

**COMMUNITY RECOVERY AND RESILIENCE BUILDING IN THE
AFTERMATH OF FLOOD HAZARDS IN THE SMALL ISLAND
DEVELOPING STATE OF MAURITIUS**

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

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Signed  Date: 30 June 2014

Abstract

At the global level, a noticeable rise has been observed in the adverse impact of an increasing number of hazards, in particular floods, on society. This condition has brought into greater focus the issues of vulnerability, environmental justice and resilience in the recovery of community groups. In Mauritius, economic development, growth in population and intensive land use have resulted in greater human use-environment interaction with accompanying increase in flood conditions and the vulnerability of inhabitants exposed to flood risk. Traditional *top-down* hazard risk reduction strategies have not been very effective in reducing vulnerability or in promoting resilience of affected communities as they are often left to fend for themselves immediately after the emergency and relief stage of the recovery process.

Using three case studies, this thesis explored the perception of the affected communities in building resilience to recover in the aftermath of flood hazards. Mixed methods of collecting and analysing data using both quantitative and qualitative approaches were used. They provided a comprehensive way of gathering information from households, agency stakeholders and secondary sources. The data were analysed and the results assessed through the lens of the overarching concept of community resilience that encompasses six types of resilience. This new approach provided a holistic perspective in exploring factors that influence the building of community resilience and the realisation of long-term recovery and rehabilitation.

Findings from this study showed evidence of social inequity and environmental injustice mostly among the low income groups in all the three case studies. Evaluation of results revealed a number of factors that were gradually increasing their level of vulnerability and adversely impacting on their resilience. In order to achieve recovery and community resilience, the various types of resilience needed to be reinforced. It was found that social networking and a combination of local knowledge with that of experts, through community participation in decision making, were crucial in reinforcing community resilience.

Based on the research findings, an integrated framework for disaster risk reduction management (IFDRRM) was developed. The framework could be applicable in defining policy options and implementation strategies in Mauritius and possibly in other Small Islands Developing States (SIDS) with similar challenges.

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Acronyms

AMSL	Above Mean Sea Level
CLC	Cité La Cure
CRED	Centre for Research on the Epidemiology of Disasters
DRR	Disaster Risk Reduction
EJ	Environmental Justice
EM-DAT	Emergency Events Database EM-DAT of CRED
EPA	US Environment Protection Agency
GB	Grand Bay
GIS	Geographical Information System
IDNDR	International Decade for Natural Disaster Reduction
IFDRRM	Integrated framework for DRR management
IPCC	Intergovernmental Panel on Climate Change
ISDR	United Nations International Strategy for Disaster Reduction (UN/ISDR)
LH	Le Hochet
NGO	Non-Governmental Organisation
NDU	National Development Unit
NPU	National Disaster Preparedness Unit
OFDA	Office of U.S. Foreign Disaster Assistance
RCRCS	Red Cross and Red Crescent Society
SIDS	Small Islands Developing States
UN	United Nations
UNDP	United Nations Development Programme
BCPR	Bureau for Crisis Prevention and Recovery (UNDP)
OHRLLS	Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and SIDS of the UN
WMO	World Meteorological Organisation

Chapter 1 General Introduction

1.1 Introduction

Since the 1970s, the adverse impacts of an increasing number of hazards, and in particular floods, on society at a global level have brought the issue of vulnerability, recovery and, more recently, resilience under greater scrutiny (Manyena, 2006). Prior to that period, risk reduction models of hazards were developed primarily from discrete physical and natural viewpoints rather than from a human perspective. However, it was soon realised that such models did not adequately bring out the differential vulnerability of groups within communities or variations in the recovery and resilience building processes in the aftermath of a hazard. As a result, other models in risk reduction were developed that included the human-nature interaction perspective, implying a paradigm shift in the study of flood hazards (Section 2.2.2).

Similarly, in Mauritius, over the last two decades, floods have been observed to be increasing with a corresponding increase in societal impacts. Traditionally, floods had been associated with tropical cyclones, which were the focus of all mitigation strategies. However, while no cyclone has directly hit the island in over the last decade, floods have continued to have an adverse effect on society and the economy (Bhankaurally et al., 2010). The successful warning system and emergency measures developed to mitigate the impact of cyclones were soon found to be inadequate in the case of flooding.

These observations in Mauritius, and the evolving concept of the causes of flooding globally, especially of the human-nature interaction, provide the setting for this study. In line with findings elsewhere, flood disaster mitigation is scrutinised mainly from a human-nature interaction viewpoint. This new perspective of the causes of flooding along with the researcher's personal experience in Mauritius contributed to the formulation of the research questions and the corresponding objectives focusing on resilience building during recovery in the post-disaster phase.

This chapter, therefore, briefly introduces the global context of natural hazards, before discussing the gaps in the literature regarding community vulnerability and community resilience in small island developing states (SIDS) and in Mauritius, in particular. It elaborates on the research motivation and then formulates the research questions. Finally, it provides a brief outline of the whole thesis, explaining how it is structured and how its components contribute to the overall aim of the study.

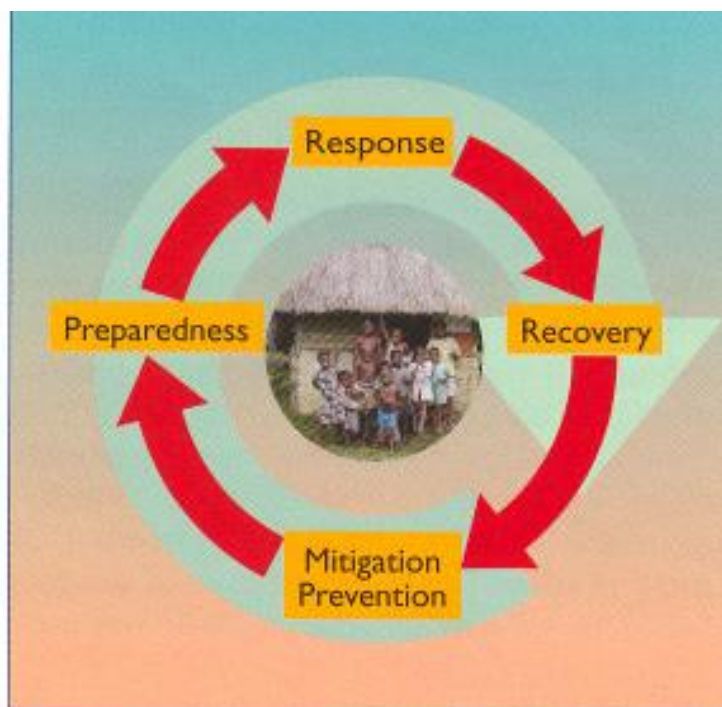
1.2 Natural hazards in the global context

Natural hazards are generally regarded as events of large magnitude that have a relatively short life span (Bryant et al., 2005), except in the case of severe droughts. When natural hazards turn into disasters, they cause large death tolls and widespread destruction with an increase both in the number of people affected and in monetary losses (Degg and Chester, 2004). They make headlines in the media and are listed in international or national registers as major catastrophes that call for international attention or help (Lewis, 1978; Bull-Kamanga et al., 2003). The Asian tsunami (2004), hurricane Katrina in the United States (2005), the earthquake in East Pakistan (2005), floods in India (2007), the tropical cyclone in Haiti (2010), floods in Australia and Sri Lanka (2011), hurricane Sandy in the United States (2013) and the recent flood disaster of March 2013 in Mauritius that claimed the lives of 11 people, (Le Mauricien, 2013) are but a few of the major natural disasters that have hit the news headlines all over the world (BBC, 2013a).

When such hazards strike nations, whether rich or poor, they cause considerable harm to people, damage to the infrastructure, and lasting degradation of the environment. Traditional efforts to reduce the impact of natural disasters through improved preparedness measures and post-disaster relief and rehabilitation have not produced the desired effect of recovery and long-term resilience building, as related institutions at national and international levels focus mainly on the geological and biophysical events, often ignoring the human and societal dimensions of vulnerability (Haque and Etkin, 2005).

1.3 Recovery and rehabilitation – a long-term process

Recovery refers to the period following a hazard or disaster event (Section 2.9). In the traditional sense, it is illustrated in Figure 1.1 as one of the four phases of the risk mitigation model proposed by the World Meteorological Organisation (WMO, 2006). In the *risk reduction management model* of hydrometeorological hazards, recovery is defined in relation to the other phases in the model.



Source: World Meteorological Organisation (2006)

Figure 1.1 The four phases of a risk reduction model

The risk management model in Figure 1.1 comprises the flowing four phases:

- *Mitigation* phase involves the identification of vulnerability to particular types of hazards and what steps should be taken to minimise the risks. The actions include structural as well as non-structural planning with the help of the government aid relief agencies in achieving vulnerability reduction on a long-term basis.
- *Preparedness* phase involves the participation of the wider community in recognising and responding to the hazards.

- *Response* phase involves the implementation of measures developed during the mitigation and preparedness phases.
- *Recovery* phase comprises the steps taken soon after the event and consists of repairing the damage and aiding community rehabilitation.

In this model, which is based essentially on a natural hazard viewpoint, the population at risk is shown to be at the centre but, with the exception to some extent in the preparedness phase, is seen to be waiting passively for outside help. The natural hazard is seen as a single discrete event that has affected society and the infrastructure. All actions to mitigate the impacts on the communities of such a natural disaster come from the authorities and relief agencies, implying essentially a ‘*top-down*’ approach. The current model of risk reduction management, which is applied in this study, is discussed in Section 2.4.1.

In the recovery phase, once the ‘threat’ is over, warnings are lifted and the population is allowed to resume its normal activities. In the case of a disaster resulting from a hazard, emergency and relief measures take precedence in returning the community exposed to the disaster back to normal. This approach is exemplified by Shaw (2006), who showed how post-disaster recovery was organised in several Asian countries following the Asian tsunami of 2004. Shaw stated that recovery should have been seen as a long-term process involving the concerted efforts of a host of stakeholders including local people, governments, NGOs, and external agencies working to restore the economy and livelihood of the affected communities. However, he observed that soon after the relief and emergency stage of the disaster was over, the governments of the countries affected by the tsunami were more concerned about restoring the economy and rebuilding the infrastructure of the country rather than in addressing the long-term human aspects of the vulnerability and the resilience to future disasters of the affected people. The issue of recovery is discussed further in Section 2.9 and is seen as a long-term continual process. It is this concept that is applied in this study.

According to Wisner et al. (2006) and Pelling (2007), natural hazards, such as tsunamis, floods, hurricanes, or cyclones in the developing world, rarely come as a single discrete event but rather come as a sequence of other events, such as localized flooding, storm

surges, mudslides or outbreaks water-borne diseases. The associated events cumulatively result in differences in the rate of recovery of vulnerable communities. Therefore, greater insights into the human and societal dimension of vulnerability would be required to build resilient communities in the context of sustainable development (Maskrey, 1999; Tobin, 1999 and Wisner et al., 2006).

In this study, the recovery phase comprises rehabilitation and possible relocation and is considered to be a long-term process during which building the resilience of the community exposed to disaster takes place. In this sense, it goes well beyond the immediate emergency and relief stage. The process is illustrated schematically in Figure 2.4 (Section 2.9.1).

1.4 Resilience building in SIDS against natural and human-induced hazards

SIDS are formally recognised by the United Nations (UN) as a special entity. The first UN Global Conference on SIDS was held in Barbados (United Nations, 1994) as a follow up to the UN Conference on Environment and Development (United Nations 1992). SIDS are characterised by their small size, remoteness, and narrow resource base. They share many of the characteristics of other developing countries including a high level of intrinsic vulnerabilities due to their low competitiveness in the world economy (Pelling and Uitto, 2001). Furthermore, their geographical position in the world makes them particularly vulnerable to a wide range of natural hazards including climate change, sea-level rise, and other extreme events (IPCC, 2007). Some SIDS are located near tectonic plate boundaries and are susceptible to volcanic activities and earthquakes, while others, situated in the inter-tropical zones, are frequently visited by tropical cyclones and floods.

In view of their high exposure to natural hazards, SIDS rank among the most disaster-prone countries (IPCC, 2007). Natural disasters can have enormous socio-economic and environmental impacts on small islands (Méheux et al., 2006). In addition to climate-based hazards, small island countries are increasingly being threatened by hazards caused by human-environment interaction. Environmental factors, pressures from economic development, the depletion of agricultural lands for building purposes, the exploitation of coastal zones for tourism, the pollution of lagoons, and the destruction of

fragile ecosystems, such as wetlands, leading to the loss of their unique biodiversity, are among the major threats to SIDS (Briguglio, 1995).

Very few studies related to the socio-economic and environmental impacts of natural hazards, including those arising from nature-human interaction, have been carried out in Mauritius, and still fewer have been published. Therefore, published work at the global level and more specifically on SIDS elsewhere regarding the vulnerability and resilience of communities to natural hazards and their experiences of them was researched first. A few studies that have been carried out on SIDS have focused mainly on the economic and environmental vulnerability largely linked to developments in tourism and agriculture (Briguglio et al., 2006; Méheux et al., 2006). The human dimension of vulnerability in relation to natural hazards has been studied in a few islands of the Pacific region (Finau, 1987; Méheux and Parker, 2006; Mercer et al., 2007; Schwarz et al., 2011; Combest-Friedman et al., 2012) and of the Caribbean region (Jessamy and Turner, 1999; Pelling and Uitto, 2001; Linnekamp et al., 2011; Ferdinand et al., 2012). In the Northern Indian Ocean, studies on the Maldives have focused on the adverse impact of climate change (Ghina, 2003) and on the participatory activities of communities in the tsunami reconstruction phase (Pardasani, 2006). In the South-West Indian Ocean island of Mauritius, hazard studies have mostly been based on their physical aspect. For example, Bhankaurally et al. (2010) used GIS-based hydrological models to map out flood prone areas over one region of the island, and Parker and Budgen (1998) carried out studies on the effectiveness of Cyclone Warning Dissemination Systems, while Bunce et al. (2009) explored the impact of drought on Rodrigues (which forms part of the Republic of Mauritius) due to a degraded environment caused by human use.

Howort (2005) claimed that the vulnerabilities of SIDS have increased over the last decade, whilst resilience building has not kept pace. Island communities with limited resources continued to be dominated by growing vulnerability as a result of exposure to hazards. A study by Mohanty (2006) of the poor urban squatters in Fiji revealed that people residing in environmentally hazardous sites were among the most vulnerable population groups in the country. Thus, their capacity to cope with hazards or overcome vulnerability seemed limited. The UN, referring to social conditions that cause the vulnerability of communities in SIDS, stated:

'Even as natural hazards are on the rise, vulnerability is also increasing due to higher poverty levels, unplanned urbanization and environmental degradation. Natural hazards are inevitable, but disasters are not.' (United Nations, 2005,p.78)

The above quotation is significant in view of the growing trend in the number of disasters, notably floods, as shown by EM-DAT-CRED (Figure 2.1) and the implication that poorer communities have no choice but to live with flood events. Hence, the need to build capacity for prevention and develop resilience against flood conditions becomes an imperative option in Disaster Risk Reduction (DRR) management. According to Howort (2005), satisfying such needs is essential to enable island communities to reduce risk and recover from hazard impacts. The need for communities to build resilience against disasters was particularly emphasised in the Mauritius Strategy for the further Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States in 2005 (United Nations, 2005) as follows:

'Small island developing states are committed to promoting sustainable development, eradicating poverty and improving the livelihoods of their peoples by the implementation of strategies which build resilience and capacity to address their unique and particular vulnerabilities.' (United Nations, 2005, Para 6, p. 8)

This statement was adopted only a couple of months after the Asian tsunami disaster in December 2004, which drew global attention to the urgent need for fast recovery and for the rapid restoration of the victims' livelihoods. Therefore, the overall objectives of the 2005 Mauritius Strategy meeting were geared towards post-disaster recovery policies and sustainable redevelopment. Ingram et al, (2006) suggested that the hastily designed policies in the aftermath of the Asian tsunami were based on the relocation of the affected population, and they proved ineffective. This approach overlooked the social, economic, and institutional factors that influence the vulnerability and resilience of the most affected populations, that is, those living in coastal areas. These factors, along with a few others that will be considered during the research, are

infrastructural/environmental and community competence (Cutter et al., 2008), and psychological resilience to flood hazards (Norris et al., 2008).

1.5 Research motivation and project objectives

While the Mauritian economy is undergoing a rather rapid transformation, the well-being of its population is increasingly threatened by more frequent floods, which are having an adverse impact on the livelihood of inhabitants occupying flood-risk zones. As a result, this study has been motivated by the following considerations:

- (i) *the researcher's first-hand experience of the impacts of hazards in Mauritius which is a Small Island Developing State in the South-West Indian Ocean:* Over the years, early warnings, preparedness, emergency measures, and effective responses from the population have considerably reduced the cyclone-related disaster risk to life. However, in the aftermath of a cyclone, the communities exposed to such disasters are often prone to other types of natural hazards, such as localized floods and water-borne and vector-borne diseases, which add to their vulnerability. For example, an outbreak of typhoid fever was recorded after a cyclone in 1980 (Ministry of Environment and National Development Unit, 2005a), while a cyclone in 1995 triggered the resurgence of malaria, a disease that had previously been previously eradicated in this area. Similarly, during the 2005/2006 rainy season, an outbreak of *chikungunya*, which is a disease caused by mosquitoes (Beesoon et al., 2008; Goorah et al., 2009), showed the growing risk and vulnerability of a population exposed to flood conditions.
- (ii) *the observation that there has been an increase in the frequency of flood hazards during rainy seasons even in the absence of cyclones:* The flood of 26 March, 2008, caused the loss of four lives and widespread devastation to the infrastructure and agriculture. Recently, the flood disaster of 30 March, 2013, caused the loss of 11 lives and made the news headlines worldwide.
- (iii) *active involvement of the researcher in helping the local community exposed to flood risk in the recovery phase of the major flood disaster of 26 March, 2008:* The researcher, as a representative member of the community exposed

to flood hazards, participated in the Fact Finding Committee, which was held in April, 2008. The Committee was instituted by the government of Mauritius in the aftermath of the flood.

- (iv) *awareness of the growing impact of flood on communities in Mauritius and the extensive coverage of the topic in the local newspapers and in the electronic media*
- (v) *the limited attention given to flood hazards that are triggered by the human use--environment interaction that created the conditions for flood disasters or amplified their impacts on certain groups of people*
- (vi) *the observation that floods were still considered as discrete physical events that required top-down solutions, ignoring their social dimension and the participation of vulnerable communities in decision-making*
- (vii) *the publication of very few studies on the social aspects of vulnerability to flood hazard or in resilience building in Mauritius: A couple of studies that were published were based on the hazards of the natural systems, but there were none based on those of the human use-environment interaction system that increasingly characterises flood hazards.*

In the light of the above, the following broad objectives were identified:

- (i) to investigate and assess the range of the factors that determine vulnerability and resilience building in various sectors of communities in the aftermath of flood events
- (ii) to critically examine the roles and responsibilities of all stakeholders in the recovery phase and in promoting resilience against flood hazards
- (iii) to propose a framework for flood DRR management

In order to achieve these objectives, the study focuses primarily on the aspect of flood disasters as seen from the householders' perspectives. Other stakeholders' views are also considered along with their roles in mitigating flood hazards and enhancing the community resilience of those exposed to flooding. These considerations, which relate to vulnerability, resilience building, and recovery, generated the research questions discussed in the next section.

