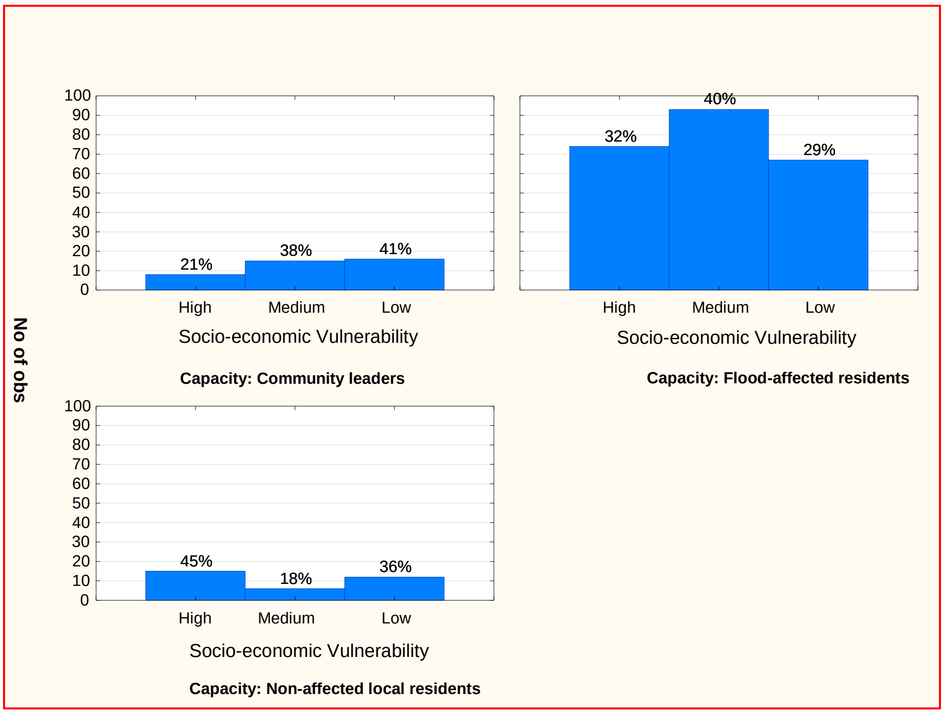


Figure 5. 20 Proportionate socio-economic vulnerability of the interviewed residents

Though statistically there is no difference between transects (Chi-square (df=4) =5.74, p=.21929), Figure 5.21 shows that socio-economic vulnerability is evenly distributed across the Basin. Approximately 30% of the residents of each of the transects fall in the category of high socio-economic vulnerability.

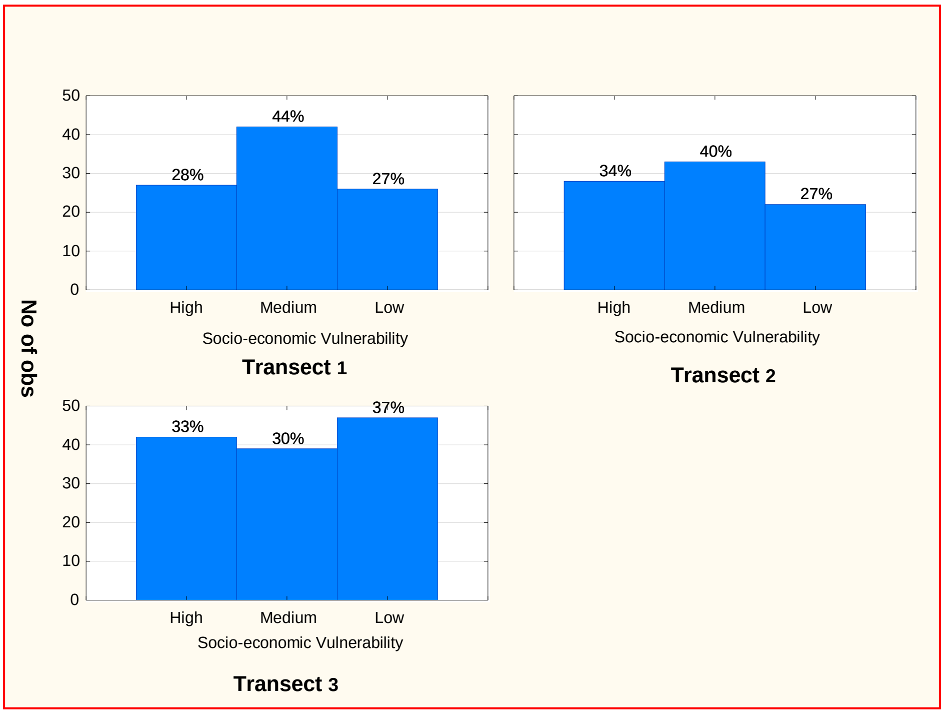


Figure 5. 21 Socio-economic vulnerability across transects

Various other factors influencing socio-economic vulnerability observed in the Cuvelai such as urbanization, land allocation, residents with special needs and other risk factors are presented. This section closes by evaluating the role of socio-economic vulnerability in exacerbating the overall vulnerability of the residents.

5.5.2.1 The impact of urbanization

As shown in Figure 5.17, 3% of the flood-affected residents (n=1) indicated that vulnerability due to developments in or close to their residence is on the increase. These could be rural residents particularly residing relatively closer to urban centres such as those mentioned in Othingo. The impact of urbanization is discussed under a number of sub-headings which include: Impacts of structural features; rural-urban migration; and the impact of land dispossession on flood vulnerability.

- Impact of structural features on flood vulnerability

In villages in close proximity to the town peripheries, residents settling near dumpsites, roads as well other man-made features such as cemeteries are said to have their flood risk exacerbated due to those factors. Residents further narrated, that road grids, ditches, and storm sewer systems can also act as a network of tributaries channelling the flood waters to the nearby rural residences.

It was also reported that another factor sharpening the flood impact in the Basin is the effect of roads and bridges with smaller than necessary culverts. They claim that most culverts are too small to accommodate the amount of flood waters that pass through such streams. As a result, waters accumulate on the one side of the bridge, subsequently flooding the adjacent fields. As compared to a natural stream bed, road surfaces, culverts, and storm sewers possess relatively smooth surfaces. This decrease in surface roughness allows runoff to move much more quickly to the main stream channels than it would in a more natural setting, as residents report.

The gravel road shown in Figure 5.22 leading to Uuvudhiya from Elim junction intersects one of the main channels in the area. Notice the two small culverts. Also see Figure 5.23 for more inappropriate culverts in the area. The poorly constructed road is reportedly shorter in height than necessary, and over toping and cut-off of accessibility are some of the associated negative consequences.

Figure 5. 22 Inappropriate construction efforts may exacerbate the flood impact

This point also addresses the intentional blockade and redirection of flood waters by town authorities in an attempt to stop or reduce the impact of flooding on urban centres, which end up deflecting towards rural areas as the residents allege. The activities range from sand embankments, river widening and deepening, as well as direct redirection of major streams as pictured in Figure 5.23. Rural residents residing closer to such embankment features suffer the most.

Figure 5. 23 Some of the inappropriate sand choked culverts in iishana channels

A specific and popular example of channelization is that of the *Okatana River* and *Ompundja streams* near the Oshakati urban area leading to increased runoff as expressed by the local residents. The negative aftermath of channelization and related processes thereof are already being felt and experienced by the rural settlers in close-to-medium proximity to the town, downstream of the catchment as it is gathered from the interviewees.

Flood-affected residents in villages in close proximity to urban and built-up areas have additionally attributed a high risk of increased flooding to several other construction and development initiatives. Overall, an urban or altered environment will result in faster runoff with more runoff reaching the streams than in a rural or natural setting.

- Rural- urban migration and squatter camps

Residents especially community leaders alleged that immigration places increasing pressure on rural areas bordering cities' peripheries, exposing them to a high flood risk. As they cannot afford to secure decent land in towns, illegal immigrants erect their shacks in unfavourable places usually in the villages near towns' peripheries and in stream beds. Erecting the shacks in *iishana* alters the flow of waters in streams, and in addition, the waste produced chokes the streams to the extent of stopping or slowing down the flow. This causes the water to stand and accumulate there, subsequently spilling to the adjacent fields. Several areas especially on the Ompundja roads have expressed this concern and claim to have experienced flooding only since the recent mushrooming of adjacent squatter camps.

A dumpsite in the Othingo area is reportedly contributing to the high risk of flooding of people residing near the landfill. Low-lying and inappropriately located in a high flood prone area, flood waters contaminated with refuse flow down to nearby houses and fields, causing major environmental and human health concerns. Residents also report that cemeteries, especially those in the sandy soils are affected by seepage. Communities are further faced with cemetery space needs and are eager to conserve good high value land space for cemeteries and low lying areas for other activities such as residences.

- Impact of land dispossession on flood vulnerability

In recent years, as in the past, authorities have dispossessed rural areas, due to the pressure on expanding towns. Compensation for dispossessed land is allegedly insufficient, according to community leaders, for families to re-establish themselves. This has a direct impact on rural land availability, productivity and the ability of the poor to sustain a livelihood. With no voice and power, residents vacate fertile land to relocate to flood prone zones as reported in Oluno, Ondangwa, Oshakati, Ongwediva and Helao Nafidi. The community leaders have also iterated that village leadership is put under pressure from the ever increasing number of land seekers from towns under such circumstances.

This practice leaves many village heads powerless. In an attempt to oppose land grabbing strategies by town councils, some village heads have allocated most flood prone areas in their villages to victims of town land dispossession in the hope that the situation will become obvious for the government to intervene.

5.5.2.2 Settling on allocated land

- Early settlers from elsewhere

The relationship between socio-economic vulnerability and the age of the household (Figure 5.24) is statistically weak (F(2, 302)=1.8089, p=0.17 Kruskal-Wallis p=0.38)... In many cases newer fields are just as susceptible to floods as older ones and a past settler is just as much at risk of flooding as the recent settler settled in a low lying area.

Some residents revealed that, coming in search of land and better livelihood opportunities, inexperienced land seekers may find themselves settling in unsuitable spaces. The Traditional Authority (TA) does not necessarily interfere with land selection by the land seeker. It is thus the responsibility of the land seeker to identify land that is most visually appealing to them or where they want to settle. The land seeker would then approach the TA such as the village headman for advice. If available, for the price of NAD600.00 or a negotiated sum or cattle, the land seeker is allocated the land, without any advice on the vulnerability of the property leaving the settler at risk.

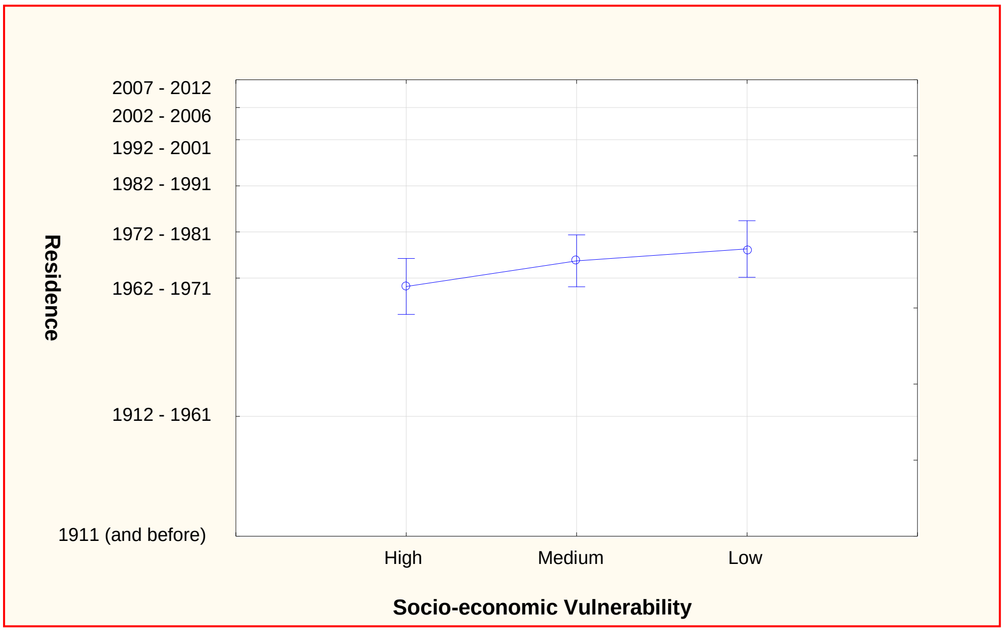


Figure 5. 24 Association between time of residence and socio-economic vulnerability

Some residents allege that changes in cultivation practices have contributed to soil evolution and the susceptibility to erosion has increased. Many previously high-lying areas have been affected and old land has reduced in elevation. In some cases, local residents believe that the older the field becomes, the lower it also becomes, increasing the flood risk to the people living on land previously considered safe.

- Households built after 1990s, including refugees and returnees

It has been observed that many of the flooded households were built since 1990. According to respondents, before 1990, people lived in concentrations and closer to their families, mostly for the feeling of protection. After Namibian independence, people moved to places once regarded as unsafe. Everybody wanted their individual independence and a sense of belongingness to the area. The population had also started to increase rapidly. This spread of people all over the Basin brought some undesired effects, such as settling anywhere, where space could be found.

The intense spread of the local population after the 1990s was also accompanied by the increasing number of war refugees and returnees as it is gathered from the residents interviewed. War veterans had nowhere to settle as their land had been re-allocated. The landless returnees would settle anywhere, regardless of flood risk. The majority settled in flood prone areas, in most cases the only available land, regardless of risk. Settlers resided on the flood prone peripheries of urban-rural transition zones at the time, such as the area covered by a belt of informal housing between Oshakati and Ongwediva, as the elderly respondents narrated.

- Re-allocated land

Apart from those residents that abandoned their land due to reasons such as war, there are also some fields that were abandoned due to flooding and severe seepage impact. Headmen also revealed that they do not have offices and keep no records of the nature of productivity or vulnerability of all fields. New land seekers often find themselves re-allocated land that has been vacated due to its proneness to floods.

5.5.2.3 People with special needs

People with special needs are especially vulnerable in flood situations. This category includes physically, mentally disabled and those with chronic illnesses. During floods, these people are especially at risk of drowning as a consequence, needing constant care, which is not always available. Many of the reported drowning cases in the past floods involve persons with special needs. Discussed below are some of these victims as identified by local residents, categorized as: orphans, senior citizens, pregnant women, single-head households and widow, and the disabled.

- Orphans

Residents reported that young orphans living by themselves in houses are more vulnerable than orphans residing in their caretakers' homes. Due to loss of parents from HIV/AIDS and other factors such as accidents, many children are left orphans with no immediate families to take care of them. As observed, many of the orphan households are in a very dilapidated state, placing them at a much higher risk of being washed away by flood waters. Many are reliant on provision of food and clothing by other people. It was also gathered during the survey that orphans often do not have the necessary documentation to register for OVCs' government assistance, and cannot receive government assistance if not attending school.

- Senior citizens

Elderly residents are reportedly at higher risk of drowning during flood events. Elderlies claim that with most of them staying alone or with many dependents at home, they remain unable to upgrade or construct durable homes for themselves. Due to limited finances in some cases, the elderly are most often not capable of utilizing paid labour for services such as house construction. In addition, some of the elderly may still have many dependents. Some elderly may also have employed families looking after them Figure 5.25 below shows extremely vulnerable elderly at home on the left and less vulnerable elderly at home on the right.

Figure 5. 25 Socio-economically vulnerable elderly: more vulnerable (left) and less vulnerable (right)

- Pregnant women

With accessibility to health facilities interrupted and no ante-natal care, some pregnant women reportedly resort to potentially unsafe home deliveries during floods with assistance of their fellow inexperienced residents. The infants do not receive immediate medical attention. Home deliveries in the area are however not completely unusual, and in some cases they are preferred over hospital births as the residents expressed.

- Single-headed households

Though both male and female-headed households are vulnerable, it was found that households headed by women and people with special needs are the most vulnerable.

- Households with disabled persons

Individuals and families with special needs need extra care. These persons can be categorized as, mentally challenged persons and the blind, some of whom in this case are staying alone in typically small houses on smaller pieces of land. Due to stigma in society, people with special needs are reportedly said to be neglected by their community members and receive minimal assistance when disasters strike.

- Widows and 'widow-stigma'

In the Cuvelai, there is a practice that is, for purposes of this study, referred to as *widow-stigma*. A traditional or rather cultural practice, local residents narrated that after losing her husband and immediately after the mourning of burial, a widow is chased off the land and house by her in-laws. The in-laws inherit everything regardless of whether items belonged to the woman or her deceased husband. Inherited items may include but are not limited to livestock, small stock, food items, pots, dogs, blankets, clothes (including the widows'), materials used to construct the house such as wood and corrugated iron sheets, all other tangible items, and children who are mostly inherited against their will. Emanating from traditional land acquisition practices still observed in many areas of the Cuvelai, a woman has no right to land ownership, but should be provided for by the man, the land is viewed as belonging to the husband and his paternal family. Land is then passed down through a blood line of family members and inherited only from and by paternal relatives. As a consequence, the widow has to return to her relatives. In cases, especially where relatives are far away or where land is limited; the widow is reportedly forced to establish herself, often on the peripheries of the village or on inappropriate land. Some widows narrated that in some areas, they are regarded as outcasts, treated with disrespect, and village heads refuse to allocate suitable living land to them, thereby increasing their vulnerability. A remarkable number of flooded old homesteads comprises of houses belonging to elderly widows.

5.5.2.4 Other socio-economic vulnerabilities

In this section other cases of socio-economic vulnerability caused through human and physical factors, identified by residents, are discussed.

- Nepotism

Residents allege that some headmen allocate better land to members of their families and close persons. Ordinary residents with no special ties with the village leadership are left disadvantaged.

- The poor and vulnerable: house construction

Residents living in houses constructed of natural matter such as mud, stalks, grasses and plastics such as those shown in Figure 5.26 (also see Figure 5.15 in Section 5.4.3.1), are reportedly at high risk of flooding. The impact and consequences of flooding on these vulnerable residents and the coping mechanisms will be discussed in detail in Chapter 7 and Chapter 8.

Figure 5. 26 Highly socio-economically vulnerable houses constructed of bio-degradable grasses, stalks, and mud

The natural construction materials can easily decompose in damp, warm conditions and are not durable enough to withstand floods. Houses constructed of natural material may be completely destroyed by the flood and other disasters. Residing in such properties are usually the poor who cannot afford better housing.

Figure 5. 27 (a) Medium socio-economically vulnerable house (left) constructed of wood; and (b) low socio-economically vulnerable house (right) with cement walls

By comparison highly socio-economically vulnerable homesteads are constructed from bio-degradable grasses, stalks and mud (Figure 5.26), medium socio-ecomically vulnerable homesteads can be constructed out of wood (but this is relative), that is still bio-degradable but longer lasting (Figure 5.27a), and low socio-economically vulnerable homesteads have permanent structures such as cement walls (Figure 5.27b).

- Lazy residents, substance abuse, cattle herders, and school going children

It was mentioned by some, that there are fellow residents who put themselves at risk of being flooded as they are too reluctant to upgrade their homes with stronger building materials or they '*just do not have time for that*'. Respondents have also accused shebeens in the villages for creating a level of excessive dependency on alcohol. This excessive drinking hinders productivity as people tend to neglect work. Residents alleged that money is lost to alcohol instead of improving the homestead.

5.5.2.5 Socio-economic vulnerability exacerbates overall flood vulnerability

Table 5.2 shows a relationship between flood-affected residents and their level of socio-economic well-being. Flood-affected residents with medium socio-economic vulnerability are higher in Transect 1 and 2, while Transect 3 flood-affected residents are equally impacted despite their socio-economic status.

Table 5. 2 The percentage of homes per transect at different degrees of socio-economic vulnerability

Transect number	**Socio-economic vulnerability**			
	High	**Medium**	**Low**	**Totals**
1	25 (33%)	34 (45%)	17 (22%)	76
2	16 (29%)	26 (46%)	14 (25%)	56
3	33 (32%)	33 (32%)	36 (35%)	102
Totals	74	93	67	234

There is a strong statistical correlation between geographic and socio-economic vulnerability, (Spearman r=0.11, p=0.06 indicated in Table 5.3) with socio-economic vulnerability extremely variable across the transects (p=.22716 from Table 5.2). Despite various socio-economic challenges, flood-affected residents have developed coping mechanisms, both in terms of their philosophy about flooding ('temporary inconvenience') as well as the use of various measures such as temporary housing structures. These results will be presented in Chapter 6.

5.5.3 Physical (structural/ technical) vulnerability (Impact of flood damage)

Residents, both young and old, tend to have short memories of floods and forget easily once the waters have receded. Measured through direct and indirect variables, the flood impact is mostly understated. Notice both residents pointing below the flood marks to demonstrate the impact of flooding on their households, shown in Figure 5.28.

Figure 5. 28 Flood marks are visible just above the yellow lines

Mahangu is the staple crop for rural residents in the Basin. After harvesting, the grains are stored for many months and sometimes years in wooden silos (Figure 5.29). The silos are traditionally sealed with mud to protect against insects, animals and direct sunlight, but not rain or flood waters. The poles keep the silos slightly off the ground to guard against moisture and termites. The risk of storage grain germination is therefore very high in most cases when floods strike. This can happen within a period of four to eight days once grain comes into contact with moisture.

Figure 5. 29 Traditional low lying mahangu storage silos are prone to adverse conditions and increase the impact of flood damage

The researcher observed a few elite community members in the Basin who have artificially constructed silos built either of insulated cement or recycled plastic, elevated off the ground. For the majority of the residents however, traditional silos remain the primary cause of grain loss and damage during floods. Germination can also occur just before the cobs are harvested. This germination causes crop failure, which puts enormous economic strain on residents who solely depend on agriculture. The situation can be remedied by purchasing maize flour, which comes with increased prices during floods, a rather unfortunate situation for economically vulnerable individuals.

Figure 5.30 summarizes the structural / technical vulnerability per transect and shows that the overall flood impact was high in all three transects with 79% reporting High impact in Transect 1 and 68% in both Transects 2 and 3. There is no significant difference between transects in the impact of the floods (Chi-square (df=4) =4.24, p=.37453).

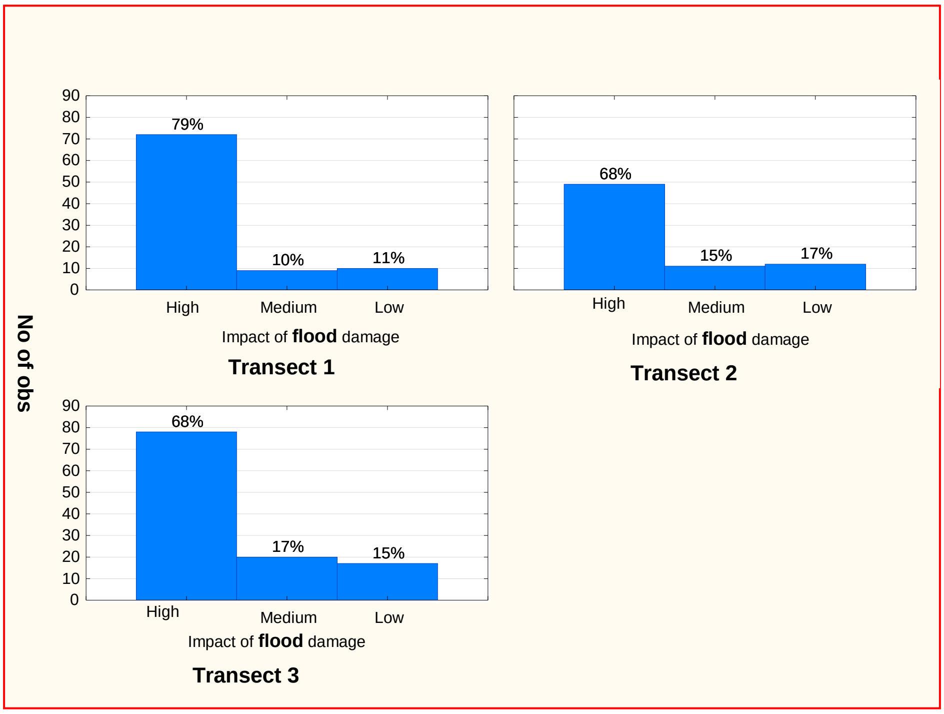


Figure 5. 30 Tertiary vulnerability rate per sampling transect

After reporting on geographic, socio-economic and physical vulnerabilities separately, the interaction between is described.

5.5.4 Location, socio-economic conditions and level of damage

The correlation matrix between the three types of vulnerability, geographic, socio-economic as well as evidence of damage is given in Table 5.3. Again, it is worthwhile to note that vulnerability types are not necessarily in direct proportion to each other.

Table 5. 3 Spearman correlations between geographic vulnerability (1), socio-economic vulnerability (2), and physical vulnerability/impact (3)

Variable 1	**Variable 2**	**Spearman**	**p-value**	**cases**
Geographic (1)	Socio-economic (2)	0.11	0.06	266
Geographic (1)	Impact (3)	0.42	<0.01	252
Socio-economic (2)	Impact (3)	-0.00	0.95	274

Though there is a significant correlation between geographic vulnerability and the impact of flood damage ($p<0.01$), this is not the case with socio-economic vulnerability and the impact of damage. There is also a strong relationship between geographic vulnerability and socio-economic vulnerability ($p=0.06$).

CHAPTER 6: FLOOD HISTORY AND HOUSEHOLD PRACTICAL ADAPTIVE STRATEGIES IN THE CUVELAI BASIN

In this chapter the results of the data with regards to the flood history and household practical adaptive strategies in the Cuvelai Basin as collected in Chapter 3 are presented. In this chapter the flood history is described from the residents' perspective and is predominantly qualitative in nature. After evaluating the current situation, some of the actions taken by flood-affected residents in the past that differ from current practices in counteracting the consequences of flooding are highlighted. This chapter also describes practical adaptive strategies that help residents cope with flooding.

Data was collected and then processed in response to the problems raised in Chapter 1. Four fundamental objectives drove the collection of the data and the subsequent data analysis. Those objectives were to assess the impacts of flooding in the study area, to assess whether headmen and village residents can use flood risk maps to plan ways of reducing flood vulnerability, to assess the geographical or physical circumstances that place residents at risk and to assess socio-economic conditions that lead to vulnerability, and recommend alternative practical adaptive strategies to flooding in consultation with local village headmen and residents. The findings presented in this chapter demonstrate that these objectives were accomplished.

6.1 FLOOD HISTORY

6.1.1 Current situation

Nearly 80% of the local residents (n=52) have indicated that there has been an increase in the flood extent as the years progressed. The data also reveals that these are generally respondents who settled in the area prior to the recent flood cycle years, and have not experienced other [historic] flood events before. In some areas however, the flood extent has been on a decrease as shown by 2% of the respondents.

In contrast, residents (n=8, 12%), who have lived in the Basin for many decades and have inherited their homesteads through family ties, have indicated no increase in the flood extent. Many reasoned that some areas currently occupied by recent settlers were flood plains and fossil channels of the Basin. Some of the more elderly folk (n=12, 18%) reported worse flood events in the long past and 'around the 1950's and '70s'. Figure 6.1 illustrates the different ways in which respondents have viewed the changes in the flood extent.

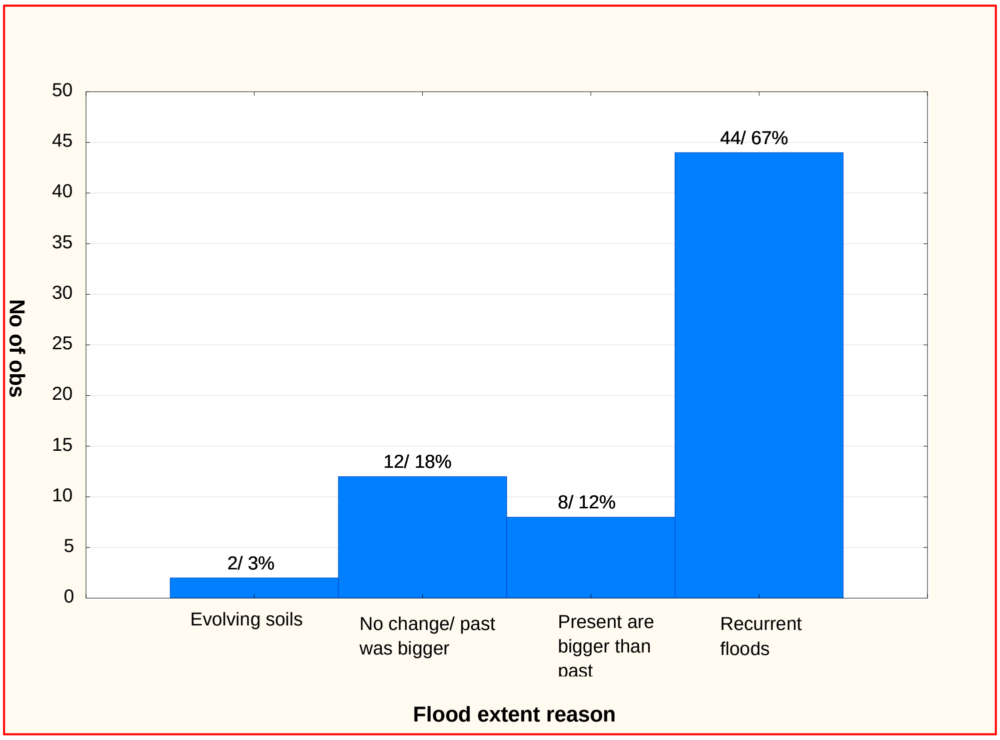


Figure 6. 1 Change and processes in flood extent as observed by local residents

Three percent of the respondents attributed the change in extent to the evolving soils and area topography over the years. According to some respondents, this may be due to traditional versus modern cultivation practices changing the soil profile in the Basin.

6.1.2 The past

6.1.2.1 Cuvelai floods are influenced by natural climatic cycles

Some communities shared that big floods such as these recent once were last experienced some 50 years ago. The senior citizens stress that the flood situation has been worse in the 'long past' when compared to current flood years. Previously recorded as a small flood, 1950 has been referred to as a big flood year by the senior citizens in the field. In addition, the years of 1954, 1957 and 1978 that have been recorded as no flood years in a similar table, Table 1.1 in Section 1.1.2, have been identified by the elderly interviewees as worst flood years as shown in Table 6.1. The elderly were also able to fill in some small gaps, adding that 1964, 1971 and 1974, shown as no record years in Table 6.1, have also experienced worst floods in the area, further commenting that the flood situation seem to be '*reverting back to the past*'.