1.6 Research questions

- I. *What is the vulnerability of different sectors of a community in Mauritius to flood hazards, and how does it relate to recovery and resilience building?*

In order to answer this question, the community exposed to floods and its sectors is defined and the characteristics that describe their vulnerability are identified. The factors that cause variations in vulnerability are derived from the perception of the risk posed to the community by flood hazards. These elements are used to identify others that are essential to resilience building in the broad context of long-term recovery. The research considers and evaluates the elements of vulnerability in terms of the different types of resilience that constitute the concept of community resilience.

- II. *What are the stakeholders' perceptions of what can be done to reduce community vulnerability and promote resilience in the recovery phase of the disaster response model, with particular attention paid to the current and potential role of science and technology?*

Vulnerability reduction and resilience building of the community exposed to flooding are seen in a holistic manner and take into account the viewpoints of all stakeholders. For this purpose, an understanding of the respective roles of stakeholders and their responsibilities in the process is considered essential. The community exposed to flooding is considered as the key or *primary stakeholder* and is involved in risk assessment (Manyena, 2006), while those having an official role in disaster management, as well as NGOs, are considered as *agency stakeholders*. The views of the community exposed to flooding are considered in depth when answering question I above; research question II investigates and critically assesses the views of all agency stakeholders on how they contribute to enhancing the resilience of the community

exposed to flooding. In particular, all stakeholders are invited to express their opinions on the current and potential role of science and technology.

III. *How is the conceptual framework of ‘environmental justice’ useful in understanding variations in vulnerability and resilience in groups of communities?*

The concept of environmental justice is explored and defined in the context of this study. Variations in vulnerability among household groups are examined. In this regard, the disparities perceived by householders (i) in the assistance received after a flood event, (ii) in building the resilience of marginalised groups within the communities exposed to flood, and (iii) in improving the quality of life for such groups are explored. These issues, along with the related issue of governance and social equity as perceived by householders, are studied in the overall context of environmental justice. The nature and the extent of injustice are examined with respect to their influence on variations in vulnerability and how they act as impediments to strengthening the resilience of flood-affected communities.

IV. *How can the above critiques of community vulnerability, resilience and environmental justice in the recovery phase inform the development of a framework for disaster risk reduction management in Mauritius?*

Key findings resulting from the answers to research questions I to III from the case studies are used to develop a disaster risk reduction (DRR) framework that will provide a new approach to flood mitigation management in Mauritius and that could possibly be applied to other SIDS.

1.7 Thesis structure

This first chapter provides the general context for the thesis, elaborating on the motivation, clarifying the objectives, and identifying the research questions. The remaining sections of this chapter outline the content of the other chapters.

Chapter 2: **Literature Review**

This chapter considers published work in the field of this study with a view to identifying the concepts and approaches used for addressing questions similar to those formulated here. The materials for the literature review are obtained from various sources including peer-reviewed journals, books, official reports of governments and international organisations, unpublished communications, the internet, and the media. All these sources contribute to the shaping and designing of the theoretical background of the research process. The focus of the literature review is on those works that reflect a paradigm shift in the view of hazards as a natural event system to the view of hazards as being caused by the increase in human use-environment interaction. The key elements of resilience building and recovery that form the distinctive features of this research are explored within a combined framework of vulnerability and resilience. Approaches and existing models in hazard risk management are explored critically regarding their relevance to SIDS and in particular to Mauritius, and the gaps in the research are identified. The review of the methodology used by other researchers in flood disaster studies served as a guide in the design of the researcher's own methods.

Chapter 3: **Hazards in Mauritius**

In order to examine the issues identified in the research questions, this chapter provides an overview of the overall situation in Mauritius. It starts with a short description of the different hazards that adversely affect Mauritius. A brief review is given of how the inhabitants' internal migration, land-use change, and possibly climate change, have contributed to an increase in the frequency of flood hazards in the three chosen localities over the last two decades. The overview subsequently addresses the growing impact of flooding, as part of a human use-environment interaction system.

Warning systems in force in Mauritius have proved effective for cyclones but are severely lacking in the case of floods and other natural disasters. This deficiency is explored further along with its implication for flood risk reduction strategies, taking into account the social, political, economic, environmental, and other factors that increase vulnerability and impede the resilience of a community exposed to flood hazard.

Chapter 4: **Methodology**

Keeping in view the research questions, this chapter describes and justifies the methods, procedures, and techniques used to explore and assess the vulnerability as well as the resilience and recovery of communities exposed to flood hazards. A description of mixed methods using quantitative and qualitative approaches is given, and their suitability for the analysis of the different types of data gathered is discussed. The choice of the case study approach is discussed, and descriptions of the three sites selected and the reasons thereof are provided. A pilot survey was carried out at one of the locations to assist in the design of the main questionnaire survey. The data collection methods and the techniques used in the analysis are described along with the data recording procedures and the ethical aspects of the research.

Chapter 5: **Results from analysis of the questionnaire survey data**

This chapter presents the analysis of the primary data collected from the responses obtained from the questionnaire. The numerous variables are analysed using SPSS software. The results are suitably displayed taking into account the research questions that need to be answered. Household characteristics from the three case studies are compared. Vulnerability, recovery, and resilience patterns are examined from the social, economic, infrastructural/environmental, institutional, and psychological and community competence view-points as derived from the perspectives of households.

Chapter 6: **Results from statistical analysis of questionnaire survey data**

In this chapter, statistical tests based on the data gathered in response to Research Question I are reviewed, and the most suitable one for the present purpose is identified. Possible associations between certain household characteristics (independent variables) and some 220 responses (dependent variables) are identified. A possible explanation is given for the causality of any association obtained between household characteristics and the corresponding dependent variable. Due to the statistical analysis, it is possible to identify the most vulnerable groups and suggest possible reasons for their vulnerability and the factors that may inhibit resilience building and recovery in the aftermath of flood events. The results are used to investigate and to gain deeper insights into how the

vulnerability of affected household groups could be reduced, their resilience to flood strengthened, and their recovery in the longer-term achieved.

Chapter 7: **Results from qualitative analysis**

Chapter 7 provides the qualitative analysis of the interviews and participatory activities conducted mainly in answer to research questions II and III. Nvivo software is used to identify the themes from the transcripts of the interviews. The data obtained from the various data-gathering processes are analysed from a resilience perspective focusing on its components, namely, social, economic, infrastructural/environmental, institutional, and psychological and community competence aspects of the communities exposed to flood risks.

Chapter 8: **Discussion**

This chapter draws on the findings of the study. It examines vulnerability and community resilience in a wider context. In this sense, it aims to meet the objectives of this study while answering the research questions set out in Section 1.6. It also discusses how far the knowledge, concepts, and issues identified in Chapters 2, 3, and 4 influence the understanding of the problems under study. The choice of the research methods and the processes used, as described in Chapter 3, are critically reviewed. The overall results from the analyses in Chapters 5, 6, and 7 and their application in the development of a model for flood risk disaster mitigation and management in building community resilience and in related policy-making in Mauritius are discussed and justified. The extent to which the study is helpful in providing options for policy-making or academic work is also discussed.

Chapter 9: **Conclusions**

The chapter reflects on what has been realised during the course of this research work and reviews the key findings of the study and their implications for other SIDS. Suggestions for further studies on the subject are made. The chapter concludes with some general remarks on the problems of eradicating poverty amongst the most

vulnerable groups and suggests the empowerment of those communities in the decision-making process.

Chapter 2 Literature Review

2.1 Introduction

The chapter presents a literature review of the key concepts related to the subject of the thesis. These concepts, which serve as the theoretical background to the study, are drawn from various sources, namely, academic and scientific journals, books, conference proceedings, media, grey literature, and reports from governments and international organisations. As the study relates to vulnerability and to resilience against natural hazards, the chapter starts with a brief historical perspective of natural hazards in the global context (Section 2.2) in order to trace the origin of the paradigm shift from hazards being viewed as discrete physical events to hazards being viewed as the result of changes in the environment due to human activities. The conceptualisation of hazards in the study is discussed. In Section 2.3, the concept of risk in relation to hazards is examined. The two types of risks, namely, *objective risk* and *perceived risk*, along with their applicability in hazard risk management are discussed. Section 2.4 explores the two approaches to hazard risk reduction management: ‘*top-down*’ and ‘*bottom-up*’. As part of the top-down approach, the role and adequacy of science and technology in reducing vulnerability are examined. Section 2.5 explores the concept of vulnerability and its determinants in society. In Section 2.6, the concept of environmental justice is examined in relation to vulnerability and its integration in the study. The idea of resilience as a primary concept in the study of a human use-environment interaction system and as a lead concept in this study is taken up in Section 2.7. The application of the concept of resilience as a way to assess vulnerability and promote community resilience is investigated in Section 2.8. Recovery as a long-term process for communities affected by flooding, which is one of the major themes of the thesis, is critically examined in Section 2.9. In Section 2.10, some models related to hazards and how they influence the development of a framework for building the resilience of a community exposed to flood risks are explored. Section 2.11 discusses the types of resilience that may be used as indicators of community resilience. There is also discussion of how the indicators are used to define variables for data gathering and analysis and the formulation of a framework for flood risk reduction management. A summary of the chapter is given in Section 2.12.

2.2 Natural hazards

The International Strategy for Disaster Reduction (UN/ISDR, 2009) defines natural hazard as follows:

'A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage'(UN/ISDR,2009,p.20).

Natural hazards become disasters when people's lives and livelihoods are destroyed.

The definition of a disaster given by UN/ISDR (2009) is:

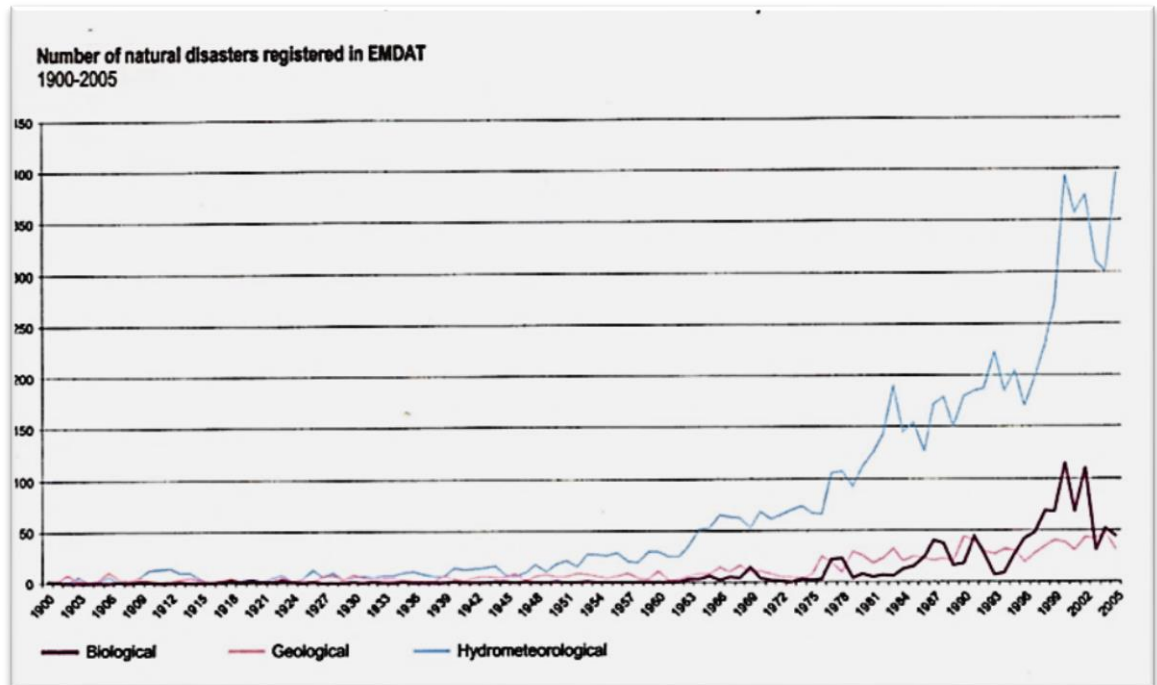
'A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources' (UN/ISDR, 2009, p.8).

2.2.1 Concept of natural hazards from a historical perspective

In ancient times, when a natural hazard struck, it was regarded as an 'act of God' visiting humanity (Burton, 2005) or as a product of the 'wrath of nature' (Cutter, 2006) over which societies had little or no control. With the advent of science and technology, a better understanding of the physical nature of natural hazards, such as lightning, extreme weather systems, and earthquakes, evolved (UN/ISDR, 2001). A paper titled *Disaster Ecology* by Lewis (1978) stated that hazard studies began in the US as a result of '*continuous disasters caused by conditions of hazards*' while in the UK, they were triggered by '*a desire to improve awareness and response to disasters in developing countries*'. Hazard studies were intensified, and they soon covered a broader spectrum of issues as the impacts of severe and frequent hazards on humans worldwide became insupportable. A few of the major events include the severe drought over Sahel in Africa in the late 1960s and early 1970s and the disastrous cyclones in the 1970s that claimed hundreds of thousands of lives (Hagos and Cook, 2008); the powerful 1971 cyclone accompanied by high coastal waves that caused the death of some 300,000

people in Bangladesh (Haque, 1996); and the severe droughts in the 1980s and 1990s in the Horn of Africa that caused the death of over a million people in Ethiopia and resulted in massive out-migration to other places (Ezra and Kiros, 2001).

Initially, disasters were viewed primarily as a natural event system. Advances in science and technology led to a better understanding of hazards and to a wider application of the knowledge in reducing risk and vulnerability to society and in strengthening its resilience. However, the cost to nations resulting from the adverse impacts of hazards continued to increase as the number and types of natural disasters globally were on the rise (IPCC, 2007). Figure 2.1 illustrates the globally rising trend in the number of natural disasters, especially hydrometeorological hazards, since the 1970s.



Source: EM-DAT (OFDA/CRED, 2011) (Accessed March 2012)

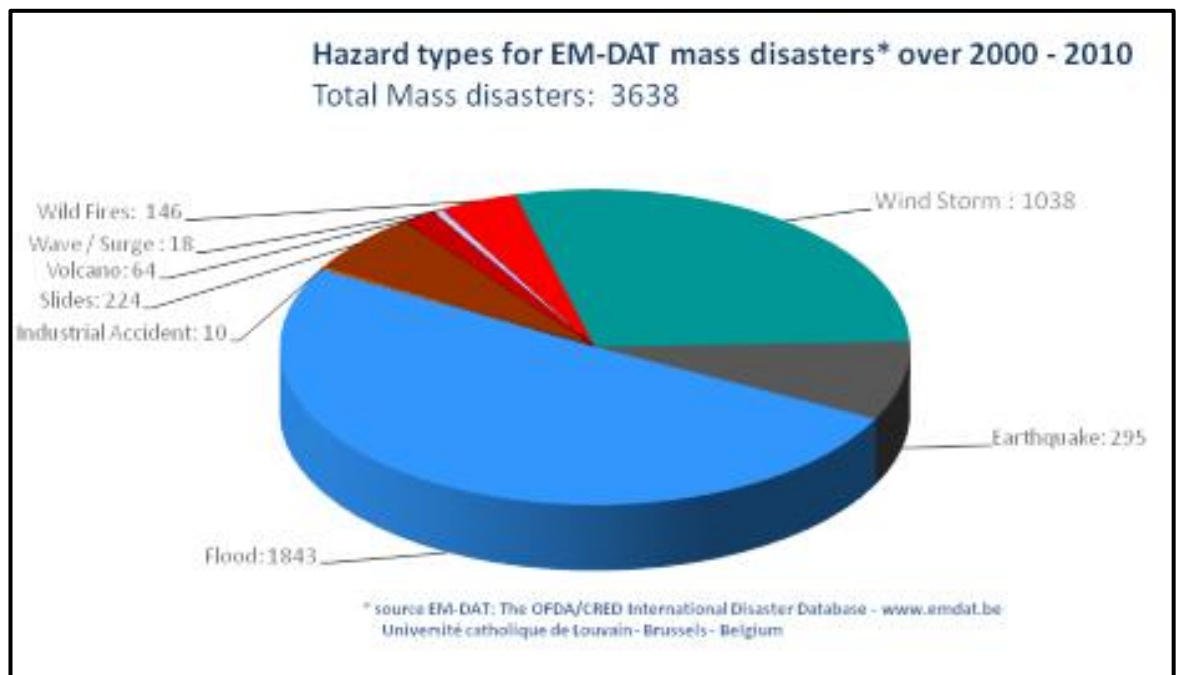
Figure 2.1 Number of hazards (biological, geological and hydrometeorological) recorded at EMDAT for the period (1900 to 2005)

Data on specific phenomena (Figure 2.2) show that worldwide hydrometeorological hazards accounted for slightly over half of all the mass disasters that occurred between 2000 and 2010 (OFDA/CRED, 2011). These data were entered into the EMDAT database as they fulfilled at least one of the following criteria (CRED, 2009):

- Ten (10) or more people were reported killed.
- A hundred (100) or more people were reported affected.

- A state of emergency was declared.
- There was a call for international assistance.

A WMO report (United Nations, 2005; WMO, 2006) stated that at least 90 per cent of all natural hazards over the decade (1995-2004) had been hydrometeorological in origin. This can be deduced from more recent events including the devastating August 2010.



Source: EM-DAT (OFDA/CRED, 2011) (Assessed June 2014)

Figure 2.2 Distribution of hazard types for the period 2000 to 2010

floods in Pakistan, the worst in the country’s history, which killed more than 1,900 people and affected more than 20 million; the January 2011 floods in Australia and in Sri Lanka; the March 2011 storm in Myanmar, when some 700 people were drowned at sea; and the unprecedented November 2013 super typhoon Haiyan, which killed over 6000 and affected over 10 million people in the Philippines (IFRC, 2013). These types of events are projected to increase in frequency and severity as the climate changes in the years to come (IPCC, 2007) and could increase the vulnerability of SIDS, as commented in Section 1.4.

2.2.2 Hazard of the ‘human use-environment interaction’ type

Berz et al. (2001), in their study, indicated that among all the hazards investigated, floods were the most frequent and caused the utmost damage to society. Floods that

occur quite regularly in some parts of the world can be categorised as belonging to three main types:

- (i) run-off from widespread heavy or torrential rains
- (ii) flash floods resulting from high intensity local rains, which are often associated with severe thunderstorms
- (iii) coastal flooding aggravated by storm surges, which are often triggered by the strong winds at times associated with tropical cyclones or other powerful weather systems

In Mauritius, all three types have been observed, but the most common is type (i).

Understanding the type of flood is helpful in determining the mitigation measures that are best suited for a given community. It is realised that in spite of the increase in flood events, people who are marginalised or economically deprived are often compelled to occupy hazard-prone areas, such as flood plains, hill-sides, and areas near volcanoes or industries, to obtain their livelihood (Davis and Hall, 1999), irrespective of the nature or frequency of the floods. For such groups of people, exposure to hazards is largely involuntary (Smith, 2013). Furthermore, the occupation of these areas intensifies human interaction with the hitherto unoccupied environment, triggering or amplifying hazardous events such as floods.

In the face of frequent and increasingly severe worldwide disasters, which are having an unprecedented impact on society (OFDA/CRED, 2011, RCRC, 2003), there are now compelling reasons why hazards can no longer be viewed as a separate natural event system. Studies of the factors that cause disasters led Lewis (1978) to state that the effects of hazards *'may have been exacerbated by many of the activities undertaken by human beings'*. Therefore, hazards had to be seen from the perspective of a human use--environment interaction system as well (Smith, 2007). This dichotomy required that hazards and their consequences on the human system had to be studied from both natural science and social science perspectives (Bankoff et al., 2004). Both approaches had the same objective of reducing the human, social, economic, and environmental losses due to natural hazards and of building resilient communities so that they could recover as promptly as possible.

According to Burton et al. (1993), the concept of a human use-environment interaction system refers to human transformation of the environment. While the change in the environment may generate resources, it may also cause hazards or intensify them. Over the last few decades, the rapid increase in population in specific areas and the resulting human activities through the widespread and intense use of natural resources for the population's well-being, livelihood, and socio-economic development have contributed enormously to the increase in the number and intensity of hazards (Tobin and Montz, 1997; Cutter, 2006; UN/ISDR, 2007). It is anticipated that such a human use-environment interaction will play an ever growing role in disaster generation or amplification, particularly in SIDS (Briguglio, 1995).

2.2.3. *Conceptualizing hazards in the research study*

The study will be primarily concerned with the human-related aspects of hazards, notably floods, which are thought to be triggered or aggravated by the increasing human use-environment interaction. Such changes are more evident in SIDS like Mauritius where there is limited land surface available to satisfy fully the needs of a growing population and an expanding economy. According to Hogan and Marandola (2007), the risk of hazards has always influenced to some degree the settlement pattern of human populations. The study will thus focus on floods that are seen to arise or be amplified from human use-environment interaction and their impact on vulnerable communities. In cases where such communities are unavoidably exposed to floods and have to live with such hazards, the study will attempt to understand these problems from the perspective of the communities and how such risks could be managed to reduce the communities' vulnerability and enhance their resilience to aid long-term recovery.

The concept of hazards will be addressed from both approaches—a hazard as a discrete event and a hazard as a human use-environment interaction system. However, the study will focus on human aspects of hazards as there is an acknowledged shift from the idea of natural hazards as a discrete biophysical event to seeing them as an environmental concern. The human-nature interaction system is relevant to developing countries and SIDS as it requires an understanding of the components of vulnerability. In this context, risk is an essential element. To this end, the concepts related to risk are addressed in the next section.

2.3 Establishing risk in the context of hazard studies

2.3.1 *Definition of risk*

Risk is considered to be a complex concept that represents something unreal and is related to random chance or uncertainty (Holton, 2004). However, while the concept of risk is associated with the known, uncertainty is associated with the unknown (Gough, 1998). In the field of hazard studies, the term ‘risk’ can be used to refer to the hazard itself, or the probability or consequences of the hazard or of a potential adversity (UNDP-BCPR, 2006). While natural hazards cannot be prevented, many of the associated risks can be assessed and the consequences prevented or mitigated (UN/ISDR, 2005).

Risk is quantified objectively for risk assessment and risk management (Slovic and Weber, 2002). According to Haque and Etkin (2005), the objective method of quantifying risk has proved to be ineffective since it neglects a wide range of disaster impacts, such as the psychological effects and social disruption (McEntire, 2005) that are known to increase vulnerability. Some drawbacks of objective risk in DRR management are as follows:

- Quantitative risk evaluation is understood only by a minority of people and thus is poorly understood by the public and those who are most at risk.
- Risk analysis also ignores individual’s concerns and fears in hazardous conditions. It is often difficult to quantify risks from multiple hazards, especially those created by low-frequency/high magnitude events. The risk may also be spread very unevenly between different communities (Smith, 2007).
- Decisions to implement risk reduction strategies are made by the government and other experts with little participation from the public (Patt and Schröter, 2008).

- The collection, processing, and assessment of data are subject to *cognitive biases* based on human judgement before a decision is made (Cutter, 2006). Therefore a ‘quantitative expert view’ may not be entirely objective.
- ‘Top-down’¹ institutional measures to reduce risk in the aftermath of a hazard have proved to be ineffective. A ‘bottom–up’ community-based rehabilitation scheme is recommended for increased effectiveness (Haque and Etkin, 2005).
- The focus of risk management has somehow neglected the wide range of disaster impacts, such as psychological and social disruption (McEntire, 2005).

Given these limitations in reducing risks, disasters have continued to increase globally (IPCC, 2007), and systematic efforts to lessen the vulnerability of people and property have not been successful (UN/ISDR, 2007). Taking an interdisciplinary approach by including not only the physical but also the human perspectives in DRR management would be beneficial to decision making. The human perspective of risk is explored in the next section.

2.3.2 Perceived risk

Perceived risk was defined by Slovic (1987) as ‘*a set of mental strategies or heuristics that people employ in order to make sense of the uncertain world*’ (p. 280). People think, feel, and make judgments and ultimately choose the level of risk they can accept. Anderson-Berry and King (2005) stated that many of the decisions people take are based on their perception and understanding of risk. People’s interpretation of risks is also shaped by their own experience, personal values, and cultural beliefs and by a changing social environment (Eiser et al., 2012). A determinant factor suggested by Anderson-Berry and King (2005) in managing risks is the empowerment of communities in understanding the nature and dimensions of risk and in sharing their

¹ The top-down approach as a conventional disaster response approach has a historical background in civil defence and the application of a ‘command and control’ approach to dealing with emergencies and immediate recoveries (Haque and Burton pp. 335-353 in *Mitigation of Natural Hazards and Disasters-International perspectives, 2005*)

local knowledge with other stakeholders. Among other factors that influence risk perception are socio-economic conditions (Pelling, 2007; Berkes, 2007; Wisner et al., 2006; Linnekamp et al., 2011); the situational characteristics of the person, such as age and gender (Kellens et al., 2011); educational level (Patt and Schröter, 2008); and experience (Smith, 2007; Houston et al., 2007).

Some of the drawbacks of perceived risk that have to be taken into consideration in addressing DRR management are as follows:

- The concept embodies elements of subjectivity. Nevertheless, it provides insight into the complexities of public perception.
- Given the subjectivity, the cost-effectiveness of the different solutions aimed at reducing risk cannot be assessed when the phenomenon occurs on a large scale.
- Risk perception is found to be useful in formulating preparedness strategies but a lack of resources may not allow the implementation of mitigation measures in an environment where there are very diverse views (Terpstra and Lindell, 2012).
- Risk perception can be conflicting in communication when experts and lay people hold different views. Haynes et al. (2008) claimed that social, cultural, political, and economic forces distort risk messages, leading the public to rely more on a network of lay knowledge.
- Studies are exploratory in nature with difficulties in measuring and analysing patterns of behaviour in people's perceptions of risk. This heterogeneity leads to problems in comparing results among studies (Kellens et al., 2011)

In spite of these drawbacks, risk perception has been intensively used to highlight issues related to the flood risks suffered by vulnerable communities. A few studies on risk perception are listed below as they provide a valuable guide to this study:

- (i) Household surveys in Guyana by Pelling (1999) were used to assess the perception of risks linked to environmental problems. The study incorporated social and economic aspects along with the exposure of communities to environmental hazards. The study showed that politically-oriented elite groups usually excluded marginalised people from any decision-making. It was therefore deduced that the assessment of risk should involve representative groups and take into account the location and needs of the affected communities.

- (ii) In a study of flood hazards in Scotland, Werritty et al. (2007a) used questionnaires at the household level and conducted focus groups and stakeholder interviews to collect data on flood risks. The analysis of the data enabled the authors to gain in-depth insights into the vulnerabilities of affected communities based on their perception of flood risks. It was found that enhancing social resilience remained a major challenge requiring much more detailed research on the location and on the needs of communities at risk of being flooded.

- (iii) Miceli et al. (2008) explored risk perceptions of residents exposed to hydrogeological phenomena in an alpine valley of northern Italy through a questionnaire survey. The results showed that the assessment of perceived risk of localised communities was useful in formulating preparedness against future hazards.

- (iv) Linnekamp et al. (2011) carried out a study on the risk perception of households regarding flooding, as part of possible climate change impacts on two cities in the Caribbean. The research was carried out via interviews with householders about perceived risk with regard to disaster preparedness measures. The study showed that the households perceived the existence of differences in vulnerability as a result of socio-economic inequalities and differential exposure to natural hazards. The results also showed that collective action by affected communities and national authorities were lacking in the building of resilience.

- (v) A case study in the Netherlands by Terpstra (2011) indicated that emotions related to previous flood hazards influenced citizens' perception of risk and preparedness strategies in the event of future hazards.

The outcomes of the above studies in both developing and developed countries show how achieving a reduction in vulnerability requires an understanding of the following:

- the dimensions of the risks that residents face
- how they take decisions in the light of their perception and understanding of those risks
- how they take decisions about what level of risk is acceptable
- what actions they decide on or the behaviour they wish to adopt to minimise their exposure to risk.

2.3.3 *Conceptualizing perceived risk in this research study*

While the concepts of objective and perceived risks have comparative advantages in particular situations, the concept of perceived risk is more suited to answering the research questions in this study (Section 1.6). The study requires an assessment of the perceptions of stakeholders (householders and officials—Research Questions I and II hold.). The answers to these questions form the basis for understanding how the concept of '*environmental justice*' can be used in the study (Research Question III) and for the development of a framework for DRR management in Mauritius (Research Question IV). However, the experience of previous studies (Section 2.2.3) in the use of perceived risk needs to be taken into account, in particular:

- (i) the differential vulnerabilities due to differences in the socio-economic status of households
- (ii) the emotional and behavioural patterns that may render coping and resilience building strategies difficult

- (iii) the involvement of marginalised groups in decision-making as a form of community-based participation

It was important to give careful consideration to conceptualising risk perception in this study when developing the methodology to collect and interpret data.

2.4 Approaches to hazard risk reduction management

This section explores flood risk reduction management strategies using two approaches:

The ‘*top*

- a) the ‘*top-down*’ approach, which is practised in many countries (Schelfaut et al., 2011) is described in Section 2.4.1. This comprises primarily expert and scientific knowledge.

- b) the ‘*bottom up*’ approach to risk reduction management is described in Section 2.4.2. This comprises the traditional lay situational knowledge of communities.

2.4.1 *Top-down approach to hazard risk reduction management*

The top-down approach is a common method applied in hazard risk reduction management (Section 1.3); it involves reducing vulnerability and managing risk (Ingledon, 1999) by applying *structural* and *non-structural* measures. Structural measures in relation to hydrometeorological hazards include engineering work, such as the building of waterways, levees, and wind-resistant buildings. Strategies involving structural measures for adaptation to sea-level rise through the construction of seawalls and levees have proved to be inefficient and have led to more disasters (Kates et al., 2006). Non-structural measures include early warning systems, emergency relief operations, insurance cover, education, capacity building, and awareness raising (UN/ISDR, 2005). Risk assessment and early warning systems are essential investments that protect and save many lives and livelihoods, and much property, contributing to the sustainability of development. In addition, these are far more cost-effective as they involve strengthening coping mechanisms rather than relying primarily on post-disaster response and recovery.

In the top-down approach, risk assessment procedures in disaster management are viewed as 'technocratic' 'technocratic', with the human dimension ignored after the warnings have been lifted (Section 1.3). Emergency relief after a disaster is considered as a short-term approach in reducing vulnerability where underprivileged community groups are exposed indefinitely to a cascade of sequential hazards after the main event (Wisner et al., 2006). The introduction of micro-insurance, when implemented before a disaster strikes, can help poor people recover their losses in the event of a natural disaster (Worldwatch Institute, 2007). However, few people in developing countries carry insurance against natural disasters compared to those of industrialised countries. Kellens et al. (2011), though, suggested that a shift in flood risk management from the traditional objective approach to an integrated approach based on social aspects would be able to address gaps in the recovery process.

Science and technology

Science and technology have made it possible to understand the mechanisms and processes that govern natural hazards, including their characteristics, frequency, and magnitude. Scientific knowledge has been accommodated via structural and non-structural changes and preventive measures (UN/ISDR, 2005), as described above. With progress in science and technology, surface- and space-based real-time observations, computer modelling and prediction, and information exchange and communications connected with hazards have proved very useful, especially in risk identification, mapping, monitoring, local assessments, and early warning activities and in vulnerability assessment. For example, Cicone et al. (2003) developed geospatial models that were used to identify areas where human populations were vulnerable to natural hazards in Africa. Science-based knowledge of the spatial distribution of human vulnerability can help countries to prepare themselves more effectively against disasters and develop mitigation strategies to reduce further losses (Cutter, 2006). The use of a geographic information system (GIS) in understanding hazards provides complementary information in reducing their adverse social, economic, and environmental impacts. For example, the application of High Resolution Remote Sensing data and GIS techniques were used to monitor and assess the threat of tsunami hazards in the Nicobar Islands (Kumar et al., 2007).

Science and technology may be successful in preventing loss of life, but they are often too expensive for developing countries and communities and do not offer a long-term solution to the problem of vulnerability mitigation and disaster prevention (Mustafa, 2003). Moreover, it is difficult to define a standard indicator framework for disaster prevention for developing countries due to the lack of data or inconsistency in the data sets. Nevertheless, developing countries can benefit more fully from the multiple benefits of science and technology in disaster prevention measures. Therefore, there is a need to build better partnerships with industrialised countries and strengthen cooperation among developing countries regarding the sharing of technology, information, and expertise

Recently, a number of resilience tools based on science and technology have been developed, especially among developing countries. For example, in Kilimo Salama, Kenya, an insurance programme for small-hold farmers who use wireless weather sensors has been effective in protecting the farmers financially against climate volatility. Around the world, a service called Ushahidi empowers communities to exchange information during a crisis using their mobile phones (Zolli, 2012). These technologies could be helpful on a national scale to reduce vulnerability but could also be applied at the smaller community level where communication through radio and television, and networking through mobile phones could provide reliable means to raise awareness in the event of localized hazards such as floods. Such tools exist in Mauritius and could be considered when developing a framework for disaster reduction from floods.

2.4.2 *Bottom-up approach in hazard risk management*

Lay knowledge is sometimes known as '*indigenous knowledge*' or '*traditional knowledge*' and is also described as '*common knowledge*' or '*local knowledge*', which has been acquired by local people and handed down from one generation to the next (Mavhura et al., 2013). It was found that local knowledge played an important role as '*tangible evidence*' (Scammell et al., 2009; McEwen and Jones, 2012) in coping strategies and in building community resilience to floods in Zimbabwe (Mavhura et al., 2013). Mercer et al. (2007) stated that local knowledge was often excluded in decision-making processes and suggested the need to integrate lay knowledge with the expert knowledge of the development agencies of governments, which rely mostly on scientific evidence (Scammell et al., 2009) in disaster risk management. Similarly,

Cottrell (2005) emphasized the importance of complementing experts' knowledge with lay knowledge (Section 2.3.3), but the role of all stakeholders in the recovery process should also be acknowledged as a crucial element in community resilience building (Lopez-Marrero and Tschakert, 2011).

Furthermore, Schelfaut et al. (2011) suggested that community participation in flood mitigation plays an important role in promoting resilience but has not been widely practised as it has been considered to be an unimportant activity by institutions where a top-down approach to flood management is still prevalent. The bottom-up approach takes into account the community's perspective, lay knowledge, and stakeholders' views at all levels in building community resilience. However, this approach may present a challenging task in some countries. For instance, bringing together all stakeholders in many developing countries and SIDS to form linkages could be problematic. In the Maldives, a SIDS in the Indian Ocean, Pardasani (2006) noted that local communities and NGOs were not able to work together effectively in building community resilience during the reconstruction stage of the 2004 tsunami. This prompted the government to set up National Disaster Management Centres as official permanent mechanisms where the concerted efforts of all stakeholders could be mobilised in support of the recovery programme. These issues related to the involvement of all stakeholders are relevant to this study on vulnerability and resilience building and were applicable in the development of the research methodology.

2.5 Vulnerability

2.5.1 Evolution of the concept and selected definitions from other studies

The concept of vulnerability has its roots in geography and natural hazard research, but the term is used in a variety of other research contexts (Füssel, 2007) and in various disciplines. Consequently, the definition of vulnerability has become blurred (Adger, 2006) with no universally accepted definition (Cutter, 2006). In the context of hazard, the concept of vulnerability was traditionally used to denote the degree of exposure and the fragility of the exposed elements. The concept gained prominence with the advent of an increasing number of hazards affecting a greater number of people (Westgate and O'Keefe, 1976). In recent decades, there has been a tendency to move away from the physical aspect of natural disasters and focus more on their social dimension. This

change was the result of the unsuccessful efforts in mitigating the impacts of successive natural disasters, particularly in developing and least developed countries (RCRCS, 2003). Consequently, the new emphasis on social aspects became the springboard for the subsequent evolution of the concept of vulnerability (Cardona, 2004). In Table 2.1, a representative list of definitions primarily applied to the social characteristics of vulnerability to natural hazards is given.