Table 6. 1 Updated flood levels from year to year and implications in long-term flood monitoring and prediction- community interviews

Year	Size	Year	Size	Year	Size	Year	Size	Year	Size	Year	Size	Year	Size	Year	Size
1941	s	1951	n	1961	0	1971	0	1981	n	1991	m	2001	m	2011	b
1942	s	1952	n	1962	0	1972	0	1982	s	1992	n	2002	n	2012	m
1943	m	1953	b	1963	0	1973	0	1983	m	1993	s	2003	n	2013	n
1944	s	1954	n	1964	0	1974	0	1984	s	1994	m	2004	b		
1945	n	1955	m	1965	0	1975	m	1985	m	1995	b	2005	m		
1946	m	1956	b	1966	0	1976	b	1986	n	1996	s	2006	m		
1947	s	1957	n	1967	0	1977	b	1987	m	1997	m	2007	n		
1948	n	1958	s	1968	0	1978	n	1988	n	1998	s	2008	b		
1949	b	1959	n	1969	n	1979	m	1989	n	1999	m	2009	b		
1950	s	1960	0	1970	b	1980	n	1990	s	2000	m	2010	m		

As noted earlier, people have a short memory of flood disasters and tend to forget easily. Local residents have attributed disaster unpreparedness to lack of resources, lack of alternative land and information awareness. More factors leading to lack of preparedness hindering mitigation strategies are presented in Section 6.1.2.

Table 6. 2 Updated summary of floods per decade

Flood Magnitude	1941-50	1951-60	1961-70	1971-80	1981-90	1991-2000	2001-10	2011-13	Total
Big (b)	2	4	2	5	0	1	3	1	18
Medium (m)	2	1	0	2	3	5	4	1	18
Small (s)	4	1	0	0	3	3	0	0	11
None (n)	2	3	1	1	4	1	3	1	16
no data (0)	0	1	7	2	0	0	0	0	10

Figure 6.2 shows the researcher (with hat) interviewing a local senior citizen while an assisting local student looks on.

6.1.2.2 Overpopulation and overcrowding

Overcrowding of the Basin by the human populace is a current problem, as people settle in flood plains as land becomes scarce elsewhere. As time goes by and the population in the area continues to increase, the number and needs of people per unit of land increases, exceeding the carrying capacity of the land. As a result many people have in recent years been building homes in flood prone areas, increasing their geographic vulnerability (including exposure) to flooding.

Figure 6. 2 Interview with a local senior citizen

6.1.2.3 Media attention and involvement by the international community

The elderly reveal that there is a big difference in how flooding was received and handled in the past by local residents, government, and the general public as compared to recent years. Floods in recent years have gained tremendous media attention, something which was not the case in the past, raising the awareness of the general public.

6.1.2.4 Decreased social cohesion and increased dependency on government

The elderly also narrated that many residents could only associate themselves with government since Namibia's independence in 1990. As a result, dependency on government was much lower in the past than it is currently. Temporary relocation as a result of floods is not necessarily a new thing, but what has changed, according to them, is the approach and means by which it is conducted. Instead of being provided with temporary camping tents in the past, and by using traditional means and materials such as thatched huts, flood-affected residents used to temporarily relocate to portions of highland enclosed in *ekoves* locally known as *okatunu*, without government assistance as it is in the current years. A detailed presentation on traditional temporary relocation is given in Section 6.3.5. As the elderly share their experiences from the long past, there were also many residents who relocated to neighbours as opposed to relocation camps opted for in recent years.

6.1.2.5 Field sizes and quality of soils

Early settlers were able to select large pieces of land in the most seemingly desirable places in the area. Later settlers could only divide among themselves what was left, settling anywhere for as long as there was space, regardless of its vulnerability status. As a result, being in the most desirable spaces, elderly feel that old fields are less geographically vulnerable to floods. Big field size also meant not all agricultural yields will be lost to floods as the field is highly variable.

Figure 6. 3 Small houses on small pieces of land, located at the peripheries of iishana

Apart from loss of vegetation cover, loss and reduction of livestock especially cattle, due to droughts and floods, and loss of interest in farming activities by the younger generation who migrated to urban centres in search of jobs, reduced trampling livestock trampling and thus manure, in many areas has been regarded as a trigger towards reduced soil quality and fertility. Cow dung manure is the mostly used manure by many residents. This has greatly reduced agricultural productivity at household level.

6.1.2.6 Early warning mechanisms

In contrast to current situations where early warning mechanisms operate via technical means such as SMS messages, radios or internet, the elderly in the 'long past' relied heavily on Indigenous Knowledge (IK) and word-of-mouth (wom) for their predictions with regards to climate and weather patterns. IK included the interpretation of the constellation of galaxies, decrease (drought will occur in the following year) or increase (good rains or floods the following year) in local fruit tree production, animal behaviour (small or large stock), as well as behaviour in children. In many parts of the basin, especially close to the Namibia-Angola border where communication via network is limited or unavailable, IK and wom are still the most reliable methods of early warning.

In summary, Cuvelai floods are not a new thing, and as the elderly have revealed, floods in the Basin have always been in existence. Table 6.3 compares the flood characteristics of past and present flood years as gathered from the local residents.

Table 6. 3 Summary of the flood situation characteristics since 'long past' flood times until 'recent past' flood years

Flood situation characteristics	**Past (before 2008)**	**Recent (since 2008)**	**Overall impact**
Media attention	none	high	
International assistance	none	high	
Dependency on Government	none	high	
Flood impact	low	high	
Local population	low	high	
Vulnerability	low	high	recent = high
Social coherence	high	low	
High land availability	high	low	
Field sizes	high	low	
soil quality	high	low	
Crop productivity	high	low	
Livestock productivity	high	low	Past = low
Early warning	IK, wom	IK, wom, Technical	
Flood intensity	high	Generally stable	
Flood extent	high	Generally stable	
IK = indigenous knowledge, wom = word-of-mouth			

In recent years the overall impact of media attention, international assistance, dependency on government have all increased along with an increase of impact and vulnerability on the local population. In the past higher social cohesiveness, greater land availability and larger fields led to lower vulnerability and less damage from floods even through the flood intensity and extent were perceived to be greater.

6.1.2.7 Structural differences

Mechanical changes within the hydrological and socio-economic systems have been associated with the difference in which people dealt with floods in the 'long past' compared to recent years. As gathered from the local respondents, some of these changes include damming, intentional blockade and redirection of streams, ditches and trenches, and deepening of streams.

- Impact of dams on flood vulnerability

From a community perspective, damming was not practiced in the 'long past' in contrast to recent years when water has been released from dams without communities' knowledge. Residents expressed that sudden increases in flood waters, could be attributed to pumping, or release of dam waters during floods, as the levels increase. Responses came in statements such as '*it is as if they release water from elsewhere these days. Maybe long ago there were no places where they could release the water from'*.

- Impact of river ditching on flood vulnerability

According to local residents, ditching, stream redirection, deepening, and blockade by town councils in an effort to counteract flooding of urban areas, has a double effect on the rural communities. Such activities place residents near such streams at an increased risk of flooding as water is deflected towards their fields. Residents also allege animals are endangered from crossing these ditches as they are sometimes too deep. Additionally, ditching and deepening of streams is especially necessary in areas where the streams have silted up over many years and where the increasing shallowness of such streams exacerbate the impact of flooding. As *iishana* are continuously becoming shallower as a result of sedimentation and deposition of soils washed off fields, the chances of spillage of flood waters over *iishana* to the neighbouring fields are extremely high.

- Ditching at household level for flood control

Another somewhat seemingly neglected practice of reducing the flood impact mentioned by the residents is that of digging trenches around a household. These trenches are later filled with alternating layers of thick grass stems, bricks and other debris as well as soil in the flooded and eroded parts of the field or house. Residents report that this helps to improve the strength of the soil structure and durability of the flooded parts of land. Residents state that, currently thick grass has been constantly flooded and eroded. As a result, smaller seasonal grasses, which are less strong, colonise the areas after flood events. These grasses do not provide the same structural support. Another shortcoming to this practice is lack of man power in households. As the young men leave rural areas in search of jobs in urban centres, many households are left under the sole care of parents and the elderly who are accompanied by young children not ready to take on such kind of work.

- The impact of traditional house construction on flood vulnerability

Residents report that in the past, wood locally known as *iifini*, was used to construct many if not all huts and houses in the households. This contributed to, and accelerated deforestation as presented in Section 6.1.2.8. Mud is currently commonly used for building purposes by the rural poor. Traditional huts were completely made of wood and grass. Sometimes mixed with *mahangu* stalks, wood and grass continues to be utilized as the thatching element (Figure 5.15, Figure 5.26, Figure 5.27 and Figure 6.4).

Figure 6. 4 Household construction is the primary cause for deforestation in the Basin

Mud, sometimes mixed with cow dung, has in the past been used as flooring and to fill the spaces between the wood in the walls. In the past, the Cuvelai was a heavily vegetated area, with Mopane trees. Mopane trees are known to be a highly desirable wood tree for home construction. Favourable cultivation conditions in the Basin attracted huge numbers of the Angolan-originated (*Ámbo) Oshiwambo* people to settle in the area. With no direct source of income, they used available natural resources for building houses, kraals, demarcation of huge parcels of lands, and for fuel. Subsequently, deforestation has increased, leaving the Cuvelai with few trees in isolated parts of the Basin. When looking at households built several years ago, they are completely constructed from a large quantity of good quality strong wood. It is a culture in the Basin that at least annually or after some desired time a household must relocate. While it may become a necessity to revamp the house after some years, such practices are ritual in some cases, especially when head of the house dies. In the process, most of the old wood is replaced with new wood, regardless of the condition of the wood, a process which has intensified harvesting of trees at an increased pace.

Currently, due to the shortage of trees, mud is used as an alternative building material to construct huts and houses. Most of the huts in the lower Cuvelai, where there is a natural lack of trees due to saline conditions, are constructed mainly out of mud and grass by the rural poor.

According to residents, unlike wood, mud quickly absorbs a lot of water, and as a result mud huts and houses degenerate easily. This is especially prevalent in flood and seepage prone areas. Another shortcoming of using mud for construction is that, unlike timber, it cannot be re-used for construction once it crumbles after floods as the cohesiveness is lost. Even though water may seep into wood huts, wood may not necessarily get destroyed and building material is still available even after the disaster had passed and can be re-used. Deaths associated with collapsing of mud sleeping huts are also reported in the area, while none have been reported when wood material is utilized for construction.

6.1.2.8 Non-structural differences

- Deforestation: slash and burn practices

Early village settlers expressed that in the past *these were places where wild animals roamed freely and the population in places that had people residing in them, was low*. *The villages used to be thick forests and there were many plants to intercept the water*. *As the area became more populated, deforestation also increased. Uprooting of trees and other plants caused the soil structure to weaken*, increasing flood susceptibility.

- Shifting of households and kraals (cultural practice)

On an annual basis, as a matter of culture and tradition, households shift to a different place in the same *ekove*. In addition, many local people rely on the use of animal fertilizer for agriculture by rotating and moving kraals from place to place over many years. Sometimes however, households are moved to more vulnerable land.

- The impact of deforestation

It was noted that deforestation can have a significant impact on infiltration and surface runoff. With little or no plant matter on the surface, water is left to run-off much faster than when a surface is covered with vegetation. With minimal obstructions to intercept surface water, water will have less time to infiltrate the ground. With no root structure to bind the soil together, runoff from deforested areas is likely to contain more sediment. The sediment load chokes the stream channel, which would otherwise be available to handle increased flow, leading to increased runoff and greater flood vulnerability.

6.1.2.9 Changing patterns of natural phenomena

Though vague, some terms used by local residents are '*the sun is too hot nowadays*'; '*it used to be drought years, but now rains are too many*'; '*it rains too much in neighbouring countries nowadays*'; '*rains also come too early now as compared to the past*' communicate to the researcher that community members have a general idea about global warming and shifting climate and weather cycles.

6.1.2.10 Lack of indigenous information and ignorance

Senior citizens noted that a lack of community knowledge in dealing with flood disasters is a factor that contributes to younger generations acting indifferent and with ignorance in attempts at reducing the impact of floods at a household level.

Places of residence are chosen based on aesthetic personal preferences. Where one may choose to settle and how one wants to construct one's houses and with what material remain the land seeker's decision. With good experience of the area and the area's flow patterns, the senior citizenry were much more cautious and informed when it came to choosing land for various purposes. Much of this information lay in indigenous knowledge of local features as presented in Section 6.1.2.6. These features are used to predict and understand the past and future occurrences of events such as rains, droughts, years with good harvest and so on. Indigenous knowledge systems are generally criticized by the liberal youth as the elders report. Elders indicate that younger generations often underestimate and undervalue indigenous knowledge, and refuse advice on where to settle in a village when it is based on indigenous knowledge. Several confessions were made by middle-aged and young household owners that they ignored warnings of certain elderly, not taking advice from village headmen and have experienced flooding in the past five years. Many of these houses were built after the 1990s.

6.1.2.11 Cultivation and agricultural practices

Another difference between the 'long past' and 'recent past' as gathered from the local communities lies in the varied ploughing mechanisms used over the years. In the past, people used to plough by hand, generating high rounded plots that resembled grave mounds with wide open passage ways in-between them to allow free flowing of water. In recent years however, tractors and ox- or donkey-drawn ploughs are used. The plots created by tractors and animal-drawn manually operated ploughs are relatively flat, with no clearly defined water ways in-between them causing water to flood the plots. Standing water in the fields may cause extensive waterlogging presented in Section 5.4.2. After floods, seasonal grasses reportedly establish themselves and colonise the flood affected fields and other areas. This subsequently hampers crop productivity as poor *mahangu* is produced, thus increasing vulnerability. Areas not previously flood-prone, especially between *ombuga* and the salty dry areas around Ongandjera that were later abandoned for residence, are nowadays subjected to flooding after years of reworking the land.

6.1.2.12 Superstitions and beliefs

Residents narrated that hundreds of years ago, there were superstitions that the rains had 'owners', and that rain events followed these 'owners'. This meant that when the person linked to the rains dies, the belief is that the rains disappear altogether with them, sometimes causing droughts in some parts of the area. There was also another group of people that did not own the rains, but had developed special powers to 'warn' the rain so that it does not fall at certain times. When these people die, they take their powers with them to the grave. As a result, rains come uncontrollably at these times as there is nobody to 'warn' it. One activity linked to such superstitions is the fact that people used to cross water riding on cattle, who are naturally good swimmers. This whole belief was locally referred to as *okuhomeka odula*, directly translating as *preparation of the rain*. Some residents feel it floods because *God is angry with us and how we are behaving in today's world.* Some compare the floods with biblical revelations e.g. Noah's ark.

6.1.2.13 Other factors contributing to high risk of flooding in rural areas

- Ignorance and lack of information awareness

Residents are not aware of the hydrology of their places and how to deal with natural phenomena such as floods in their area. There is an expressed need for information awareness campaigns and sensitization programs to foster understanding of floods and other environmental matters.

- Fencing-off of large fields (to be reserved for families at later stages)

Many people tend to fence off land and reserve it for their children when they decide to make their own homesteads. The land can later be subdivided among the sons of the house. This leads to unutilized pieces of good land fenced off and reserved for family usage for many years ahead.

- Illegal fencing and land grabbing by the rich and famous

Another factor classified as contributing to high risk of flooding is bribery and greediness of the TA leadership, accepting cash in exchange for land to the wealthier members of the community. These 'bribery for logging' practices have led to a greater decrease in the community forests that existed in the past when bribery was very minimal. See also Section 5.5.2.

Illegal fencing is mostly a practice of the rich and influential members of the community, TAs, business and the political arena who are powerful enough to bribe the TA. Fencing-off of large pieces of land denies other community members a chance to choose good land, leaving them no choice but to reside in flood prone areas.

6.2 HOUSEHOLD LEVEL MITIGATION STRATEGIES

In this section the community perspective on mitigation strategies that can be implemented at household level are presented looking at general preparedness, response to floods as well as mitigation and reduction activities.

6.2.1 Preparedness

There is a general perception in the community that *floods are God's given punishment and therefore there should be no need to prepare against God's wishes*. Beliefs and superstitions of this nature may render residents even more vulnerable as they would not value early warning initiatives.

6.2.1.1 Incorporation indigenous knowledge in early warning strategies

Using resources and indigenous knowledge as presented in Section 6.1.2.10, residents ((Chi-square (df=2) =0.14, p=.93394) gave their predictions on whether flood conditions will prevail within the coming year. The responses (Figure 6.5) are quite similar for all types of residents (community leaders, flood-affected residents and non-affected local residents), with an average of 58% expecting future impacts of flooding while 42% do not foresee chances of flooding in the following year.

Some specific indigenous knowledge based predictions were made, stating that *2013 would be a year of drought*. Though some residents could predict floods or droughts for the coming year, as shown in Figure 6.6, the majority of flood-affected residents (89%) were not able to use indigenous knowledge to predict that they would be flooded.

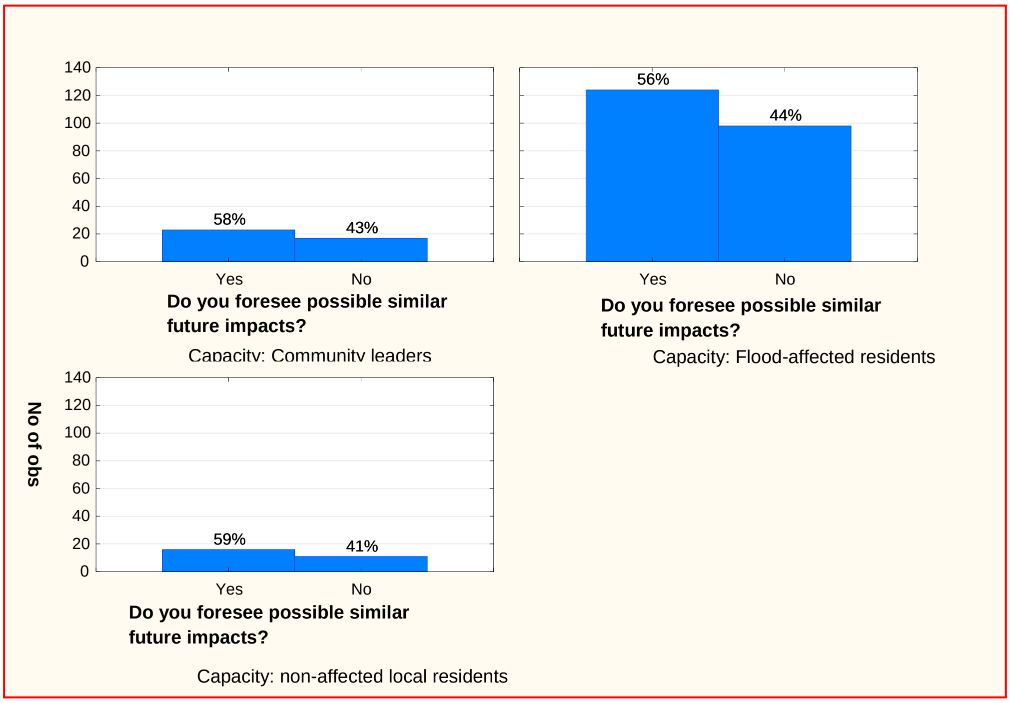


Figure 6. 5 Community predictions based on a combination of technical early warnings and indigenous knowledge

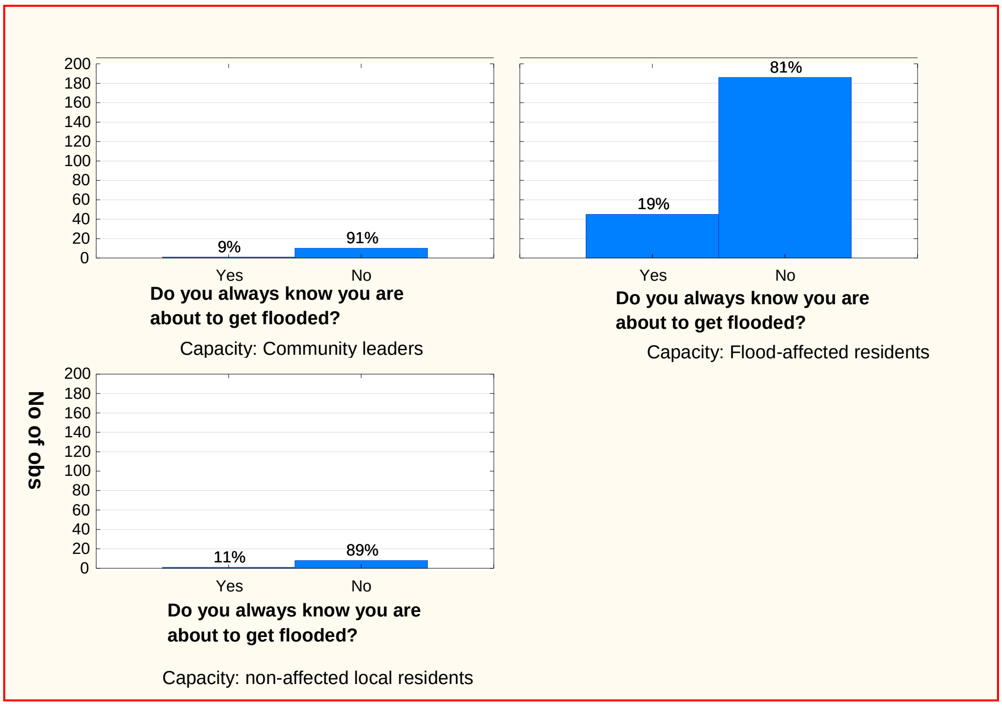


Figure 6. 6 Community's knowledge pre- floods

Just as they are able to predict future floods, some residents are able to forecast when immediate floods would reach their areas (Chi-square (df=2) =1.27, p=.52994). There are also those that are able to predict the approximate days when the floods are expected to reach their areas from other areas or villages within the course of the floods. Such information has allegedly been built up over years of word-of-mouth communication between residents.

6.2.1.2 Preparedness strategies

Like the flood-affected residents, non-affected local residents and community leaders that are often not prone to floods, do have preparedness strategies in place (Figure 6.7). However, the residents not affected by flooding are less prepared than flood-affected residents (33% vs. 65%).

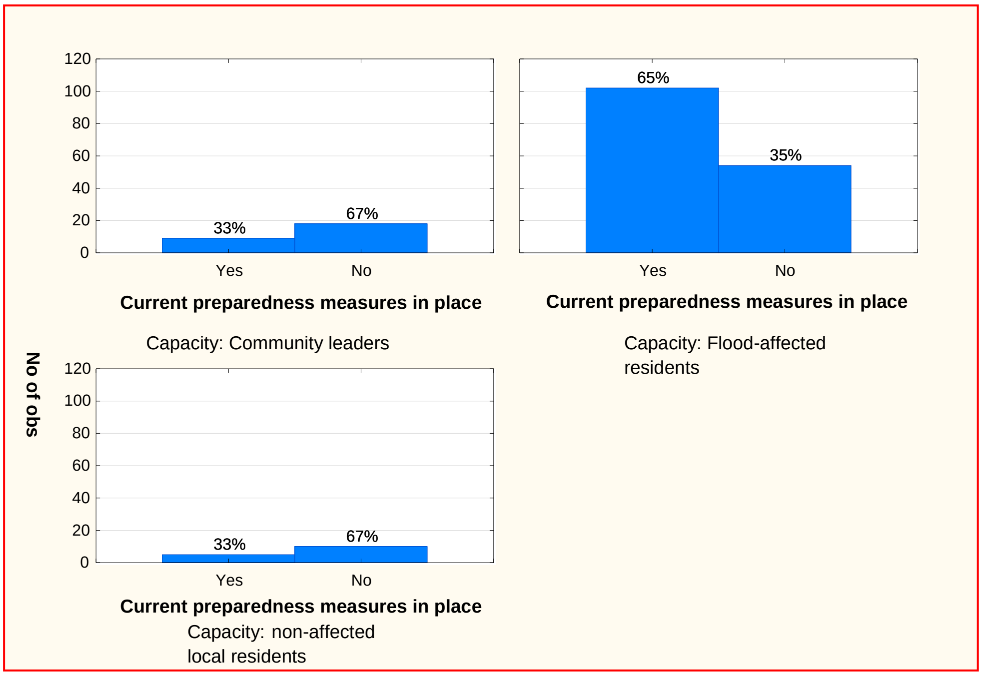


Figure 6. 7 Proportion of residents with preparedness measures in place to that of residents with no flood preparedness measures in place

Though such differences do exist, statistically, there is no significant relationship between the type of resident and flood preparedness measures ((Chi-square (df=2)=13.90, p=.00096). In response to the questionnaires various preparedness measures were suggested and recoded into four categories: alter agricultural practices (13%); build back differently after floods (26%); mechanical intervention (10%); or do nothing (51%). Geographically vulnerable residents (*High* in Figure 4.39) were more likely to suggest rebuilding differently after floods (86%) and using mechanical intervention (82%). Forty one percent of socio-economically vulnerable residents (*High* in Figure 4.39) also chose mechanical intervention as preparedness measure while only 21% thought that altered agricultural practices would benefit them in times of flooding. There is a rather weak association between the level of geographic vulnerability and the flood preparedness measure (Chi-square (df=6)=6.49, p=.37017), as well as between socio-economic vulnerability and flood preparedness measures (Chi-square (df=6)=8.68, p=.19226) as shown in Figure 6.8 and Figure 6.9 respectively. Seventy nine per cent of geographically vulnerable residents (Figure 6.8) and 34% of socio-economically vulnerable residents (Figure 6.9) believe that they do not have to prepare for flooding events.

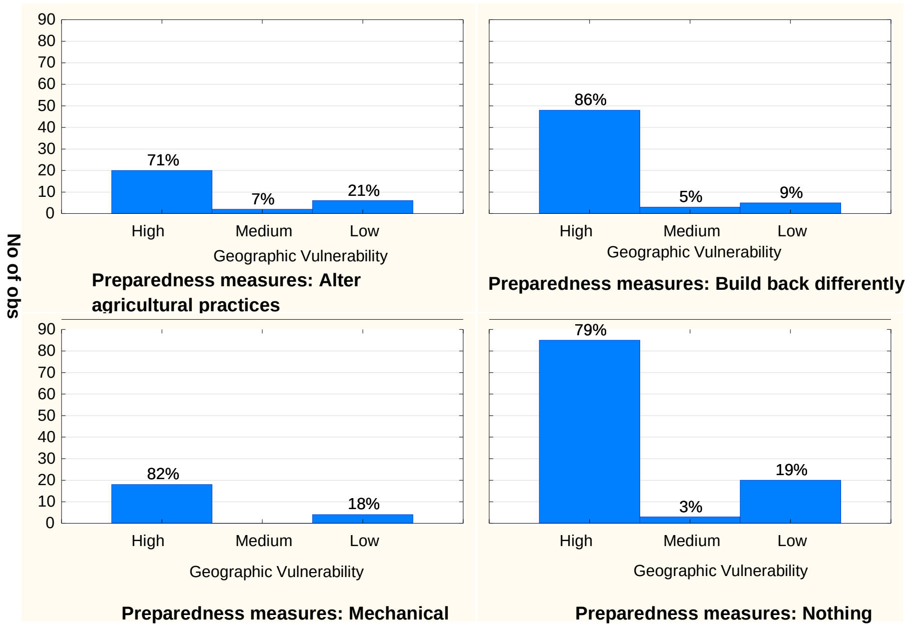


Figure 6. 8 Different flood preparedness measures suggested by geographically vulnerable residents

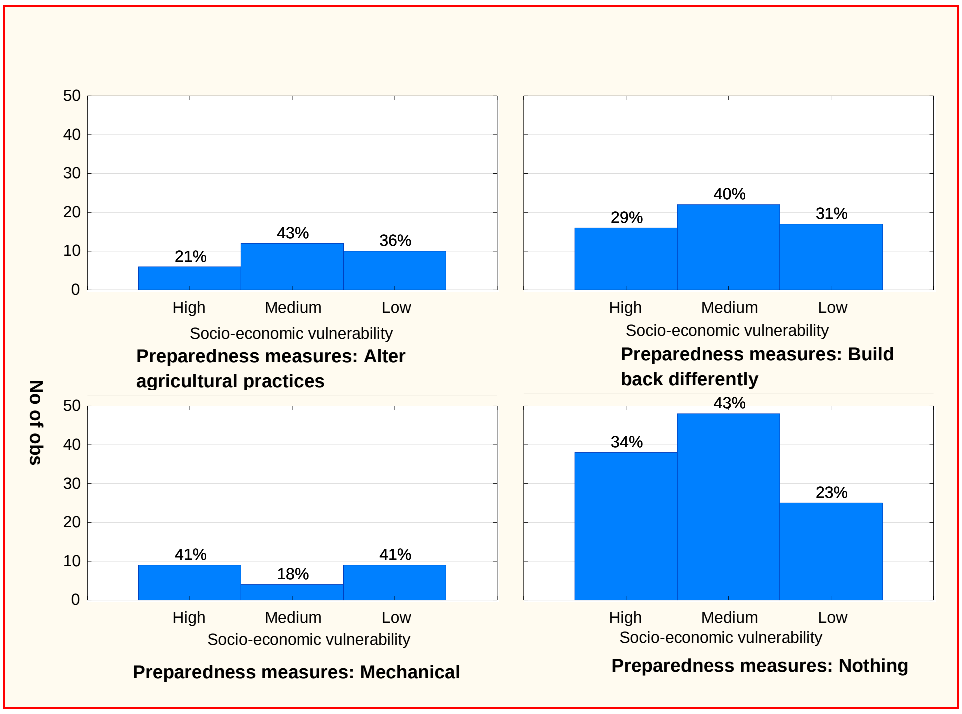


Figure 6. 9 The impact of socio-economic status on flood preparedness

Fifty percent of flood-affected residents with high geographic vulnerability were prepared for floods compared to 46% that are moderately or low geographically vulnerable. While a considerable number decide not to prepare for floods (51%) due to perceptions, *lack of resources and exhaustion of alternative options*, there are those that see the need to prepare. Details of these preparedness strategies outlined by residents include: altering agricultural practices, build back differently strategies and mechanical strategies, structural at both regional and household level, have been presented in Section 6.1.2.7.

6.2.2 Response

As a result of high standing water, some residents (~30%) relocate to neighbours and relocation centres where they stay for the duration of the flood season, or until water levels subside. Many residents (~70%) indicated reduced willingness to relocate in the future, due to reported cases of *crime*, *harassment*, *theft of personal property while in the communal tents* and *house burglary while house owners are in relocation camps*. This is the case in all three transects, where the majority of the residents (Chi-square (df=2) =2.33, p=.31182) indicated they would stay at their residences regardless of the flood magnitude and extent (Figure 6.10).

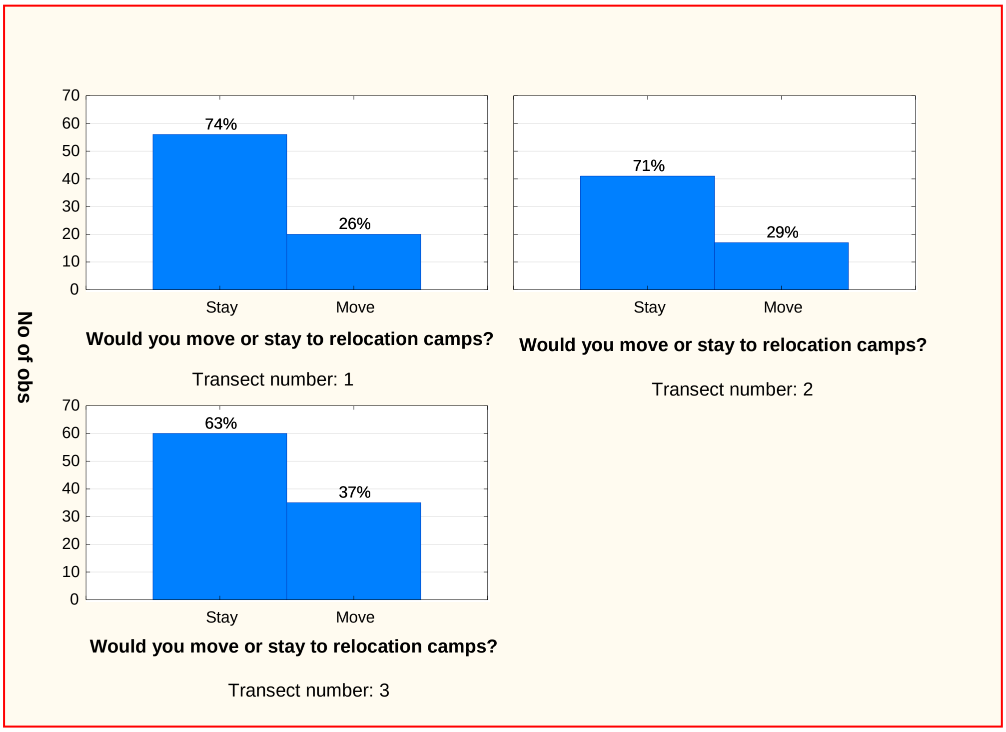


Figure 6. 10 Willingness to relocate should future floods occur

It has been reported that the tents and free items given in relocation centres during flood events have *increased dependency on leadership*, and *triggered parasitism in residents who would relocate to tents even when they are not flooded*. Residents have made recommendations for *village headmen and village committees to be consulted first when residents seek refuge in tents*. *Letters of recommendation from village leadership for residents to seek refuge at relocation camps* have also been suggested. Many residents suggest that *individual tents should be allocated to flood-affected residents per village as communal tents are inconvenient*. *Unhygienic conditions and conflict between residents* are some of the associated consequences of living in relocation camps.

Residents willing to relocate prefer permanent relocation (79%) to any new land where they can re-establish their households over temporary relocation to relocation camps (21%). Residents opting for temporary relocation prefer *camp sites in their own village* (Figure 6.11 in close proximity to their residences where they *would be able to watch over and protect their crops, livestock, houses, and guard against robbery* (Chi-square (df=1)=18.43, p=.00002).

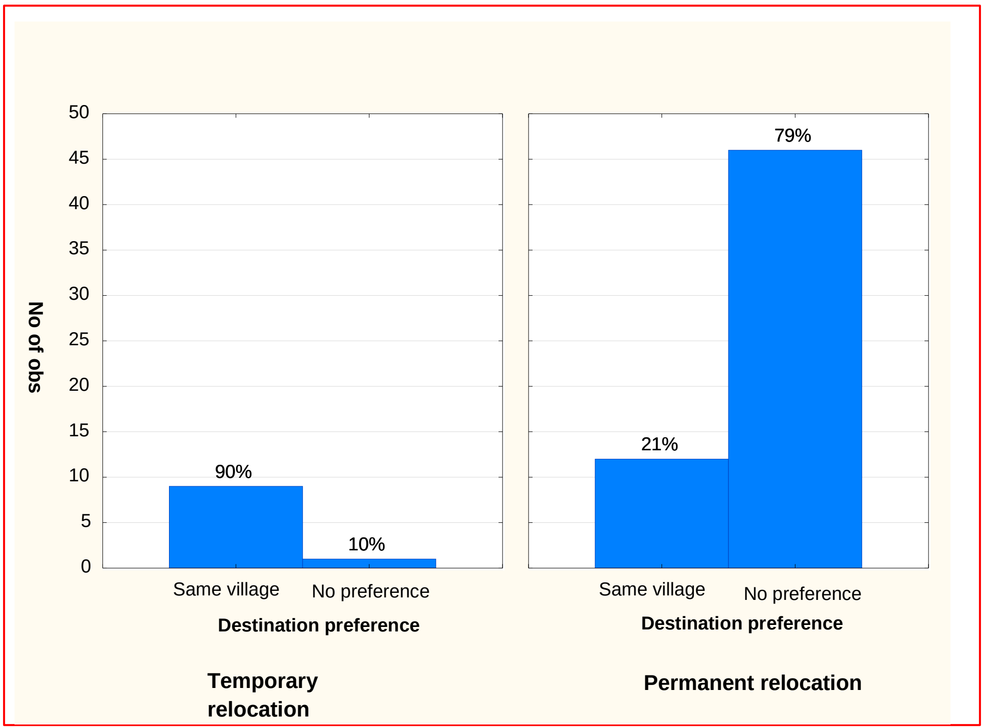


Figure 6. 11 Preferred relocation type

6.2.3 Mitigation and reduction

The more money a household accumulates, the better the chances of building flood resilient structures, and the more likely such households are to re-establish themselves post-disaster (Chi-square (df=2)=1.78, p=.41078). One of the possible mitigation methods is *building a flood protection barrier around the ekove*. Sixty three percent (n=139) of respondents expressed that it would be impractical to surround their *ekove* and households with flood protecting barriers such as cement walls or other kinds of barriers. Only 27% highly socio-economically vulnerable residents would be able to afford such a barrier (Figure 6.12).

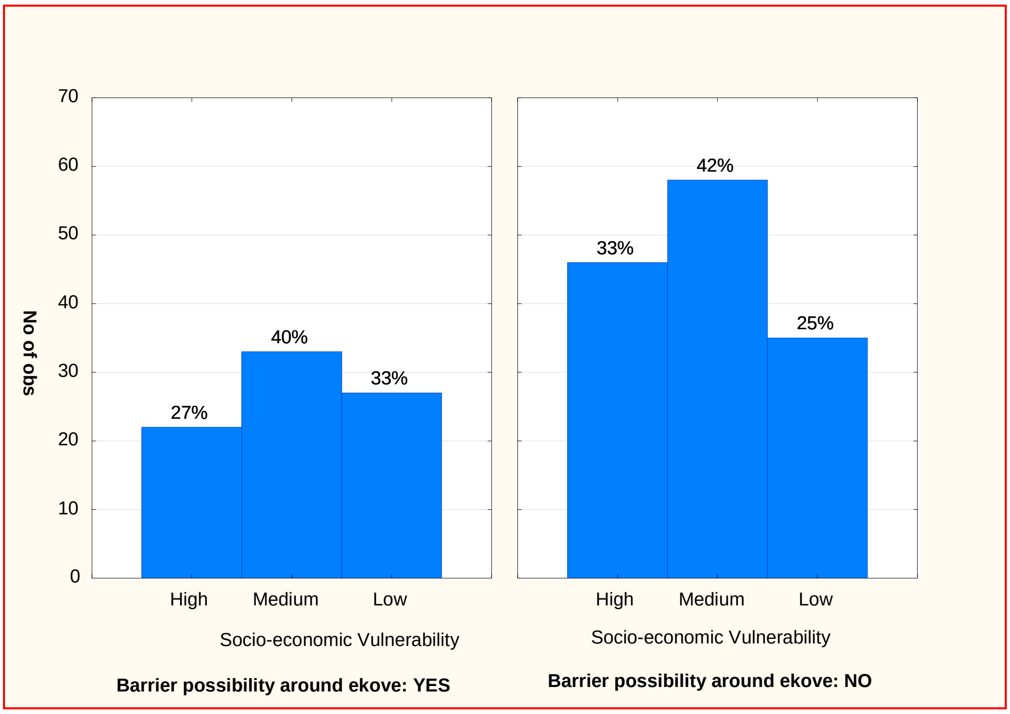


Figure 6. 12 The impact of socio-economic conditions on flood mitigation

Apart from affordability, another reason for not constructing flood protection barriers is the high magnitude of floods experienced in certain areas where *proposed structures would not be able to withstand the water pressure*. Another interviewed group expressed the fear that *structural based methods may change the natural water courses, deflecting flood waters to neighbours*. Structural features are presented in Section 4 6.1.2.7.

6.3 PRACTICAL ADAPTIVE STRATEGIES

In addition to mitigation measures discussed in Section 6.2, the interviewees have also suggested various practical adaptation strategies to floods which include mechanical and household construction recommendations, addressing high lying land shortages, temporary and permanent relocation, community projects and education, better communication and altered agricultural practices. Some mitigation strategies such as '*altering agricultural practices*' presented in Section 6.1.2.11 are further detailed in Section 6.3.9.

6.3.1 Mechanical recommendations

- Damming at critical sites along *iishana* channels, redirection and deepening of *iishana*

The residents have recommended that the amount of *earth dams on iishana channels should be increased*, suggesting that apart from technical surveys, they should also be *involved in the siting process of the earth dams locations*. A similar issue that is raised is the *redirection and deepening of critical streams to lessen the amount of water reaching the communities* *residing near iishana. Deep trenches are however deemed dangerous to human and livestock wishing to cross the iishana from one place to another*, adding that *warning signs should be erected at sites of excavations* for human safety.

- Deepening of water ponds in *ekoves* and tunnelling

According to residents, the *ondobe* depressions become choked with sand by many years of soil deposition. *This makes them shallower than they initially were, causing water to overflow to other parts of ekove and houses*. Residents felt that by deepening the *ondobe* depressions, most of the *flood waters can be retained, thereby minimising excess spillage and run-off, reducing the impact of flooding at household level*. In cases where depressions do not occur naturally, residents have recommended that *large holes be excavated in ekoves at several low lying sites to trap the flood waters*.

In addition, residents suggested that *a large canal (ditch) should be dug on the side of oshana, just between oshana and ekove, to avoid the flood waters from reaching the fields, at the same time channeling the water along the iishana*. This trapping practice has been reportedly used locally in the 'long past' to control army worms' invasion from one *ekove* to the other. Though rare, an effective example of this activity was reported by a Transect 2 interviewee in Othingo village. While reducing the amount of water reaching the field in some areas, some residents are opposed to ditching as it has reportedly *exacerbated flooding of households further downstream of the trenches*. Digging trenches from inside the house to *iishana* works in some areas, but *worsens the flood situation inside the house when water levels in iishana rise excessively*. Other similar mechanisms suggested are the use of *sand embankments and sandbags*.

- Constructing crossing bridges to schools

To make it easy for school-going children to cross the flood prone *iishana* on their way to school, *construction of crossing bridges to all schools* were suggested. This will help against keeping learners away from classes for pro-longed periods of time by floods.

6.3.2 Household construction practices

The materials selected for house construction have a huge impact on how a household is affected by the floods. Choices of construction material depend on what a household is able to afford. For socio-economically vulnerable households several mitigation measures have been suggested by the interviewees as shown in Figure 5.26 in Section 5.5.3.

- The less poor households have suggested *replacing mud walls with cement or corrugated iron sheet especially for sleeping rooms as cement* lasts longer, is not so prone to seepage when used properly and does not dissolve in flood waters like mud. To cut costs, only the *foundation of the rooms could be built of cement to counteract seepage*, leaving the rest of the walls to be constructed of mud.

- Poorer households have suggested *replacing mud walls with stalks and grasses as they are less fatal when dismantled in floods*. With the concern that grasses and stalks, just like mud, cannot be recycled for construction, some residents have suggested the *replacement of mud walls with wood, as wood does not decompose as fast as grasses in damp conditions and can thus be re-cycled many times* (See Figure 5.27 and Section 5.5.3.

To *minimise standing water and erosion, sand or clay soils are piled inside the homes to raise the foundation*. *Alternating layers of thick grass stems, bricks, debris and soil are placed in dug trenches to reinforce erosion prone areas*. To further counteract the consequences of seepage, the following practices have been suggested: *placing plastic layers underneath the mud floor during construction; using locally made wooden beds instead of sleeping on the floor; placing plastic layers underneath blankets if sleeping on the floor; cooking on top of elevated iron sheets or placing an elevated cement veranda in cooking areas; elevating storage facilities as well as stacking bricks together to create temporary stairs leading between rooms and to the outside of the house.* Other recommendations include *donating gas cooking stoves to each household*, *thatching the roofs before every rainy season*, and *building away from water bodies*.

6.3.3 Addressing high lying land shortages

In the Transect 3 village of Engombe where high lying land is typically scarce, some areas are reportedly being fenced off by authorities for alleged projects without the consent of the local people. The residents have called for community level involvement and agreement in such matters.

Interviewees have recommended that when cattle posts, especially in the *ombuga* areas, have not been used for a long time, *surrounding fences should legally be removed to enable re-use of this scarce resource by those in need*. Some residents have even recommended that *all cattle post land be re-distributed among households in flood prone areas*.

6.3.4 Permanent relocation

- Assistance with permanent relocation

Seventy-nine per cent of interviewees have indicated that they are willing to relocate (Figure 6.11 in Section 6.2). Residents that are willing to relocate have highlighted *lack of resources* (mentioned in Section 6.2) as the main obstruction to the relocation process. Residents called on government to provide assistance especially with *supply of constructions material, transportation of such materials to relocation sites, clean water supply, and schools at relocation sites*.

- Permanent elderly homes on high lying land

Residents from Transect 2 proposed the construction of special homes with assisted living conditions on high lying land for the elderly. People from the villages could be employed on a full time basis to take care of the elderly, and police facilities would be available on site to ensure safety of the elderly, thereby allowing the elderly to have trust in the system. Such a setup residents say will allow the elderly to keep occupied with normal activities such as weaving of baskets. This would reduce the shock brought about by potential relocation, which is expected as one headmen put it, '*to ease pressure on residents when they relocate during floods as the elderly are stubborn and refuse to relocate even when houses are flooded. It puts pressure on me as I have to cross iishana sometimes two times a day to see, door to door, how they are doing. Two elderly people in my village refused to relocate even after the Red Cross intervened on more than two occasions'*. To avoid pensioners from crossing *iishana* when collecting their government pension money during floods, pension sites could be made available near these elderly homes.

6.3.5 Temporary relocation

- Provision of individual rather than communal tents

Residents opting for temporary relocation have suggested that '*individual rather than communal tents should be offered'* [to the flood-affected residents]. Instead of having to re-apply each year a flood occurs, some tents should be stored at a safe facility within the village (possibly the headmen's home). Residents feel that this will decreases the long waiting period for tents to arrive thereby reducing the impact on flood-affected residents. Residents would also prefer to *relocate within the same ekove* in order that they could watch over their homes to curb theft that increases when home owners are away at relocation camps.

- Relocating a traditional hut to *okatunu* for temporary relocation at household level

Some residents, with 'attitude type two' or optimists as described in Section 5.1, felt that there is a need to '*reduce over-dependency on government'*. Their adaptive strategy is to *construct a permanent emergency hut within the same ekove*. This emergency hut, located on *okatunu*, a high lying piece of land within *ekove* not large enough for a household (should be equipped with basic necessities such as kitchen utensils, blankets, firewood and *mahangu*. Though extremely uncommon, this practice has been observed in few places in the study area, most especially in Transects 2 and 3, and may need to be further encouraged.

- Constructing permanent structures for temporary relocation at village level

A further adaptive strategy to facilitate relocation at village level is the construction of a permanent building in each village, to be used during floods. This permanent structure should contain three components: a *storage component*, where individuals can store their *mahangu* and other belongings under lock and key during flood events; a *sleeping component* where families can get sleeping rooms during floods and other disasters; and thirdly, a *cooking component* should be incorporated in the facility. Facilities should have proper sanitation services and electricity. The cooking facility will allow non-affected residents to prepare meals for the flood-affected residents, especially children, the elderly and people with special needs, and to distribute the prepared food items to the flood-affected residents.

Each village should allocate land for temporary relocation purposes. Villages with no remaining high lying land should negotiate with neighbouring villages for cooperation.

6.3.6 Community projects

- Legally enforced community fields and silos

It is the custom for flood-affected residents to take shelter at the headmen's houses during flood disasters, which places immense pressure on the headmen's household to produce food for all residents camping there for the duration of the critical flood period. This prompted the headmen to suggest the idea of communal fields in each village. Each village is to *identify a piece of commonage land, on which all villagers must cultivate crops or provide financial assistance towards cultivation, in addition to their own fields. The agricultural produce should then be stored in community silos to be distributed to the needy during disasters*.

As the headmen narrate, this practice is not entirely new. In the 'long past' villagers falling under TAs were expected to cultivate on their chief's fields, or donate a barrel of *mahangu*, a donation locally known as *eempale*, to the chief's silo. This *mahangu* would then be distributed to the needy during times of need. This practice fell into disrepute in some areas as some chiefs misused their powers to care for their excessively large families. In addition, due to successive drought years, many villagers were no longer able to give *eempale*. There are still some TAs practicing *eempale* to date, but the process is not as strict or compulsory as it was in the 'long past'.

When not used for production of *mahangu* during the rainy season, community fields are cultivated to produce fresh vegetables to be sold at reasonable prices during dry periods. This allows for job creation, thus attempting to alleviate poverty and malnutrition at village level. An example of such a community project can be found in the Transect 2 village of Etope in the *ombuga* areas, where the village headmen coordinated the households to make monetary contributions towards the project. Monies administered by the village headmen were used to install a network of water pipes for the communal field. Since this type of community project is so beneficial, the headman has recommended that the government get involved with financial assistance and promotion of such community projects.

6.3.7 Community education

- Training of village committees on flood related matters and other disasters

Village committees often do not understand matters surrounding flood risk management in their villages, and are left unsure of what to do, how to act and what procedures need to be followed during a disaster in their villages. They have indicated that '*there is always confusion*'; '*we cannot easily identify who is a flood-affected residents and who wants to be a parasite.'; 'We cannot help our people because we do not know how to help them'* and '*we need to be taught how to handle our people during disasters'.*

- Training of young persons in communities in basic map and image interpretation

Maps aroused a lot of interest in the communities as seen in Figures 5.2 and 5.5 in Section 5.2. Generally, community leaders are more acquainted with map reading skills than other community residents (Figure 5.4). The residents have recommended that *young people from the villages should be trained in basic map interpretation who can then in turn train other villagers*.

- Information awareness campaigns and community empowerment

The interviewees have reiterated that providing flood early warning information to communities without providing knowledge on how to interpret such information does not help them in any way. Early warning messages have typically been received by radio, which has been difficult for some residents to understand, causing some communities to rather rely on traditional early warning signs by using indigenous knowledge. They also recommended that early warning should '*not only tell that floods are coming'*, but should also '*inform communities how much is expected, and what areas will be affected, not in numerical terms, but by descriptive means e.g. comparing the expected floods with previous floods'* so that residents can gauge how much they will be affected.

Residents have highlighted the need for education and training at village level as a very important adaptive strategy for alleviating flood vulnerability.

6.3.8 Communication

- Incorporating indigenous knowledge in disaster risk management at community level

While some residents indicated lack of early warning information, others maintained that technical early warning information is untimely. Those closer to Angola especially in upper Transect 1 have noted that they have successfully over the years relied on 'word-of-mouth' warnings from their Angolan counterparts upstream rather than technical early warnings from government. There is thus a need to incorporate indigenous knowledge and communities in early warning and disaster risk management initiatives.

- Direct communication between TAs and the government

Village headmen and the community leaders recommended that early warning information should be passed down from '*the water people'* to the headmen rather than only to administrative regional councilors as it is currently practiced. Comments such as '*keep us in closer contact too'*, '*incorporate TA administration in early warning matters',* '*we are treated and made to feel like empty vessels who cannot lead our own villages and people'*, '[government] *officials undermine TAs'* were used.

Many residents have [Frequency Modulation (FM)] radios which makes it easy for regional councillors to warn residents of the disaster when notified. However in some parts where people do not have radios, the village headmen when contacted, hold emergency village meetings or in some cases walk house to house to warn the villagers.

'*Regional councilors are politically elected* [leaders] *and have no say in matters directly relating to land in villages, they lead on a short term, most of the times they are relatively young, and they do not have background information or knowledge on flood history or the people in an area, as compared to the village headmen. On the other hand, the village* *headmen understand the area and its people, and should be the ones to be in direct contact with the villagers rather than the regional councilor only'*.

6.3.9 Alter agricultural practices

- Synchronise cultivation periods with rainfall patterns

Through information awareness campaigns presented earlier in Section 6.3.7, '*community residents should be made to understand that rainfall patterns are changing, and they should cultivate according to the changes'*. '*Nowadays Angola waters come too early when mahangu is still small and vulnerable, unlike in the past when it flooded once harvesting was complete or nearing completion'*. It is recommended by some residents to '*plough early'* ahead of the floods. Should floods come when harvesting is not complete, mature *mahangu* cobs should be harvested and placed on top of alternating layers of dry grass and stalks, allowing for water to seep through while slowing down cobs sprouting and spoilage.

- Substituting mahangu with water tolerant crops

Rice cultivation, tested by one family in Onandjamba village in Transect 1 with positive results, has been a successful replacement crop for *mahangu* during periods of excessive floods. The family grew rice in the lowest lying land of their field, while planting *mahangu* on higher lying land parts. While reaping almost nothing in *mahangu* areas, they experienced good rice production during the 2009 floods and were able to survive primarily on rice for most of the subsequent year, prompting the household to replace *mahangu* with rice production during floods.

- Substituting crop cultivation with grocery shopping

Since the floods in the past years, some residents reported that they have not cultivated their fields and have opted to rather purchase groceries from supermarkets, thereby saving the money invested in ploughing services and maintenance of fields. Due to potential accessibility issues during floods, residents are compelled to buy enough maize meal flour and *mahangu* grains to last for the entire flood season.

- Ploughing differently

Residents have recommended ploughing their fields in the direction of the water flow. This, they say, channels excess water to *iishana* and causes much less erosion.

Residents have also indicated that due to increased erosion and years of modification, the agricultural productivity of soils has decreased. Residents who have been using artificial fertilisers have reported good harvest and have recommended the of use fertilizer to hold the soil together and increase crop productivity to other residents.

The people of the Cuvelai feel that they have a lot to offer in terms of practical adaptive strategies to reduce the vulnerability to floods, much which hinges on education and training and better communication strategies.

CHAPTER 7: FLOOD IMPACT AND VULNERABILITY ANALYSIS OF THE CUVELAI BASIN

7.1 INTERVIEWEES

It was mentioned in Section 5.1 that village headmen identified the worst and least affected residents' households from the village maps and crated their vulnerability status from least to worst affected in the village. Due to increasing sample homogeneity and community leaders advice, the total number of households visited was reduced to 314 from 495. As mentioned earlier in Section 3.8, purposive sampling is a deliberate informant selection tool which does not need underlying theories or a set number of informants (Tongco 2007). The idea to take purposive sample from the communities has been documented by Lopez *et al*. (1997); Seidler (1974); Smith (1983) and Zelditch (1962). Bernard (2002) and Lewis & Sheppard (2006) also mentioned that the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience. Informants may also be chosen out of convenience or from recommendations of knowledgeable people (Lopez et al. 1997; Seidler 1974; Smith 1983; Zelditch 1962), as it was regularly done by the local headmen and their representatives for this study. As can be seen in Figure 5.1, the distribution of respondents per transect were slightly varies with Transect 1 housing 32% of the respondents, while Transect 2 and 3 contributed 27% and 41% respectively. Majority of the selected respondents interviewed, fell in the category of 'flood-affected residents victims' that were adversely affected by flooding in the past (237 out of 314).

The focus here must therefore be shifted not on the number of interviewees gathered in each transect, but rather on the useful and reliable information that was gathered on flooding in the Cuvelai at village and household level, a general argument supported by Gomez-Beloz (2002) as well as Karmel & Jain (1987). Such studies encourage the used purposive sampling and have optionally decided to disregard statistics when it comes to sampling. Alexiades (1996); Bernard (2002) and Snedecor (1939) have also argued that random sampling is not always feasible, and not always efficient for sampling and data collection (see Section 3.8).

It was also raised that the perceptions of local residents towards the government greatly and randomly varies from place to place, and a consequence, two types of 'attitudes' were observed by the researcher. 'Attitude one' has poor and pessimistic residents that had generally lost faith and trust in government and may vent their frustrations first before they agree to commence with the interview process citing lack of trust in government. 'Attitude two' is more optimistic in nature, and residents are willing to easily cooperate with or without any immediate benefits from the government. Much of 'attitude one' speaks to the cognitive approach towards trust which is based on the idea that people decide whether to trust a person or institution (the 'trust object') by weighing a combination of factors about the trust object, such as commitment, competence, caring, predictability and openness as described by Kasperson et al. (1992) in Section 3.7.1.

7.2 VULNERABILITY MAPS

The 'good' to 'average' categories (a cumulative of 76%) of residents with knowledge and interpretation of maps by community respondents as shown in Figure 45.4 is not entirely surprising. Since the beginning of 2011, traditional community leaders and representatives in communal areas of the country started receiving basic week-long training covered the overview of the Communal Land Reform Act (Act No. 5 of 2002), Traditional Authorities Act (Act No. 25 of 2000), land conflict and boundary resolution, and land management issues at the grass root level, in which interpretation of maps was a very basic component (Government of Namibia n.d.). The project, also known as the Communal Land Support (CLS) Project was executed by the Ministry of Lands and Resettlement. Though the difference that this training left in rural communities was never quantified or measured as the project is still on-going (and most likely never will be), the mark that this training has left is quite observably obvious in some areas. By comparison, other parts that were not covered by such programme tend to struggle with map interpretation. It will thus be of great importance for community residents to receive basic map interpretation awareness campaigns of a similar nature to ensure that vulnerability maps are optimally and rightfully utilized by the villagers.

7.3 UNDERSTANDING THE FLOOD CONCEPT

There are three main ways that residents understand floods in the Cuvelai Basin that were identified in this paper. Firstly, residents defined floods based on direct damages and impacts of floods. Secondly, the local residents described flooding as steps in the process and flow of flood waters as they progress from upstream to downstream. Thirdly, the local residents have described floods by relating to how they interact with those upstream and downstream of them. These three closely intertwined perspectives of understanding floods by local residents have never been documented at basin level, and are discussed below.

As it was mentioned in Section 5.3, the definition and understanding of flood events by local communities is heavily dictated by residents' experiences and the direct impact flood waters have had on the residents and property. A considerable number of residents have defined flood as either ‘standing water in houses or fields’ posing a direct impact on agricultural production and human activities (Figure 5.6). An equal number of community members understand floods as a combination of flood waters coming from the highlands of Angola in combination with local rainfall. Though a small number, three households related to flood events as an opportunity to get more food for livestock and human consumption. If Tongco’s et al. (2007) belief that it is the quality of responses that matters and not necessarily the quantity of the sample is to be applied here, this finding is equally important as in cases where a large number of households represented a particular response. As a result of better understanding of local phenomenon by the village headmen partly expressed in Section 5.2, many of the community leaders mentioned to have associated local floods as generated elsewhere up in the catchment in Angola. The Cuvelai Basin, in northern Namibia, is a shared hydrological resource between Namibia and Angola (Figure 1.1), with Angola typically referred to as the upstream at a wider basin scale, and Namibia being located on the downstream of the basin. Conversely, flood-affected residents mostly defined floods as standing water associated with direct damages and losses to property. This is understandable seen from the perspective that flood-affected residents mostly experience the impact of flooding at first hand, and the negative consequences thereof. As NHS (2010) documents and as it is also observable from Figure 1.2 (also see Section 4.2.2), many of the villages also lie in areas where the iishana are not well defined, and flooding is primarily due to local rain, (including flash floods) rather than as a result of water flowing in from elsewhere. Consequently residents in such areas will define floods as standing water from local rain rather than that of a riverine based flow as defined elsewhere across the basin.

Flood definitions provided by local residents also indicate a step in the process and flow of flood waters as they progress from upstream to downstream (Figure 5.8). FEMA (2014) has documented in Section 4.2.3 that the dynamics of riverine flooding vary with terrain. The elevation is not uniform all over the Cuvelai Basin, and the downstream course, just like that of any other basin, has relatively lower and flatter elevation than the upstream course. In relatively flat floodplains, areas may remain inundated for longer durations (FEMA 2014). Residents in Transect 1 (upstream), being the most northern and closer to Angola, define floods as overhead waters from Angola that combines with local rainfall to create catastrophe. This is understandable as the location makes Transect 1 residents the first receivers of floodwaters from the Angolan highlands. As explained in detail in Section 4.2.3, Transect One, Transect Two and Transect Three are thus envisaged to represent the upstream, the midstream, and the upstream river courses of the Basin as the elevation drops in the north-south or upstream-downstream direction.

The closer proximity to Angola also provides residents a chance to receive word-of-mouth (wom) notifications with regards to floods ahead of time, from their Angolan counterparts. Being the first-hand encounter with floods as the flood waves enter Namibia, respondents from Transect 1's definition of floods, that is, 'Angola & local rain' is similar to that of the low lying Transect 3 where flood waters collect and the impact is directly felt for longer periods. On the other hand, the areas in Transect 2 with gently sloping topography, may allow waters to stand for a while as opposed to steeper sloping geographies of Transects 1 and 3.

7.4 THE IMPACT OF FLOODING ON RURAL LIVELIHOODS OF THE CUVELAI

7.4.1 Cuvelai livelihoods are flood cycle-dependent

As indicated in Section 5.3.1, survey results show that there are a great number of people that prefer floods since there are long term benefits associated with flood conditions. Mendelsohn (2013) documented that the main and most general benefit is the coming and going of floods that had made life in the Cuvelai possible and suitable for human habitation and subsequent agricultural productivity. Therefore the livelihoods of the people of the Cuvelai are floods dependent (Mendelsohn 2013). Other researchers as documented in Chapter 1 and Chapter 3 have also recognized the importance of floods to the livelihoods of those residing in the affected areas. Tanner, (2005) stated that annual floodwaters of the Nile and other large rivers deposit fertile soils along the surrounding floodplains, which are used extensively for agriculture. Nguyen & James (2013) have also found that residents of the Mekong river delta have intentionally settled in these low lying areas due to good fertile soils and optimum conditions for agricultural purposes.

Results revealed that this is most especially true in very dry areas with low rainfall, especially areas covered by Transect 3. Residents herein have associated flood waters by definition with increased food production (Figure 5.8). In years with normal rainfall and greatly reduced stream density (see Section 4.2.2) and as according to local residents, such areas can go for long periods of time without water. As the residents alleged, the dry situation is worsened when there is no influx of waters from elsewhere to fill the normal water channels that have to reach crop fields or to recharge temporary water ponds. Flood disasters are regarded as 'a temporary inconvenience' in this area (as described in Section 4.2.9), an indicator on the lower continuum that was used among other indicators, towards determining geographic vulnerability. Though floods may cause many inconveniences, the local communities in these areas consider the long term benefits to outweigh the short term inconvenience of flooding. Some of the benefits of floods include increased harvest and livestock productivity for drier places, recharge of sub-surface water reserves and aquifers, as well as increased fishing activities and income.