Table 2.1 Selected definitions by various authors of the concept of vulnerability

Definition	Source
The degree to which a society is at risk from the occurrence of extreme physical or natural phenomena where risk refers to the pejorative probability of the occurrence of a disaster event, and the degree to which <i>socio-economic factors</i> affect a community's <i>capacity to absorb and recover</i> from the effects of extreme phenomena	Westgate and O'Keefe, 1976, p. 6
Vulnerability involves more than the likelihood of people being injured or killed by a particular hazard, and includes the type of livelihoods people engage in, and the <i>impact</i> of different hazards on them (on groups of people that are at different levels of preparedness, <i>resilience</i> and with varying <i>capacities for recovery</i>).	Cannon, et al., 2003
Vulnerability is a product of <i>physical exposure</i> to natural hazard, and human capacity to <i>prepare for or mitigate and to recover</i> (cope with) from any negative impacts of disaster.	Pelling and Uitto, 2001, p. 57
Vulnerability not only captures <i>susceptibility and coping capacity but also adaptive capacity, exposure</i> and the interaction with perturbations and stresses.	Turner, et al., 2003, p. 8074
The conditions determined by physical, social, economic and environmental factors or processes, which increase the <i>susceptibility</i> of a community to the impact of hazards.	UN/ISDR, 2005
Vulnerability is the product of social inequalities. It is defined as the <i>susceptibility</i> of social groups to the impacts of hazards as well as their <i>resiliency or ability to adequately recover</i> from them.	Cutter and Emrich, 2006, p. 103
The characteristics of a person or a group and their situation that influence their <i>capacity to anticipate, cope with, resist and recover from the impact of a natural hazard</i> (an extreme natural event or process).	Wisner, et al., 2006, p. 11

The definitions of vulnerability in Table 2.1 taken from several studies refer to social conditions of *exposure, adaptive capacity* and *resilience with varying capacities to recover* from the impact of natural hazards. These variables, therefore, encompass the social, economic, cultural, political, environmental, and geographical contexts in which people live (McEntire, 2001; Pelling and Uitto, 2001; Wisner et al., 2006). The factors

that determine vulnerability, in particular exposure and the socio-economic conditions that largely govern adaptive capacity, are considered in the following section.

2.5.2 *Factors affecting vulnerability*

(i) Exposure to hazards

Several factors are responsible for exposing people to risk. These include land use for construction and infrastructure and the expansion of urban areas to accommodate incoming people in search of a better livelihood (Wisner et al., 2006). This situation contributes to the creation of areas of crowded settlement, mostly by the poorer sections of the population, who often occupy fragile environments liable to flooding and landslides (Pelling, 1998). Pelling (2007) described how poor households tend to live in riskier areas of urban settlements, including a garbage dump in the Philippines, putting them at risk from flooding, disease, and other chronic stresses. The reasons why poorer people occupy hazardous areas can be attributed to many factors. Poor people often occupy hazard-prone areas involuntarily for compelling reasons, such as livelihood, low cost housing, and proximity to an agglomeration with numerous facilities and amenities. Furthermore, many activities (e.g. deforestation and urbanization) that humans undertake may modify the fragile surroundings in which they live and trigger events that become a threat, resulting in increased risk and vulnerability for them (Wisner et al., 2006).

(ii) Socio-economic factors and the 'ratchet effect' of vulnerability

In both industrialized and developing countries, when a disaster strikes, the impact is felt differently by groups of people with varying levels of preparedness, resilience, and capacity to recover. Similarly, even within the same locality, vulnerability may vary from one socio-economic group to another (Werritty et al., 2007a). People with progressively lower capacities to anticipate, cope with, resist, and recover from disaster have progressively higher vulnerabilities (Schroeder and Yocum, 2006). In developing countries, however, it is often the poor people who are the most exposed to hazards due to improper land use, low assets, and marginalization (Wisner et al., 2006). Poverty drives people to more precarious and unsustainable means of survival, including the occupation and farming of fragile areas such as watersheds and the encroachment of

hillsides by urban slums, all of which contribute to flooding and landslides (Davis, 1999).

According to the Worldwatch Institute (2007), slum settlements around cities in developing countries are increasingly exposed to hazards. Cutter (2006) claimed that the growing vulnerability leading to disasters in some societies is intimately tied to urbanization, development patterns, disproportionate exposure to unhealthy conditions, and social injustice. Navarrete et al. (2007) considered these factors as one element of ‘*vicious cycles*’ driven by ineffective land-use planning and the occupation of hazardous zones by poor people and the degradation of their environment. As a result, they suggested that vulnerability should be understood in the context of a human use-environment interaction system.

A focus on human use--environment interaction highlights the increasing and differentiated vulnerability of community groups exposed to successive post-hazard events (Wisner et al., 2006; Few, 2007). The impact of each new hazardous event, without complete post-hazard recovery, exacerbates existing vulnerability, leading to the ‘*ratchet effect*’² stated initially by Chambers (1996) and cited in Pelling (2007). Consequently, vulnerable households hardly ever recover as they become even more vulnerable to successive hazards (Cannon et al., 2003). They continue to live in precarious conditions as the incomplete recovery phase continues from one event to the next (Wisner et al., 2006; UN/ISDR, 2005). This inequality raises the question of environmental justice, which is the subject of the next section.

2.6 Environmental justice (EJ) issues

There is no universally agreed definition of EJ. Interpreting the notion of justice is problematic given that each country has its own standards for dealing with the term (Walker and Bulkeley, 2006). A few examples of recent definitions which are relevant to this study are given in Table 2.2 below.

² Ratchet is metaphor which, in the context of vulnerability, means that an event reduces the resources of a group or an individual to resist and recover from the next environmental shock or stress.

Table 2.2 Definitions of EJ relevant to the study

Definition	Author(s)
The fair treatment and meaningful involvement of all people regardless of race, colour, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.	Cory and Rahman (2009, p. 1828)
Access to healthy and clean environment, including environmental amenities.	Faber D and Kreig (2002)
Promoting equitable treatment of people of all races, incomes and cultures with respect to environmental laws, regulations, policies and decisions.	Higgs and Langford (2009, p. 63)
The equal access to a clean environment and equal protection from environmental harm irrespective of race, income, class or any other differentiating socio-economic feature.	Pearce and Kingham, (2008, p. 981)
Requires attention to the disproportionate distribution of environmental impacts and a wider recognition of fairness to the poor who are the most affected by environmental degradation.	UNEP (2012, p. 51)

Formerly, the issue of EJ originated from the pollution and toxicity problems in the US and from the politics of race and civil rights, but its application has now been extended to other parts of the world for the purpose of addressing environmental law and implementing environmental policies in the context of sustainable development (Faber and Kreig, 2002; Manntay and Maroko, 2009). As stated in the definitions above, EJ is concerned with inequality in communities regarding differences in race, ethnic origin, colour, and culture, and of minorities and poor people as well as relating to the fair treatment of women, children, and the elderly (Manntay and Maroko, 2009). Therefore, EJ relates to the issue of communities having a good quality of life in a clean environment and protection from environmental harm (Pearce and Kingham, 2008).

2.6.1 Some of the forces that generate environmental injustice

Forces that generate social injustice may be related to distributive issues of resources, space allocation, governance, and power relations over time. Chess et al. (2005) considered that forms of environmental injustice arise from historical approaches to governance. The government uses ‘one tone’ to communicate to the population about the sharing of natural resources, often ignoring the cultures, attitudes, and specific needs of minority communities.

Injustices often occur when governments and investors use space in a location for building purposes and fail to recognize the safety hazards posed by issues such as a high water table and unstable ground (Whiston-Spirn, 2005). The occupation of space over time for industrial development and the historical settlement patterns of different social groups often contribute to environmental risks and inequalities. Such activities also shape environmental and social history (James, 2009). Kreig (2005) commented that despite scientific analysis of the disproportionate impact of environmental hazards on vulnerable communities over more than a decade, questions regarding the forces that generate environmental injustice remained unanswered.

2.6.2 *Methodology used to investigate EJ*

Since EJ is an inherently spatial issue (uneven settlement patterns of social groups as regards environmental hazards, as explained in the previous section), GIS is widely used in the studies of EJ. Higgs and Langford (2009) used this tool to test the correlation between the population residing in close proximity to landfill facilities and increased deprivation compared to that of the wider community in Wales. GIS offers essential tools to assemble data, analyse spatial relationships, and present outcomes via maps and summary statistics. Land survey methods have proved useful in investigating and assessing who and where the populations at risk are and in providing useful indicators for enforcing environmental laws, regulations and policies (Manntay and Maroko, 2009; Cory and Rahman, 2009). However, Walker (2012) suggested that quantitative measures do not focus on all dimensions of inequality relevant to EJ, as the corresponding notions involve many interacting complexities that need to be addressed by other methods.

How EJ (environmental ‘goods’ and ‘bads’) is understood by different social groups needs to be analysed. Qualitative approaches, such as focus groups and participatory methods that draw on people’s local knowledge to identify sources of hazard risks, could help in identifying patterns of exposure to such risks and in improving local policy (Walker, 2012). The studies cited below highlight the use of a qualitative approach in EJ studies for formulating policy options.

Hoffmann et al. (2009) carried out an epidemiological study to investigate the distribution of environmental exposures and health outcomes in pre-school children, and

also examined the role of social position. Analysis showed that environmental exposures were more prevalent among socially disadvantaged groups of families, who carried a disproportionate burden of environmentally related diseases.

It is widely believed that public participation contributes to better projects, better development, and collaborative governance (Enserink and Koppenjan, 2007). Communities affected by pollution and concerned about environmental hazards frequently request health studies from their local or state departments of public health, but are often frustrated with the results. Group interviews or focus group participants offer insights on the perspectives of the community (Scammell et al., 2009). Lloyd-Smith (2009) argued that community participatory research in addressing health disparities and EJ is important in epidemiological studies and risk assessments, which traditionally have allowed little opportunity for meaningful community input. Community-based participatory research (CBPR) is increasingly being used to study and address EJ in environment health programmes and to promote relevant public policy.

The cumulative exposure of communities to hazards due to disproportionate contact with hazardous sites, particularly coloured and working class communities has led to the establishment of programmes and policies that ensure environmental equity. The objective is to promote greater community participation in the problem solving and decision-making processes that affect those communities. The involvement of all stakeholders is required to ensure EJ (Faber and Kreig, 2002).

2.6.3 Integrating EJ in the research

Most of the research on EJ has been done in the US, with a few studies in other parts of the world and hardly any in SIDS. A specific application of the concepts of vulnerability and EJ has been studied by Werritty et al. (2007b). They examined the distribution of population in the flood-risk zone in Scotland. A survey of flooded households was carried out to identify which sub-groups were least able to withstand the effects of floods. Consideration was given to the extent to which flooded households experienced participative justice from the point of view of both environmental vulnerability and EJ. It was found that low income households were disproportionately

more vulnerable to flood risks and were more susceptible to lasting impacts that could reduce post-disaster recovery. These outcomes and issues raised with respect to EJ are relevant to the research questions of this study (Section 1.6, especially Research Question III). The approach used by Houston et al. (2007) to gather information on the perceptions of the people at risk and to conduct a suitable analysis of the data served as a useful guide to the researcher in designing the methodology framework for integrating EJ in this study.

2.7 Resilience building against hazards

2.7.1 Resilience as a concept

Table 2.3 Definitions of resilience in the context of hazard

Definitions of resilience from a hazard perspective	Author(s)
Resilience is the measure of a system's or part of a system's capacity to <i>absorb and recover</i> from the occurrence of a hazardous event.	Timmerman, (1981, p. 21)
Resilience is broadly the capacity of a group or organization to <i>withstand loss or damage or to recover</i> from the impact of an emergency or disaster.	Buckle, et al., (2001, p. 8.)
Resilience is the ability of groups or communities to <i>cope with</i> external stresses and disturbances as a result of social, political and environmental change.	Adger (2000, p 347)
Resilience to natural hazard is the ability of a person to <i>cope with or adapt to</i> hazard stress. It includes the planned preparation and spontaneous or premeditated adjustments undertaken in the face of natural hazards including relief and rescue.	Pelling (2007, p. 48)
The ability of a system, community or society exposed to hazards to <i>resist, absorb, accommodate to and recover</i> from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.	UN/ISDR (2009)
Resilience is the ability of a social system to <i>respond to and recover from</i> disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event, as well as post-event, adaptive processes that facilitate the ability of the social system to re-organize, change, and learn in response to a threat.	Cutter, et al., (2008, p. 598)

The term 'resilience', referred to so far in contrast to vulnerability, has its roots in ecology, where it was applied to describe the persistence of organisms in the face of changes in the ecosystems (Holling, 1973). Its first use to study the vulnerability of human societies was by Timmerman (1981) in relation to climate change. He defined

resilience as *'the measure of a system's or part of a system's capacity to absorb and recover from the occurrence of a hazardous event'* (p.21). His approach was related to the concept of vulnerability as it applied to natural hazards. Since then, the concept of resilience has been introduced and is now used extensively in many domains with the result that it has gained multiple meanings (Rose, 2007). Table 2.3 gives some definitions of resilience that were adapted and used for the purpose of this research.

As can be noted from the above definitions, the term 'resilience' is based around the idea of the ability of a system or a community to plan ahead to *'cope, accommodate, resist or adapt and recover'* from a disaster impact. Implicit in the above definitions are the ideas of *'exposure to'* and *'recovery from'* hazards and building long-term resilience.

2.7.2 Resilience in relation to vulnerability

Over the years, there have been many arguments over the conceptualization of resilience-whether it should be considered to be the opposite of or be linked to vulnerability, or whether it is an outcome of recovery or a process to achieve sustainable or resilient communities. An analysis of these concepts is undertaken next.

Some authors like to define resilience as the *opposite of vulnerability*, meaning that high levels of vulnerability imply a low resilience and vice-versa (Timmerman, 1981; Cannon, 2008; Adger, 2000; Shaw, 2006). Others consider that resilience and vulnerability are not opposing concepts but that resilience may be linked to vulnerability. For example, Buckle et al. (2001) considered that a person may be vulnerable to flooding but may have resilience in terms of having enough personal skills to rebuild and recover. Similarly, in a study by Akter and Mallick (2013), it was found that highly vulnerable poorer household groups were more resilient and better able to withstand disaster shock than were their well-off neighbours. In such cases, resilience is taken to be clearly related to the response capacity, which is a component of vulnerability, and thus it would not be the opposite or 'flip side' of vulnerability (Gallopini, 2006; Folke et al., 2006; Cutter, 2006).

Others take resilience to imply an *outcome* when it is defined as the ability to cope with a hazard event and is imbedded within vulnerability (Manyena, 2006; Cutter et al.,

2008). However, process-related resilience is defined more as an ability derived from continual learning and taking responsibility for making better decisions to improve the capacity to handle hazards (Sapountzaki, 2007). Whether resilience is taken to be an outcome or a process or is viewed as a component of vulnerability, its application to disaster reduction nevertheless marks an important conceptual step forward. It is considered as a promising concept for preventing and mitigating the impacts of hazards (Cutter et al., 2008) and where appropriate, it may be studied in conjunction with vulnerability. This implies that most of the factors that determine the vulnerability of a community, namely, social, economic, environmental, and psychological factors, for example, could be similar to those determinants that also influence community resilience. The concept of community resilience is discussed in Section 2.8.

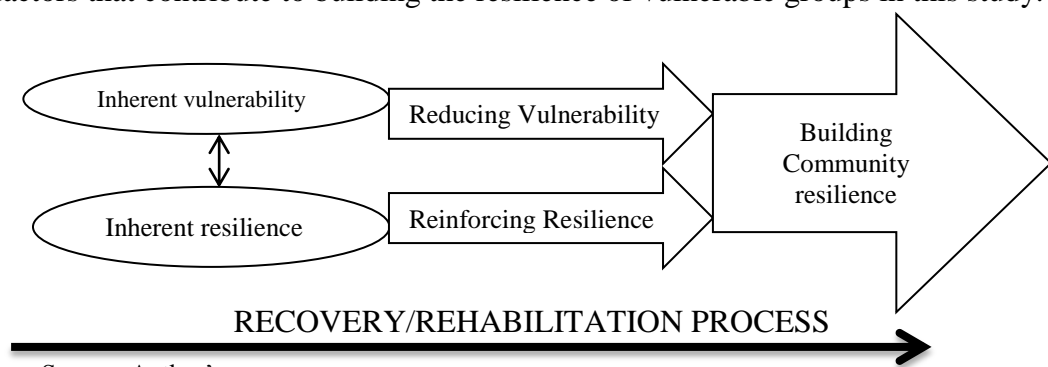
2.7.3 Conceptualising resilience in relation to vulnerability and EJ

In the study of natural hazards, resilience is taken to be related to vulnerability and to the recovery process after disasters (Tobin, 1999; Pelling, 2007; Klein, 2003; Wisner et al., 2006; UN/ISDR, 2009). It encompasses coping strategies as well as the post-event adaptive capacity of a social system (Cutter et al., 2008). Adaptive capacity in this context is considered as the ability of individuals or households to survive soon after a stressful event and to make a long-term sustainable adjustment (Smit and Wandel, 2006). It bears a similarity to coping strategies in the face of hazard impacts (Turner et al., 2003; Gallopín, 2006).

In conceptualising resilience, it is necessary to differentiate the coping capacities of fragile societies that are unable to cope and those that are capable of recovering on their own (Gaillard, 2007). As regards fragile societies, hazards resulting from environmental degradation deprive them of their main resources and push them to rely on external resources in order to recover. Other factors that are known to influence resilience building in fragile societies during recovery are their degree of vulnerability and the nature of the hazard. These factors vary significantly in time and space and from one disaster to another. For example, the resilience of the community struck by the 2004 tsunami in Thailand for the first time was different from that of communities who are used to experiencing frequent climate-related catastrophes such as cyclones (Schroeder and Yocum, 2006), implying that resilience is hazard-specific.

Overall, the resilience of a community (Section 2.8) implies its capacity to endure when confronted by hardship and to ‘*bounce back and return to normal*’ after going through ‘*an unusual distressing threat*’ (Cutter et al., 2008). In contrast, vulnerability describes the fragile state of a community at a given time (Section 2.5) and the recovery process (Section 2.9) which aims at bringing the community to a level where it will be increasingly less vulnerable. For the purpose of this thesis, the starting point of resilience building that takes place during the recovery phase (Figure 2.3) will be the existing inherent³ vulnerability and the inherent resilience of the community. Resilience building will comprise both the reduction of inherent vulnerability and the reinforcement of inherent resilience. However, wherever more appropriate, vulnerability will be used in conjunction with resilience as a parameter in the collection, analysis, and interpretation of data as a way of assessing community resilience (Ferdinand et al., 2012; Ainuddin and Routray, 2012).

Resilience is related to the concept of EJ (Section 2.6) when the disadvantaged sub-groups of a community are least able to withstand the effects of disasters and recover (Wisner et al., 2006). The efforts required in building the resilience of community groups and achieving recovery are determined by the extent of marginalisation and the differential exposure to environmental ‘bads’ (Houston et al., 2007; Cutter and Emrich, 2006). These issues have implications for the design of methods and the exploration of the factors that contribute to building the resilience of vulnerable groups in this study.



Source: Author’s survey

Figure 2.3 A representation of the recovery/rehabilitation as a process

In the above Figure, the notions of vulnerability and of resilience are shown to be linked. According to Berkes (2007, p. 283), ‘*Vulnerability is not only exposure to*

³ The word ‘*inherent*’ was used by Cutter et al. (2008) to denote the characteristics of vulnerability and resilience of social systems in conjunction with coping and recovery from disasters.

hazards but resides in the resilience of the system experiencing the hazard'. Thus a person may have *inherent* vulnerability to flooding but may also have *inherent* resilience in terms of having enough personal skills to rebuild and recover (Buckle et al., 2001).

2.8 Community resilience

2.8.1 Community resilience in traditional societies

Community resilience has emerged as a new concept over the last decade and has gained in importance as a key concept in reducing vulnerability in the face of growing natural hazards (Lopez-Marrero and Tschakert, 2011) although this concept had previously existed in many traditional societies (Berkes, 2007). Gaillard (2007) reported studies on such societies worldwide which found that community recovery from natural disasters often necessitated only small changes in the traditional ways of life in order to adapt to the new environmental, economic, social, and political changes resulting from the disasters. This signifies that resilience is brought about by the notion of change, which means a shift from vulnerability, where people suffer from the impact of disasters, to that of increasing their coping capacity and resilience (Cannon, 2008). Berkes (2007) mentioned how communities in developing countries such as Bangladesh develop resilience to frequent flood disasters by living with flood events. For example, they can maintain their livelihood of catching fish by building houses above the ground on stilts.

In responding to hazards, squatter communities in Kuala Lumpur have developed resilience through networking among themselves as well as with government officials and by adapting a number of affordable structural modifications. Zahari and Ariffin (2013) found that by communicating about risk and sharing knowledge with members within their communities as well as following guidance by the responsible government agencies, those people are able overcome their vulnerabilities to the hazards presented in their daily lives. Thus it can be seen that social processes, such as community cohesion, good leadership, and individual support for collective action, are critical factors that influence the perception that people have about their community's ability to build resilience and cope with disturbing events.

On the other hand, in SIDS, such traditions are being undermined as their economies are becoming increasingly integrated into the world economy through globalization (IPCC, 2007). Inter-connection with the social and economic processes of the wider world is having an impact on traditional values. Schwarz et al. (2011) indicated that the principles of intra-community solidarity, reciprocity, and collective support that have been the norm in the social fabric of some Pacific island communities are being eroded by modernity and individualism. This has consequently led to a weakened capacity to cope with disasters in some traditional societies (Pelling and Uitto, 2001; Campbell, 2009; Schwarz et al., 2011). Similarly, communities in the Solomon Islands have undergone major social transformations as globalization has intensified (Lauer et al., 2013). They identified some positive as well as some negative issues resulting from this transformation; these are listed below (Lauer et al., 2013).

Some of the positive impacts include

- greater education/professional opportunities, which have led to the formation of effective leadership
- improved information links to international agencies, enhanced ability to carry out multifaceted tasks, and an aptitude to communicate across national institutions—in all cases showing marked improvements over traditional leaderships
- broader economic and social forces - diversification with less reliance on subsistence foodstuffs and being better informed for decision making and negotiation

Some of the negative impacts include

- replacement of local ecological knowledge by other forms of knowledge
- shift in livelihood to a market-dominated life style as globalization intensifies with an accompanying decline in local institutional diversity
- top-down regularisation with an increased call for international expertise in disaster mitigation

- environmental degradation with greater human impact on local systems accompanied by higher vulnerability, which is also brought about by urbanization and economic development (Pelling and Uitto, 2001)
- erosion of local coping mechanisms based on traditional social relationships by market expansion, privatisation of communal resources, and the penetration of the state
- the break-up of traditional social networks caused by extended commercialisation in urban areas, emerging societal issues, and the outbreak of a social crisis (Pelling, 2007)

The impacts of globalisation on social resilience to disasters have implications for Mauritius as a SIDS where traditional forms of coping with hazards, specifically, floods, are being eroded. These factors will be further investigated in relation to vulnerability and resilience building in the next chapter on ‘Hazards in Mauritius’.

2.8.2 *What is community resilience?*

The notion of community is difficult to define owing to the complexity of its meanings (Norris et al., 2008); its dynamic nature, with individuals of different socio-economic backgrounds moving in and out for different reasons; and the influence of external linkages with political and global networks within which the community thrives (Twigg, 2009). Cutter et al. (2008) viewed communities as *‘the totality of social system interactions within a defined geographic space having different levels of vulnerability and resilience that could result in recovery disparities’* (p.599).

Communities are bounded by a network of cultural, economic, political, social, environmental, and geographical conditions in which people live (McEntire, 2001; Pelling and Uitto, 2001; Wisner, et al., 2006; Buckle et al., 2001). As such, these factors are considered to be drivers of community resilience.

Community resilience is therefore a multi-faceted concept that has several components that are themselves networked (Bosher et al., 2009). This definition makes it difficult to measure and quantify community resilience. According to Cutter et al. (2008), community resilience can be evaluated by the use of indicators that relate to the type of

resilience (social, economic, environmental, infrastructure, and community competence). It is generally accepted that the integration of more dimensions, such as psychological aspects (Whittle et al., 2012), culture, environment, and health, among the list of indicators can positively contribute to raising the level of measured resilience (Schelfaut et al., 2011) and can help identify the types of resilience that need to be reinforced during the recovery process. A weakness in one component of resilience will have a negative effect on the other components, hence reducing the overall resilience of the community.

In view of the above considerations, community resilience may be subdivided into *types of resilience*; specifically, to the five types of resilience mentioned by Cutter et al. (2008), namely, (social, economic, environmental, infrastructure, and community competence). One more type (*psychological*) has been added, as this type of resilience has been found to be an important issue. Table 2.4 gives a list of the types of resilience and the various elements that could be used as variables. The contents of the table have been adapted from various sources in the literature.

Table 2.4 Types of resilience

Type of resilience	Variables
social resilience	household characteristics, flood experience, flood characteristics, living with flood risk and coping
economic resilience	property ownership, socio-economic status, loss of belongings
infrastructural /environmental resilience	house type, access to services, built environment, land use, state of built environment after flood
institutional resilience	engagement with local and national institutions and agencies for flood recovery; role of science and technology, communication, assistance, governance
psychological resilience	anxiety about diseases, living with flood trauma, stress and uncertainties about the future
community competence	living with flood risk, neighbourhood relationship, values and beliefs, local knowledge on flood, wellness, quality of life

Adapted from Cutter et al., 2008; Schelfaut et al., 2011, Cannon, 2008; Norris, et al., 2008

The types of resilience listed in Table 2.4 could be used as a conceptual framework for this study of community resilience in the aftermath of flood hazards. A review of the literature showed that studies on community resilience to hazards have been based

mainly on case studies. The following research on community resilience is outlined below since such research may serve as examples for this study.

Schelfaut et al. (2011) applied the concept of resilience to study the impacts of floods on communities in Europe. They used quantitative data from three case studies and structured interviews with key institutions and residents to evaluate community resilience. The study emphasized the importance of the local knowledge of residents in flood risk management. Ferdinand et al. (2012) assessed the levels of vulnerability and resilience of four Windward Island communities in the Caribbean. This assessment was based on a questionnaire survey at the household level, on semi-structured interviews, and on information obtained from the key stakeholders involved in community development and disaster management. The study used both qualitative and quantitative approaches to assess the social and community competence aspects of community resilience.

In a small town in Australia, local residents who had experienced flooding and representatives of both local and national agencies were involved in a case study on a flood mitigation management programme. The study showed that the participatory activity contributed to raising awareness and integrating local knowledge with that of the experts, thereby convincing government agencies of the need for better flood prevention measures and hence for promoting community resilience (Cottrell, 2005). The study used a qualitative methodology and included social and community competence indicators.

Lopez-Marrero and Tschakert (2011) carried out participatory activities in Puerto Rico that encouraged the social learning of affected communities by using the technique of 'mapping out' the causes of flood in their area. The findings suggest that enhancing community resilience required on-going support, building on existing knowledge, and collaboration between the community members and institutions engaged in integrated flood management. Participatory activities therefore involved the integration of local knowledge into flood DRR (Mavhura et al., 2013). In the current study, a qualitative method of analysis is used in addition to a quantitative method. The indicators are social, economic, institutional, psychological, and community competence.

The findings indicate the value of a knowledge system (Mercer, 2004) as a crucial element in building community resilience to flood disaster (Mavhura, et al., 2013). The importance of integrating local knowledge (Section 2.4.2) with expert knowledge is found to be beneficial in vulnerability reduction (Mercer, 2004) and in resilience enhancement.

Overall, the studies show the importance of using different types of resilience as indicators of community resilience. They also indicate the gaps in resilience building that need to be filled to achieve better flood mitigation measures. These issues are considered in greater detail during the course of this study.

2.9. Recovery in the aftermath of hazards

2.9.1 *The recovery concept*

In hazard studies, recovery is defined as ‘*the restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors*’ (UN/ISDR, 2009,p.23). The recovery period follows the disaster (Chhotray and Few, 2012). Referring to the major disaster of the Indian Ocean tsunami of 2004, Shaw (2006) reckoned that recovery involves several activities:

- *rescue phase* - starts during and immediately after a disaster. It involves helping out or evacuating trapped victims
- *relief phase* - may last longer depending on the severity of the impact on communities
- *rehabilitation and reconstruction phases* -are related to the community’s needs in order to increase its capacity and resilience to any future disasters

The three levels of activities represented in Figure 2.4 are renamed ‘stages’ so as to differentiate them from the term ‘phase’, which is applied to the longer term recovery process.

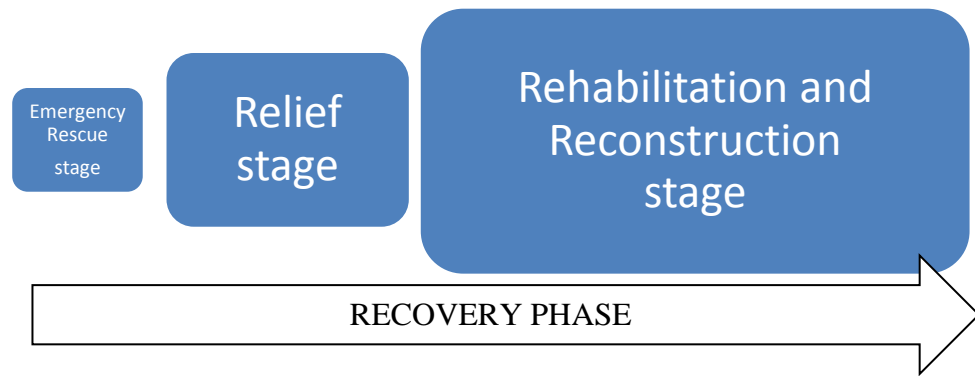


Figure 2.4 Activities during the recovery phase starting with the emergency and rescue stage during or immediately after a disaster; adapted from Shaw (2006).

Taking examples from major disasters across the world, Shaw (2006) identified the role of various stakeholders at each of the above stages of the recovery and rehabilitation processes. He stated that the neighbours and the local community as *primary stakeholders* are mostly among the first to respond during the short-term emergency rescue and relief stages through local associations or NGOs. They assist with the coordination and act as an interface between the community as a whole and the authorities and other interested parties by communicating the community's needs and priorities. In the case of severe damage, the rehabilitation and reconstruction stages, which are long-term processes, are generally costlier and require the expertise and resources of local authorities, the government, and aid agencies (Shaw, 2006).

Recovery can be achieved on a short- or long-term basis and can be a rather complex process. The duration of the recovery phase depends on a number of factors, such as the severity of the damage, the livelihood situation, and the availability of resources to the disaster-affected people as well as depending on the efforts of various stakeholders in reducing disaster risk factors (Chhotray and Few, 2012). Soon after the tsunami disaster in Sri Lanka, Pardasani (2006) noted that short-term recovery measures focused on restoring basic living conditions and local infrastructure. He added that longer term recovery required efforts to be made regarding the vulnerability reduction and resilience building of affected communities. Thus, in the emergency and relief stages (Figure 2.4) of the tsunami disaster (Ingram et al., 2006), quick post-disaster policy measures to rebuild led to the increased vulnerability of those communities who were relocated away from the disaster zones. After this stage, the affected people are left to themselves as implementing the next stage may require considerable resources, with the result that

the most vulnerable households and individuals do not fully recover (Wisner et al., 2006).

2.9.2 Recovery as ‘getting back to normal’

The idea of re-building and restoring the livelihood of communities in the aftermath of disasters is a highly debated issue as it can mean ‘*getting back to normal*’ (Tobin, 1999) or returning to the conditions prior to the advent of the disaster. Mustafa (2003) argued that the ‘*normal*’ life of marginalised people after a disaster is often characterized by both social and environmental injustice, which adds to their vulnerability (Section 2.5). Other social factors that impede recovery from disasters are examined in the following sub-sections.

(i) Social and institutional factors

Tobin (1999) and Pelling (1999) claimed that the assistance given to disadvantaged people by relief agencies or the government soon after hazards barely contributes to their reconstruction and welfare, as resource allocation is quickly exhausted in buying basic necessities. Following the tsunami disaster of 2004 in Sri Lanka, Ingram et al. (2006) noted the disparity in the reconstruction activities among those who were affected. Wealthier people were able to repair and recover quickly, whilst poor fishing communities were forced to relocate away from their source of livelihood and long-established community life. Institutional support from local and national authorities was therefore found to undermine the process of recovery and to contribute to an increase in vulnerability (Chhotray and Few, 2012). Referring to the vulnerability of urban populations to flooding, Pelling (1999) stated that local elites involved in relief and aid programmes were often politically-oriented and excluded vulnerable sectors of the population in any decision-making process.

(ii) Health issues

Health concerns in the longer term recovery process from hazards were often neglected once the emergency and relief stage was over (Whittle et al., 2012). Few (2007) identified a number of health problems that could affect people in low income countries exposed to water-borne diseases and stated that the risk of exposure to frequent flooding led to psychological problems in the longer term.

A study by Alderman et al. (2012) covering the period 2004 to 2011 revealed the escalating impact of flood disasters on both the physical and psychological health of a society. In developed countries as well, qualitative research by Whittle et al. (2012) on adults and children, after the 2007 and flood disaster in Hull, UK, found that recovery from emotional stress was a long-term process and might remain unnoticed. Carroll et al. (2010) found that local residents' disputes with insurance and construction companies exacerbated psychological health problems. For example, a study on the impact of flooding on health among residents from 30 localities in England and Wales found that due to physical and psychological health effects and mental health problems, social support was required to build resilience after the event (Tunstall et al., 2006). Furthermore, the issue of health and safety hazards in communities exposed to a high risk environment was studied by Whiston-Spirn (2005) in the US. They were found to be linked to the concept of EJ (Section 2.6). However, it should be noted that these problems have been studied more extensively in developed countries. Further studies in that field are necessary to understand the 'root causes' of vulnerability (Wisner et al., 2006) in developing countries and SIDS and to apply the knowledge to strengthen resilience among flood affected communities in the recovery phase of disasters.

2.9.3 Recovery as a 'window of opportunity'

Tobin (1999) argued that recovery does not simply mean cleaning up and putting a community back on its feet, but instead requires long-term rehabilitation processes. In this context, recovery provides opportunities to make physical and social changes that reduce the risk of vulnerability to future disasters (Yarnal, 2007). Jessamy and Turner (1999) equally agreed that reconstruction following a disaster can be considered as a 'window of opportunity' for rebuilding livelihoods and for the planning and reconstruction of socio-economic structures, in a way that will reduce vulnerability and build community resilience against future disasters. According to Birkmann (2006), recovery provides an opportunity to bring about change and improvement leading to better networking in the various organisations involved in disaster risk management strategies. Shaw (2006) considered that the concerted effort of all stakeholders in a community, including neighbours, relatives, and NGOs, as well as government authorities involved in the reconstruction process, offers 'development opportunities' (p.19) to reduce vulnerability and promote community wellbeing.

2.9.4 Recovery - a way forward to reducing vulnerability and building community resilience

The recovery process, especially during the rehabilitation stage (Figure 2.4), offers an opportunity not only to improve livelihoods but to build resilience as well. However, if issues of vulnerability, marginalization, and EJ are left unsolved during recovery, community resilience is reduced (McEntire, 2001; Pelling and Uitto, 2001). The increase in disasters, as shown in Figure 2.1, is extending the exposure of communities around the world to hazards, thus making resilience building and recovery a more arduous task. A report by UN/ISDR (2005) stated that disasters cannot be prevented but that the risks associated with them could be mitigated or reduced by developing suitable coping and adaptation strategies or resilience. In line with the findings of the report, the UN/ISDR adopted in 2005 the *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters* (UN/ISDR, 2005). The framework was expected to encourage nations to involve communities in recovery within the context of DRR management (UN/ISDR, 2005). It is used operationally by several governments in recovery following disasters. For example, this approach is being applied in Australia to build or strengthen community resilience. The shift is from a previous top-down approach to risk reduction (Haque and Etkin, 2005) to a more innovative approach where recovery is seen not ‘*simply as the replacement of what has been destroyed and rehabilitation of those affected*’ but seen as ‘*the coordinated process of supporting affected communities in the reconstruction of the built environment and the restoration of emotional, social, economic, built and natural environment wellbeing*’ (Carey, 2011, p.17). This approach should lead to reducing vulnerability, building more robust resilience, and ensuring a faster and fuller recovery.

2.10 Framework of DRR management

2.10.1 Existing systems and models

In view of international commitments to disaster risk reduction, conceptual frameworks have been developed in most countries to minimise vulnerability and offer DRR management. The section describes a few frameworks that have been developed as models in DRR management. These include the following:

(i) *The framework established by the UN/ISDR*

The framework of UN/ISDR (2005) provides an important overview of different phases in risk reduction. These include vulnerability analysis, hazard analysis, and early warning and response. The framework is widely used, but according to Birkmann (2006), some of the concepts within the framework are not explicit. It is a technocratic model used mainly for a response to the warning of hazards, and it portrays natural hazards as being a physical process, thus excluding the human dimension of vulnerability.

(ii) *Pressure and release model (Wisner et al., 2006)*

This conceptual model (Wisner et al., 2006), presents risk as the result of some conditions of vulnerability in relation to hazards. Vulnerability is obtained by identifying the social pressures and relations from a global to a local level. At the global level, they are called '*root causes*', such as social, political, and economic structures. At an intermediate level, they are called '*dynamic pressures*', such as population growth, urban development and population pressures, environmental degradation, and the absence of ethics. At a local level, they are called '*unsafe conditions*', such as social fragility, potential harm, or poverty. Risk reduction signifies intervention at each level: conditions of insecurity, the dynamic pressures, and the root causes. This model gives a comprehensive picture of the human dimension of vulnerability and has been widely used in the literature; however, it provides little information on the resilience aspects.

(iii) *Turner's Global Framework*

Turner et al. (2003) developed a more global framework by illustrating a wider concept of vulnerability encompassing exposure, sensitivity, susceptibility, and resilience within the concept of climate change and sustainable development. This framework, given in Appendix 1, takes a holistic approach and examines vulnerability within the broader human use-environment interaction context. The model aims at reducing long-term vulnerability to future hazards by considering the social, physical, environment, economic, and political components that interact to influence vulnerability (Birkmann, 2006). The conceptual framework also takes into account the concept of adaptation, which is viewed as an element that increases resilience.