7.4.1.1 Increased agricultural productivity

It is indicated in Section 5.4.1.1, five per cent of residents responded in favour of floods. In drier parts of the Basin especially where waters wouldn't reach under normal circumstances, floods are reportedly preferred over 'no flood situations', and any long standing source of surface water, though often rare, as Mendelsohn (2013) documents, is considered a valuable asset to the livelihoods of the people residing there. According to Verhoeven & Setter (2010), humans have been cultivating land for food production and initially, human settlements primarily occurred in fertile areas along rivers. Residents have associated high flood waters with blossoming grasses for thatching and for livestock consumption as well as increased catfish for food. As Verhoeven & Setter (2010); Tanner (2005) and Mendelsohn (2013) indicate, due to their fertile soils as a result of regular sediment deposition during flood events. These riverine wetlands have been recognized as valuable land areas for food and fodder production since the early beginning of agricultural activities.

The Cuvelai residents also report that only when floods are big enough to reach areas at the lower extents of the basin, can residents and livestock temporarily get unlimited access to surface water. Similarly in north-west Europe as Verhoeven & Setter (2010) documents, in the long history of floodplain use for agriculture, the floodplain systems remained intact as wetlands with regular flooding until major engineering operations started about 200 years ago to protect crop fields and human settlements from flooding, processes with altered the ecosystem, hindered the free flow of natural flood waters, and thus reduced agricultural productivity. Due to lower rainfall, lower stream density and subsequent poor soil fertility reported by the residents of Transect 3, dry areas are dominated by seasonal grasses and few shrubs, of which grasses are a primary house construction material. The higher parts of the floodplains are highly suitable for growing crops, while the lower parts are wetter but are often suitable for grazing (Verhoeven & Setter 2010). Some residents of Transect 3, being located lower at the basin, have associated high flood waters with blossoming grasses for thatching and for livestock consumption as well as increased catfish for food. After the floods recede, the soil is left moist and plants can grow for a number of months until it eventually dries out again. Some of this water is trapped in ponds for future use by the residents and their livestock after the flood event.

7.4.1.2 Recharge of sub-surface water reserves and aquifers

Section 5.4.1.2 has qualitatively listed the recharge of ground water sources as another benefit that comes along with floods. Many people in the Cuvelai depend on underground water for survival. According to Mendelsohn (2013), groundwater or rainwater that has seeped into the ground where it is stored in water bearing layers known as aquifer for many years is usually valuable in places where no other water suitable for human consumption is available. This is the case over large areas south of Etosha and in eastern Oshikoto and western Omusati.

Groundwater is also used to supplement supplies obtained from other sources. Notably water is pumped from the Kunene River into a vast network of pipelines across much of the northern half of the Basin. Other surface water in this area is available from *iishana* and pans after good rains have fallen, and from small freshwater ponds known as *ondobe*. This surface water is often contaminated by livestock, however, and not well-suited for human use. Cleaner water is also widely available in small quantities from shallow hand-dug wells called *omifima* (Mendelsohn 2013).

7.4.1.3 Fishing

Welcomme et al. (2006) wrote that river floodplains provide a major benefit to river fisheries. Many river-dwelling fish species spawn in aquatic vegetation on floodplains and the fish larvae feed on the floodplains, so that fisheries can be strongly enhanced by water management that allows river flooding on a regular basis.

As mentioned in Section 5.4.1.3, fishing is one of the main sources of income in the Cuvelai Basin that has been reported by local residents. Fish are caught and sold to the local markets as well as neighbouring Angola and as far as the capital city, Windhoek. Most fish is also dried and reserved for drier seasons, and it is a common delicacy in northern Namibia. The common fish species associated with the Cuvelai waters are the Catfish (Clarias *spp.* e.g *Clarias gariepinus*), Straight- fin Barb (*Barbus paludinosus*), as well as the Three-spot Tilapia (*Oreochromis andersonii*) (Cunningham et al. 1992). The catfish are associated mainly with flood events and seasons of particularly good flows. This particular fish is suspected by some to have come with flood waters from Angola, subsequently colonising the lower parts of the Basin (Cunningham et al. 1992). It has also been suspected by some to aestivate during the dry season and resume from dormancy again when sufficient waters flow in the area. The nature surrounding the Catfish is still a matter of debate, and it is beyond the scope of this project.

In the long past, fishing was more confined to *iishana* such as the traditional seasonal and highly irregular 130km wide *iishana* channel network amalgamation which occurs during times of wide floods. In the recent flood years however, as described by local communities, the fishing area has increased in geographic extent and widened to even include fields and homes within the flood extent zones. While this observation may be true in some areas irrespective of transect, it may not hold as such in others. Though the extent of floods and fishing may have increased, the people have started constructing houses and commencing with agricultural activities directly in or closer to old, dry and seemingly safe looking *iishana,* thus increasing vulnerability of residents to floods. While certain residents willingly reside in flood prone areas in search of better agricultural purposes and income (see Section 3.5.1); they also however, lack land use planning at village level as discussed earlier in Section 3.6, and this further exacerbates the residents' vulnerability to floods.

7.4.2 Livelihood destruction

As outlined in Min et al. (2011) and Pall et al. (2011), an abundance of water in some place may be a direct consequence or a direct driver of shortage of water elsewhere. While floods may have led to increased productivity in some areas, the disaster may have equally exacerbated the negative impacts in others. Human habitation in old streams with or without proper knowledge of the area could become a potential hazard. This section outlines some of the negative impacts of flooding at household level as outlined by the local communities.

7.4.2.1 Destruction to crops and reduced harvest

Section 5.4.2.1 stated that the perception of residents of 'standing water' (indicated in Figure 5.6, Figure 5.7 and Figure 5.8) is mostly linked with destruction of crops and immovable property, also expressed in Figure 5.9 (also see Section 5.3). Results suggested that majority of the population endured the negative impact of crop damage with reduced harvest as compared to years of relatively good rains. The damage was mostly a result of waterlogging and leaching, and direct washing away of crops, consequences also reported by Ndjodhi (2011).

A small percentage of residents did not manage to produce any crop during the consecutive flood years due to heavy flooding which caused extensive remodeling and altering of the fields rendering them unsuitable for cultivation. According to FAO (2014), waterlogged soils deter agriculture, even in parts of the world where an excess of water is not usually thought of as a problem. Waterlogging has been reported by FA0 (2014) to interfere with agriculture in Egypt where about one-third of the Nile Delta has a water table only 80 centimetres below the surface. Soil can also become degraded through loss of nutrients - chiefly nitrogen, phosphorus, and potassium - if these are not replenished to maintain soil fertility (FA0 2014). Besides being lost through erosion, nutrients are also depleted by the crops themselves, particularly if the same crops are grown on the same land year after year (FAO 2014; Ransom 2013; Cannell & Jackson 1981). Many fields as reported in Section 5.4.2.1, were either completely submerged by floods or were highly waterlogged which made ploughing impossible or extremely difficult. Even though most of the *mahangu* crops withstood direct washing off, the grains and flour was unpleasant to consume due to reported discolouration, unusual yet potent odour and loss of taste. The fields with less firm crops suffered the most consequences, with all crops washed away altogether with the flood waters into the *iishana*. Grain crops such as millet, dry legumes such as beans, as well as corn have also been reported by Ransom (2013) in Section 3.3 as some of the most waterlog intolerant crops. Apart from sorghum, these are also the main crops heavily planted by many residents in Cuvelai, with *mahangu* planted in all cultivating subsistence fields. In 2009 and 2011 especially, there were homesteads that failed to harvest even a single grain from the fields, a situation that created increased dependency on Government and donor food relief as it can be inferred from respondents' answers. The impact of floods on crops is also substantiated by Huber et al. (2009); Van de Steeg & Blom (1998); Van Eck et al. (2004); Voesenek et al. (2004); Banach et al. (2009); Schipper et al. (2011); Ransom (2013); Cannell & Jackson (1981) and Beumer et al. (2008) in Section 3.3.

Even though during flood years most fields undergo extensive flood damage and destruction of crops, according to the information provided there was a comparatively small number of less than ten percent did not experience any crop damage associated with floods as the flood impact was very minimal to non-existent in these areas (Figure 5.9). This condition is also reflected in Verhoeven & Setter (2010) when they documented that in the long history of floodplain use for agriculture, the floodplain systems of north-west Europe remained intact as wetlands with regular flooding and agricultural productivity has been high as discussed earlier in Section 7.4.1.

- Determining reduction in crop productivity

Also referred to as 'agricultural output', crop yield is defined as a measurement (metric tons or kilograms per hectare) of the amount of a particular crop harvested (often cereal, grains, or legumes) per unit area of land (Investopedia 2013). Alternatively, the actual seed generation from a particular crop can also directly be used as a measure (ratio or percentage) of crop yield (Investopedia 2013). In order to estimate crop agricultural output, the amount of produce gained from a sample area is calculated.

The most common grain measuring instrument used by rural small scale farmers to measure their annual agricultural production in the Cuvelai is the 20 L equivalent barrel called '*olata*'. To calculate crop productivity there is a need to convert litres (a measure of volume with L^3 dimensions) to kilograms which is a measure of mass (M). An equivalent of 1 L is roughly 0.96 kg of grain. Hence 20 L will yield an equivalent of 19.2 kg. The volumetric-mass conversion technique is a day to day common chemistry based conversion (such as meter to millimetres or Degree Celsius to Fahrenheit conversions among other somewhat infinite examples) and is not unique to this paper. The size of a barrel itself does not determine the final conversion value, but it also depends on what is being measured, in this case, grains. This means that converting a 20L barrel of oil and a 20L barrel of *mahangu* grains to units of mass will yield totally different results. For minerals especially, temperature and pressure as well as levels of hydrocarbons among other many factors must be taken into consideration. Investopedia (2013) as described above, documents some of these conversions, but to a somewhat less explicit extent. While details of conversion are not directly relevant for this paper, it is also important for a reader not to be caught up in these conversions or to miss the purpose of this section.

- Determining loss of crop income

Section 5.4.2.1 indicated that much of the crop produce which residents do not sell for money is often bartered between non-affected residents in other areas that were not heavily affected by floods, and flood-affected residents in exchange for fish which is in turn a scarce commodity in areas where floods do not often reach. Flooded residents have plenty of fish and very limited or no crop yield, while non-flooded residents may have good crop yield and less to no fish, creating a need for this kind of bartering trade among the residents. According to Kukulka (1993), barter is nothing new, and people have always traded goods and services instead of buying the things they need. With high taxes and ever growing inflation rates, it becomes relevant to reconsider and encourage barter trade initiative at community level such as the Cuvelai. Though most of the community barter systems recorded are operating in developed countries such as the Americas as documented by Silver (1993) are usually sophisticated, it becomes questionable whether such systems can be simplified and adapted to local conditions not only in the Cuvelai but in Namibia communal areas, as a measure of alleviating poverty which remains an indirect contributor towards socio-economic vulnerability.

It was also stated in Section 5.4.2.1 that not many residents have indicated their status as trading cash crops (n=20) as shown in Figure 5.11. According to the Communal Land Reform Act (CLRA) (Act No. 5 of 2002), utilizing communal land for commercial purposes, which is initially reserved for the poor, can be considered illegal (Government of Namibia 2002). Another reason could be parasitism, when a resident resumes a state of absolute lack of income with an intention or hope of receive assistance from government in the future. Thus, due to Government dependency driven reasons and possible expectations of residents to receive food assistance if their harvest is poor however, the figures of cash crops may be greatly underestimated.

7.4.2.2 Destruction to indigenous fruit trees

It was mentioned in Section 5.4.2.2 that since the recent flood years as per comments made by local residents during interviews, communities have observed a striking reduction in local fruit bearing trees such as those of various berries and marula trees in the area. Local residents have recorded a significant drop or lack thereof, of fruit bearing indigenous trees usually central to the livelihoods of some residents in the basin. It was also revealed that berry trees in the most waterlogged soils especially begin to wilt and eventually die or reduce in productivity. The impacts of soil waterlog has been discussed by Ransom (1993) and other scholars in Section 3.3. This has had a major setback to the economy of the local people, as it had subsequently led to reduced production of the indigenous products for commercial purposes.

The destruction of local fruit trees by strong floods is a major concern outlined by local residents during the interview. One of the main sources of income to the local people of the Cuvelai lies in the production of natural local brandies called *omagongo* (produced from marula fruit (*Sclerocarya birrea*), also known as m*ukumbi* by the Vhavenda people of Limpopo) and *ombike* (produced from Bird plum (*Berchemia discolour)* berries locally known as *eembe*).

- Marula tree (*Sclerocarya birrea)*: Impact to local livelihoods

According to Mutshinyalo & Tshisevhe (2003) and Shackleton (2002), widespread in Africa from Ethiopia in the north to KwaZulu-Natal in the south and in most of the arid and semi-arid areas of sub-Saharan Africa, the marula tree is one of the plants that played a role in feeding people in ancient times. In Namibia some people use the wood for sledges. Boats are also made from the trunk. Red-brown dye can be produced from the fresh skin of the bark and is used to colour traditional beads and attires. The gum, which is rich in tannin, is mixed with soot and used as ink (Mutshinyalo & Tshisevhe 2003). The frequently community dominant tree is referred by Shackleton (2002) as a keystone species (that has a disproportionately large effect on its environment) in community ecology and productivity. Because of its widespread occurrence and use, the marula has frequently been identified as a desirable species to support development of rural enterprises based on the fruit, brandy or nuts, and therefore a species for potential domestication. Though the marula growly very fast (1.5m per year) (Mutshinyalo & Tshisevhe 2003) [in favourable conditions], uprooting and impact by local flooding in the Cuvelai has made the recovery rate somewhat stagnant, an impact that has been felt by those heavily dependent on this plant for income generation.

- Bird plum (*Berchemia discolour)*: Impact to local livelihoods

Distilled from the boiled local fruit which are soaked and let to ferment for days, *ombike* is sold to fellow local residents, local markets, and during community events and gatherings. For a higher profit, the brandy is transported to as far as Windhoek and other urban centres where it is usually in a much high demand, or as far as Angola. The drink is also served in some restaurants that specialise in traditional foods mostly located in major urban centres such as Windhoek. The market of *ombike* is actually higher than that of *omagongo*, but both contribute to the economy of the local people.

Often found on clays, and stream valley and riverine soils, bird plum berries are quite nutritious as the fruit is very high in ascorbic acid and sugar (FAO 2014). The yellow-brown wood is one of the hardest in East and Central Africa, making excellent furniture, pestles, ladders, poles and is used in general construction (FAO (2014); Musaba & Sheehama (2002)). Just like the marula, roots produce a black colour, the wood brown, and the bark red used to dye various traditional attires and equipment such as baskets.

Bird plum is especially susceptible to waterlog and Forest Research Strategy for Namibia 2011-2015 by MAWF (2011) has recommended that monitoring of episodic events such as floods is necessary for increased harvest of bird plum. The impact of waterlogging on plants is documented in detail in Section 3.3.

7.4.2.3 Impact on livestock

As revealed by Thornton et al. (2006) in Section 3.4, livestock is of utmost importance for status, income, livelihoods, as well as survival of populations and cultures that are relying on livestock production. Lammy et al. (2012) has also outlined that climate, which largely influences types of disease and parasite outbreaks, is one of the major factors affecting livestock production.

Results in Section 5.4.2.3 Figure 5.13 show that nearly 70% of the households reported several cases of unhealthy livestock. Residents narrated that the most affected animals were goats, sheep and calves. Relatively, mature cattle were not as badly affected by flooding as small stock and calves. Animal ill-health conditions and symptoms such as ‘splitting hooves’ and rashes dominated the list of negative impacts that flooding had on the communities. In many cases, no veterinary services visited the affected areas due to inaccessibility of the roads leading to the areas cut-off by floods. Many cases also went unreported to veterinary services for investigations as it is revealed by the local residents. Lammy et al. (2012) validates that diseases are among the most severe factors that impact livestock production and productivity, adding that animal diseases have a great global impact on food supply, trade and commerce, as well as human health, further exacerbating poverty on rural communities.

The study revealed that in *Ombuga* areas such as Etope, deadly symptoms were experienced in cattle. Affected animals were reported to have succumbed to death within a day of showing symptoms of, in addition to the ones mentioned above, weak joints and inability to give birth unassisted. Some residents reported to have lost close to 100 heads of cattle over the recent flood years.

According to Navarre (2006), cattle, goats, horses, pigs and sheep surviving disasters are vulnerable to several diseases, including infectious diseases and toxicities. Animals surviving disasters, especially animals that have been evacuated or displaced and relocated, are under a tremendous amount of stress. They also may be commingled with other livestock. This combination of stress and exposure to new diseases can lead to outbreaks of respiratory and gastrointestinal diseases. Abrupt feed changes are also stressful and can cause significant disease and even death (Navarre 2006), so feed changes should be minimized as much as possible.

Navarre (2006) has outlined various diseases that can be contracted by livestock post-flood events such as: *Blackleg* (which can occur in cattle, sheep and goats following floods, particularly in areas where grass is short and animals are grazing close to the ground. The signs vary with the particular disease, but acute death is common with all. This disease is easily prevented with an inexpensive vaccine, and surviving animals should be removed from areas where these diseases have occurred); *Botulism* (a toxin that can proliferate in decaying animal carcasses or vegetables and can contaminate water supplies. Birds and horses are particularly susceptible. This disease causes paralysis, which shows up first as weakness with difficulty eating and swallowing. Treatment is supportive care, and prevention is avoiding exposure to stagnant water and decaying carcasses and vegetables); *Foot rot* (animals standing in mud or water for prolonged periods of time may develop foot rot (cattle, sheep, goats) or thrush (horses). Animals should be removed from the muddy, wet environment, the hooves and soft tissue should be cleaned, and dead tissue should be trimmed away. Antibiotics may be needed in severe cases).

Though all of the above diseases mentioned by Navarre (2008) have characteristics similar to the ones described by the local residents of the Cuvelai, no veterinary services were ever called to investigate most of these cases. This paper does not have scientific evidence or proof to link the symptoms narrated by the Cuvelai rural residents with those documented by Navarre (2006).

Apart from disease outbreaks, many animals succumbed to death as a result of hunger, as much of the grazing land became submerged subsequently reducing grazing and habitat land. This situation has led to overcrowding, starvation and unhealthy conditions such as diseases and death. According to residents, a greater percentage of animals had also died as a direct result of drowning. Affected mostly were small animals like goats. As explained by the residents, herders relocated their cattle to better land in time in 2011 as opposed to for instance 2008 and 2009. As a result, cattle were not as a badly affected as other animals in the 2011 floods.

- Livestock productivity

In northern Namibia, the local population is primarily dependent on livestock for the production of meat, fat, milk, and hides as well as for services such as transportation, ploughing, and provision of fertilizers, as in Thornton et al. (2006) and Lammy et al. (2012). Cattle are also seen as a symbol of an individual’s wealth and status in the community.

Flooding affects livestock productivity in many ways, and local residents have identified some of the associated negative impacts. Apart from factors outlined earlier by Lammy et al. (2012) and Navarre (2006) such as diseases and disasters, some examples of negative consequences associated with livestock reduction, as narrated by the local residents, include *reduced trampling of livestock on field and reduced fertilisers* discussed in detail in Section 7.1.2.

- Determining livestock productivity

The steps used to determine reduction in livestock productivity are similar to those used in determining crop productivity, and it is unique to this paper. An average number of cattle that died due to floods per year during the recent flood years was calculated and compared to the average number of cattle a farmer had during years of no floods. In some cases, this is a generalization. A cumulative amount of cattle deaths during flood years was then subtracted from the total cattle pre-floods. The resultant difference was then used as a measure of reduction or increment in cattle productivity. A percentage of the difference (*Equation 6*) was then used and computed into 7 classes shown in Figure 5.14. In the Cuvelai, livestock may be viewed in the same light as cash, and a cattle kraal in the same light as a bank account. There are thus some residents (n=24) who decided not to disclose the number of livestock lost to a mere stranger. For interest sake, questions of how many heads of cattle lost to floods and how many are left were often reversed back by interviewees, asking how much money the researcher has in their bank account. Productivity of livestock given here would therefore be an understatement of true events.

- Loss of human life

It was mentioned in Section 5.4.2.3 that some residents had direct contact with sick animals during consumption and handling of animals and their carcasses. Navarre (2006) mentioned earlier that if un-inoculated animals are not handled properly, the diseases may be transferable from livestock to persons in contact with the animal or their carcases. As a result, many of the signs as described earlier by Navarre (2006) in Section 6.4.2.3, depicted by animals spread to human beings. Some of those included wounds on the body, rashes, splits in-between fingers which lead to bleeding in some cases and itchiness. As stated earlier in Section 6.4.2.3, no medical assistance was sought as clinics and health facilities were inaccessible and mobile clinics were either limited or not in close proximity to respective affected communities as the residents revealed (see Table A3).

Residents also revealed that most residents affected by drowning were school children who cross vast and deep *iishana* to and from schools; drunkards; old people; people with special needs; the weak and vulnerable members of society. Figure 5.17 indicates additional vulnerable members in the community identified by the local residents. In Transect 3, cattle herders were reported to be another category of flood-affected residents when trapped by flood waters for days in search of cattle or while at cattle posts with no means of communication. Another group of flood-affected residents are people who are new to the area and unaware of safe crossing points. To some degree, this vulnerability can be mitigated if community members' recommendation of the need for vulnerability village maps and signs are implemented. These maps can illustrate places that are safe for crossing as well as warning signs at dangerous places for guidance. These vulnerable groups are further discussed in Section 6.5.2.

7.4.3 Other risk factors

There are various physical conditions precipitated by floods that place residents at risk and lead to increased vulnerability. These include the *danger of snakes* as well as *accessibility affected by floods*.

7.4.3.1 Snake problem

It was mentioned in Section 5.4.3.1 that snake bites are one of the many negative consequences that come with floods. As the Cuvelai area is devoid of vegetation, many snakes and crawling creatures find haven in burrows under the ground surface. As the floods progress and grow in magnitude and spatial extent, the waters fill up their shelters, causing snakes to abandon the water-filled burrows. Areas along the lower parts of Transect 3 are known to be the home to various species of snakes, including black mambas and adders that remain a threat to humans.

During the flood season and after disruption of their natural habitats, snakes escape to other limited safe places available, including shade trees, in homes and huts and nearby relatively high-lying fields that are not flooded. The destruction of natural habitation of the snakes has led to an unspecified but allegedly high number of snake bites of especially migrant labourers in Ambala (Sharma 2010). Being good swimmers as rural Cuvelai residents narrated, some snakes stay in the water, causing danger to humans, and animals crossing the *iishana*. Sharma (2010) asserts that some snakes such as the cobra, krait and vipers are considered to be 'residential snakes', as they have been recorded to live in and around human habitats. Under normal circumstances they don't bite, they bite only if they are attacked. A flood event is however not a normal situation, both for the snakes and the humans, and levels of alert are high for both parties. Romulus Whitaker, a snake expert as cited commenting on New Delhi monsoon on Associated Press (2007), said, ‘everything, everyone, is restricted to tiny, tiny islands with very little space, everyone is crammed in together and the chances of running into snakes, stepping on them, grabbing them and sleeping on them is much, much more’.

Some deaths and skin deformities as a result of snake bites especially in the *ombuga* area covered mostly by Transect 3 and partly by Transect 2 have been reported by the respondents. Snake bites during floods are highly common globally. In South Sudan for example, Miraya FM (2013) reported that five people have had their legs amputated in Gogrial East, Warrap State, as a result of an infection following snake bites.

According to Associated Press (2007), the reason there are so many snake bites in the small farms is that they provide the perfect habitat for snakes' prey, such as rats or frogs, which become quite plentiful during the Cuvelai’s floods. These serpents even climb trees. They are as nervous and scared as human beings and they bite only if they are disturbed (Whittaker in Associated Press 2007). Local residents revealed that most snake bites took place in the residents’ homes, and shade trees in and around homes. Local residents also reported snake bites occuring in fields when working, in *iishana* or when crossing, as well as in fishing places when the movement of snake in a fishing basket is confused with that of a trapped catfish.

In greener areas of the Cuvelai with more trees such as in Transect 1, green mambas (mainly for camouflage as an adaptation strategy) are said to dominate in those areas. Casualties reported with green mamba bites however have primarily been associated with cattle than human, as per local residents’ responses.

7.4.3.2 Accessibility issues: destruction of roads and other structures

Section 5.4.3.2 reported that floodwaters overtopped major roads and bridges, causing breakage and destruction of day to day movement between places (also recorded previous in PDNA (2010)). As the residents concurred, this hindered local accessibility to a greater extent and cut- off of rural residents to urban centres, places of worship, health facilities, schools and other important spheres of interaction in their lives (see Section 1.2.2). As a result, flood-affected residents had to stay for longer periods without basic necessities such as medication and food.

As stated earlier, persons living with HIV in flood affected rural areas are vulnerable because of lack of access to Anti-Retro Viral (ARV) therapy and other acute treatments. Though mobile clinics were dispatched to some of the centres in the villages, ARV dependent residents could still not get their medication as such medication can only be given out at a hospital by a doctor. This poses long-term health insecurities for the people needing the medication. It is not practical to prevent treatment disruptions during disasters, but rather the communities should be prepared for such events. According to Integrated Regional Information Networks (IRIN 2010), research by the Health Economics and HIV/AIDS Research Division (HEARD) at South Africa's University of KwaZulu-Natal compared three recent crises that caused treatment disruption: Mozambique's 2008 floods, Zimbabwe's public healthcare crisis, and South Africa's 2007 public sector strike – to identify potential strategies for keeping patients on treatment during emergencies. The thesis identified poor planning as the biggest weakness in responding to gaps in treatment access, and suggested that doctors and patients receive better training on what to do during disruptions (IRIN 2010).

Home births without professional assistance were also reported, with pregnant women missing ante-natal visits to health centres.

7.5 VULNERABILITY OF FLOOD-AFFECTED RESIDENTS

As it was stated in Section 5.5, three categories of assessing vulnerability were developed which include geographic vulnerability (Cutter et al. 20009; Dilley et al. 2005; Cardona et al. 2012), socio-economic vulnerability (Danielson 2009; Yohe et al. 2006; Holling 1973; Bruijn 2004), and physical vulnerability (Ciurean et al. 2013; Kappes et al. 2012; Apel et al. 2004; Scoones 1998) (see Chapter 2). These three vulnerability assessment categories were used to address the objective of assessing the circumstances (geographical or physical) that place residents at risk as well as the socio-economic conditions that lead to vulnerability.

7.5.1 Geographic vulnerability

This assessment of vulnerability is based on the geography or location of the household and its relationship to flooding (Cutter et al. 2009; Dilley et al. 2005). It appears as if flood frequency did not play a large role in assessing geographic vulnerability due to the fact that most flood-affected residents seemed to easily forget flood events, and frequently could not establish clearly the number of times they had been affected by floods. These findings are unique to this study and should not however mean flood frequency should be ignored in similar studies. The length of time that a household has been established did not greatly influence geographic vulnerability as expected. Statistically, this indicates that more recently established households are not necessarily more prone to floods. However as Alexiades (1996); Bernard (2002) and Snedecor (1939) documented earlier in Section 3.8, random sampling is not always feasible, and not always efficient, and therefore one often may have to look beyond the statistics (Karmel & Jain 1987) and consider actual local conditions in which the study was conducted (Brown 2008). “Nonetheless, it is only in recent years that concerted efforts have been made to develop indices and generate maps that depict the global distribution of people and place highly vulnerable to environmental stresses” (Archer et al. 2006: 150).

The results in Section 5.5.1 further revealed that there is a strong link between geographic vulnerability and household location. Most villages are initially established on high lying areas, and as the households increase in size, the village grows outwards to its peripheries which are usually lower in elevation than the middle of the village. As a result, those at the edges of the villages are at greater risk of flooding (Figure 5.16). However, some believe that those residing in the centre of the villages are more at risk than those at the edges of the village. This is because as one moves towards the *iishana* which in many cases border the villages, it becomes steeper, compacted and the slope contrast between the near edges of the *iishana* and the *iishana* themselves are quite noticeable. As an observed result, water drains off quite faster from steep edges to *iishana* centrelines. Both scenarios however depend on the soil characteristics at a particular site. Organic matter in soil for example can absorb and store much more water than can inorganic fractions. It acts like a sponge, taking up water and releasing it as required by plants (FAO 2010).

It was also presented in Section 5.5.1 that some residents are regarded as vulnerable due to residing in close proximity to certain developments that channel flood waters into their homes and fields regardless of geography. These persons make up a very small percentage of the respondents. They reside at the peripheries of the villages just at transition zones between rural areas and urban centres, like those of Othingo and other villages alike. It is also stated in Konrad (2014) that urbanization generally increases the size and frequency of floods and may expose communities to increasing flood hazards. The impacts of structural developments on flooding are described in detail in Section 8.1.2.7.

It was also mentioned in Section 5.5.1 that Transect 1, people residing in low lying areas suffer the most flood consequences. In 2008 and 2009 waters also flooded those residents residing at relatively higher places. Compared to Transect 3 and parts of Transect 2 where the topography is relatively gentle, Transect 1 is a high-lying area, where elevation highs and lows are clearly distinguished from each other. In this upper part of the Central Cuvelai, few households are flooded inside the houses, with floods affecting only a portion of the field and *ekove*. As previewed earlier in Section 4.2.3, it was also noted by FEMA (2014) that generally downstream tend to be more susceptible to floods than the upstream (see Table 5.1 summarizing the vulnerability across various geographic spaces of residence compiled from the information collected from local residents during the survey and gives insight into the safety of various spaces within the Basin). As shown in Table 5.1, geographic vulnerability is heavily dictated by the geographic space in which local residents choose to reside or cultivate. More than 70% of the local residents are 'highly' geographically vulnerable to floods in all transects and subsequently across the study area. As it is expected, residents residing directly in *iishana* are highly prone to floods than those on highland characterized by Kalahari sands, while residents residing on other types of highland are less vulnerable to the flood risk than those on the edges of the *iishana*.

As one moves down the Cuvelai Basin in a North-South direction, the slope becomes extremely gentle and flat. Points of highs and lows are not as clearly discerned, making these *ombuga* and surrounding areas highly prone to floods. *Ombuga* is a local name for a desert and is used by the local people to describe areas of Transect 3 and some of Transect 2 west. As a result, one would expect that areas around Transect 3 are at higher risk of flooding than those in Transect 1 and Transect 2. As the water trickles down the Basin making its way to Omadhiya and Oponono lakes, the lowest geographical point in the Basin, the many *iishana* channels converge into fewer, bigger, well-defined channels, reducing in stream frequency and drainage density (Matsuda 2004). As a region in general, Transect 3 may be regarded as vulnerable, but at household level, not as highly geographically vulnerable as Transects 2 and 1. A very dry compacted area with low seepage (FAO 2014) and low population density, non-affected local residents in Transect 3 have reported increased crop productivity since the onset of recent floods (Section 5.4.1). Transect 2 is relatively gentle in terms of relief, as compared to Transect 1 which is comparatively higher and Transect 3 which is flatter. As a result, households in Transect 2 and surroundings experience moderate floods (see Section 4.2.3).

It was also mentioned that Transect 1 is theoretically relatively safe because the channels are well defined. There exists what is locally known as *oumulongela* which are deep trenches in the *iishana* channels restricting water to the confines of the main channel. This is also an area dominated by patches of sandy soils, which worsen the impact of seepage due to their high permeability. Vulnerability due to geology referred to in Figure 5.17 describes the impact of soil type on flood vulnerability and is closely related with geography. The size of the soil pores is of great importance with regard to the rate of infiltration (movement of water into the soil) and to the rate of percolation (movement of water through the soil). Pore size and the number of pores closely relate to soil texture and structure, and also influence soil permeability. The more permeable the soil is, the greater the seepage becomes (FAO 2014). In some areas, those residing closer to *iishana* are said to be better off in terms of flood risk as water slopes off quicker into these low lying trenches. As a result, the people residing in areas characterised by Kalahari sands called *omufitu* suffer from seepage while water tends to stand for much longer than in areas of harder surfaces characterized with *iishana* banks or edges. It is also in this upper central Cuvelai area where good soils are found, making it the highly populated area of the Cuvelai (Mendelsohn 2013). Also notice the high geographic vulnerability in Transect 1 being the first receivers of flood waters as shown in Figure 5.18.

Quantity of water alone is not the only factor determining that influences floods. In fact a high amount of water may not necessarily lead to floods. Soil surface properties can be the most important influence on runoff in some areas (FAO 2014; WMO 2013). If water is unable to infiltrate the soil surface, the characteristics of the soil profile below become unimportant. Impermeable surface materials, soil compaction, deforestation, and fire are some of the many factors that reportedly affect infiltration into the soil profile.

When the rate of rainfall exceeds the infiltration capacity, water that cannot infiltrate, also known as *infiltration excess overland flow (Hortonian flow)* becomes surface runoff (WMO 2013). A common characteristic of short-duration intense rainfall, this *infiltration excess* occurs not only when the soil becomes saturated, but also when the underlying soil is dry. This kind of runoff is especially accelerated in areas with high clay content. Soils with a high percentage of silt will have higher infiltration and drainage rates than clay, but not as high as sand. Consequently, clay soils may result in greater surface runoff than sandy or silty soil during intense rainfall. Sandy soil will generally produce the least surface runoff, but will yield the highest seepage consequences later. Water drains from clay soil more slowly than from sandy soils. So in successive rain events, clay soils may remain saturated between storms and therefore produce more runoff in later rain events (WMO 2013).

Infiltration excess can also occur where the surface has been altered by soil compaction, urbanization, or fire. Covering ground surfaces with impermeable materials such as concrete and asphalt means less water can infiltrate. In addition, as soil becomes more compacted, the infiltration, percolation, and soil moisture storage all decrease. In general, human activity results in less infiltration, less storage, and greater surface runoff, WMO (2013) thereby increasing the risk of flooding.

Apart from silting up of the *iishana*, new streams can form starting off as minor dongas and gullies in a localised setting then spreading over a less stable and flood prone soil structures (Figure 5.19). Any weak point, mainly roads, tracks, and passages in-between the plots in the fields, can be a starting point for a new stream to establish itself. Roads especially have been reported to channel flood waters into some homes, and a number of such small streams have been reportedly widening at a relatively high pace. The pace at which these dongas and gullies have been widening in the area have not yet been established or fully studied. The FAO (2014) has also documented this phenomenon, saying 'the formation of gullies is frequently encouraged by man and his animals. Many gullies begin with stock trails, farm roads, and other regular or irregular pathways on sloping land. Some large gullies develop tributaries, particularly at points where livestock habitually enter and leave a ravine'. FAO (2014) further revealed in a study on severe gully erosion at the head of a creek in New South Wales, Australia. This revealed that the erosion began during periods of cultivation and overgrazing. Gullies are relentless destroyers of good farmland. They can cut up a field into small, odd-shaped parcels and restrict the free movement of animals and farm machinery. They are a menace to livestock; calves and other animals frequently fall in and are unable to escape. The stabilization and repair of gullies is the most costly of all erosion control work. FAO (2014) further wrote that stopping a gully often requires extensive earthmoving and construction of dams or other measures. Cuvelai residents are generally poor, and measures as expensive as these may be impractical for the residents and their households. Good land use and awareness thereof should rather be encouraged as a measure of preventing gullying which in turn exacerbates flood impacts in certain areas.

7.5.2 Socio-economic vulnerability

By using the factor or indicator based approach to assess socio-economic vulnerability which has been described earlier by Cutter et al. (2000) in Section 2.2.3, socio-economic vulnerability was determined by prioritizing the category (*high, medium, low*) with the highest cumulative ranking across all contributing variables per household. This highly subjective indicator based method is also described by Carpenter et al. (2001), Colding et al. (2003), Folke et al. (2002), and Berkes & Seixas (2005) among others in Section 2.2 and by Kim & Mueller (1978), Ciurean et al. (2013), and De Vaus (2002) in Section 2.2.4.

As mentioned in Section 5.5.2, majority of the flood-affected residents interviewed at household level are socio-economically vulnerable as indicated in Figure 5.20, with 72% falling in the medium to high vulnerability class. As expected, community leaders are not very vulnerable, with only 21 % being highly socio-economically vulnerable. An interesting observation from Figure 5.21 is that ~30% of flood-affected residents were not socio-economically vulnerable (low), yet had suffered some flood damage in the past as shown in Section 5.5.1. Socio-economic vulnerability and geographic vulnerability however are not necessarily in direct proportion with each other.

Section 5.52 also stated that approximately 30% of the residents of each transects fall in the category of high socio-economic vulnerability. This validates vulnerability studies at household level to get a detailed account of actual vulnerability at grass roots level rather than using overly generalized statistics.

In this section the outcome of the interviews and discussions, also coded as quantitative data, are discussed. In addition, the researcher touches on the effect of various other contributors to/factors influencing socio-economic vulnerability observed in the Cuvelai such as urbanization, land allocation, residents with special needs and other risk factors are discussed. This section closes by evaluating the role of socio-economic vulnerability in exacerbating the overall vulnerability of the residents.

7.5.2.1 The impact of urbanization

As shown in Figure 5.17, 3% of the flood-affected residents (n=1) indicated that vulnerability due to developments in or close to their residence is on the increase. These could be rural residents particularly residing relatively closer to urban centres, and the impact of urbanization is discussed under a number of sub-headings.

- Impact of structural features on flood vulnerability

It was mentioned in Section 5.5.2 that households in close proximity to town peripheries with residents settling near dumpsites, roads as well other man-made features such as cemeteries are said to have their flood impacts exacerbated due to those factors.

WMO (2013) also documents that road grids, ditches, and storm sewer systems can also act as a network of tributaries channelling the flood waters and effectively increasing stream density. Higher stream density results in more rapid runoff to the stream channels, thus increasing the amount of water in the area. Urban features such as road embankments and berms can also act to break down natural basins into smaller sub-basins. Smaller drainages react much quicker to localized rainfall than larger basins as the distance and area the water has to travel is greatly reduced, with flood peaks being experienced sooner than in relatively larger basins of similar physical properties (WMO 2013).

Another factor sharpening the flood impact in the Basin is the effect of roads and bridges with smaller than necessary culverts. Most culverts are too small to accommodate the amount of flood waters that pass through such streams. As a result, waters accumulate on the one side of the bridge, subsequently flooding the adjacent fields. The pictures in Figure 7.1 show flooding due to smaller culverts and inappropriate construction during the 2013/2014 flood season. As compared to a natural stream bed, road surfaces, culverts, and storm sewers possess relatively smooth surfaces (WMO 2013). This decrease in surface roughness allows runoff to move much more quickly to the main stream channels than it would in a more natural setting, as residents report.

Figure 7. 1 Flooding due to smaller than necessary culverts and inappropriate construction during the 2013/2014 flood season

Another good example of the negative impact of infrastructure is shown in Figure 7.2 during the 2009 floods. The road with inadequate drainage capacity at the flow crossings crosses the natural flow channels thus acting more as an embankment.

The gravel road shown in Figure 5.22 leading to Uuvudhiya from Elim junction also intersects one of the main channels in the area. Notice the two small culverts. Also see Figure 5.23 for more inappropriate culverts in the area. It has been reported that water builds up on the side of the road, flooding households. The poorly constructed road is reportedly shorter in height than necessary, and over toping and cut-off of accessibility are some of the associated factors.

Figure 7. 2 Roads intersecting major *iishana*

Infrastructure should thus be routed following high grounds as much as possible, and parallel to the flow of water. Neglecting this endangers the infrastructure, puts more residents at risk and it adds to blockages for free flows.

Though not a worrying process in Namibia at the moment due to the very minimal scale at which it has been implemented, ‘channelization’ may become more popular as it becomes integrated in ‘flood mitigation master plans’ of some towns in the Cuvelai, such as Oshakati (NHS 2010), which acts as a node for habitation of a significant number of rural settlers. This point also addresses the intentional blockade of flood waters by town authorities in an attempt to stop or reduce the impact of flooding on urban centres, which end up deflecting towards rural areas as the residents alleged. The activities range from sand embankments, river widening and deepening, as well as direct redirection of major streams as pictured in Figure 5.23. Rural residents residing closer to such embankment features suffer most. If not well planned or maintained, flood mitigation structures stand a chance of failing to protect against flooding, subsequently worsening the impact on the unsuspecting residents (White 1945; White 1975; Burby et al. 1985; Stein et al. 2000; Larson & Pasencia 2001).

Sometimes as part of channelization streams are straightened by having meanders removed. This is also practiced in Namibia, where some channels near Oshakati have been redirected in an attempt to redirect the flood waters from 'important places'. A specific and popular example is the partial channelization of the *Okatana River* and *Ompundja streams* near the Oshakati area (NHS 2010) leading to increased runoff as expressed by the local residents. Though a positive consequence for the urban settlers of the concerned areas as its main purpose is to redirect the flood waters from the town, the negative aftermath of channelization and related processes thereof are already being felt and experienced by the rural settlers in close-to-medium proximity to the town, downstream of the catchment as it is gathered from the interviewees.

It was also mentioned in Section 5.5.2 that flood-affected residents in villages in close proximity to urban and built-up areas have attributed a high risk of increased flooding to construction and development initiatives. Buildings such as schools, local shopping centres, hospitals and shebeens have been built directly in the floodplains, redirecting the water and blocking natural water courses, causing water to spurt and overspill to the nearest fields and homes (NHS 2010). Overall, an urban or altered environment will result in faster runoff with more runoff reaching the streams than in a rural or natural setting.

- Rural- urban migration and squatter camps

Immigration places increasing pressure on rural areas bordering cities' peripheries, exposing them to a high flood risk. As they cannot afford to secure decent land in towns, illegal immigrants erect their shacks in unfavourable places usually in villages closer to the cities' peripheries and in stream beds. Nchito (2007) also documented that residents who could not secure land formally had to use marginal sites, adding that unplanned settlements are usually on low-lying land, which is prone to flooding during the rainy seasons. Residents concurred to this notion saying that building in the stream bed interferes with the natural flow of water in the streams and has a negative impact not only directly on the people residing in these areas, but also indirectly on the rural residents in close proximity to these establishments.

Erecting the shacks in *iishana* alters the flow of waters in streams, and in addition, the waste produced chokes the streams to the extent of stopping or slowing down the flow. This causes the water to stand and accumulate there, subsequently spilling to the adjacent fields. Several areas especially on the Ompundja roads have expressed this concern and claim to have experienced flooding only since the recent mushrooming of adjacent squatter camps, also similar sentiments expressed by Nchito (2007).

A dumpsite in the Othingo area is reportedly contributing to the high risk of flooding of people residing near the landfill. Low-lying and inappropriately located in a high flood prone area, flood waters contaminated with refuse flow down to nearby houses and fields, causing major environmental and human health concerns. Cemeteries, especially those in the sandy soils are affected by seepage. In some parts, communities are faced with cemetery space needs and are more eager to conserve good high value land space for cemeteries and low lying areas for other activities such as residence. According to NHS (2010), major sewerage ponds seem to be preferentially situated in low-lying areas. Polluted water mixes with the flows in the channels, and many people downstream use that water for domestic purposes posing several health risks to the residents. For long-term mitigation, all sewerage ponds and other water works should move to high-lying safe areas.

- Impact of land dispossession on flood vulnerability

Section 5.5.2 also asserted that expansion of urban areas pushes rural residents further into harm's way. This subsection thus addresses the question 'Is leadership impeding the provision of less-flood prone land from the rural poor?' which may exacerbate the risk to socio-economically vulnerable individuals. In recent years, as in the past, authorities have dispossessed rural areas, due to the pressure on expanding towns. Compensation for dispossessed land is allegedly insufficient for families to re-establish themselves. This has a direct impact on rural land availability, productivity and the ability of the poor to sustain a livelihood. With no voice and power, residents vacate fertile land to relocate to flood prone zones as reported in Oluno, Ondangwa, Oshakati, Ongwediva and Helao Nafidi. Village leadership is put under pressure from an ever increasing number of land seekers from towns under such circumstances.

Many village heads are left powerless, making them even more rebellious to the notion. As previewed in Section 3.6, Mendelsohn (2008) had also documented that there are several TA without communal land and as a result they have to rely on towns' leadership in which their new residences now fall, to represent their needs. In an attempt to oppose land grabbing strategies by town councils, some village heads have allocated flood prone areas to victims of town land dispossession in the hope that the situation will becomes obvious. It raises the question of who suffers the most harmful consequences of land dispossession and at whose expense? Better alternatives for the affected villagers need to be put in place by the villages and the town councils.

7.5.2.2 Settling on allocated land

- Early settlers from elsewhere

Residents have indicated that early settlers with no knowledge on the village have settled in areas vulnerable to flooding. Coming in search of land and better livelihood opportunities, inexperienced land seekers often find themselves settling in unsuitable spaces. Contrary to what is documented in Mendelsohn (2008) in Section 3.6, the Traditional Authority (TA) does not necessarily interfere with land selection by the land seeker. It is thus the responsibility of the land seeker to identify land that is most visually appealing to them or where they want to settle. The land seeker would then approach the TA such as the village headman for advice on availability and not vulnerability thereof.

Section 5.5.2.2 has however documented a weak statistical relationship between socio-economic vulnerability and the age of the household (Figure 5.24). It was observed that in many cases, newer fields are just as susceptible to floods as older ones and a past settler is just as much at risk of flooding as the recent settler settled in a low lying area. Land degradation is detailed by FAO (2014) in Section 8.1.2.5.

- Households built after 1990s, including refugees and returnees

Though a generalization, it has been observed in Section 5.5.2.2 that many of the flooded households were built since 1990. According to respondents, before 1990, people lived in concentrations and closer to their families, mostly for the feeling of protection. After the Namibian independence, people moved to places once regarded as unsafe. The population had also started to increase rapidly. It was mentioned that the intense spread of the local population after the 1990s was also accompanied by the increasing number of war refugees and returnees as it is gathered from the residents interviewed. According to the Traditional Authority's Act (Act No. 25 of 2000), a field or piece of allocated land which had not been utilized for a period of three or more years must be re-allocated to the next person needing to use that land for settling and cultivation purposes. Returning war veterans had nowhere to settle as their land had been re-allocated. The landless returnees would settle anywhere, regardless of flood risk. This spread of people all over the Basin brought some undesired effects, such as settling anywhere, where space could be found. Displacement of residents from safer places of residence to disaster prone areas is still happening elsewhere in the world today. In South Sudan for example, it was reported by the Republic of South Sudan (2014) in their 2014 Crisis Response Plan that more than 475 000 residents have fled their homes and spontaneously settled in flood prone areas where access to or delivery of humanitarian assistant is extremely difficult.

- Re-allocated land

Though unutilized land is re-allocated to land-seekers, not all of this land is suitable for human habitation. Apart from those that abandoned their land due to reasons such as war, there are also some fields that were abandoned due to flooding and severe seepage impact. Since there is no formal record of the nature and productivity of individual fields kept for the villages, the headmen may be unaware of the reasons why the land had been abandoned before it is re-allocated. New land seekers often find themselves trapped in this kind of situation. There is thus a need to keep a detailed record of spaces of importance in the villages. Detailed vulnerability maps at village level can contribute to record keeping and decision making processes.

7.5.2.3 People with special needs

According to Cardona et al. (2012), certain population groups may be more vulnerable than others to climate variability and extremes. For example, the very young and old are more vulnerable to heat extremes than other population groups. Danielson (2009) also added that social differences within a given place can make some household members more vulnerable people more vulnerable even than members of their own immediate household. It was also mentioned that as a result of stigmatization, people with special needs are reportedly said to be neglected by their community members and receive minimal assistance when disasters strike.

Section 5.5.2.3 mentioned that people with special needs are especially vulnerable in flood situations. This category includes the disabled and people with chronic illnesses. During floods, these persons are especially at risk of drowning as a consequence, needing constant care, which is not always available. Many of the reported drowning cases in the past floods involve persons with special needs as victims. Discussed below are some of these special needs victims as identified by local residents, including widows, orphans, senior citizens, pregnant women, and single-head households.

- Orphans

Namibia is home to 120,000 orphaned children, with 'orphan' defined as a child under the age of 18 who has lost one or both of his or her parents and who is in need of care or protection. Of these 120,000, 70,000 are AIDS orphans (CAFO 2011). As of 2009, 15.1 per cent of Namibia's population was living with HIV (PDNA 2010; CAFO 2011) (see Section 1.2.2).

It was mentioned in Section 5.5.2.3 that young orphans living in houses by themselves are more vulnerable than orphans residing in their caretakers' homes. Residents also revealed that due to primarily HIV/AIDS, accidents and other factors, leave many children as left orphans with no family to take care of them. As observed, many of the orphan households are in a very dilapidated state, placing them at a much higher risk of being washed away by flood waters. Many are reliant on provision of food and clothing by other people. These independent orphans often do not have the necessary documentation to register for OVCs' government assistance, and cannot receive government assistance if not attending school.

According to Church Alliance for Orphans (CAFO) (CAFO 2011), a local faith-based organization in Namibia, many orphaned children have been made more vulnerable by flooding in the northern parts of Namibia. In its impact assessment survey, CAFO (2011) stated that floods have left the OVCs in a precarious state. CAFO's (2001) survey found that when it comes to food security and health care, children's needs are far from being met. Most children have not even been incorporated into feeding programmes because food is scarce. Moreover, many children (including those who are already sick) are not receiving proper preventative or curative medical attention. Children who have been separated during the floods, especially those previously orphaned, are particularly vulnerable to abuse in communities and relocation sites.

- Senior citizens

Section 5.5.23 reported that elderly residents are at risk of drowning during flood events due to reduced mobility and old-age associated factors. Cardona et al. (2012) wrote that a rapidly aging population at the community to country scale bears implications for health, social isolation, economic growth, family composition, and mobility, all of which are social determinants of vulnerability. With many elderly staying alone or with many dependents at home, they remain unable to upgrade or construct durable homes. They are most often not capable of utilizing paid labour for services such as house construction due to limited finances. Some elderly persons may also have many dependents which increase their socio-economic vulnerability. Others though have employed families looking after them thereby reducing their socio-economic vulnerability as shown in Figure 5.25.

When assessing similar situations in an international context, Graham (2011) reported that older people have been severely affected during the 2011 floods in Thailand, mainly due to poor mobility and lack of money. Thousands were stranded in their homes without basic essentials such as food, water and medicine. Some refused to leave as they did not want to leave their houses unattended. Others claimed they did not want to be a burden to their children or other family members, so decided to stay back. Saddening enough, elderly in the Cuvelai had also shared the comparable sentiments.

- Pregnant women

With accessibility to health facilities interrupted and no ante-natal care, some pregnant women reportedly resort to potentially unsafe home deliveries during floods with assistance from inexperienced residents. The infants do not receive immediate medical attention which may be necessary. Home deliveries in the area are however not completely unusual, and in some cases they are preferred over hospital births.

The first hours and days of a child's life are the riskiest, even without the added complications posed by a disaster. On the 2010 Pakistani floods, Muscara (2010) has reported that displacement; increased impoverishment, crowded living conditions, disease and infection, endanger the lives of mothers and their new-born babies. Mothers were also reported to have given birth in flimsy shelters just steps away from stagnant water and debris.

- Single-headed households

This includes single-headed households for both men and women. Though both male and female-headed households are vulnerable, it was found in Section 5.5.2.3 that households headed by women and people with special needs are more vulnerable than those headed by men. According to Childers (1999), female-headed households are four times likely to be in poverty than male-headed households. As a consequence, female-headed households therefore are more likely to recover from disasters at a slower pace than other households. Females are also more vulnerable to disaster impact and recovery due to socially defined gender roles. Chowdhury et al. (1993), Miyano et al. (1991) and Parasuraman (1995) also documented that women in lower income countries are more likely to die in disasters because of caregiving responsibilities whether to children or to the elderly, or because they are physically isolated and do not get to hear the warnings on time. The situation is however worsened when all of the three vulnerability factors (geographic, socio-economic and impact) coincide.

- Widows and 'widow-stigma'

Widow-stigma as mentioned in Section 5.5.2.3 discriminates widows in terms of land acquisition and better treatment.

When he assessed the flood impacts on the socio-economic livelihoods of the Sikaunzwe community in Zambia, Mwape (2009) found that the status of household head played an important role in determining the livelihood strategy. He found that other households had a diversity of livelihoods (crop production, trading, beer brewing, fishing and charcoal burning) as opposed to the single, divorced, separated and widowed household heads. When they investigated the impact of floods on natural resource dependent communities in Northern Ghana, Armah et al. (2010) found that widows are prone to damage, loss and suffering in the context of the frequency and magnitude of the floods.

It was also mentioned that after widow's spouse's passing, the widow's in-laws inherit everything, in some cases, including land, leaving the widow in a rather precarious state. Subsequently, a widow is forced to establish herself, often on the peripheries or on inappropriate land. It was also reported that in some areas, a widow is regarded as an outcast, treated with disrespect, and village heads refuse to allocate suitable living land to them, thereby increasing their vulnerability. The Communal Land Reform Act 2002 (Act No.5 of 2002), lists women as considerably vulnerable members of society especially when it comes to issues of land acquisition and ownership in the country. The Act also gives women rights to land acquisition as it does to men. Looking at all these factors, it is crucial that all elderly households and households of all vulnerable members of society are mapped are properly identified mapped so that the necessary assistance can be delivered timely when disasters strike.

7.5.2.4 Other socio-economic vulnerabilities

In this section some other cases of socio-economic vulnerability caused through human and physical factors, identified by residents, are discussed.

- Nepotism

It was also mentioned that in some villages, headmen allegedly allocate better land to members of their families and close persons. Often times, ordinary residents with no special ties with the village leadership are left disadvantaged. If not monitored, nepotism has the capacity to cause social unrests in communities. In Kenya for example, many residents have lost their lives and others uprooted from their ancestral lands as a result of tribal clashes manifested through unfair and unjust allocation of national resources engineered by malice and nepotism (Musa 2012).

It has been noted that poorly constructed houses made of natural matter (Figure 5.26) are vulnerable to flooding than those made of cement walls (Figure 5.27b). Natural construction materials are biodegradable and can easily decompose in damp, warm conditions and are thus not durable enough to withstand floods. Houses constructed of natural material may be completely destroyed by the flood and other disasters. Apart from floods, they are also susceptible to fires, creating double tragedy for the residents, which is, flood during wet seasons and fires during dry seasons, thereby increasing socio-economic vulnerability. Similarly Yohe et al. (2006) found that households with tile roofs were less resistant to fire events than wooden shingles that were found to be more vulnerable to fires (see Section 2.2.1). Residing in such properties are usually the poor people who cannot afford better housing. “Considering lack of resources and capacity to prevent or cope with the impacts, it is clear that the poor are the most vulnerable to natural disasters” (Archer et al. 2006: 152).

- Lazy residents, substance abuse, cattle herders, and school going children

There are also residents who put themselves at risk of being flooded as they are too reluctant to upgrade their homes with stronger building materials or they ‘just do not have time for that’. Shebeens in the villages have created a level of excessive dependency on alcohol. This excessive drinking hinders productivity as people tend to neglect work. Money is lost to alcohol instead of for instance improving the homestead. According to WHO (2013), Namibia is ranked fifth on the African continent in terms of annual alcohol consumption with the average Namibian consuming 9.62 litres of alcohol per year. The WHO measured this by the amount of pure ethyl alcohol consumed per capita per year by people aged 15 and older.

Section 5.5.2.4 reported that in 2011 alone, 103 drowning incidences were recorded in the area (DDRM 2011). Residents alleged that some of these victims attempted to cross the *iishana* while under the influence of alcohol. In his media briefing on the flooding and drowning in Ohangwena Region (northern Namibia, Cuvelai Basin), Governor Usko Nghaamwa warned residents against alcohol abuse during the rainy season, advising that “people should take care of themselves by avoiding going to cuca shops during rainy seasons”. He was further quoted (in Tueumuna 2009) saying "They [residents] go to cuca shops in the morning, and stay there for the whole day. When they return in the evening, they are too drunk and the water is just too strong". Most drowning victims as reported by Tueumuna (2009) drowned while coming from cuca shops (shebeens) and were under the influence of alcohol.

It was also mentioned that among drowning statistics were also many school going children who have attempted to cross dangerous waters without guidance of seniors. Learners that crossed under guidance of professional, such as those drowned in the Oshigambo River at the Oshigambo High School Bridge, after the boat that was ferrying them to school capsized, killing the school children and the professional ferrying them (FEMCO 2011). Drowning cases were indeed higher than this. FEMCO (2011) also revealed that 166 schools closed during the 2011/2012 flood season, affecting over 100,000 school children. The interviews also revealed that cattle herders were at high risk, as they are trapped in O*mbuga*'s cattle posts by the floods, while they are taking care of the livestock, with no one to warn them of the floods.

7.5.2.5 Socio-economic vulnerability exacerbates overall flood vulnerability

As reviewed in Section 2.2.1, Yohe et al. (2006) maintains that certain human systems can resist damage from a hazard more easily than others. It becomes interesting to know whether flood-affected residents are able to re-establish themselves to the state their households were before floods, once the disaster has passed. Contrary to expectations, Table 5.2 (as presented in Section 5.5.2.5) shows a relationship between flood-affected residents and their level of socio-economic well-being. The table presented that unlike Transect 3 flood-affected residents who are equally impacted upon by floods despite their socio-economic status; flood-affected residents with medium socio-economic vulnerability are higher in Transect 1 and 2. This indicates that irrespective of economic status, geographic vulnerability is the primary vulnerability, of which socio-economic vulnerability can only exacerbate overall vulnerability state and not necessarily cause it. This is exactly what Cardona et al. (2012) revealed in Section 2.1; the risk to life tends to vary greatly over space, more than other forms of vulnerability. When socio-economic vulnerability coincides with geographic vulnerability the result is catastrophic (Wisner et al. 2004). For example, a blind elderly person staying alone in a house in poor conditions with no bed can be quite risky. A channel of water running from outside to the inside of the house is also observable just behind the researcher (with a book) and the headman assistant in Figure 5.15.

The conclusion that can be drawn from the results in Table 5.2 is that though at household level the level of socio-economic may vary, in more general terms the entire Basin is socio-economically vulnerable. Being rural small scale farming based community, the results are not entirely surprising. Residents have thus developed coping mechanisms, both in terms of their philosophy about flooding ('temporary inconvenience') as well as the use of various measures such as temporary housing structures, as discussed in Chapter 8. The strong statistical correlation between geographic and socio-economic vulnerability is also shown in Table 5.3 in Section 5.5.4 with socio-economic vulnerability extremely variable across the transects.

7.5.3 Physical (structural/ technical) vulnerability (Impact of flood damage)

The measure of the severity of flood damage, as demonstrated by physical evidence of damage or impact of the flood is termed physical/structural/technical vulnerability (Ciurean et al. 2013) (see Section 2.3). Section 5.5.3 adapts the physical vulnerability classification method used by Papathoma-köhle et al. (2011) when they published their paper on the "physical vulnerability assessment for alpine hazards". The method classified damage intensity into three classes namely *low* (persons barely at risk and only low damages at buildings or disruption expected), *medium* (persons outside of buildings are at risk and damage to buildings occur while persons in buildings are quite safe and sudden destruction of buildings is improbable), and *high* (persons inside and outside of buildings are at risk and the destruction of buildings is possible or events with lower intensity occur but with higher frequency and persons outside of buildings are at risk). Physical/ structural vulnerability assessment is detailed under Section 2.3.

Often residents, both young and old, have a short memory of the floods and forget easily once the waters have receded. Due to direct and indirect measured variables the flood impact is mostly understated. A somewhat universal common indicator of damage used by the residents is not only damage to crops and livestock as expressed in Section 5.4.2, but it also includes damage of the actual grain already stored in silos. According to the Namibian Agronomic Board (2014), *mahangu* farmers in Namibia are amongst the few populations in Africa that have successfully developed an integrated food storage system where they can store their grain in storage baskets made of wood strips for up to five years. Storage of food grain is necessary in order to ensure constant supply for the year and also to provide to distant areas. The most important physical factor in grain storage is moisture content because it affects the growth of mould, with which all stored grain is infected. It is generally accepted that climatic condition leads to physical changes in stored bulk grain through the movement of moisture which leads to deterioration (Sawant et al. 2012).

Traditionally sealed with mud (Figure 5.29) to protect against insects, animals and direct sunlight, silos do not protect grains against rain or flood waters. As a result the grains are highly susceptible to germination during floods. Germination can also occur just before the cobs are harvested, causing crop failure thereby putting enormous economic strain on residents who solely depend on agriculture. The situation can be remedied by purchasing maize flour, which comes with increased prices during floods. This has proven to be an unfortunate situation for economically vulnerable individuals. A few elites in the Basin have artificially constructed silos built either of insulated cement or recycled plastic, elevated off the ground. For the majority of the residents however, traditional silos remain the primary cause of grain loss and damage during floods.

As shown in Figure 5.30, there is no significant difference between transects in the impact of the floods. Taking into consideration that some households are more seepage prone as a result of soil type rather than mere location, renders geography and socio-economic status irrelevant if physical vulnerability is to be assessed from this perspective.

7.5.4 Location, socio-economic conditions and level of damage

Having examined each of the three types of vulnerability, geographic, socio-economic as well as evidence of damage, it is important to investigate the correlations between the three factors. The correlation matrix is given in Table 5.3. Again, it is worthwhile to note that vulnerability types are not necessarily in direct proportion to each other.

It was presented in Section 5.5.4 that though there is a significant correlation between geographic vulnerability and the impact of flood damage. This is not the case with socio-economic vulnerability and the impact of damage. Even though evaluation of vulnerability and the combination of the hazard and the vulnerability to obtain the risk differs between natural phenomena as Ciurean et al. (2013) explained in Section 2.3, physical vulnerability mostly remains dependent both on the acting agent (physical impact of a hazard event) and the exposed element (structural or physical characteristics of the vulnerable object). The strong relationship between geographic vulnerability and socio-economic vulnerability are possibly explained by the fact that wealthier homes generally tend to be situated in less flood prone areas and associated large pieces of land increases chances of productivity thereby reducing overall socio-economic impacts (as in Yohe et al. 2006).