This framework was used by Ingram et al. (2006) to conceptualize the components of vulnerability within Sri Lanka's coastal communities in relation to the recovery and rehabilitation processes after the 2004 Asian tsunami. It was also used to identify where post-disaster policies should focus to reduce the vulnerability of coastal populations more effectively and to promote resilience.

(iv) *Cutter's model of disaster resilience of place (DROP) model*

The DROP model (Appendix 2) focuses on the community from a holistic human use-environment interaction perspective. It consists essentially of the conditions of vulnerability and resilience as inherent conditions that interact with hazards to produce post-hazard effects, which are determined by the ability of the community's response and coping capacities.

The model, developed by Cutter et al. (2008), is similar to that of Turner et al.'s (2003) in the sense that both models are based on the human-environment system views and have the same objectives, that is, to reduce vulnerability and enhance resilience. Both consider the social, physical, environmental, economic, and political factors that influence vulnerability and resilience. However, Cutter et al.'s (2008) model is based on the inherent conditions of vulnerability and resilience occurring on a local scale and influenced by several factors as shown in Appendix 2. The difference is that this model focusses on hazards at local and community levels whereas Turner et al.'s model focusses on global environmental change as the result of climate change. Both models are viewed as continuous processes. The resilience of the community in Cutter et al.'s model is considered to be inherent as it is the result of past experience and of existing networks of social, environmental, and economic resources. These types of resilience are used as examples of indicators to measure vulnerability, and they will be applied to improve disaster resilience at a community level in this study.

2.11 Use of types of resilience as indicators in this study

The overall aim of this study is to explore the vulnerability and resilience in community groups in the aftermath of flood events. Due to its complexity and multi-faceted dimension, community resilience is difficult to measure and quantify, but it can be evaluated in terms of the impact of hazards on its various components. Those identified

in the literature are social, economic, infrastructural/environmental, and psychological, and community competence (Cutter et al., 2008).

In this study, these types of resilience (Section 2.7) are used as indicators to evaluate and assess the vulnerability and resilience of three different communities exposed to flood hazards in three localities in Mauritius. Different variables for each indicator were used to collect relevant information at each level and provide baseline information for the evaluation of community resilience. As an indication, a few of the main variables that relate to each of the indicators (Table 2.4) is given below:

- (i) social resilience (demographic variables e.g. age, education level of the respondent)
- (ii) economic resilience (occupation, property and house ownership)
- (iii) infrastructural/infrastructural/environmental resilience (types of housing, access to services)
- (iv) institutional resilience (engagement with local and government institutions, support)
- (v) psychological resilience (worries and post disaster trauma of living with floods)
- (vi) community competence (community cohesion and networking)

The results from the analysis of the data are integrated and evaluated alongside the components of community resilience and assessed in terms of vulnerability and in conjunction with types of resilience in Chapter 8.

2.11.1 Developing a model of flood risk reduction for Mauritius

The current practice of DRR in respect to flood disasters is technically based on warning response systems and on providing structural measures of building drainage. However, these measures are not adequate as they do not address the root causes of vulnerability. This means that there should be a shift in approach from studying hazards with the purpose of providing technical solutions for hazard mitigation towards an approach that identifies and assesses the various factors (economic, political,

environmental, and others) that determine the vulnerability of the people affected. Developing indicators and assessing societies' vulnerability to flooding are therefore important elements in effective risk reduction management. The concept of community resilience developed by Cutter et al. (2008) seems a promising tool for use in vulnerability reduction and resilience enhancement. This model, along with the approaches adopted in the other models described above, could provide deeper insights into the development of a new model of flood risk reduction management as a way to build community resilience in the context of Mauritius.

2.12 Summary

This chapter reviewed the concepts related to hazards and the paradigm shift from discrete physical to human use-environment interaction events. The various concepts of risks were examined and their application to disaster risk management was critically examined. The relations between the concepts of vulnerability and resilience were discussed with emphasis on their links to the differential exposure of community groups and to EJ.

Community resilience was found to be influenced by different types of resilience as indicators emanating from social, economic, infrastructural/environmental, institutional, and psychological and community competence interrelationships. These indicators have been found to be useful in assessing community resilience in an integrated manner and in the formulation of a framework of the concept of community resilience.

Some case studies of community resilience highlighted the different approaches, namely, quantitative and qualitative, and the participatory activities that could guide the methodology of this thesis. The next chapter explores the different hazards in Mauritius, with emphasis on the social aspects of vulnerability and resilience to flood hazards, which is the overall theme of this study.

Chapter 3 Hazards in Mauritius

3.1 Introduction

This chapter analyses hazards in Mauritius, the vulnerability of communities to flood events, and the system in place to mitigate their impacts. The analysis is based mainly on government reports, limited published literature, and media reports. To this end, some aspects of the geography of Mauritius are considered: its location is introduced and discussed in Section 3.2, its physical characteristics in Section 3.3, its climate in Section 3.4, the socio-economic profile and cultural characteristics of the population in Section 3.5, and land use patterns in Section 3.6. An analysis of the types of hazards that cause more frequent flooding across the island, which are mainly cyclones and torrential rain, are given in Section 3.7. Data collected from media reports on flood episodes from 2003 to 2011 are analysed and graphically displayed in Section 3.8. Section 3.9 discusses the paradigm shift in the description of flooding from a single natural event to that of a human use-environment interaction system in the Mauritian context. The exposure of the communities to the risk of recurrent floods is reviewed in Section 3.10, while in Section 3.11, the ‘top-down’ approach for mitigating disaster risk, including warning systems and public sensitization, is scrutinized. In addition, the adequacy of the system in place to mitigate the impacts of flooding is discussed. Vulnerability is addressed in conjunction with resilience in Section 3.12, while the reason for choosing the three localities for the case studies is discussed in Section 3.13. Finally, a summary of Chapter 3 is given in Section 3.14.

3.2 Geographical position of Mauritius

The Republic of Mauritius is situated between latitudes $19^{\circ}58.8'$ and $20^{\circ}31.7'$ south and between longitudes $57^{\circ}18.0'$ and $57^{\circ}46.5'$ east, approximately 850 km east of Madagascar (Figure 3.1). The Republic includes the islands of Rodrigues, Agaléga, St. Brandon, and Tromelin and the Diego Garcia Archipelago. Mauritius is part of the Mascarene Islands including La Réunion (*France*) and Rodrigues (*Mauritius*). The geographic position of Mauritius in the ocean and east of the African continent determines its climate and the types and nature of weather-related hazards (Ministry of Environment and Quality of Life, 1991).



Source: <http://act.rsmas.miami.edu/journal/2011/nov-7/images/Indian-Ocean-Map.jpg>

Figure 3.1 Map of Indian Ocean with Islands of the Republic of Mauritius (adapted from above source)

3.3 Physical characteristics of Mauritius

The main island of Mauritius has an area of approximately 1 865 km² (Figure 3.2) out of a total land area of about 2 040 km² for the Republic. It was formed by volcanic activity some 12 million years ago and consists of basaltic rocks, except for the sandy beaches and fringing coral reefs that surround most of the 322 km of coastline. The topography (Figure 3.2) is characterized by undulating plains in the north, east, and west of the island and by an irregular central plateau with a mean elevation of 300-400 m rimmed by mountains, with the highest peak rising to 828 m. The three major mountain ranges in Mauritius strongly influence local weather conditions and the nature of flooding as they may exacerbate or reduce rainfall brought in by the persistent south east trade winds. The coastal regions are quite narrow in several places, especially in the east, south, and west. As mentioned previously, coral reefs surround most of the island except in the south, which makes the region particularly vulnerable to the storm surges and heavy swells associated with strong trade winds in winter and cyclone-generated swells in summer (Ministry of Environment and National Development Unit, 2005b).



Source: <http://mauritiusattractions.com>

Figure 3.2 Topographical map of Mauritius with the case study sites marked: CLC, LH, and GB

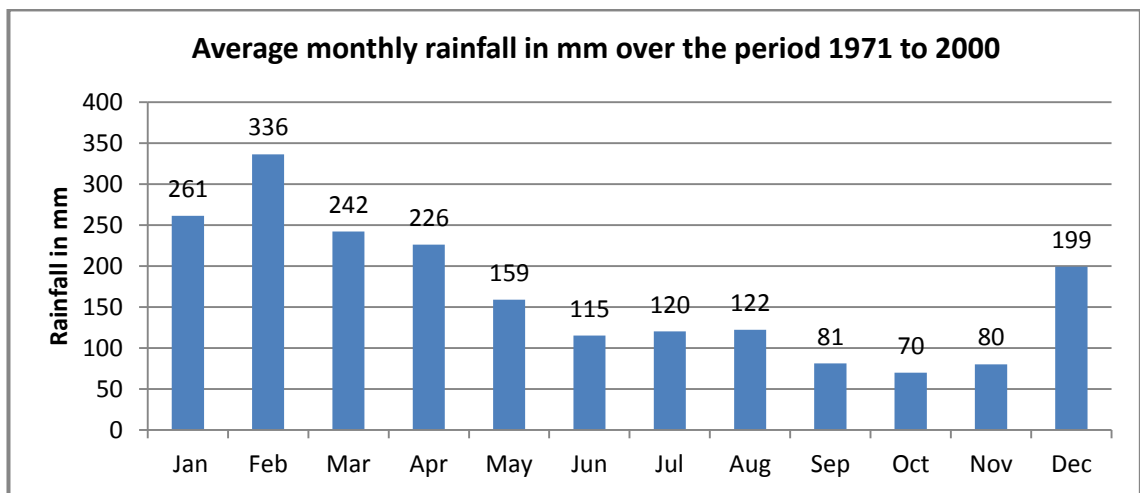
3.4 Climate of Mauritius

Due to its oceanic position far away from the African continental land mass, Mauritius has a mild sub-tropical maritime climate throughout the year, with a warm humid summer extending from November to April and a relatively cool dry winter between June and September. Tropical cyclones and floods occur mostly in the summer months

(Mauritius Meteorological Services, 2012). However, occasional floods are known to occur in other months, such as the flood of September 2008 (Figure 3.10).

3.4.1 *Rainfall over the regions of the study*

The warmest months are January and February and the coolest are July and August. The average monthly rainfall distribution over mainland Mauritius for the period 1971-2000 is presented in Figure 3.3. The summer months of December to April are the rainiest and, therefore, the most susceptible to flooding. The summer rains are very often associated with tropical systems, thunderstorms, or sea breezes, and these contribute significantly to replenish the country’s reservoirs and aquifers.



Source: Mauritius Meteorological Services; <http://metservice.intnet.mu/climate-services/monthly-rainfall-climatology.php> (Adapted)

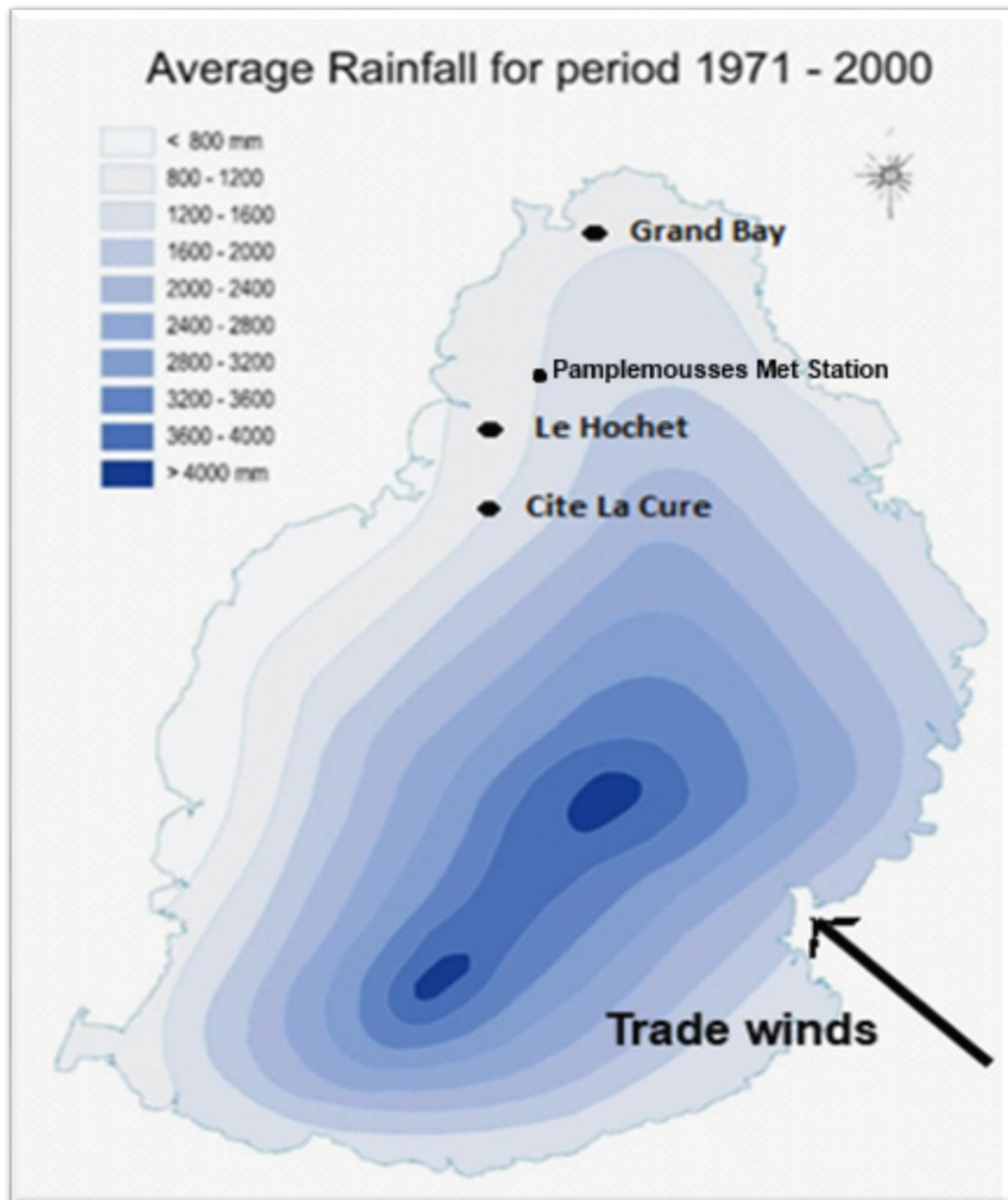
Figure 3.3 Average monthly rainfall over the island for the period 1971 to 2000

No official rainfall recording stations exist at the localities studied, but estimates extrapolated from Figure 3.4 show that LH and GB receive between 800 and 1200 mm annually whereas CLC receives closer to 1200 mm.

3.4.2 *Representative climate of the region covered by the study*

Table 3.1 provides reliable climate information from Pamplémousses meteorological station; the station is about 10 km from the sites and so this information is broadly representative of the general conditions at the sites studied. A day is described as being ‘rainy’ if the rainfall measured is greater than 1 mm. During the period January to August, almost every other day at the station is rainy, with nearly half of the rainy days

occurring during the summer months. The probability of flood conditions in the areas of the study can be considered to be higher during the summer months, that is, from January to April than the rest of the year.



Source: Mauritius Meteorological Services, 2010; <http://unfccc.int/resource/docs/natc/musnc2.pdf>)

Figure 3.4 Rainfall distribution in mm over Mauritius for the period 1971 to 2000. The arrow points in the direction of the persistent trade winds

3.4.3 *Climate change and impact*

The Environment Outlook Report for Mauritius (Ministry of Environment and Sustainable Development, 2011) stated that the effect of climate change is already apparent in Mauritius with increasing temperatures, decreasing rainfall, and a rising sea level. Beach erosion and an increase in the intensity of extreme weather events, with associated floods, are noticeable. In particular, the floods of March 2008 and March 2013 resulted in disasters that caused the loss of several lives (Mauritius Meteorological

Services, 2014). As the impacts of climate change are forecast to grow, a better understanding of the vulnerability of communities in Mauritius and of the measures needed to build resilience are therefore important for the future of the country.

Table 3.1 Climate data at Pamplermousses weather station (1970 to 2000)

	Rainfall (RR) (mm) (1971-2000)	Number of days with RR>1 mm	Number of days with RR>5 mm
January	206.2	16	8
February	239.9	16	9
March	158.9	15	7
April	157.6	15	6
May	99.2	12	5
June	68.1	12	4
July	72.9	14	5
August	75.1	13	4
September	46.0	9	2
October	47.9	8	2
November	49.5	8	2
December	127.5	10	5
Year	1348.8	148	59

Source: Mauritius Meteorological Services (2010); <http://metservice.intnet.mu/pdfs/North.pdf>

3.5 Socio-economic and cultural characteristics of the population

3.5.1 Historical perspective

Mauritius had been uninhabited prior to the 17th century. There were occasional visits recorded by seafarers after the 11th century, but these occurred mostly during the 16th and early 17th centuries. Following brief visits by the Portuguese in 1511, Dutch sailors visited the island on and off between 1598 and 1637. The Dutch attempted a first settlement in 1638, and they named the island ‘Mauritius’ after Prince Maurice de Nassau of the Netherlands. Dutch settlers introduced sugarcane plants, monkeys, and other domestic animals from the Indonesian island of Java. However, they abandoned Mauritius in 1710. The dodo, a native flightless bird of the island, became extinct

during that time. However, Mauritius was a strategic point for the growing trade route round the Cape of Good Hope of South Africa to the East and was a stop-over destination for early colonisers. The French subsequently colonised the island around 1715. They grew crops, mainly sugar cane, and brought slaves from Africa and from Madagascar (Selvon, 2012; Barnwell and Toussaint, 1949).

In 1810, the British took over the island from the French and abolished slavery in 1835 (Selvon, 2012). Thus, Indian immigrants from various parts of India were brought to make up for the labour shortage in the sugar cane plantations. Chinese workers also came in the early 19th century but were confined to small retail businesses round the island. The British occupied Mauritius and the neighbouring territories of Rodrigues, Agaléga, and Diego Garcia (Figure 3.1) until its independence in 1968. It was then proclaimed a republic in 1992. Since the early 19th century, the demographic history of the island has been marked by a rapid population growth. Following the expiry of their contracts, many of the indentured labourers stayed on. Along with many of the artisans, they left the sugar estates to occupy and avail themselves of the relatively cheap and unproductive plots of land often in the poorly drained regions. This process was further intensified by the closure of many of the sugar factories, which had built residential complexes for the workers in their vicinity. The subsequent socio-economic development of the country and the limited land available to those leaving the sugar estates led to the current mix of populations of different cultures in the three communities surveyed for this study. The history of land occupation in flood zones provides a background to an understanding of the issue of EJ (Teelock, 2001; Varma, 2008).

3.5.2 *Population and economic background*

The population of the republic is 1.24 million (Statistics Mauritius, 2011). The constitution recognises the following ethnic groups as comprising the population: Indo-Mauritians of Indian descendants (68%), Creoles of African and Malagasy descendants (27%), Sino-Mauritians of Chinese descendants (3%), and Franco-Mauritians of French descendants (2%) (Foreign and Commonwealth Office, 2009).