CHAPTER 8: FLOOD HISTORY AND HOUSEHOLD PRACTICAL ADAPTIVE STRATEGIES IN THE CUVELAI BASIN

8.1 FLOOD HISTORY

In this section, flood history is described from the residents' perspective and is predominantly qualitative in nature. After evaluating the current situation, some of the actions taken by flood-affected residents in the past that differ from current practices in counteracting the consequences of flooding are highlighted. This section describes practical adaptive strategies that help residents cope with flooding.

8.1.1 Current situation

It was reported in Section 6.1.1 that majority of the non-affected local respondents have indicated an increase in the flood extent over the years. The data also reveals that these are generally respondents who settled in the area prior to the recent flood cycle years, and have thus not experienced other [historic] flood events before. In some areas, and most particularly due to intervention measures such as local small scale dykes and ditches near problem streams and other adaptation strategies, the flood extent has been on a decrease as shown by a smaller percentage of the respondents. Note that structural mitigation measures may reduce impacts in some areas, while exacerbating impacts in others. Structural and non-structural measures are presented in Section 6.1.2.7 and Section 6.1.2.8.

In contrast, residents who have lived in the Basin for many decades and inherited their homesteads through family ties have indicated no increase in the flood extent. Many reasoned that some areas currently occupied by recent settlers were flood plains and fossil channels of the Basin. Some of the more elderly folk reported worse flood events in the long past and 'around the 1950's and '70s'. Figure 6.1 illustrates the different ways in which respondents have viewed the changes in the flood extent.

Some respondents attributed the change in extent to the evolving soils and area topography over the years (as in FAO (2014) Section 6.1.2.5). According to some respondents this may be due to traditional versus modern cultivation practices changing the soil profile in the Basin presented in Section 6.1.2.12.

8.1.2 The past

8.1.2.1 Cuvelai floods are influenced by natural climatic cycles

According to Namibia Hydrological Services, the heaviest rainfalls ever recorded are those of 2011. As reported earlier, these rains resulted in severe flooding (UNOCHA 2011). In 2009, an estimated 350 000 people were affected by floods, termed the worst recorded by DDRM (2009). Floods of similar severity have not been experienced before (DDRM 2008). Some communities shared that floods such as these were last experienced some 50 years ago. As a result, the level of flood preparedness was at its lowest. Furthermore, there is various other flood years neither recorded locally nor are they documented in the literature.

The senior citizens stress that the flood situation has been worse in the ‘long past’ when compared to current flood years. As per current insinuations that [big] floods in the area are recent, much older local residents claim that floods have not changed course or extent. Senior citizens, having tapped some of their indigenous knowledge from generations of hundreds of years ago, further claimed that floods in the ‘long past’ are most likely to be greater in magnitude and impact when compared to floods in the ‘recent past’. People have however, a short memory of flood disasters and tend to forget easily.

Previously recorded as a small flood in the literature (Mendelsohn 2013), 1950 has been referred to as a big flood year by the senior citizens in the field. In addition, the years of 1954, 1957 and 1978 have been recorded as no flood years in a similar table, Table 1.1 in Section 1.1.2, have been identified by the elderly interviewees as worst flood years as shown in Table 6.1. The elderly were also able to fill in some small gaps, adding that 1964, 1971 and 1974, shown as no record years in Table 6.1, have also experienced worst floods in the area, further commenting that the flood situation seem to be “*reverting back to the past*”. Currently, there are no long term historic flood data or pattern of the Cuvelai. This study also finds that the attempt to reconstruct a qualitative record by Mendelsohn (2013) may be overly misleading as years with inadequate information are shown the same as years with no or negligible flows. Years with big floods as according to the respondents, are also shown in Mendelsohn’s (2013) table (Table 1.1) as years with small or no floods.

With a lack of historic records, procuring historic information about the Basin requires communication with the elderly to pass on their vast knowledge t and what their parents and grandparents have passed on to them. Only then can accurate flood information of the Cuvelai as it was in the long past be gathered and verified. Figure 6.2 shows the researcher (with hat) interviewing a local senior citizen while an assisting local student looks on. The elderly respondents have tried to substantiate that recent floods are not any worse than past floods by using factors in the following sub-section under this section.

8.1.2.2 Overpopulation and overcrowding

It was revealed in Section 6.1.2.2 that overcrowding is one of the primary causes of flood damage in the Cuvelai Basin. As time goes by and population increases, the number and needs of people per unit of land increases, and exceeds the carrying capacity of the land. As a result many people have in recent years been building homes in flood prone areas, increasing their geographic vulnerability (exposure) to flooding. Though the study confirms Min et al. (2011) and Pall et al. (2011) results that human impact might have exacerbated the impact of flooding, it does not extend such revelations to climate change or make any sort of association thereof.

8.1.2.3 Media attention and involvement by the international community

There is a big difference in how flooding was received and handled in the past by local residents, government, and the general public as compared to recent years. As mentioned in Section 6.1.2.3, floods in recent years have gained tremendous media attention (as in Brody et al. (2009) Section 3.7.2), something which was not the case in the past, raising the awareness of the general public. As a result, there is greater attention from international bodies and agencies as well as increased interest in the flood sector. This leads to international donors flocking to provide millions in money and other assistance, giving the Namibia floods international recognition, something not associated with 'long past' floods. The impact that media and globalization has had on global recognition of flooding in the Cuvelai is understated.

8.1.2.4 Decreased social cohesion and increased dependency on government

Section 6.1.2.4 revealed that many residents could only associate themselves with government since Namibia's independence in 1990. As a result, dependency on government was much lower in the past than it is currently. Temporary relocation as a result of floods is not necessarily a new thing, but what changed is the approach and means by which it is conducted. Instead of being provided with temporary camping tents in the past, and by using traditional means and materials such as thatched huts instead of camping tents, flood-affected residents used to temporarily relocate to portions of highland enclosed in *ekoves* locally known as *okatunu*, without government assistance as it is in the current years. A detailed discussion on traditional temporary relocation is given in Section 4.7.5. As the elderly share their experiences from the long past, there were also many residents who relocated to neighbours as opposed to relocation camps opted for in recent years. Donor dependency is described in detail earlier in Section 1.2.2.3 where it is stated that in 2011 alone and in response to flooding caused by the heaviest recorded rainfall ever in the country, UN's Central Emergency Response Fund (CERF) allocated some US$1.2 million (NAD 11 745 245) for humanitarian response in Namibia. The donor funding was allocated via four main UN organizations. World Health Organization (WHO) received some US$500 000 (NAD 4 893 852) to bolster emergency response in the areas of health and nutrition. Some US$350 000 (NAD 3 425 696) was allocated to UNICEF for the strengthening of emergency response in the water, sanitation and hygiene and education sectors. United Nations Population Fund (UNFPA) used some US$250 000 (NAD2 446 926.17) for emergency response in the protection sector, and the World Food Programme (WFP) received some US$65 000 (NAD 636 200) to strengthen emergency food distribution scheme.

8.1.2.5 Field sizes and quality of soils

As it was revealed in Section 6.1.2.5, early settlers were able to select large pieces of land in the most seemingly desirable places in the area. Later settlers could only divide among themselves what was left. Residents settled anywhere for as long as there was space, regardless of its vulnerability status. As a result, being in the most desirable spaces, old fields are locally considered less geographically vulnerable to floods. The characteristic big field size also reduces socio-economic vulnerability as not all agricultural yields will be lost to floods. On the other hand, recent settlers with low-lying and relatively small fields such as the one shown in Figure 6.3 tend to be highly socio-economically and geographically vulnerable. The impact on such land is very much higher than on 'old' pieces of land. Accordingly vulnerability was lower in the past. This illustrates that it is not the flood extent that has changed, but rather settlement patterns coincided with flood plains that due to lack of knowledge, were seemingly safe in the past.

Apart from loss of vegetation cover, loss and reduction of livestock especially cattle, , loss of interest in farming activities by the younger generation due to urban economic migration, reduced trampling livestock trampling and thus manure, in many areas has been regarded as a trigger towards reduced soil quality and fertility, due to droughts and floods.

Changes in cultivation practices have contributed to soil evolution and the susceptibility to erosion has increased. Many previously high-lying areas have been affected and old land has reduced in elevation. In some cases, the older the field becomes, the lower it also becomes, increasing the flood risk of the people and lands previously considered safe. According to

FAO (2014), soil is a dynamic mixture which is continuously changing as water comes and goes and plants and animals live and die. Wind, water, and gravity move soil particles about either slowly or rapidly depending on local conditions. But even though soil changes, the layers of soil stay much the same during one human lifetime unless they are moved or scraped, or ploughed by man (FAO 2014), as it is the case in most of the Cuvelai Basin which heavily relies on livestock and crop farming.

It is commonly alleged that residents, in the majority of instances, degraded the soil when they began agricultural operations. The highest risk agricultural operations are conducted on cropland, particularly prone to soil erosion as most farming systems leave the land bare for part of the year, exposed to wind and water.

FAO (2014) also maintain that soil is a renewable resource and soil degradation is a process and ancient high lying places became today's low lying places. The following three quotes were taken from FAO (2014:s.p): "civilizations began where farming was most productive. When farm productivity declined, usually as a result of soil mismanagement, civilizations also declined - and occasionally vanished entirely". "In countries bordering the Mediterranean, deforestation of slopes and the erosion that followed has created man-made deserts of once productive land". "Ancient Romans ate well on produce from North African regions that are desert today". A recent study of the collapse in Guatemala around 900 AD of the 1700 year-old Mayan civilization suggests that it succumbed for similar reasons. Researchers have found evidence that population growth among the "Mayans was followed by cutting trees on mountainsides to expand areas for farming. The soil erosion that resulted from growing crops on steeper and steeper slopes lowered soil productivity - both in the hills and in the valleys - to a point where the populations could no longer survive in that area. Today only empty ruins remain".

FAO (2014) maintained that the same processes of soil degradation which destroyed civilizations in the past are still at work today, adding that billions of tons of soil are being physically lost each year through accelerated erosion from the action of water and wind and by undesirable changes in soil structure. Many soils are being degraded by increases in their salt content, by waterlogging (as described earlier by Ransom (2013) in Section 7.4.2.1), or by pollution. Many soils are also losing the minerals and organic matter that make them fertile, and in most cases, these materials are not being replaced nearly as fast as they are being depleted (FAO 2014). This mismanagement of land results in loss of soil and reduction in agricultural land productivity.

8.1.2.6 Early warning mechanisms

It was mentioned in Section 6.1.2.6 that in contrast to current situations where early warning mechanisms operate via technical means such as SMS messages, radios or internet, the elderly in the ‘long past’ relied heavily on Indigenous Knowledge (IK) and word-of-mouth (wom) for their predictions with regards to climate and weather patterns. IK means included the interpretation of the constellation of galaxies, decrease (drought will occur in the following year) or increase (good rains or floods the following year) in local fruit tree production, animal behaviour (small or large stock), as well as behaviour in children. In many parts of the basin, especially close to the Namibia-Angola border where communication via network is limited or unavailable, IK and wom are still the most reliable methods of early warning. Kamara (2014) wrote that in Africa, local communities had well-developed traditional indigenous knowledge systems for environmental management and coping strategies, making them more resilient to environmental change. This knowledge had, and still has, a high degree of acceptability amongst the majority of populations in which it has been preserved. These communities can easily relate to this knowledge and it facilitates their understanding of certain modern scientific concepts for environmental management including disaster prevention, preparedness, response and mitigation.

In Swaziland, as Kamara (2014) documents, floods can be predicted from the height of birds’ nests near rivers. Moth numbers can predict drought. The position of the sun and the cry of a specific bird on trees near rivers may predict onset of the rainy season for farming. The presence of certain plant species indicates a low water table. Indigenous knowledge is therefore an essential element in the development process and the livelihoods of many local communities. A major challenge that African countries continue to face is how to reconcile indigenous knowledge and modern science without substituting each other, respecting the two sets of values, and building on their respective strengths (Kamara 2014).

In summary, Cuvelai floods are not a new thing, and as the elderly have revealed, floods in the Basin have always been in existence as indicated in Table 6.2 which compares the flood characteristics of past and present flood years as gathered from the elderly. In recent years the overall impact of media attention, international assistance, dependency on government have all increased along with an increase of impact and vulnerability on local population. In the past higher social cohesiveness, greater land availability and larger fields led to lower vulnerability and less damage from floods even through the flood intensity and extent were perceived to be greater.

8.1.2.7 Structural differences

As mentioned in Section 6.1.2.7, mechanical changes within the hydrological and socio-economic systems have been associated with the difference in which people dealt with floods in the 'long past' compared to recent years. Damming, intentional blockade and redirection of streams, ditches and trenches, as well as deepening of streams are some of the mechanical mechanisms put in place to deal with flood impacts.

- Impact of dams on flood vulnerability

From a community perspective, damming was not practiced in the 'long past' in contrast to recent years when water has been released from dams without communities' knowledge. Residents expressed the idea that the sudden increase in flood waters could be attributed to pumping or releasing of water from dams during floods, as the levels increase. This highlights the need to commence with dam safety bulletins, community awareness campaigns, and other early warning systems regarding dam safety by institutions dealing with dams in the area, be it large or small scale dams.

Damming in the Cuvelai for flood control purposes is impractical and will continue to pose negative consequences if continue. Being a relatively flat area, the Cuvelai has no suitable relief for large storage reservoirs. According to NHS (2010), small excavation dams, locally known as 'earth dams', miss the capacity to retain any continued flows. A typical dam of 15,000 m3 will already overflow within 1 hour for a typical inflow rate of 5 m3/s.

- Impact of river ditching on flood vulnerability

It was mentioned in Section 6.1.2.7 that mechanisms such as ditching, stream redirection, deepening and blockade by town councils in an effort to counteract flooding of urban areas has a double effect on the rural communities. First, it can deflect flood waters towards some fields. Trenches may also trap and endanger. Secondly, it can help get rid of siltation problems that sometimes result in excessive flooding. As *iishana* are continuously becoming shallower as a result of sedimentation and deposition of soils washed off fields, the chances of spillage of flood waters over *iishana* to the neighbouring fields are extremely high. As a result, this motion has been welcomed with mixed emotions by the residents and the general public at large. For example in its recommendation NHS (2010) motivated for deepening of the main channels to deflect water from certain areas, which is opposed by the first point on this subsection as above, while the second set of respondents believe it will lessen flood that occur due to siltation. Opposing ditching, Tetenbaum (1999) wrote that the faster water runs from the watershed into the river, the higher a flood will be, and thus anything that increases runoff speed like excessive pavement or ditching of farmland will contribute to floods. Practical measures should thus be taken taking into consideration the geography and activities of certain areas.

- Ditching at household level for flood control

Another practice of reducing the flood impact which is somewhat taken for granted by many is that of digging trenches encircling a household to act as a flood water trapping barrier. Lack of strong grasses and other material during flood is considered by the residents as a hindrance for this practice. Additionally, the preparation of the trenches is labour intensive, and as a result this has been to some extent unintentionally, but due to circumstances, neglected as a mitigation measure at household level.

- The impact of traditional house construction on flood vulnerability

In the past, wood locally known as *iifini*, was used to construct many if not all huts and houses. This has led to major deforestation in the area over the years. Deforestation has catchment-wide effects by increasing flood magnitudes, and also by increasing land erosion, which results in siltation and reduction of flow capacity of channels (NHS 2010). Mud is currently commonly used for building purposes by the rural poor Traditional huts were completely made of natural and bio-degradable material. After immediate threat to the human lives, the next most vulnerable are the houses. The impact of earthquakes and floods on houses has been enormous and hence the reconstruction of houses after these natural disasters is always an uphill task for the communities (Shah et al. 2013).

It will be impractical to recommend that usage of natural matter for house construction should be stopped. It is thus important that recommendations made in this paper are doable putting into consideration that this specifically targets the poor residents. Thus to overcome this in Bangladesh, Ahmed (2005) suggested that fibrous thatching material, such as grass and straws need to be soaked in a chemical preservative solution at least only 12 hours to prevent rot during floods. Such chemical preservatives presented by Ahmed (2005) may however pose health concerns to those that may come in to contact with it. The chemicals are also high maintenance and may prove too sophisticated for the Cuvelai. Gloves, protective glasses or plastic bags should be worn on hands when applying the preservative. These items are not readily available in some rural areas of the Cuvelai. Children and animals should be kept at bay during the application process. Small stock and uncontrolled animals may be difficult to manage and this may pose a health concern to animals that may end up consuming part of the preserved grasses and stalks. The unused chemicals should be discarded, which may prove impractical in rural areas with no proper dumping sites or waste management plants. Some preservatives may also contain oils, which may act to accelerate combustion of these already fire prone households. Other feasible alternatives should thus be investigated further.

Currently, due to the shortage of trees and other plants, mud is used as an alternative building material to construct huts and houses. Most of the huts in the lower Cuvelai, where there is a natural lack of trees due to saline conditions, are constructed mainly out of mud and grass by the rural poor. According to Shah et al. (2013), a great majority of the poor people in the developing countries are living in mud houses mainly due to easy availability of raw material and local skills for its construction.

It was also reported that unlike wood, mud quickly absorbs water, and as a result mud huts and houses degenerate quicker in these flood and seepage prone areas. Mud cannot be re-used for construction once it crumbles after floods as the cohesiveness is lost. These types of houses are made with moulded earth. Earth lumps are made and stacked to make the wall. Earth is not compacted. When the wall has been built, it is trimmed to give better finishing to the wall. Environmental performance of these buildings is very good but these are very vulnerable to floods or rain (Shah et al. 2013).

Deaths associated with collapsing of mud sleeping huts have been reported in the area. The mud bricks are very weak in shear, tension and compression, which cause collapsing of the walls (Shah et al. 2013). The usage of mud as a primary building element in most poor homes has however increased vulnerability of the local residents to floods and other disasters as mentioned by Yohe et al. (2006) in Section 2.2.1. A situation like this has made the current generation more vulnerable than in the past. On the contrary, no such deaths have been reported when wood housing structures.

8.1.2.8 Non-structural differences

- Deforestation: slash and burn practices

Section 6.1.2.8 mentioned that slash and burn has been one of the major causes of increased flood impact in the Basin over the years. According to Lindsey (2004), slash-and-burn method of agriculture is never more than a short-term solution. Typically within a few years, the initial influx of nutrients from the burned forest is used up. When the soil fails, farmers move on to a new patch of forest. The old patch may be abandoned or turned into cattle pasture, which must be re-burned frequently to encourage grasses rather than trees or shrubs. Fires can pose severe consequences on subsequent runoff (WMO 2013). In addition to the typical deforestation problems, fires have the potential to alter the soil surface and make it temporarily hydrophobic, that is, unable to absorb water. This is especially true in areas with trees of high oil content. The oils and resins from the trees vaporize and get infused into the soil. This effect creates a hydrophobic layer at or near the surface, which acts as an impermeable blanket and a barrier between the earth and water. The severity of runoff and sediment loading can often be seen by the scour on the tree trunks and the alluvial deposits left after the floodwater passes (WMO 2013).

Early village settlers expressed that in the past these were places where wild animals roamed freely and the population in places that had people residing in them, was low. The villages used to be thick forest and there were many plants to intercept the water. As the area became more populated, deforestation increased. Uprooting of trees and other plants caused the soil structure to weaken, increasing flood susceptibility.

- Shifting of households and kraals (cultural practice)

It was also mentioned that annually, as a matter of culture and tradition, households shift to a different place in the same *ekove*. In addition, many local people rely on the use of animal fertilizer for agriculture by rotating and moving kraals from place to place over many years. Such relocation however does not always come with informed decision making, creating the opportunity of moving a household to more vulnerable land.

- The impact of deforestation

Deforestation can have a significant impact on infiltration and surface runoff. Deforestation plays several roles in the flooding equation because trees prevent sediment runoff, and forests hold and use more water than farms or grasslands (Tetenbaum 1999). According to Tetenbaum (1999), some rainwater stays on the leaves, and may evaporate directly to the air (the more water used in the watershed, the less remains to run off). Tree leaves reduce raindrop impact, and gentler rain causes less erosion, while the roots absorb water from the soil, making the soil drier and able to store more rainwater. Additionally, tree roots hold the soil in place, reducing the movement of sediment that can shrink river channels downstream. With little or no plant matter on the surface, water is left to run-off much faster than when a surface is covered with vegetation.

It was briefly mentioned in Section 6.1.2.7 that deforestation has catchment-wide effects by increasing flood magnitudes, and also by increasing land erosion, which results in siltation and reduction of flow capacity of channels (NHS 2010). With minimal obstructions to intercept surface water; water has less time to infiltrate the ground. In addition, with no root structure to bind the soil, runoff from deforested areas is likely to contain more sediment. The sediment load chokes the stream channel, which would otherwise be available to handle increased flow, leading to increased runoff and greater flood vulnerability. Deforestation, as according to WMO (2013), therefore affects both the frequency (indirect consequence) and spatial extent (direct consequence) of flooding.

According to Tenenbaum (1999), people often blame floods on heavy rains, maybe El Nino or global warming. Deforestation was proven to be a problem and primary cause of flooding in the Yangtze catchment of China. This catchment lost 85 percent of its forest cover in the past few decades, during the 1998 floods (Tenenbaum 1999).

8.1.2.9 Changing patterns of natural phenomena

As mentioned in Section 6.1.2.9, community members have a general idea about global warming and climate change. Some residents felt its getting hotter. According to the World Bank (2010), the African continent has warmed about half a degree over the last century and the average annual temperature is likely to rise an average of 1.5-4°C by 2099. The World Bank (2010) further wrote that Africa is becoming the most exposed region in the world to the impacts of climate change. In Sub-Saharan Africa extreme weather will cause dry areas to become drier and wet areas wetter; agriculture yields will suffer from crop failures; and diseases will spread to new altitudes. In agriculture, as much as nine to 20 percent of Sub-Saharan Africa’s arable land will become much less suitable for farming by 2080. Extreme poverty, frequent natural disasters such as droughts and floods, and heavy dependence of agriculture on rainfall further increases the continent’s vulnerability. According to the Economist (2007), some scientists think climate change may be even more severe to certain areas of Africa than current predictions suggest. The important point, they say, is not the degree of warming but the continent's vulnerability to it. A University of Pretoria study estimates that Africa might lose $25 billion in crop failure due to rising temperatures and another $4 billion from decreased rain (Economist 2007). The already impoverished dry lands would suffer most. Major floods that used to happen only once in 100 years now take place every 10 or 20 years. Unfortunately, as the Economist (2007) continued, few African leaders have grasped the scale of the challenge posed by climate change. Most oil-producers have squandered their bonanza. Nigeria has failed to plan for how to stem the dreadful pollution in its oil-producing Delta region or to prevent desertification tearing at the fabric of its dry Muslim north. South Africa is only just beginning to own up to its coal addiction. Uganda is fighting off a rare insurrection from his supporters against plans to turn a piece of Ugandan rainforest over to farming. The World Meteorological Organisation says that weather data collection in Africa has recently got worse, just as the need for accurate figures has grown; many of the automatic weather stations it helped set up have fallen into disrepair. The African Union has done little to sound the climate change alarm.

Contrary to Min et al. (2011) and Pall et al. (2011) as discussed in Section 3.2, scholars such as Thompson (2009) proclaims that it's impossible to quantify how much of the change in rainfall is caused by man and how much is due to the cyclical patterns in nature It is clear though, a significant change is afoot: a succession of productive growing seasons with predictable sun and rain has been replaced in recent years by a series of extreme weather events, leaving places like the Cuvelai with little time to recover from one disaster to the next.

8.1.2.10 Lack of indigenous information, ignorance and awareness

It was mentioned in Section 6.1.2.10 that elders cited a lack of community knowledge in dealing with flood disasters as a factor that contributes to the younger generations acting indifferent and with ignorance in attempts at reducing the impact of floods at a household level.

The level of education in rural areas is low, and places of residence are chosen based on aesthetic personal preferences. With lack of 'village-planning' initiatives when it comes to land allocation and housing construction, where one may choose to settle and how one wants to construct one's houses and with what material remain the land seeker's decision. The impact of land allocation on floods is described in Section 3.6.

With good experience of the area and the area's flow patterns, elders were much more cautious and informed when it came to choosing land for various purposes. Much of this information lay in indigenous knowledge of local features as presented in Section 6.1.2.6 and also in Kamara (2014). This knowledge enabled them to predict and understand past and future rains, droughts, years with good harvest and so on. Indigenous knowledge systems are generally criticized by the liberal youth as the elders report. Younger generations often underestimate and undervalue indigenous knowledge, and refuse advice on where to settle in a village when based on it. Several confessions were made by middle-aged and young household owners that they ignored these, and failed to heed the advice from village headmen other elders, and have experienced flooding in the past five years. Many of these houses were built after the 1990s.

The concept of indigenous knowledge is only gaining accelerated media attention in recent years. However, there are several African scholars and philosophers who have been researching the concept of indigenous knowledge for many years now. Gbolonyo (2009:195) stated an example, citing ignorance of indigenous knowledge: ‘the act of knowing is rooted in awareness, understanding, and familiarity. It is the knowledge that is gained as a result of acquiring a certain level of awareness or gaining certain understanding of concepts, relations, and situations in terms of their fundamental principles’. Gbolonyo (2009) provides an opportunity for the public and researchers to increase their understanding and awareness to gain fruitful results in relevant knowledge of IK. Once people are aware, taking cognizance of indigenous knowledge would much be easier. Will the integration of indigenous knowledge with technical systems perhaps attract more young generations of the Cuvelai to pay attention to local knowledge when it’s appropriate?

Gbolonyo (2009:196) further emphasized that the ‘freedom that comes from lack of self-knowledge/ignorance only enslaves or makes one a slave. That is, the self-knowledge that is worth having and really freeing is the awareness or knowledge of how much one does not know. Anything short of not knowing how ignorant one is, about the fundamental principles of the mind and of wisdom, is equated with being in slavery’. Again, Gbolonyo (2009) teaches us that indigenous knowledge will set a man free to live and to relate himself meaningfully and purposefully to others in his surroundings. There is thus an expressed need for information awareness campaigns and sensitization programs to foster understanding of floods and other environmental matters.

But then how do we advocate for the youth and the ignorant to become aware and take cognizance of indigenous knowledge if it means reducing vulnerability to floods? The use of this indigenous knowledge and traditional warning systems requires an in-depth investigation, and has become a personal and professional interest for the researcher.

8.1.2.11 Cultivation and agricultural practices

It was mentioned in Section 6.1.2.11 that another difference between the ‘long past’ and ‘recent past’ lies in the various ploughing mechanisms used over the years. In the past, people used to plough by hand, generating high rounded plots that resembled grave mounds with wide open passage ways in-between them to allow free flowing of water. A report released by the UK-based International Institute for Environment and Development (IIED) revealed that traditional agriculture methods could help protect food supplies and make agriculture more resilient to the effects of climate change (IIED 2005). According to the report, traditional knowledge, rather than modern methods, has helped indigenous people in countries like China, Kenya and Bolivia to cope with extreme weather and environmental change. The report further narrated that policies, subsidies, research and intellectual property rights promote a few modern commercial varieties and intensive agriculture at the expense of traditional crops and practices. This is perverse as it forces countries and communities to depend on an ever decreasing variety of crops and threatens with extinction the knowledge and biological diversity that form the foundations of resilience (IIED 2005).

In recent years, tractors and ox- or donkey-drawn ploughs are used. The plots created by tractors and animal-drawn manually operated ploughs are relatively flat, with no clearly defined water ways in-between them causing water to flood the plots. Standing water in the fields may cause extensive waterlogging discussed in Section 6.4.2 as in FAO (2014). After floods, seasonal grasses establish themselves and colonise the flood affected fields and other areas. This subsequently hampers crop productivity as poor *mahangu* is produced, thus decreasing local food security. Areas not previously flood-prone, especially between *ombuga* and the salty dry areas around Ongandjera that were later abandoned for residence, are now subject to flooding after years of reworking the land. Many soils are being degraded by increases in their salt content, by waterlogging (as described earlier by Ransom (2013) in Section 7.4.2.1), or by pollution. It was also noted in the same section that soils degrade after being reworked for many years. When rain falls heavy, and if floods continue at the same rate as in the past five years, local residents will suffer the consequences of flooding in a similar manner though not to the same extent as those people residing in low lying areas and *iishana*.

8.1.2.12 Superstitions and beliefs

As documented in Section 2.2.3 beliefs and customs are major factors that influence social vulnerability. It was also mentioned in Section 6.1.2.12 by the residents that centuries ago, there were superstitions that the rains had ‘owners’, and that rain events followed these ‘owners’. This belief was locally referred to as *okuhomeka odula*, directly translating as *preparation of the rain*. Some residents feel it floods because *God is angry with us and how we are behaving in today’s world.* Some compare the floods with biblical revelations e.g.

Noah's ark. These kinds of beliefs could jeopardize effective flood impact mitigation if taken with too much seriousness by the communities.

Associating floods with superstitions is not uncommon elsewhere in the world, and it is definitely 'not just an African thing'. Just recently in 2014 a local British politician was expelled for associating floods with superstitions. In England during the storms that caused widespread flooding in the UK 2013 winter, some Christians and politician believed that God is angry over gay marriage and God can actually show that anger (British Broadcasting Corporation (BBC) (BBC 2014)). According to DeYoung (1998), "storms, floods, and earthquakes are indeed a part of the present world. We sometimes call them 'natural disasters', but they are not a surprise to God. Yes, God certainly can control the weather and send deadly storms". Beliefs such as these may hinder preparedness of the communities, as they believe there is nothing they can do to reduce the impacts of floods.

8.1.2.13 Other factors contributing to high risk of flooding in rural areas

- Fencing-off of large fields (to be reserved for families at later stages), and Illegal fencing and land grabbing by the rich and famous

Though stipulated in the Communal Land Reform Act (Act No. 5 of 2002) and the Traditional Authorities Act (Act No. 25 of 2000) that any piece of land not utilised within three years after it has been secured by the owner shall revert back to the TA, it was mentioned in Section 6.1.2.13 that many residents fence off land and reserve it for their children for when they decide to make their own homesteads. The land can later be subdivided among the sons of the house. This leads to unutilized pieces of good land fenced off and reserved for family usage for many years ahead. It is also stated that all pieces of land should not exceed 20Ha per household (Communal Land Reform Act (Act No. 5 of 2002)), and fencing-off of pieces of land exceeding 20 ha has been illegal, since 2003 when the CLRA was enacted in parliament. Re-enforcement of the law thus seems to remain a huge challenge especially when it comes to land issues in not only the Cuvelai Basin but in the whole country at large.