A profound transformation has occurred in the Mauritian economy since independence. From a poor agricultural country with high unemployment and the main export of sugar,

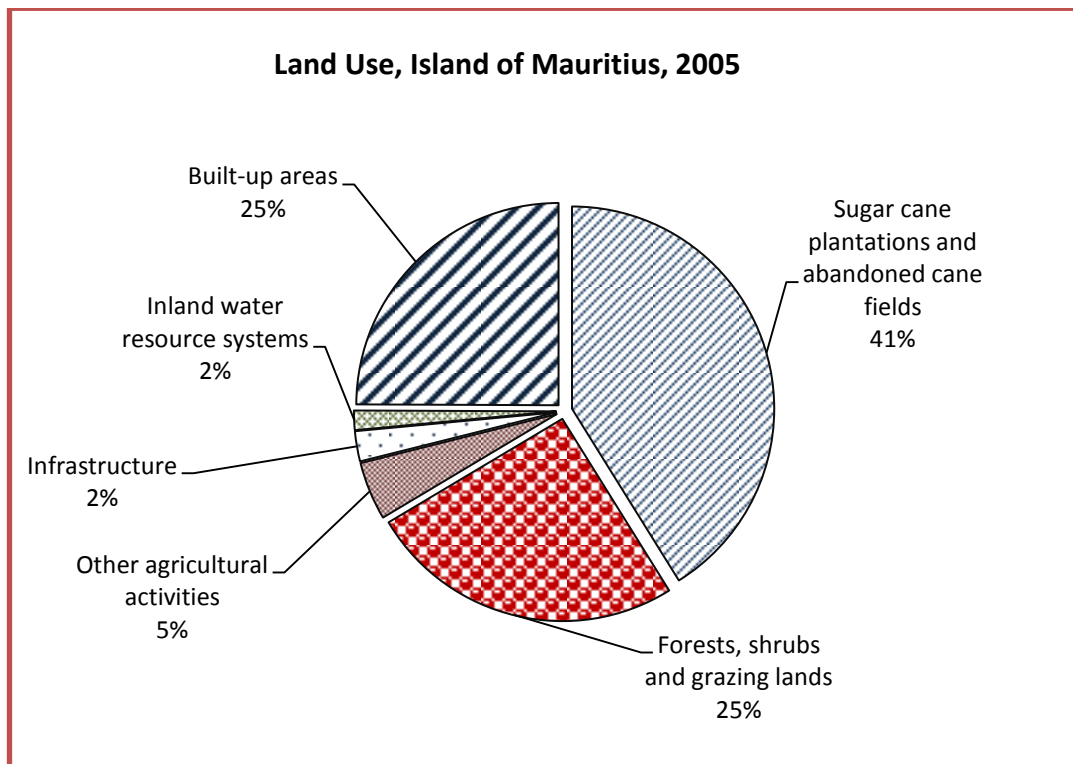
Mauritius has become relatively prosperous and has a diverse economy. The exceptional sugar boom, with high world prices in the mid-1970s, and the accompanying increase in foreign aid brought in new resources, which were injected into the creation of an export processing zone with textiles as its backbone complemented by the development of the tourism industry. By the 1980s, the export industry surpassed sugar as the principal export-earning sector and source of employment. Tourism also boomed, with a concomitant expansion in the number of hotels and air flights. From the early 1990s, Mauritius transformed itself by developing offshore banking and financial services. In 2011, the contributions made by the various sectors to GDP were agriculture 4.5%, industry 24% and services including tourism, finance and information and telecommunications (ITC) 71.4%. The per capita income for 2010 (estimated purchasing power parity) was \$13,670 (Ministry of Environment and Sustainable Development, 2011). However, it is estimated that 8.5% of the population is living below the poverty line (Central Statistics Office, 2007).

3.6 Land use in Mauritius

Like other SIDS, Mauritius has limited land resources. However, the warm climate, the largely favourable rainfall regime, and a rich volcanic soil have been conducive to agricultural practices, and have determined primarily the land use type.

3.6.1 Land use by category in 2005

Figure 3.5 below gives land use grouped into various categories. The indicative figures for 2005 show that agriculture (sugar cane and other agricultural activities) occupied about 46%; forest, scrub land and grazing land 25%; and built-up areas 25% of the total land area. Sugar cane, the backbone of the Mauritian economy up to the mid-1970s, can still be seen almost everywhere but most particularly on the lowlands and in the northern plains. Tea plantations occupy only a small percentage (0.08% in 2005) of the land (Mauritius Chamber of Agriculture, 2007), with tea being grown on the cooler central plateau. Other agricultural activities include food crops. Flowers and fruit production are destined for local as well as external markets. Over the period 1995 to 2005, the amount of land occupied by sugarcane, tea plantations, and forestry decreased, mainly at the expense of built-up areas.



Source: Environment Statistics – 2011 Statistical Office Mauritius (<http://statsmauritius.gov.mu>)

Figure 3.5 Representation of land use in Mauritius (2005)

3.6.2 Land use changes

An increase in the population density in Mauritius from less than an estimated 380 per km² in the 1960s to 670 per km² in 2010 (Statistics Mauritius, 2011) and an expansion of commerce, industry, and services since the mid-1970s have resulted in the conversion of land from agricultural to economic activities and human settlement. At the same time, fewer people were interested in undertaking agricultural activities (Ministry of Environment and National Development Unit, 2005a). This evolution in land use has intensified over the past two decades. For example, the area of land under sugar cane cultivation shrank from 41% of arable land in 1995 to 38% in 2005 and shrank still further in 2010. The decrease in sugar cane cultivation has been due partly to competition in the world market, to the evolution in the tastes of the population, and to the transformation of the economy into other more remunerative sectors.

In parallel, there has been an increase in built-up areas from 20% in 1995 to 25% in 2005. This trend has continued unabated. A report (Ministry of Environment and Sustainable Development, 2011) stated that urban expansion as well as land

requirements for housing, industry, tourism, infrastructure, and leisure activities have put pressure on scarce land resources. Environmentally Sensitive Areas (ESA) and coastal lands are being threatened by unplanned development; hundreds of acres of land on coastal areas and mountain slopes are being quickly developed under the Integrated Resort Scheme (IRS) for luxury villas and hotels. The report claimed that 90% of wetland areas over the island have been backfilled for construction purposes. The report also estimated that in GB alone, from 2000 to 2008, there had been a 23% decrease in wetland areas. These changes have led to environmental degradation and floods in rainy seasons over the ESA, the coastal areas, and mountain slopes and valleys. The three sites that were chosen for the case studies fall within these flood-prone areas (Ministry of Environment and Quality of Life, 1991).

3.6.3 *Land use management*

A government report (Ministry of Environment and National Development Unit, 2008) claims that pressure on land will occur over the next two decades as an additional 6200 hectares will be needed to accommodate the increase in the population and to cater for demands due to economic expansion. Previously, it had been difficult to protect environmentally sensitive zones, such as catchment areas, wetlands, coastal ecosystems, and forests areas from intense development initiatives due to the lack of regulatory measures or the inadequate enforcement of existing legislation (Ministry of Environment, 2002). Currently, the management of land resources in Mauritius focuses on a few issues (Ministry of Environment and Sustainable Development, 2011), namely, judicious land use, regulating measures on land use, eco-tourism and the protection of coastal areas, and the involvement of all stakeholders in land-use planning.

The increasing occurrence of flooding and its disruptive and damaging impact on the population in a growing number of areas will require that the above issues are taken into account in any future land use management plan. The study may also provide some further insights into various aspects of floods and how such an understanding could assist the government in the sound management of land resources in order to mitigate their impacts.

3.7 Hazards of the natural system

The major types of natural hazards known to Mauritius are cyclones, torrential rain, droughts, landslides, and tsunamis (Mauritius Meteorological Services, 2012). However, cyclones are the most common hazards that affect society; they are often characterised by violent winds and torrential rain. The reference to cyclones in this study is due to the fact that heavy flooding was almost always associated with them.

3.7.1 Cyclones in Mauritius

Mauritius and its outer islands are found in the Inter-Tropical Convergence Zone (ITCZ) and are visited by an average of ten cyclones or tropical storms per year between November and April (Mauritius Meteorological Services, 2012). In the literature, tropical cyclones and droughts have received most attention, probably due to their considerable impact on the socio-economic sector. The agricultural insurance scheme introduced in 1946 in Mauritius covered these phenomena and excessive rainfall (Ray, 2013). Cyclones in Mauritius were recorded as early as 1615 (Parker and Budgen, 1998). Table 3.2 below lists the 44 major tropical cyclones/depressions that adversely affected Mauritius and brought severe flood conditions over the period from 1892 to 2012.

Table 3.2 Major tropical cyclones/depressions that have affected Mauritius (1892 to 2012)

Year	Date-Month	Name	Classification	Nearest Distance from Mauritius	Highest Gusts km/h	Lowest Pressure hPa
1892	29 Apr	-	-	-	216	947 *
1931	5 – 7 Mar	-	Intense Cyclone	-	180	969
1945	16-17 Jan	-	Intense Cyclone	Over Mauritius	156	953 *
1945	1-2 Feb	-	Intense Cyclone	South	150	969
1946	30 Jan-1 Feb	-	Intense Cyclone	Close West	129	984
1958	6-9 Apr	-	Intense Cyclone	80 km West Reunion	129	1004
1960	16-20 Jan	Alix	Intense Cyclone	30 km off Port Louis	200	970
1960	25-29 Feb	Carol	Intense Cyclone	Over Mauritius	256	943
1961	22-26 Dec	Beryl	Intense Cyclone	30 km West	171	992
1962	27-28 Feb	Jenny	Intense Cyclone	30 km North	235	995
1964	17-20 Jan	Danielle	Intense Cyclone	40 km South West	219	974
1966	5-7 Jan	Denise	Severe Depression	65 km North West	167	1003
1967	11-14 Jan	Gilberte	Severe Depression	Centre over Eastern part	142	978

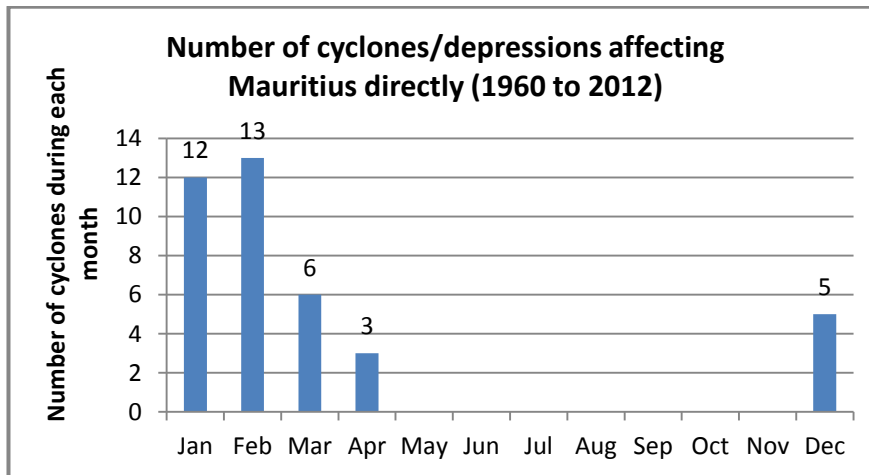
1970	23-25 Jan	Hermine	Severe Depression	240 km W South West	125	999
1970	27-30 Mar	Louise	Intense Cyclone	140 km East	140	988
1972	11-13 Feb	Eugenie	Severe Depression	240 km N North West	132	1002
1975	5-7 Feb	Gervaise	Intense Cyclone	Over Mauritius	280	951
1978	18-21 Jan	Fleur	Intense Cyclone	80 km South East	145	986
1979	21-23 Dec	Claudette	Intense Cyclone	Over Mauritius	221	965
1980	24-28 Jan	Hyacinthe	Intense Cyclone	80 km North West	129	993
1980	3-4 Feb	Jacinthe	Intense Cyclone	150 km South East	129	992
1980	12-13 Mar	Laure	Intense Cyclone	30 km North East	201	989
1981	5-7 Jan	Florine	Intense Cyclone	80 km West	135	1003
1982	5-6 Feb	Gabrielle	Mod. Depression	100 km North West	145	1001
1983	23-26 Dec	Bakoly	Intense Cyclone	55 km South West	198	992
1989	27-29 Jan	Firinga	Cyclone	80 km North West	190	994
1989	4-6 Apr	Krissy	Severe Depression	30 km South	150	976
1994	9-11 Feb	Hollanda	Intense Cyclone	20 km North West	216	984
1995	7-8 Jan	Christelle	Mod. Depression	Over Mauritius	109	994
1995	24-27 Feb	Ingrid	Cyclone	100 km North East	153	989
1995	8-13 Mar	Kylie	Severe Depression	135 km W North West	114	1005
1996	24-25 Feb	Edwige	Mod. Depression	100 km North	162	1009
1996	14-16 Apr	Itelle	Intense Cyclone	275 km North	109	1011
1996	6-8 Dec	Daniella	Intense Cyclone	40 km South West	170	998
1998	10-11 Feb	Anacelle	Cyclone	50 km East	121	985
1999	8-10 Mar	Davina	Intense Cyclone	25 km South East	173	974
2000	27-29 Jan	Connie	Intense Cyclone	200 km North West	122	1003
2000	13-15 Feb	Eline	Severe Depression	130 km North	129	1006
2002	20-22 Jan	Dina	Very Intense T.C	50 km North	228	988
2003	12-13 Feb	Gerry	Tropical Cyclone	100 km N North East	143	990
2003/04	31 Dec 03-03 Jan 04	Darius	Severe Trop. Storm	40 km South East	113	994
2005	22-24 Mar	Hennie	Severe Trop. Storm	60 km South East	112	990
2006	03-04 Mar	Diwa	Severe Trop. Storm	220 km N North West	126	1005.7
2007	22-25 Feb	Gamede	Tropical Cyclone	230 km North West	158	995.5

Source: Mauritius Meteorological Services ; <http://metSERVICE.intnet.mu/>

*Estimated

Figure 3.6 represents the number of cyclones/depressions that affected Mauritius over the period 1960 to 2012. Prior to that date, three major tropical cyclones (1892, 1931 and 1945) had been recorded. These events gave rise to the often quoted 15-year return period. As can be seen from Figure 3.6, nearly all the cyclones hit Mauritius during the summer months of January and February with fewer in March, April, and December.

The Figure could also be taken to represent the frequency of severe flood events of cyclonic origin in Mauritius during the period.

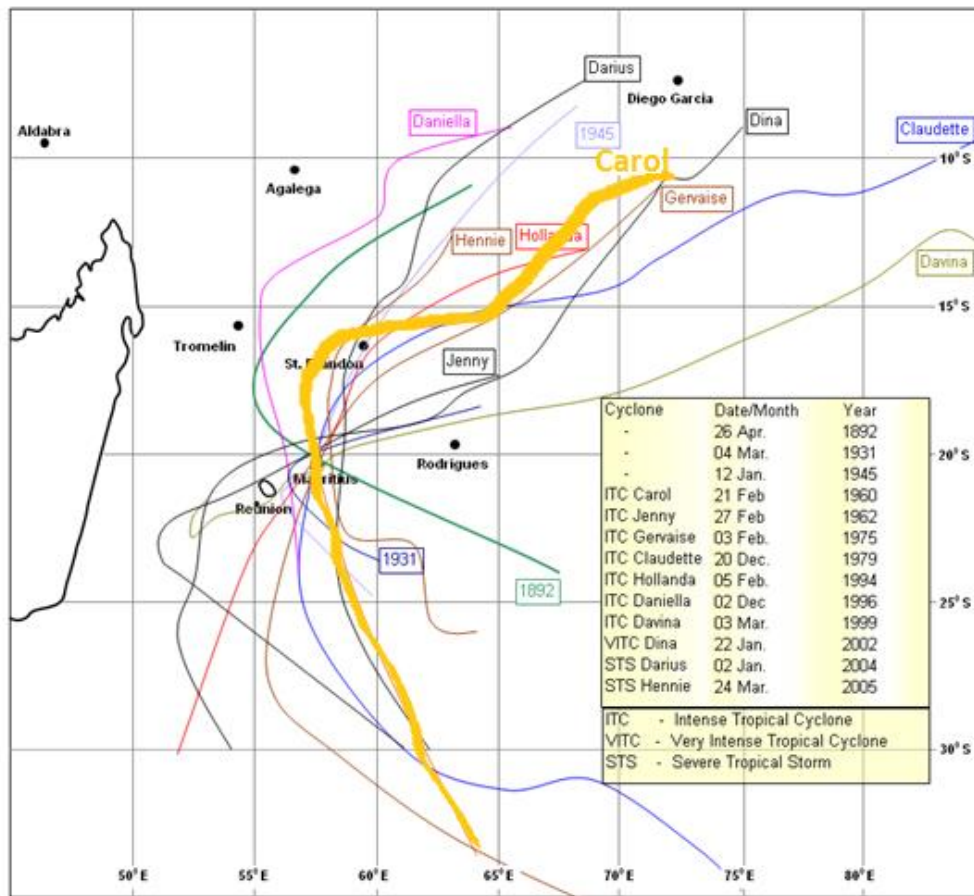


Source: Adapted from Table 3.1 *Mauritius Meteorological Services*; <http://metSERVICE.intnet.mu/>
Figure 3.6 Number of cyclones/depressions over the period 1960 to 2012 hitting Mauritius

Figure 3.7 below shows the trajectories of 13 cyclones over the period 1892 to 2005 that caused heavy damage to property and at times led to loss of life. The most memorable in recent history was cyclone Carol, highlighted in the figure.

3.7.2 *Community resilience after the major cyclone-related disaster of 1960*

The following section gives an account of a major disaster that happened in 1960 that devastated the island. In February 1960, the eye of an intense tropical cyclone named Carol (highlighted in Figure 3.7) passed over Mauritius. Given the size of the island (about 60 km from North to South) compared to that of the cyclone (diameter about 2 000 km), no part of the island was spared from its damaging winds and heavy rains. It provided a good example of the nature and scale of a cyclone’s impact. Some 42 people died, 95 were seriously injured, over 100,000 buildings were destroyed or severely damaged, and some 70,000 persons out of the island’s total population of 600,000 had to move to refugee centres. The road network, electricity supply, and telephone communications were disrupted (Pellegrin, 2007).