Another factor classified as contributing to high risk of flooding corruption among some TA leadership. Some leaders have been accused of accepting cash from wealthier members of the community, in exchange for land. These 'bribery for logging' practices have led to a decrease in community forests that existed, when bribery was minimal. See also Section 5.5.2 on nepotism and as reviewed in Musa (2012).

Tien (2001), Mendelsohn & Weber (2011), Gumbo (2006) & Vlachos (1995) indicated in Section 1.2 that most the times it is poor people that are the most vulnerable. Fencing-off of large pieces of land denies other community members a chance to choose good land, leaving them no choice but to reside in flood prone areas.

8.2 HOUSEHOLD LEVEL MITIGATION STRATEGIES

Community perspective on implementable mitigation strategies that can at household level are discussed here. The section will investigate general preparedness, response to floods as well as mitigation and reduction activities.

8.2.1 Preparedness

As mentioned in Section 6.2.1 some residents feel they do not have to prepare for floods as floods are God given and no one can challenge God. Also discussed in Section 6.1.2.12 (BBC 2014; DeYoung 1998), beliefs and superstitions of this nature are very popular among the residents, and may render residents even more vulnerable as they would not value early warning initiatives.

8.2.1.1 Incorporation indigenous knowledge in early warning strategies

The results presented in Section 6.2.1.1, indicate a very strong significance that using resources and indigenous knowledge, residents significantly can predict whether flood conditions will prevail within the coming year or not. The responses (Figure 6.5) are quite similar for all types of residents (community leaders, flood-affected residents and non-affected local residents), with majority of the residents expecting future impacts of flooding while less than half of the residents do not foresee chances of flooding in the following year.

As mentioned in Section 6.2.1.1, indigenous knowledge can be based on specific predictions, such as, *2013 would be a year of drought*. It is worthwhile to notice the agreement between indigenous knowledge predictions and current events, and more research needs to be conducted in this regard. Some sources report that close to 40% of the population was affected by drought in 2013 and it was classified as the worst drought in nearly ten decades (DDRM 2013). The Southern Africa Development Community (SADC) Regional Climate Outlook Forum's (SARCOF) Climate Service Centre in 2012 predicted normal to above-normal rainfall from October to December 2012. When interviewed between mid and late months of 2012, many rural residents ridiculed the SARCOF forecast, quoting that 2013 will be a year of extensive drought, by looking at the behaviour of animals and children and the constellation of the galaxy as discussed earlier in Section 6.1.2.6. Most strikingly, in February

2013 as reported by the DDRM (2013), Namibia Meteorological Services (NMS) produced a report contrary to SARCOF's predictions, and released an early warning in February 2013 citing drought conditions for the season. This confirms what the local residents had predicted earlier using indigenous knowledge. On 17 May 2013, the Namibian President Hifikepunye Pohamba declared a national emergency due to the "wrath of mother nature in the form of a country-wide devastating drought" (Halwoodi 2013), which had killed 6000 livestock and rendered a total of 778 504 people (of which 3,000,000 are from rural areas) food insecure (DDRM 2013) by the time it was declared.

Though some residents could predict floods or droughts for the subsequent years, the majority did not know exactly from which dates the disaster would strike, some residents are to a certain extent able to notice when immediate floods would reach their areas. There are also those that are able to predict the approximate days when the floods are expected to reach their areas from other areas or villages within the course of the floods. Residents narrate that such information has been built up over years of word-of-mouth communication between residents. It will thus be beneficial to the community and the Hydrological Services to gather this information in detail and formulate ways in which to incorporate indigenous knowledge in technical early warning techniques. Kenya has a well-established system of integrating indigenous knowledge with technical early warning information (Kamara 2014) (Section 6.1.2.6).

8.2.1.2 Preparedness strategies

It is critical to know whether direct flood-affected residents, with general long term based future predictions based on indigenous knowledge, are able to extend such information to preparedness strategies in order to reduce the flood impact. Furthermore there is the perception that those not affected by floods do not have to prepare for such disasters. Like most of the flood-affected residents, non-affected local residents and community leaders that are often not prone to floods, do have preparedness strategies in place (Figure 6.7). However, the residents not affected by flooding are less prepared than flood-affected residents (33% vs. 65%) but in actual fact should have to prepare for floods just as much as the flood-affected residents as it is the non-flooded that accommodate the flooded residents during the floods.

Preparedness measures were suggested and recoded into four categories: alter agricultural practices (13%); build back differently after floods (26%); mechanical intervention (10%); or do nothing (51%). Highly geographically vulnerable residents were more likely to suggest building back differently after floods (86%) and using mechanical intervention (82%) to counteract the consequences of flooding, while highly socio-economically vulnerable residents opted for mechanical intervention. A small percentage opted to alter agricultural practices. Perceptions, lack or resources and exhaustion of alternative options, are mentioned to be hindering preparedness measures for these local residents, also in Tien (2001), Mendelsohn & Weber (2011), Gumbo (2006) and Vlachos (1995). Details of these preparedness strategies outlined by residents have been described in Section 6.3.

8.2.2 Response

During natural disasters and floods, people are forced to leave their homes and communities. As a result, people might lose access to shelter, food, water, sanitation, education, health and a safe space to live. Some people look for support in homes of friends and extended families. Others relocate to nearby high grounds and settle temporarily in relocation sites or camp, as a last resort. The way the relocation site is set up and managed affects the dignity and capacity of recovery of its residents.

It was mentioned in Section 6.2.2 that some residents prefer to relocate to neighbours and relocation centres where they stay for the duration of the flood season, or until water levels subside. Reduced willingness to relocate in the future to temporary relocation camps has also been mentioned most especially due to reported cases of crime, harassment, theft of personal property while in the communal tents and house burglary while house owners are in relocation camps. Unhygienic conditions and conflict between residents are also some of the associated consequences of living in relocation camps, which saw many residents suggesting that individual tents be allocated to flood-affected residents per village as communal tents are inconvenient. Some residents also prefer camp sites in their own villages in close proximity to their residences where they would be able to watch over and protect their crops, livestock, houses, and guard against robbery. According to Red Cross (2009), disease outbreaks are common in camps and are accelerated due to overcrowding.

It has been reported that the tents and free items given in relocation centres during flood events have increased dependency on leadership, and triggered parasitism in residents who would relocate to tents even when they are not flooded. Residents have made recommendations for village headmen and village committees to be consulted first when residents seek refuge in tents. Letters of recommendation from village leadership to seek refuge at relocation camps have also been suggested. As it was mentioned earlier in Section 1.2.2, unlike many organizations, the NRCS does not have to wait on for Cabinet to declare a flood event 'a national disaster' before they start assisting flood-affected residents on the ground. NRCS has a high number of volunteer-staff based in the regions that inform the organization of the situation at hand. This enables the NRCS to deploy their services right away even before and during the rapid assessment phase to the communities needing assistance, with un-earmarked and readily available funds released by International Federation's Disaster Relief Emergency Fund (DREF) (Kwenani 2012, *pers com*). The NRCS however has criteria commonly used to select beneficiaries of relocation or of other services offered to flood-affected residents. Priority is often given to elderly people, women and children and targeting mainly the rural and informal settlement residents, in communities characterised by high levels of poverty, food insecurity, and HIV/AIDS (NRCS 2009).

While there are those seeking out for freebies that come along with temporary relocation, it was also mentioned that some residents find it practical to relocate permanently where they can be given new land where they can re-establish their households.

According to the International Organization for Migration (IOM) (IOM 2011), every member of the community is responsible for contributing to building a safe, secure and healthy environment in the relocation site, by participating in the camp management activities. Based on this principle, the IOM tries to remedy the insecurities and dangers associated with temporary relocation through an initiative called Camp Coordination and Camp Management (CCCM). According to IOM (2011), camp management is about how the relocation site is organized, to meet the basic needs for services and protection of its residents. Standards have been defined globally to uphold the right to life with dignity for people living in relocation sites and camps, providing guidance for minimum levels of service delivery and protection. Every person living in a relocation site should participate in the management of the camp and contribute to build a safe, secure and healthy environment for their community through several activities such as through the formation of community groups. Community groups can be formed in line with different sectors of the camp, focusing on sectors such as health, water, shelter and food. Community groups can also form other groups such as youth committees, women groups, committee of disabled, or a group of community advisors (IOM 2011). Community participation, according to IOM (2011) is important because it builds dignity and self-esteem among residents in camps; it ensures that services and protection in place are appropriate and effective; it raises standards in the relocation sites; it develops skills for life after displacement; and it puts people back in control of their own lives, decreases dependence and increases self-reliance. The initiative however was heavily emphasized post

2011 floods and has not yet encountered a major flood event since then so that its effectiveness can be tested.

8.2.3 Mitigation and reduction

Surviving the setbacks from flood disasters is one thing, but restoring and recovering oneself and a property after the disaster has passed is another. As it was mentioned in Section 6.2.3, practically speaking, the more money a household accumulates, the better the chances of building flood resilient structures, and the more likely such households are able to re-establish themselves post-disaster. One of the possible mitigation methods is building a flood protection barrier around the *ekove*. More than half of the respondents expressed that due to affordability and the high magnitude of floods experienced in certain areas where proposed structures would not be able to withstand the water pressure, it would be impractical to surround their *ekove* and households with flood protecting barriers such as cement walls or other kinds of barriers. As mentioned in Section 6.1.2.7 trenches around the *ekoves* might assist in trapping flood waters at household level. This is however possible only when flood waters are not of the high magnitude as expressed by some residents in this section. Another interviewed group expressed the fear that structural based mitigation strategies may change the natural water courses, deflecting flood waters to neighbours, as it also in WMO (2013) in Section 5.5.2.1.

The aim of the study is to recommend alternative practical adaptive strategies to flooding in consultation with local village headmen and residents. The next section provides more alternative practical adaptive strategies suggested by local residents in order to cope with the consequences of flooding.

8.3 PRACTICAL ADAPTIVE STRATEGIES

In addition to mitigation measures discussed in Section 6.2, the interviewees have suggested the following practical adaptation strategies to floods. Some mitigation strategies such as ‘altering agricultural practices’ discussed in Section 7.1.2.11 are further detailed in Section 8.3.9. Much of these adaptive strategies have been deduced from earlier in-depth discussions in this paper, and reference is made to the appropriate sections in which they are partially covered.

8.3.1 Mechanical recommendations (mitigation)

- Damming at critical sites along *iishana* channels, redirection and deepening of *iishana*

has been discussed in detail Section 6.1.2.7 as a structural difference between 'long past' and 'recent past' flood years. While earth dams have been cautioned against by NHS (2010) for flood control measures, some residents have recommended that the amount of earth dams on *iishana* channels should be increased. It was also mentioned in Section 6.3.1 that residents want to be involved in the siting process of the earth dams' locations. According to IOM (2011) as discussed in Section 7.2.2, involving communities in flood management initiatives '…builds dignity and self-esteem among residents in camps; it ensures that services and protection in place are appropriate and effective; it raises standards in the relocation sites; it develops skills for life after displacement; and it puts people back in control of their own lives, decreases dependence and increases self-reliance'…

A similar issue that is also opposed by several residents but recommended by NHS (2010) and several other residents, is the redirection and deepening of critical streams to lessen the amount of water reaching the communities residing near *iishana.* Deep trenches are however deemed dangerous to human and livestock wishing to cross the *iishana* from one place to another, adding that warning signs should be erected at sites of excavations for human safety.

- Deepening of water ponds in *ekoves* and tunnelling

As described in Section 1.1.1, human settlement in the Cuvelai Basin depends upon the availability of water. Many households have small naturally occurring depressions of water in their *ekoves* known as *ondobe.* According to the residents, the *ondobe* depressions become choked with sand by many years of soil deposition. This makes them shallower than they initially were, causing water to overflow to other parts of *ekove* and houses. Residents felt that by deepening the *ondobe* depressions, most of the flood waters can be retained, thereby minimising excess spillage and run-off, reducing the impact of flooding at household level. In cases where depressions do not occur naturally, residents have recommended large holes be excavated in *ekove*s at several low lying sites to trap the flood waters. Many people in the Cuvelai depend on underground water for survival. According to Mendelsohn (2013), groundwater or rainwater that has seeped into the ground where it is stored in water bearing layers known as aquifer for many years is usually valuable in places where no other water suitable for human consumption is available. This is the case over large areas south of Etosha and in eastern Oshikoto and western Omusati.

Groundwater is also used to supplement supplies obtained from other sources. Notably water is pumped from the Kunene River into a vast network of pipelines across much of the northern half of the Basin. Other surface water in this area is available from *iishana* and pans after good rains have fallen, and from small freshwater ponds known as *ondobe*. This surface water is often contaminated by livestock, however, and not well-suited for human use. Cleaner water is also widely available in small quantities from shallow hand-dug wells called *omifima* (Mendelsohn 2013).

At household level, residents suggested that a large canal (ditch) should be dug on the side of *oshana*, just between *oshana* and *ekove,* to avoid the flood waters from reaching the fields, at the same time channeling the water along the *iishana*. This trapping practice has been reportedly used locally in the 'long past' to control army worms' invasion from one *ekove* to another. While reducing the amount of water reaching the field in some areas, some residents are opposed to ditching as it has reportedly exacerbated flooding of households further downstream of the trenches. In Zambia for example, cultural practices such as digging trenches around affected areas for the worms to fall in and be easily destroyed by farmers using mechanical or other means has been used for many years (Kalonde 2012), a strategy that residents can use to block waters from reaching their fields. Digging trenches from inside the house to *iishana* works in some areas, but worsens the flood situation inside the house when water levels in *iishana* rise excessively. Other similar mechanisms suggested are the use of sand embankments and sandbags.

- Constructing crossing bridges to schools

To make it easy for school-going children to cross the flood prone *iishana* on their way to school, construction of crossing bridges to all schools were suggested. This will help in keeping learners away from classes for pro-longed periods of time. As documented earlier in DDRM (2008, 2009, & 2011) as well as FEMCO 2011 reports of over 200 schools were cut off by floods, accessibility was hindered and school children stopped going to school. This recommendation by the residents may need to be intensified in the area.

8.3.2 Household construction practices

It was mentioned in Section 6.3.2 that materials selected for house construction have a huge impact on how a household is affected by the floods, and choice of construction materials depends on what a household is able to afford. For socio-economically vulnerable households (as shown in Figure 5.26 and Figure 5.27b and as in Yohe et al. (2006) in Section 5.5.2.4 (also see Section 2.2.1)), several mitigation measures have been suggested by the interviewees. Less flood susceptible material has been recommended for use by the residents as in Section 5.5.2.4.

To minimise standing water and erosion, sand or clay soils are piled inside the homes to raise the foundation. Alternating layers of think grass stems, bricks, debris and soil are placed in dug trenches to reinforce erosion prone areas. Organic matters have been used to improve the speed with winch water soaks into the ground, the ability of the soil to hold water, and soil drainage. Mulch reduces runoff. Mulch protects soil from being hit directly by rain, and thus reducing soil crusting and increasing the speed with which water soaks into the ground (Niemiera 2009). While some areas have too little of it, other areas have too much groundwater to manage, especially during excessively wet seasons. In an areas of Jodhpur (India) for example, ground water levels has been on the rise and now seepage has become a grave problem for the groundwater department (Parmar 2009). Parmar (2009) suggested that water-absorbing and fast-growing plants like Eucalyptus can be planted, especially in areas where groundwater is too much. Parmar’s (2009) recommendation is a very inexpensive mechanism that residents in seepage prone areas of the Cuvelai could consider to remedy the seepage situation. Currently the Cuvelai residents attempt to counteract the consequences of seepage using various short term mechanisms such as: placing plastic layers underneath the mud floor during construction; using locally made wooden beds instead of sleeping on the floor; placing plastic layers underneath blankets if sleeping on the floor; cooking on top of elevated iron sheets or placing an elevated cement veranda in cooking areas; elevating storage facilities as well as stacking bricks together to create temporary stairs leading between rooms and to the outside of the house.

- Addressing high lying land shortages

It was mentioned in Section 6.3.3 that some areas are reportedly being fenced off by authorities for alleged projects without the consent of the local people. The residents have called for community level involvement and agreement in such matters.

As discussed in Section 6.1.2.13, illegal fencing and land grabbing exacerbates socio-economic and geographic vulnerability of the affected residents. Interviewees have recommended that when cattle posts, especially in the *ombuga* areas, have not been used for a long time, surrounding fences should legally be removed to enable re-use of this scarce resource by those in need. Some residents have even recommended that all cattle post land be re-distributed among households in flood prone areas. Stipulated in the Communal Land Reform Act (Act No. 5 of 2002) and the Traditional Authorities Act (Act No. 25 of 2000), cattle posts areas are *commonage land*, which is defined as land shared by all residents in a community, and should not be fenced off or used for personal purposes.

8.3.3 Permanent relocation

- Assistance with permanent relocation

As mentioned in Section 6.3.4 that the majority of interviewees have indicated that they are willing to relocate, but are unable to do so due to *lack of resources* (Figure 6.11 in Section 6.2). Residents have called on government to provide assistance especially with supply of constructions material, transportation of such materials to relocation sites, clean water supply, and schools at relocation sites. While some residents are adamant to relocate, some have personally approached the authorities seeking assistance with permanent relocation. While they were held at temporary relocation centres during floods, residents in the affected areas around Oshakati have reported that they "sick and tired" of being relocated every rain season, and want authorities to permanently relocate them to safer places (Shivute 2011). In the north-eastern Namibia, NRCS has managed to assist residents in that area to permanently relocate to drier areas (Kwenani 2012, *pers com*).

Sometimes however, permanent relocation of residents to safer areas comes with negative consequences associated with heavy costs on government resources, and as sensitive as it is, should be handled cautiously. In 2011, the Ondangwa Town Council in northern Namibia pleaded NAD15, 000,000 from the government to build permanent structures and to service the land catering 70 new plots for the flood-affected residents (Namibian Sun 2011). In Mozambique for example, the government has already begun to move ahead with its resettlement plans, and had previously identified 4,830 plots, the majority of them on the higher ground of Chiaquelane for such purposes (IRIN 2013). According to The Hindu (2014), residents of the Nagararu village in India's Bangalore took the government to court to demand compensation after they had been ordered to relocate and rebuild new houses in seepage-free areas. In Zimbabwe as according to Mathuthu (2014), more than 3,000 flood-affected residents of the Tokwe-Mukosi village have demanded a total of US$9 million and denied to move from the Chingwizi holding camp where they were temporarily held prior to permanent relocation, until they have received the compensation.

- Permanent elderly homes on high lying land

It was also mentioned that permanent relocation should be extended to the building of self-reliant old age homes in the villages. Elderly people are distinctly outlined as a socio-economically vulnerable group in Section 2.2 and Section 5.5.2. However according to Bane

(1996), rural elderly prefer to pick and choose the services that are important to them based on their values. According to Bane (1996), there are several major factors to consider when developing rural elderly homes. First, services must be accessible and flexible. In rural communities caregiver programs usually need to be developed on a smaller scale not to overwhelm the residents. In some areas as the community leaders mentioned, some residents have already turned down assistance from the NRCS during the past flood years. It was also mentioned that these homes should closely mimic the current rural setup to avoid shock, and thus, second, creativity in facilitating the integration of family and friends into the care system must be ensured. When advocating for elderly homes in rural areas, Carpenter (2012) also wrote that isolation in rural communities can compromise the quality of life. "At the same time we are developing strategies around rural elderly housing; we are also looking for ways to support the personal connections that are so important" (Carpenter 2012:7). "When the senior participant is disabled or too frail to perform the required self-help labour, we have utilized family members, such as brothers, sisters, sons, daughters and grandchildren to provide the required labour…. there have been occasions that we have utilized church groups, neighbours, and other rehab program participants to provide the labour" (Griffith 2012: 8). Services should be available to address short-term and emergency needs. This will also include pension points, safety and health facilities as it was mentioned in Section 6.3.4. Third, as time evolves and service delivery is critical, cooperative agreements with urban areas to improve the level of service provision should be fostered.

- Constructing permanent structures for temporary relocation at village level

A further adaptive strategy to facilitate relocation at village level is the construction of a permanent building in each village, to be used during floods. This permanent structure should contain three components: a *storage component*, where individuals can store their *mahangu* and other belongings under lock and key during flood events; a *sleeping component* where families can get sleeping rooms during floods and other disasters; and thirdly, a *cooking component* should be incorporated in the facility. Facilities should have proper sanitation services and electricity. The cooking facility will allow non-affected residents to prepare meals for the flood-affected residents, especially children, the elderly and people with special needs, and to distribute the prepared food items to the flood-affected residents.

Each village should allocate land for temporary relocation purposes. Villages with no remaining high lying land should negotiate with neighbouring villages for cooperation.

8.3.4 Temporary relocation

- Provision of individual rather than communal tents

It was reported in Section 6.3.5 that residents opting for temporary relocation have suggested that "*individual rather than communal tents should be offered*" [to the flood-affected residents], and should be stored at a safe facility within the village (possibly the headmen's home). This decreases the long waiting time for tents to arrive thereby reducing the impact on flood-affected residents already badly affected. Residents would also prefer to relocate within the same *ekove* in order that they could watch over their homes thereby curbing theft that is said to increase when home owners are away at relocation camps. For example in Pakistan during the 2010 floods, emergency shelter has been delivered to over 1 million households, but meeting only 67% of the emergency shelter needs that time (UN-Habitat 2010). This will also counteract spreading of major outbreaks as outlined earlier by Red Cross (2009).

- Relocating a traditional hut to *okatunu* for temporary relocation at household level

While some residents may depend on government resources for permanent relocation, there are those willing to cut the dependency link. Some residents, possibly with 'attitude type two' or optimists as described in Section 5.1 have an adaptive strategy to construct a permanent emergency hut within the same *ekove*. This emergency hut, located on *okatunu*, a high lying piece of land within *ekove* not large enough for a household should be equipped with basic necessities such as kitchen utensils, blankets, firewood and *mahangu*. Though extremely uncommon, this practice has been observed in few places in the study area, most especially in Transects 2 and 3, and may need to be further encouraged (see Section 6.1.2.4).

8.3.5 Community projects

- Legally enforced community fields and silos

It is custom for flood-affected residents to take shelter at the headmen's houses during flood disasters. This places immense pressure on the headmen's household to produce food for all residents camping there for the duration of the critical flood period. This prompted the headmen to suggest the idea of communal fields in each village. Each village is to identify a piece of *commonage land*, on which all villagers must cultivate crops or provide financial assistance towards cultivation, in addition to their own fields. The agricultural produce should then be stored in community silos to be distributed to the needy during disasters. When not used for production of *mahangu* during the rainy season, community fields are cultivated to produce fresh vegetables to be sold at reasonable prices during dry periods. This allows for job creation, and contributes to poverty alleviation and malnutrition at village level.

The practice of communal silos/granaries in the Cuvelai is not entirely new. In the 'long past' villagers falling under TAs were expected to cultivate on their chief's fields, or donate a barrel of *mahangu*, a donation locally known as *eempale*, to the chief's silo. This *mahangu* would then be distributed to the needy during times of need. This practice fell into disrepute in some areas as some chiefs misused their powers to care for their excessively large families. In addition, due to successive drought years, many villagers were no longer able to give *eempale*. There are still some TAs practicing *eempale* to date, but the process is not as strict or compulsory as it was in the 'long past'.

Community granary systems work well in other parts of Africa too. In Cameroon, the establishment of a community cereal banking system was identified as the most appropriate strategy to break the cycle of food scarcity, soaring market prices, chronic malnutrition and dependency on food distribution programs. The village granaries will allow for self-governance of food supplies by the villagers and curb the speculation mechanisms that generate poverty (RELUFA 2006). Eighteen villages in the District of Mokolo were identified for the establishment of a Community Grain Banking system. Each of the groups made a storage room available to serve as their village granary and secured its door with three locks. They democratically chose a management team of six persons among whom they elected the treasurer. On an on-going basis, RELUFA provides the needed sensitization and training activities through community workers of network member organizations. Since the start of the 2006 harvest season, this team has gone out to buy bags of sorghum from small farmers in the villages and stock them in the granaries of the eighteen participating communities. At the time of food shortages these stocks will be sold against an agreed upon price or on credit to needy families within the respective groups. Surpluses are sold outside the community at market price. The money earned on sales, serves as working capital to buy up cereals from the community at the next harvest and to reconstitute the stock in their granary. At the same time, families that borrowed food from the cereal bank pay back in kind (RELUFA 2006).

8.3.6 Community education and communication

It was mentioned in Section 6.3.7 that village committees often do not understand matters surrounding flood risk management in their villages, and are left unsure of what to do, how to act and what procedures need to be followed during a disaster in their villages. The residents have also recommended that young people from the villages be trained in basic map interpretation who can then in turn train other villagers. Several information awareness campaigns on DRM should be rolled out as per residents' respondents.

Residents have highlighted the need for education and training at village level as a very important adaptive strategy for alleviating flood vulnerability. Local residents especially the TAs felt undermined as flood warning messages are directly relayed to them by responsible authorities. Residents have also outlined a need to incorporate indigenous knowledge and communities in early warning and disaster risk management initiatives (Section 6.1.2.6). Plans to offer disaster risk management to at-risk communities such as outlined in the 2011 national disaster risk management plan (DDRM 2011) shall preferably be implemented. Community-Based Disaster Risk Management (CBDRM) as outlined in USAID/OFDA (2012) should also be encouraged.

Perhaps the one of the successful stories on CBDRM comes from elsewhere in the world. The Community-Based Flood Mitigation and Preparedness Project (CBFMP) of the Asian Urban Disaster Mitigation Program (AUDMP) under the Asian Disaster Preparedness Centre (ADPC) (ADPC 2009) responded to Cambodia's flood susceptibility by building the capacities of communities to plan and implement mitigation solutions (or micro-projects) that reduce their vulnerability. CBFMP counted on a network of Red Cross Volunteers (RCVs) and village-level Disaster Management Committees (DMCs) to lead communities in protecting themselves from the impact of flood in their localities. This process, was carried out by selecting project sites, training community volunteers, establishing local disaster management committees, and risk mapping in villages, had led to participatory identification of mitigation strategies.

In Namibia, the overall coordination of the flood response rests with OPM, through the DDRM and the Disaster Risk Management Committees (DRMCs) (see Section 1.2.2.2). According to the Government of Namibia (2012) in its Disaster Risk Management Act (Act No.10 of 2012), the Regional Disaster Risk Management Committees (RDRMCs) shall coordinate disaster risk management among sector governmental institutions, local authorities, communities and other role-players involved in disaster risk management at regional level; ensure the development, implementation and maintenance of disaster risk reduction strategies which will result in resilient areas, communities, households and individuals; and provide support to constituency and settlement disaster risk management committees to implement awareness programmes for the purpose of disaster risk reduction in communities exposed to specific hazards. (Also re-call from Kwenani (2012, *pers com*) in Section 6.2.2 on the large volunteer base of NRCS).

8.3.7 Alter agricultural practices

- Synchronise cultivation periods with rainfall patterns

It was mentioned in Section 6.3.8 that through information awareness campaigns discussed earlier that residents should try to align their cultivation with the prevailing season, such as by "*ploughing early*", ahead of the floods, for them to be able to reap better crop yield and thus reducing vulnerability.

Some bodies like the European farmers' organisation Copa Cogeca (2009) believe that vulnerability of farmers can be reduced by providing them with detailed information to allow the risk instead of managing the risk, and to change agricultural land that coincides with flood plains into grassland. However, there are more practical and doable alternatives that can better the Cuvelai's situation, like of Wajih (2008).

To cope with the flooding in order to reduce crop losses, it is recommended that a crop cycle calendar be developed, as described by Wajih (2008). The calendar should be planned to fit local conditions. Wajih (2008) suggested that the cycle should have three phases: The first phase is the *pre-flood cultivation* (so farmers can harvest before the floods). Should floods come when harvesting is not complete, mature *mahangu* cobs should be harvested and placed on top of alternating layers of dry grass and stalks, allowing for water to seep through while slowing down cobs sprouting and spoilage as some residents are already doing. The second phase is *cropping with floods* (crops which grow well even in floods). It was mentioned that Cuvelai rural residents who had previously tested *mahangu* harvesting with rice during periods of excessive flooding in the basin, reaped promising yields in rice plots while reaping almost nothing in *mahangu* areas, and opted to continue with rice cropping since the 2009 floods. Community awareness to aid the residents that substituting the usual mahangu and maize is not a way of undermining culture and traditions, but that of improving rural livelihoods, breaking the dependency chain, and reducing overall vulnerability at community and household level. The idea here is not necessarily to advocate for a complete abandonment of the usual crop varieties, but to promote cropping with appropriate varieties at different parts of the field, depending on the highly variable soil type, permeability, infiltration and slope of the field and thus optimising productivity of the field. Local residents may comfortably employ indigenous knowledge for appropriate siting of appropriate crops. The third phase according to Wajih (2008) is *post-flood cultivation* (planting late varieties or those plants which can withstand waterlogging). By this time the soil is other parts may still be waterlogged depending on the magnitude of the now receding flood. Most short lived plants such as several herbs and grains and those that require enormous soil moisture contents such as tubers should be encouraged (see proposed cropping strategies in Table 8.1). Table 8.1 presents the proposed strategies and various crop varieties for coping with floods during cultivation times for the Cuvelai Basin. Crops highlighted in yellow are encouraged for (further) experimenting by the local residents to maximise varieties and thus yield. Should it become necessary, as the dry season sets in, 'pondage' from the flood waters may be used to bucket irrigate small scale vegetable gardens at household level (see picture by IFPRI in Figure 8.1). This kind of cropping system will not only make sure that the soil is protected by vegetation throughout, but will also address starvation and create self-reliant communities in the long run and reducing vulnerability.

Source: International Food Policy Research Institute (IFPRI) (IFPRI 2014).

Figure 8. 1 Bucket irrigation. Man waters vegetables from a dugout

Table 8. 1 Strategies and various crop varieties for coping with floods during cultivation times for the Cuvelai Basin

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
In Namibia, the hydrological year begins every October. "Agricultural activities should be alligned to prevailing climatic conditions in specific areas. The routine of cultivating at a set pre-determined time irregardless of shifting natural cycles should be discouraged" (Cuvelai community respondent).		**Preparedness & preventive phase**				**Living with floods phase**				**Recovery & rehabilitative phase**			
		Pre-flood cultivation . **Promote early planting**				***Cropping with flood* s. Promote flood tolerant**				***Post-flood cultivation .*** **Promote post-flood crops**			
		Hydrological year starts. Plough early & harvest ahead of floods & to reduce vulnerability				Long term solution: plant Guava, Lemon & Eucalyptus trees in seepage prone areas. They suck up a lot of water. Don't plant too many to avoid overdrawing of water				Bucket irrigation & small scale household gardens: plant & water vegetables with efundja waters still in *iishana* (like in Figure 8.1)			
CROP GROUP	**CROPS**	**Keep soil covered by plants and crops all the time to keep the soil intact and reduce soil erosion. Plant appropriate plants for each season**											
CEREALS	Maize 1		p/s	p/s					h	h			
	Maize 2		h	h						p/s	p/s	p/s	
	Pearl Millet		p/s	p/s	p/s	p/s		h	h	h			
	Sorghum		p/s	p/s	p/s	p/s		h	h	h			
	Wheat	h	h						p/s	p/s			
	Rice					p/s	p/s	p/s	p/s	h	h		
LEGUMES, OIL & SUGAR	Bambara groundnut & Groundnut			p/s	p/s			h	h				
	Cowpea			p/s	p/s			h	h				
	Sunflower 1			p/s	p/s			h	h				
	Sunflower 2	h	h						p/s	p/s			
ROOT TUBERS	Potato 1			p/s	p/s			h	h				
	Potato 2		h	h					p/s	p/s			
	Cassava	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h
	Sweet potato 1	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h	p/s + h
	Sweet potato 2		p/s	p/s				h	h				
VEGETABLES	Common cabbage							p/s	p/s			h	h
	Carrot							p/s	p/s			h	h
	Melon rainy season		p/s	p/s	p/s		h	h					
	Melon winter season							p/s	p/s			h	h
	Onion							p/s	p/s			h	h
	Pumpkin rainy season		p/s	p/s	p/s			h	h				
	Pumpkin winter season							p/s	p/s			h	h
	Spinach							p/s	p/s	h	h		
	Squash							p/s	p/s	h	h	h	
	Tomato							p/s	p/s	h	h		
	Water melon rainy season		p/s	p/s	p/s		h	h					
	Water melon winter season							p/s	p/s	h	h		
KEY		p/s	planting/sowing period			h	harvesting period			p/s + h	sow & harvest all year through		

- Substituting crop cultivation with grocery shopping

It was mentioned in Section 6.3.8 that 'since the floods in the past years, some residents have not cultivated their fields and have opted to rather purchase groceries from supermarkets, thereby saving the money invested in ploughing services and maintenance of fields'. This idea ties in with Copa Cogeca (2009) discussed earlier, who believe it is much more economical to 'allow risks rather than managing risk' and that often floodplains should be allowed to turn into grasslands rather than crop field. While some favour buying food items from local shops, there are those who oppose it in the literature. When he advocated for hunting own meat instead of buying processed meat from the supermarket, an American hunter (Townsend 2012) motivated that it is more sustainable, healthier, and more economical to produce your own food versus purchasing it from the store. Townsend (2012) further wrote that harvesting food in an alternative to the dependency upon store-bought items. Morris (2014) added that it is the basic law of supply and demand that, when agricultural produce is in season locally, the relative abundance of the crop usually makes it less expensive. Morris (2014) further added that when food is not in season locally, it is shipped in from other parts affecting the taste and sometimes quality of the food… "Foods that are chilled and shipped lose flavour at every step of the way – chilling cuts their flavour, transport cuts their flavour, being held in warehouses cuts their flavour." She added that foods lose flavour just as they lose moisture when they are held. Fresh, locally harvested foods have their full, whole flavours intact, which they release to us when we eat them.

A majority of the Cuvelai rural residents are not financially secure enough to purchase food from grocery shops often, however, they can potentially be encouraged to support community granaries/silos discussed in Section 8.3.6. This practice involves community residents buying, at reduced cost - locally produced food items during times of need. Also see as reviewed in the same Section by RELUFA (2006).

- Ploughing differently

Due to increased erosion and years of modification, agricultural productivity of soils has decreased. Residents have been recommended to use fertilizer to hold the soil together and increase crop productivity. Just like as it was recommended by the NHS (2010) in Section 6.5.2.1 that developments should be built parallel to water flow, residents have also been advised to plough their fields in the direction of the water flow.

Ploughing mechanisms to address drought have been promoted before in the area, but no mechanisms have been advocated for flood situations as in Section 6.1.2.11. The Climate

Change Adaptation project (CCA) pilot project under the Country Pilot Partnership (CPP), an alliance of seven Ministries in Namibia supported by the United Nations Development Programme (UNDP) and the Global Environment Facility (GEF) promoted the use of rippers for ploughing. Rippers are used to dig narrow and deep furrows. It is in this deep furrows in which *mahangu* is planted. There were future plans to distribute animal-drawn rippers because many small-scale farmers do not have access to tractors which may be needed to hook the rippers on. Crops reportedly had much stronger stalks and bigger healthy looking grains (Shilomboleni 2010). Similar mechanisms to address ploughing during floods may need to be sought further investigated.

It has been observed first hand that, the people of the Cuvelai have a lot to offer in terms of practical adaptive strategies to reduce the vulnerability to floods, much which hinges on education and training, better communication strategies and the value of operational indigenous knowledge.

CHAPTER 9: CONCLUSION

To assess the vulnerability of local residents to flooding and the socio-economic impacts thereof, it is necessary that a community based flood assessment be conducted and that local residents are involved in the development processes of flood mitigation measures. In order to accomplish this, the following specific objectives were defined: (i) to assess the impacts of flooding in the study area, (ii) to assess the geographical or physical circumstances that place residents at risk and to assess socio-economic conditions that lead to vulnerability, (iii) to assess whether headmen and village residents can use flood risk maps to plan ways of reducing flood vulnerability, (iv) to assess the impact of floods to sustainable rural livelihoods of the local residents, (v) to assess the impact of land-use and allocation on vulnerability of rural residents to floods, (vi) to recommend alternative practical adaptive strategies and household level mitigation strategies to flooding in consultation with local village headmen and residents, and (vii) to assess and document technical and indigenous knowledge that can serve as a knowledge base that can be compiled and integrated into an effective village friendly flood early warning system and to garner support at the policy level. In addition, the work by other researchers has also been scrutinized in light of these objectives.

The thesis has provided a broad overview of the floods in the Cuvelai Basin, looking at the significance of flood in the Cuvelai, and how alternating cycles of droughts and floods have made the Cuvelai a habitable place. The study successfully assessed flood impacts and also indicated that village headmen can interpret flood vulnerability maps. Geographic and socio-economic vulnerabilities that place residents at increased flood risk were closely outlined and analysed. The study also successfully assessed the impact of floods to sustainable rural livelihoods of the local residents; assessed the impact of land-use and allocation on vulnerability of rural residents to floods; and assessed and document technical and indigenous knowledge that can serve as a knowledge base that can be compiled and integrated into an effective village friendly flood early warning system and to garner support at the policy level.

The study revealed that with regards to early warning to floods, local residents rely more on indigenous knowledge rather than technical early warnings from warning and response institutions. An outline was given of structural and non-structural ways in which to counteract the consequences of flooding in rural areas of the Basin in an attempt to seek practical ways to adapt to floods. Factors such as overcrowding, deforestation, superstitions, cultivation, lifestyle practices as well as socio-economic status are some of the many factors that exacerbate the flood impact both at household and basin level.

Household level mitigation strategies and practical adaptive strategies are recommended and discussed throughout Chapter 8 and part of Chapter 7. Though the study concludes that geography is the primary cause of flood vulnerability with low lying houses generally more prone to flooding than high lying houses, this trend is not necessarily directly proportional to socio-economic vulnerability, which exacerbates overall flood vulnerability.

Due to the structure of villages and non-probabilistic sampling methods applied, most of the respondents were flood-affected residents spread fairly equally across the study area. Spatial cluster analysis was therefore impractical. The collected qualitative data was recoded and statistically manipulated in SPSS, STATISTICA and Microsoft Excel.

The aim of the study was to assess vulnerability and socio-economic impacts of flooding on local residents in order to suggest ways in which to counteract the consequences of flooding in rural areas of the Cuvelai Basin. The study also sought to outline practical ways to adapt to floods and many innovative practical adaptive strategies suggested by the people of the Cuvelai have been documented. Over the past flood years, initiatives by the government to cope with floods have been response (relief) and short-term. Rural residents have however evolved long-term practices, some of which are traditional, to cope with floods and agro-climatic changes in their basin, but such knowledge is not given enough importance by policy and decision makers. The objective of compiling these practices was to document local and traditional flood responsive, mitigation and adaptive measures, while also suggesting new adaptive measures as recommended by the local rural residents. It is anticipated that this will provide support to build and strengthen people's adaptive capabilities in tackling flood disasters and mitigate impacts. The study found that there is a need to foster community level participation, buy-in and involvement in disaster risk management strategies in order to reduce the gap between technical early warning mechanisms and indigenous knowledge. It is hoped that technical and indigenous knowledge will be integrated into effective and village friendly flood early warning systems. More broadly, research and extension needs to continue supporting adaptive agriculture. Support at policy level is thus needed, with flood disasters being placed at the centre of development planning and execution, considering the recommendations made by the communities. The study demonstrated a realistic overview of vulnerability in the Basin. It was also found that in order to formulate flood mitigation measures, residents are more responsive, understanding and informed when research is conducted at household level. Communities were eager to participate when they felt included and in charge of the decisions affecting them.

The development and adaptation of practices has not only helped reduce the impact of climate change-induced floods, but also considerably helped to secure people's livelihoods. Where adaptive activities are practiced more intensively, the easier it becomes for the people to return to their normal lives once the floods recede. During the documentation process, it was also recognized that people's adaptive capacities are affected by other factors such as: natural resources in the area; income generating opportunities; physical infrastructures, services and facilities; socio-economics and gender sensitivities including what has been referred to as '*widow-stigma'* in Section 5.5.2; access to information and awareness material. One of the ways to build on people's adaptive capabilities is through raising their awareness, knowledge and capacities to earn a living through a selection of appropriate crops and techniques; the existence of social networks in the villages as described by IOM (2011) in Section 8.2.2.

It has been observed that people's livelihood resilience depends a great deal on how well the community uses the available resources in its adaptive strategies. Sometimes, such practices seem to evolve spontaneously and independently. The knowledge behind some practices is also the outcome of a synergy between farmers' indigenous knowledge and technological know-how. Even if the practice or technology is not endemic to the basin, the practice style is often innovative, according to local conditions. The adoption of any of these practices is generally needs-based, with farmers in the most adverse situations more likely to adopt these practices.

Various adaptive practices especially in agriculture have strong elements of indigenous knowledge. Without any organised mechanism of developing and imparting technical know-how for people to survive in floods and other climate change induced situations, it is people's indigenous knowledge which has helped them to adapt and survive. Today, such capability to adapt is seen as extremely important in dealing with problems related to climate change. However, adaptive practices have largely remained confined to the respective local areas, and have not been documented for wider dissemination, use, and benefit. While the farmers of the rural Cuvelai have already come a long way in adapting to the changing climate and associated hydrological extremes, their innovativeness, knowledge and skills, as well as external support that has enabled them to do this, will all continue to be essential for them to continue adapting in an uncertain future.

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APPENDICES

APPENDIX A.1: QUESTIONS FOR THE HEADMEN

1. What do you understand by the term “flooding”? Agree on a definition.
2. Where does flooding (as described in 1) occur in your village? Can you identify the areas on this map? [One map per village, draw flooding polygons on map, label polygons/homesteads with a number to keep track]
3. When looking back at the last 5 years can you rate where the worst flooding has occurred? Rank the flooding polygons using a score from 1 to 5 for frequency (number of floods) and A to C for intensity where A is the least and C is the most.
4. Are the most vulnerable people or homesteads in your village to flooding the ones indicated on the map? Agree that C5 is most vulnerable and A1 least, if not add an additional ranking which identifies the vulnerability status of people e.g. disability, many children, no husband, rated as X (least), Y and Z (most).
5. How were these people affected by flooding? Again mark on map: (P) suffered seriously, or (Q) it was just a temporary inconvenience that soon disappeared
6. If the effects of flooding were indeed bad, what were the worst effects?
7. What help was given to people who were flooded last year, i.e. recently? Establish what kind of help was given, and who gave it? List per flooding polygon.
8. How do you think those affected by flooding can take measures to reduce the impact of flooding in the future? What must C5 do, what must A1 do. How is this affected by vulnerability status of people (X,Y,Z)
9. Do you think the community should help those affected by floods? If so, in what way?
10. Did the flood-affected residents choose to live there or were they forced to live there because there was no other land?
11. Since you (as headman) are responsible for land allocations, would you be able to find other places where these vulnerable families could be settled in the same village (i.e. as opposed to moving to other areas or villages)?
12. If there is no open land to which the flood-affected residents can move, could you request those with large properties, especially with areas that they do not plant, to give the flood-affected residents a new and better place to live?
13. If the owners of large *ekoves* were to say no, what could be done to persuade them to change their minds?
14. If the headman is more than 40 or 50, ask if the extent of flooding is different from what it was when he was a child. If so, in what way is it different? Mark on the map.

15. What did the flood-affected residents do in the past that is different from what happens now to solve flooding?
16. Do you think it is useful to have village maps showing vulnerability status of households?
17. Did you receive any flood warning during the bad floods last year, or before?
18. How did you receive the warnings?
19. What did you do with the warnings? (For example by telling everyone in village or visiting homes that were likely to be flooded?
20. What changes can you recommend to the warnings to best fit your needs?

APPENDIX A.2: QUESTIONS FOR NON-AFFECTED LOCAL RESIDENTS

1. What do you understand by the term ‘flooding’? Agree on a definition.
2. Where does flooding (as described in 1) occur in your village? Can you identify the areas on this map? [One map per village, draw flooding polygons on map, label polygons/homesteads with a number to keep track]
3. When looking back at the last 5 years can you rate where the worst flooding has occurred? Rank the flooding polygons using a score from 1 to 5 for frequency (number of floods) and A to C for intensity where A is the least and C is the most.
4. Are the most vulnerable people or homesteads in your village to flooding the ones indicated on the map? Agree that C5 is most vulnerable and A1 least, if not add an additional ranking which identifies the vulnerability status of people e.g. disability, many children, no husband, rated as X (least), Y and Z (most).
5. How were these people affected by flooding? Again mark on map: (P) suffered seriously, or (Q) it was just a temporary inconvenience that soon disappeared
6. If the effects of flooding were indeed bad, what were the worst effects?
7. What help was given to people who were flooded? Establish what kind of help was given, and who gave it?
8. What did the flood-affected residents do in the past that is different from what is done nowadays?
9. How do you think those affected by flooding can take measures to reduce the impact of flooding in the future? What must C5 do, what must A1 do? How is this affected by vulnerability status of people (X,Y,Z)
10. What do you think the community should do to help those affected by floods?
11. Did the flood-affected residents choose to live in the flood zones, or were they forced to live there because there was no other land, or did the headman tell them to settle there?
12. Since the headman is responsible for land allocations, do you think it is possible that he can find other places where these vulnerable families could be settled in the same village (i.e. as opposed to moving to other areas or villages)
13. How can you help the village head to allocate less vulnerable land in the future?
14. Do you have a village committee in the village?
15. What is its involvement in flood situations in the community?
16. Do you think maps can be used for planning at the village level?

APPENDIX A.3: QUESTIONS FOR FLOOD-AFFECTED RESIDENTS

1. How long ago/in what year did you come to live here?
2. In the time you have lived here, how many times has your home been flooded?
    a. In the past 5 years
    b. In the total time you have lived here
3. Did you choose this place or did the headman tell you to build your house here?
4. When you first moved to this ekove, did you know that this place would be flooded sometimes?
    a. If yes, why did you choose to live here?
5. Have you tried to find another place to live?
    a. If so, in the same village or elsewhere?
    b. Why did you fail to find another place?
6. If you could be relocated to high land, would you move/stay?
    a. Why?
7. Would it be possible for someone who has a lot of land in your village to give you some of that land as a place to stay?
    a. If so, who can organize that: the headman, you, the village members or committee?
8. Has anyone come to help you when you were flooded?
    a. If so, who gave the help?
    b. What kind of help did you get?
9. Did you move away temporarily when you were flooded?
    a. If so, where did you stay then?
10. Was there damage to your property during the flooding?
    a. Your house?
    b. How much did it cost to repair?
    c. Were your crops damaged by the flooding?
    d. Are your crops for personal use or sale?
    e. How much income did you lose?
11. Would it be useful to build a wall around your ekove, especially close to the oshana so that the water is kept out?
12. We have had several years of flooding recently, and so do you think that more flooding will occur soon?
    a. If so, have you done anything recently to prepare for future floods?
    b. What are those measures?

13. Do you think that the headman should help you?
    a. If so, how?
14. Do you think that your community/neighbours should help you?
    a. If so, how?
15. Do you think that the government should help you?
    a. If so, how?

Table A. 1: 4-OS Regional population totals

Area	**Census year**						
	1991	2001			2011		
	Population	Population	Population increase	Percent increase	Population	Population increase	Percent increase
Namibia	1409920	1830330	420410	29.80	2113077	282747	15.40
Urban	382680	603612	220932	57.70	903434	299822	49.70
Rural	1027240	1226718	199478	19.40	1209643	-17075	-1.40
Ohangwena	179634	228384	48750	27.10	245446	17062	7.50
Omusati	189919	228842	38923	20.50	243166	14324	6.30
Oshana	134884	161916	27032	20.00	176674	14758	9.10
Oshikoto	128745	161007	32262	25.10	181973	20966	13.00
4-Os total population	**633182**	**780149**	**146967**	**92.70**	**847259**	**67110**	**35.90**

Table A. 2: Areas affected by floods classified by regions and constituencies

Adapted from: Tamayo Milanés et al. (2011)

	Areas in high risk flood zone		**Areas in moderate flood risk zone**		**Areas in low flood risk zone**		
Region	Constituency	Population	Constituency	Population	Constituency	Population	Total
Ohangwena	Ongenga	21 706	Omundaungilo	8 115	Epembe (South-East): 20%	2 972	**228 383**
	Engela	21 832	Eenhana (East): 70%	13 083	Okongo (East): 70%	15 085	
	Oshikango	25 221	Epembe (North – West): 80%	11 888			
	Ohangwena	17 887	Okongo (West): 30%	6 465	**Total**	**18 057**	
	Endola	24 804					
	Ondobe	22 253	**Total**	**39 551**			
	Omulonga	31 465					
	Eenhana (West & South): 30%	5 607					
	Total	**170 775**					
Omusati	Okalongo	28 719	Anamulenge	12 617	Ruacana (South – West): 40%	4 481	**226 239**
	Oshikuku	8 299	Ogongo	19 611	Tsandi (West): 30%	8 114	
	Etayi	35 130	Elim (West): 70%	7 595	Okahao (South – West): 50%	8 875	
	Elim (East): 30%	3 255	Outapi	31 496	Otamanzi (South): 30%	3 936	
			Tsandi (East): 70%	18 934			
	Total	**75 403**	Onesi (North): 80%	10 396	**Total**	**25 406**	
			Otamanzi (North): 70%	9 184			
			Ruacana (North – East): 60%	6 722		\	
			Okahao (North – East): 50%	8 875			
			Total	**125 430**			
Oshana	Okatana	15 325	Uuvudhiya (North): 20%	875	Uuvudhiya (South): 10%	438	**161 888**
	Oshakati West	19 862					
	Oshakati East	24 269	**Total**	**875**	**Total**	**438**	
	Ongwediva	26 700					
	Okaku	20 354					
	Ondangwa	31 694					
	Uukwiyu	12 047					
	Okatyali	2 812					
	Ompundja	4 448					
	Uuvudhiya (North): 70%	3 064					
	Total	**160 575**					
Oshikoto	Oniipa	24 730	Omuntele (North): 70%	10 612	Omuntele (South): 30%	4 548	**114 406**
	Onayena	15 459	Onyaanya (South): 40%	8 214	Omuthiyagwiipundi (North – West): 30%	7 102	
	Olukonda	9 226	Okankolo (West): 70%	9 145	Eengondi (North – West): 60%	9 130	
	Onyaanya (North – West): 60%	12 321			Okankolo (Central): 30%	3 919	
			Total	**27 971**			
	Total	**61 736**			**Total**	**24 699**	
	Grand Total	**468 489**		**193 827**		**68 600**	**730 916**

Table A. 3: Summary of the impact of flood damage in the Cuvelai between 2008 and 2011

Summary of the impact of flood damage in the Cuvelai Basin between 2008 and 2013								
		2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
General human population								
	Affected households	-	-	107 046 (PDNA 2010)	-	21 900 (FEMCO 2011)	-	-
	Destroyed households	-	-	59 996 (PDNA 2010)	-	-	-	-
	Affected (total population)	-	212 117 (DDRM 2008)	350 000 (UNOCHA 2009) 642 279 (DDRM 2009) 943 260 (PDNA 2010)	-	100 000 – 200 000 (UNOCHA 2011) 117 952 (FEMCO 2011) 141 130 (DDRM 2011)	-	-
	Displaced	-	65 000 (projection) (UNICEF 2008) 4 256 (DDRM 2008)	50 000 (NPC 2009) 4 476 in relocation camps (DDRM 2009) 92 000 (UN 2009)	-	37 000 (NRCS 2011) 5 169 in relocation camps (DDRM 2011) 60 000 (UNOCHA; UNICEF 2011)	-	-
	Relocated	-	-		-	17 555 (DDRM 2011)	-	-
	Relocation centres	-	9 (DDRM 2008)	47 (DDRM 2009)	-	71 (FEMCO 2011)	-	-
	Human deaths/ drowning	-	100 (DDRM 2008)	102 (DDRM 2009; FEMCO 2009) 92 (UN 2009)	-	110 (FEMCO 2011; DDRM 2011)	-	-
Farming								
	Domestic livestock deaths	-	63,637 (DDRM 2008)	9 982 (DDRM 2009; FEMCO 2009)	-	2 194 (Oshikoto & Omusati) (FEMCO 2011)	-	-
	Livestock affected	-	-	0 (DDRM 2009; FEMCO 2009)	-	-	-	-
	Number of fields affected	-	-	20 996 (DDRM 2009; FEMCO 2009)	-	17 351 (DDRM 2011) 28 395 (FEMCO 2011)	-	-
	Submerged crop fields size (Ha)	-	150 000 (DDRM 2008)	49 991.59 (DDRM 2009; FEMCO 2009)	-	55 585 (FEMCO 2011	-	-
Health inaccessibility								

	Health facilities	-	1 hospital (DDRM 2008)	26 Affected (DDRM 2009; FEMCO 2009) 5 Closed (DDRM 2009; FEMCO 2009)	-	45 / 201 (FEMCO 2011)	-	-
	Outreach points	-	26 clinics (UNICEF 2008) 14 clinics (DDRM 2008)		-	117 / 348 (FEMCO 2011)	-	-
	Suspended outreach clinics		53 / 145 (DDRM 2008)					
	Cholera cases		1 415 (19 deaths) (DDRM 2008)					
	Malaria cases		7 203 (29 deaths) (DDRM 2008)					
Education								
	Schools affected	-	70 (DDRM 2009)	292 (DDRM 2009; FEMCO 2009)	-	304 (FEMCO 2011)	-	-
	Schools closed	-	97 (UNICEF 2008)		-	166 (FEMCO 2011)	-	-
	Schools relocated					0 (FEMCO 2011)	-	-
	Pupils affected	-	32,050 (DDRM 2008; DDRM 2009)	84 833 (DDRM 2009; FEMCO 2009)	-	108 716 (FEMCO 2011)	-	-
							-	-
Businesses								
	affected	-	-	1 040 SMEs (DDRM 2009; FEMCO 2009)	-	598 (Omusati) (DDRM 2011)	-	-
	closed	-	-	-	-	9 (Omusati) (DDRM 2011)	-	-
Infrastructure								
	Roads affected	-	-	29 damaged (DDRM 2009; FEMCO 2009)	-	37 (FEMCO 2011)	-	-
	Roads closed	-	-	-	-		-	-
	Bridges affected	-	-	-	-	9 (FEMCO 2011)	-	-

Table A. 4: CERF Funding allocations during the 2011 flood disaster in Namibia

Adapted from: UNOCHA (2011).

CERF Funding by Country (2011) - Project Detail Namibia						
(01/01/2011 to 31/12/2011)						
Agency	**Agency Project**	**Sector**	**Window***	**Approved (money in US$)**	**Approved Date**	**Disbursement Date**
WHO	Strengthening Emergency Response in the sectors of health and nutrition (11-WHO-029)	Health - Nutrition	RR	250,915	21/04/2011	05/09/2011
UNFPA	Strengthening Protection Sector Emergency Response (11-FPA-023)	Protection/ Human Rights/Rule	RR	234,330	21/04/2011	05/11/2011
UNICEF	Support to Emergency Response in WASH sector (11-CEF-023-A)	Water and sanitation	RR	206,724	21/04/2011	05/02/2011
UNICEF	Strengthening Emergency Response in the sectors of health and nutrition (11-CEF-023-B)	Health - Nutrition	RR	176,766	21/04/2011	05/02/2011
UNICEF	Strengthening Education Sector Emergency Response (11-CEF-023-C)	Education	RR	133,209	21/04/2011	05/02/2011
UNFPA	Strengthening Emergency Response in the sectors of health and nutrition (11-FPA-022)	Health - Nutrition	RR	109,528	21/04/2011	05/11/2011
WFP	Strengthening Emergency Food Distribution Scheme (11-WFP-025)	Coordination and Support	RR	64,469	21/04/2011	17/05/2011
Total				**1,175,941**		
* RR - Rapid Response; UFE - Underfunded Emergency						

The review of Traditional Authorities (TA)s in Namibia

Namibia has roundabout 46 recognized TAs with varying spatial and household sizes, as well as historical differences. All TAs have similar operational structures, ranging from the local authority, a village head, councillors, senior heads, and then chiefs (Mendelsohn 2008). There is quite a very good number of TAs without communal land especially the Topnaar, /Khomanin and Hai-//Om, with their communal land being housed inside other TAs. Another instance pertaining to TAs lacking communal land is the influence of urban expansion. This mostly affects rural areas or villages located within certain distances from urban centres, land which currently is classified as town land. Examples of TAs who have lost ownership to communal land due to urban expansion include Kai-#Kaun, Afrikaner and !Gobanin. In such cases the TAs appoint councillors living in the towns to represent their local communities and their ideals (Mendelsohn 2008).

Older TAs including those of Owambo in the Cuvelai, as well as those of Caprivi and Kavango, date back to the 19th century, have evolved for many hundreds of years and are thus well established in terms of customary laws, leadership, and political affiliations. Most of the older and bigger TAs have relatively well established facilities such as substantial buildings which provide offices, storage space and areas in which public meetings and other community events can be held. Some offices are equipped with computers, fax machines, filing cabinets, chairs, desks and other furniture, and they function in an orderly fashion, having filing systems, record books and several staff members appointed to perform defined functions. On the other hand, relatively younger TAs being only formed roughly since two decades ago, are associated with more political unrests as well as poorly distributed boundaries. But many other TAs lack all or most of these facilities and most administrative information is therefore retained only in the memory of secretaries and chiefs. Each TA has a secretary who is fully or partially paid with funds provided by the Ministry of Regional & Local Government & Housing (MRLGH). Most secretaries work as administrative or clerical assistants, and are thus proficient at only basic tasks. Some other secretaries, including notably all those in Kavango, are obviously influential and competent members of the TAs administration. The largest TAs, for example Ondonga and Uukwanyama, have tens of thousands of families on communal land, whereas the smallest TAs, such as Gobanin and Afrikaner, are responsible for less than one hundred communal households.

The senior levels of authority are structured along similar lines in all TAs, presumably following and in accordance with provisions of the Traditional Authorities Act (Act No. 25 of 2000) and the allocation of allowances by the MRLGH.5 Each TA is headed by a chief who may be locally known as a king, queen, captain, *hompa, fumu, omukwaniilwa, elenga, ohamba, munitenge, litunga, shikati, hoofmankgosi, kgosi-kgolo, ombara, h'aiha* or *//'aiha*. The traditional council usually consists of 12 members: six senior and six junior councillors. However, many councils have additional members who are appointed in their own capacity as advisors or as ward representatives. These extra ward representatives generally serve in places where the traditional community is divided into more than 12 wards.

The chief and council are supported by an advisor (*natamoyo*) and prime minister (*ngambela*) in Caprivi, while many other TAs also have chief councillors and/or deputy chiefs to advise and deputize for chiefs. Most chiefs and councillors are men. Chiefs normally inherit their roles from within a royal family, while councillors are appointed as individuals because of their leadership abilities or knowledge. Councillors are either appointed by a chief or elected by the community they serve. The smallest TAs do not normally have lower levels of authority, each councillor serving as the sole local authority in a village or cluster of villages. However, this is the exception, and all villages in larger TAs have a headman. As the name suggests, this is usually a man who is often the patriarch of the original or extended family occupying the village. The position of headman is therefore usually inherited. Some big villages, or those in which two or more large, unrelated families live, may have more than one headman, or one headman and several junior headmen. It is indeed from, and on the basis of family relatedness within villages that traditional authority has its origins, from which headmanship over extended families later evolves into chieftainship over larger areas. As discussed below, that relatedness has a substantial bearing on access to land and the inheritance of property.

Levels of influence

At the risk of being accused of making a value judgment, my overall impression was that the TAs are much less influential than is generally assumed. While lower levels of authority indeed appear to play important functions in resolving local disputes and maintaining discipline, the role of more senior members of TAs seemed less than clear. A variety of factors were reported to threaten and steadily weaken the influence of TAs.

With respect to custodianship and management of land, a host of newly created institutions either challenge the role of TAs or are gradually taking over certain of their functions. The most prominent are Water Point Associations, Farmers' Associations, Conservancies, Community Forests, Village Development Committees, Regional Councils and Communal Land Boards (CLBs). Many of the TAs were puzzled – and indeed annoyed – by the contradiction between stipulations of the Traditional Authorities Act (Act No. 25 of 2000), which confirms their role as custodians of the land and advisors to the President on matters concerned with communal land, and those of the Communal Land Reform Act, which places CLBs as the final arbiters on access to their land. How can CLB members who are often young, disrespectful bureaucrats, with limited local knowledge and no customary authority, make decisions that overrule those of the TA? Questions of this kind were asked repeatedly, and were hard to answer!

These perceptions fuel antagonism towards customary land registration since CLR is then seen to be a government or political programme that rides roughshod over the very custodianship that TAs have on land.

Two other factors undermine TAs. Firstly, TAs lose authority over land and communities that fall within the boundaries of declared settlements or towns. These urban areas are administered by local councils supervised by central government through the MRLGH. Further dissatisfaction arises when members of other traditional or ethnic communities settle in these urban areas but then use surrounding communal land for farming.

People who leave rural areas to live in towns are largely lost to the traditional authority because they live far away and in urban societies that pay little attention to customary practice. Some TAs have appointed representative councillors in urban areas, but it is doubtful that these people play much of a role in representing their urban constituents.

Secondly, it is obvious that more educated and affluent community members often ignore or bypass TAs. Many of these people see no reason to respect old-fashioned traditional authority when they visit rural areas, or wish to build a home and farm on communal land. One poignant example of this kind of threat came from the chief of a TA who requested my help in arranging police protection to prevent abuse and insults when he visited members of his community.

Educated, wealthy people have other impacts that go beyond ignoring or abusing TAs. These include their increasing privatization of land and command over commonages, their growing importance as influential role models, and sources of help to poorer local residents. As one

After: Mendelsohn (2008).

Figure A. 1: Overview of land allocation and acquisition in Namibia

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