Source: Track of Cyclone Carol redrawn for emphasis. Mauritius Meteorological Services; <http://metservice.intnet.mu/>

Figure 3.7 Trajectories of major cyclones/depressions that hit Mauritius (1892 to 2012)

Over the following two years a vigorous reconstruction programme contributed to a reasonably rapid recovery (Padya, 1976). Cheap loans were offered to those who owned land and wanted to build their own houses in concrete, which would resist cyclonic winds. They were to pay back on very easy terms over a 20-year period. At that time, many of the people occupied or bought flood-prone lands that were available relatively cheaply and built permanent structures. These measures soon saw the mushrooming of stronger concrete houses in place of wooden or straw houses. Those who did not own land were offered accommodations built by the government at a very low rent or were relocated temporarily in government-owned lands, which were often wetlands or marginal lands known to be subject to flooding. At that time, the focus of government action was to ensure the security of the poor from cyclonic winds rather than from floods. However, it soon became difficult to dislodge or relocate them. Even today,

some of the inhabitants at Cité La Cure and Grand Bay find themselves in such situations.

While recovery was rapid, it took several decades to build resilience against cyclones. Although, the poorer sectors of the community are still vulnerable, their inherent resilience and the preparedness measures implemented by the authorities have ensured that there was no loss of life due to cyclones over the last 50 years. The application of science and technology has made possible the provision of timely cyclone warnings to the public. Particularly, the availability of satellite images and improved communications have led to enhanced monitoring and forecasting of cyclones and to the timely dissemination of warnings (Ministry of Environment and National Development Unit, 2005a).

The population has learnt to heed the warnings. In this regard, Mauritius has a very efficient warning system (Parker and Budgen, 1998), which has greatly reduced the number of deaths and, to some extent, the damage to property. Table 3.3 shows the decrease in the number of people affected by storms by a factor of 800 from 1975 to 2002.

Table 3.3 Top 10 natural disasters in Mauritius (1975 to 2002) and the number of people affected

Disaster	Date	Number affected
Tropical cyclone Gervaise	6 Feb 1975	826,258
Tropical cyclone Claudette	22 Dec 1979	105,257
Moderate depression Gabrielle	16 Jan 1982	32,000
Severe depression Eugenie	17 Feb 1972	25,016
Severe depression Gilberte	25 Dec 1967	23,524
Storm	25 Jan 1991	7,500
Severe depression Krissy	29 Jan 1989	4,507
Epidemic (Chikungunya)	Jan 2006	2,553
Tropical cyclone Hollanda	9 Feb 1994	2,300
Tropical cyclone Dina	22 Jan 2002	1,050

Source: CRED (2009); http://www.emdat.be/country_profile/index.html

3.7.3 Flood hazards in Mauritius arising from human use–environment interaction

Previously in Mauritius, floods had almost always been associated with tropical cyclones (Section 3.7.1) and had not received any particular separate attention. Records of individual flood events as such are therefore sparse. No authority is entrusted with the task of keeping records of flooding in the same way that the Meteorological Services is mandated to monitor and keep official records of cyclones in the South West Indian Ocean. Frequently, flood conditions precede or persist after the passage of a cyclone over or near Mauritius, especially if the rain bands associated with the cyclone linger on. It was always felt that given the broadly conical topography of the island, the excess water that was not absorbed by the soil would flow rapidly to the sea, and therefore, flood conditions could not prevail for extended periods (Le Mauricien, 2012). However, the land occupation pattern following the severe cyclone of 1960 described above and the subsequent haphazard construction, often in wetlands and agricultural lands resulting from the economic boom of the 1970s, have led to increased population density and poor drainage systems. Thus, floods have become more frequent in several areas of Mauritius as a result of human use of fragile land areas and poor maintenance of the environment.

The situation has become more serious, as recently, the island has been recording intense rainfall over extended time periods, which has given rise to flood conditions (Bhankaurally et al., 2010). In March 2008, there was a major flood that claimed the lives of four persons. Another major episode of flood disaster was reported on 13 February 2013, and many regions over Mauritius were affected (L'Express, 2011).

However, the most disastrous in living memory occurred on 30 March 2013 when 11 people died, over 100 people were injured, severe damage to property was sustained, and over 100 vehicles were carried away in the flood. The flash flood resulted from a downpour of 152 mm of rain in less than an hour in the built-up and heavily populated Port Louis (BBC, 2013b). Figure 3.8 shows a photograph of the flood disaster of March 2013. People are seen wading in the knee-deep flood water that invaded the streets (L'Express, 2013).



Source: L'Express Daily Newspaper; www.lexpress.mu

Figure 3.8 Extensive flooding at Port Louis, Mauritius on March 2013

3.7.4 *Torrential rain warning bulletin*

Torrential rain conditions are said to exist when the prevailing weather in Mauritius produces 100 millimetres of widespread rains in less than 12 hours and when this heavy rain is likely to continue for several hours (Mauritius Meteorological Services, 2011). Torrential rain from flash floods leads to water accumulation in flood prone areas. Heavy rain may also be responsible for the overflow of rivulets and streams and is likely to cause landslides in high-risk areas.

As soon as the Meteorological Services has registered 100 mm of rain in a period of 12 hours at several stations over the island, it advises the Ministry of Education; it then issues warnings and disseminates them at regular intervals through the local public and private radio, TV, and the print media. Furthermore, whenever torrential rain conditions exist, schools remain closed (Appendix 4). However, in many localities, local soil and drainage conditions are such that flooding may occur well before the torrential rain criteria are reached.

3.7.5 *Storm surge and heavy swells*

A storm surge often occurs in the wake of a cyclone. Nonetheless, in the absence of a cyclone, other weather systems, such as powerful winter anticyclones, can give rise to strong wind causing heavy swells over the southern coasts of Mauritius. Storm surges and heavy swells adversely affect coastal villages and cause or aggravate coastal

flooding. In 2012, a series of heavy swells of over four metres high that were not associated with cyclones were reported in the media (Le Mauricien, 2012). Table 3.4 shows that over the last four decades, major storm surges and swells have occurred mostly in the south and south-west of the island as in these regions, there are no barrier reefs to dampen the virulence of the heavy swells.

Table 3.4 Significant storm surges over the over the last four decades

Date	Phenomenon	Location	Impacts
May 1976	Storm surge	Rivière des Galets	Destroyed or carried away tens of fishing boats. Nearby cemetery seriously damaged.
May 1987	Storm surge	Pointe aux Roches	Houses flooded Beach erosion
Sept. 1994	Heavy swell (3-4m)	Coastal areas	Flooding
May 1995	Heavy swell (4m)	Rivière des Galets	Flooding

Source: Le Mauricien (2 June 2007)

Heavy swells often result in coastal flooding and damage to the coastal infrastructure, such as roads and settlements; undermine beach stability; and cause vertical scouring of up to two metres (Ragoonaden, 2007). For example, the coastal surge that occurred in 2007 caused sea water to invade many homes in the southern part of the island. These events are now becoming common and are a threat to coastal communities. Nonetheless, more and more people are building over the coastal areas, and hence there is greater exposure to the coastal flooding. In several places, gabions, which are structures made of stones and held by a wire netting, have been built for coastal protection. However, these are inefficient and often lead to more coastal degradation (Ministry of Environment and Sustainable Development, 2011).

3.7.6 *Tsunamis*

The tsunami on the 26 December, 2004, in the Sumatra area, affected Mauritius only slightly. Waves of one metre or so reached the island. Indeed, to date, no record exists of any significant tsunami affecting Mauritius. Nevertheless, there is a possibility that tsunamis generated from either the Sumatra, the Makran area, or the Indian Ocean Mid-Oceanic Ridge may reach the coasts of Mauritius or Rodrigues. A tsunami is likely to cause severe coastal flooding or aggravate existing flood conditions. This, the authorities have developed contingency measures and drills and awareness programmes

of tsunamis are carried out regularly among the population (Mauritius Meteorological Services, 2010).

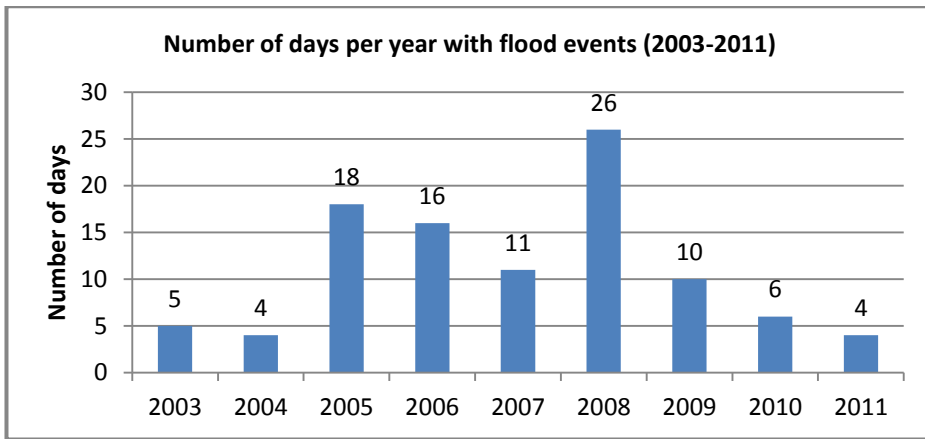
3.8 Media reports of flood events

As mentioned previously, records of floods as a separate event are not readily available from either official sources or from research papers (Section 3.7.3). However, the daily newspapers provide a reliable source of information. While the newspapers reflect severe floods in only a few localities at a time, the most significant ones do not go unreported. In addition, except for a few occasional cases, flooding reported in one locality reflects the situation across a whole region and very often the whole country.

In view of the above consideration, reports of flooding were compiled from the Mauritian newspaper L'Express, one of the four dailies in Mauritius; it also holds a comprehensive archive, which can be assessed through the internet. It was observed that floods are generally reported when they are widespread, at least over a locality, and are accompanied by severe social, economic, or environmental disruption. In this sense, the statistics may be taken to be reflecting at least the major floods. In the case of widespread flooding, the same major event is reported from various viewpoints on a given day. The information found in Appendix 5 was compiled from reports of flood events in L'Express over the period 2003 to 2011. This covers the period of the survey (August 2010 to January 2011) in the three localities. No flood event was recorded during the survey.

On the basis of media reports, the total number of days with flood events per year over the period 2003 to 2011 is represented in Figure 3.9. The annual average is 11 days.

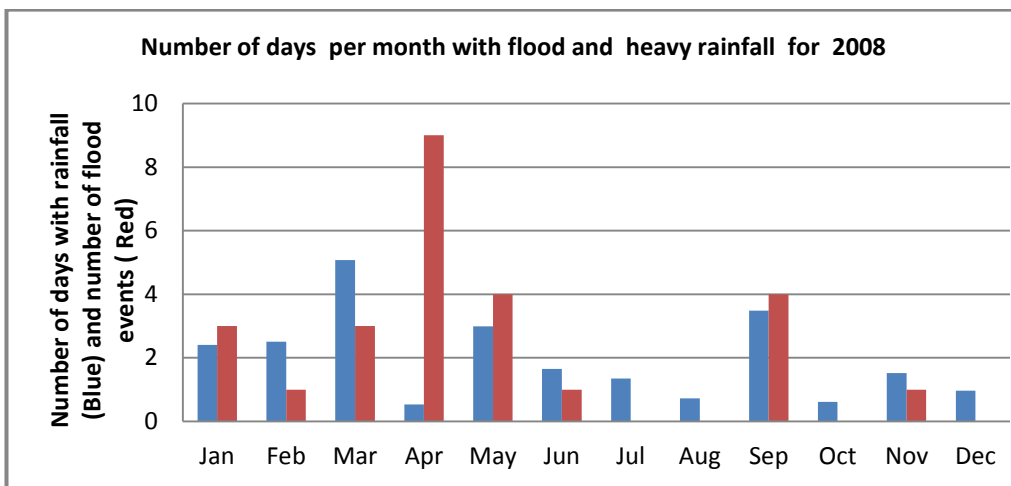
The variation in the number of flood events from year to year (Figure 3.9) is quite high, but the year 2008 may be considered exceptional. The years 2003, 2004, 2010 and 2011 are also special in view of the low number of flood-days. It is also significant that over the whole period, no cyclone either very close to or hit the island. Therefore, most of the rains were non-cyclonic in origin except in 2007. In the other cases, the rains were brought by cloud masses in the easterlies of the summer months. Unstable atmospheric conditions can also lead to thundery weather with heavy rains and flood conditions



Source: Author based on data obtained from the daily L'Express

Figure 3.9 Number of days per year with flood events (2003-2011)

especially if the soil has become saturated. In 2007, the cyclone Gamede (Mauritius Meteorological Services, 2008) was moving very slowly when it reached the north west of Mauritius. It produced exceptional rains causing flood conditions that lasted a week, as can be seen from the media data (L'Express, 2011). However, the remainder of the year was relatively dry leading to a total of 11 rain-days. Figure 3.10 illustrates the number of days when major flood events (in red) occurred and the number of days with heavy rainfall (in blue). April 2008 stands out regarding the number of flood events.



Source: Author based on data obtained from the daily L'Express

Figure 3.10 Number of days with flood (in red) and those with heavy rainfall (in blue) for the year 2008

The rainfall-days and the flood-days for the months of March and April do not appear to be in phase. This is due to the fact that most of the rainfall occurred in late March with

flood conditions persisting into early April, which turned out to be relatively dry. The respective data for September and for the remainder of the year are relatively in phase.

3.9 Hazard of a human use–environment interaction system

Hazards involving human and environment interaction are of particular concern in SIDS such as Mauritius, where pressures from economic development and an increase in the size of the population have led to the depletion of agricultural land, deforestation, and the exploitation of wetlands for building and socio-economic activities (Briguglio, 1997). In informal interviews, local inhabitants in Mauritius recalled that in the past, floods events occurred during cyclones and torrential rain, and they dealt with floods as a natural phenomenon. As there were not so many buildings, the flood water receded quickly along natural storm drains. Over the years, however, the use of land for building houses and other infrastructure has amplified the risk of flood events (Section 3.7.3). In this sense, floods could be considered to have become a hazard of the human use–environment interaction system. This also implies that more inhabitants are being exposed to flood conditions.

3.10 Exposure to flood and associated risk

Most of the flood risk zones are wetland areas situated on the coast where recent development to cater for the tourist industry has been rapid with apparently little land-use planning. Coasts are prime land and are in high demand by investors. The tourist resort of GB has lost about 66% of its wetlands in the building of infrastructures and accommodation (Ministry of Environment and National Development Unit, 2002). People employed in the tourist industry occupy wetland areas mainly because of easy access to their work place and for economic reasons. Many low income groups and immigrants from the nearby island of Rodrigues are most probably compelled by poverty to live on state-owned lands, river banks, and zones that are at high risk from flooding and associated hazards (Ministry of Foreign Affairs, 2013). In view of the precarious conditions of the underprivileged groups, the government of Mauritius is implementing a number of activities aimed at relieving poverty and building the resilience of the communities. Some of the actions are given in Box 1 (Ministry of Foreign Affairs, 2013. p. 24)

Box 1 Extract from Status Report 2013 on the government programme in promoting resilience of underprivileged communities in Mauritius
Source: Millennium Development Goals Status Report, Republic of Mauritius p. 71

The Ministry of Housing and Lands has a National Housing Programme for the next ten years, which aims at increasing access to housing and land for the low income groups, targeting families earning a monthly household income of up to Rs 25,000 (£500). The programme helps inclusion and equality among the low income groups and also strengthens social inclusion.

Regarding families earning less than Rs 6200 (£125), the Ministry of Housing and Lands provides land to the National Empowerment Foundation as and when required for the construction of houses.

The Government also encourages self-help construction of housing units by very low to low income families who already own a plot of land. These families are financially assisted through a grant scheme either for the casting of roof slabs to complete their construction or for the purchase of building materials to start their construction.

The Housing Programme pays particular attention to families that are facing hardships, such as victims of floods, landslides, and other natural calamities, as well as families being evicted from their home and other social cases.

Improved access to land tenure to reduce vulnerability to poverty

Improving security of tenure is an essential instrument to reduce vulnerability to poverty. While the State Land Act tends to discourage the illegal occupation of state lands, it also allows the regularisation of squatters by the grant of a building site lease over the occupied site. In 2004, a Government policy was introduced that moved towards regularising pre-July 2001 residential squatters by the grant of building site leases expiring in the year 2060.

Source: Millennium Development Goals Status Report, Republic of Mauritius p. 71

3.11 Institutional framework for disaster risk management

As discussed previously, (Section 3.7.2), Mauritius has a robust contingency plan for cyclones, including preparedness and early warning systems. This has been possible through the efforts of various institutions that constitute the framework of the National Disaster Preparedness Unit (NPU).

3.11.1 Warning systems

In order to reduce the risk of natural disasters, the Mauritius government, through an agreement with international agencies, has developed a model National Action Plan based upon the WMO four-stage disaster cycle (Section 1.3). A description of the warnings system applied by the Mauritius Meteorological Services and the precautions to be taken by the public at various phases of the disaster cycle is given in Appendix 6. The aim of the warning system is to mitigate and reduce disaster risk and take timely measures for the recovery of the population. The Meteorological Services, national and local institutions, the media, social welfare services, the private sector, the government, and NGOs, all work in a concerted effort throughout a cyclonic period to ensure the safety and security of the population and the follow-up recovery in the aftermath of the disasters (Parker and Budgen, 1998). However, once the ‘threat’ is over, the warning is lifted, and the population is allowed to resume its normal activities. In the event of destruction, recovery and rehabilitation programmes are initiated, but no strategy exists to build long-term resilience.

3.11.2 Awareness-building and public education

In order to ensure that the warning system is well understood, the Meteorological Services (MMS) produces booklets and posters designed to provide information to the public and to the different stakeholders who are involved in cyclone hazard management. The posters are fixed in public places, factories, schools, and offices. Warning bulletins are broadcast in different languages understandable to different sections of the general public at regular intervals on television and radio. The bulletins are disseminated whenever a threat exists and are followed by more frequent bulletins during and immediately after cyclonic conditions. The weather conditions and forecasts are disseminated through newspapers relaying accounts of the positions and evolution of cyclones in the vicinity of Mauritius. As part of the awareness-building, the personnel of Meteorological Services give talks on cyclones and the warning system in schools and community centres. Workshops and exhibitions are organised across the country especially prior to the cyclone season. Awareness-building and sensitisation are focused on cyclones, with flood and other related disasters mentioned mostly in conjunction with cyclones.

This section showed how effective are the strategies used by institutions in DRR, principally for cyclones. Most of the decisions are taken by higher authorities that typically present the ‘top-down approach’ (Haque and Etkin, 2005) also referred to in Section 1.3. It is noted that the population is ‘trained’ to respond and is rarely involved in any decision-making. Further information on these issues with emphasis on flood mitigation measures was obtained from agency stakeholders during semi-structured interviews.

3.11.3 Insurance

The Sugar Insurance Fund was established in the wake of a cyclone that devastated sugar cane crops across the island in 1945 (Sugar Insurance Fund Board, 2014) as an agricultural insurance scheme (Section 3.7.1) to cover losses due to cyclones, drought, and excessive rain. Today, many insurance companies have diversified their policies to cover a wide range of services. People in the medium to high income group have their houses, vehicles, and life insured from the risk of cyclones, floods, and other hazards. However, insurance companies do not take the responsibility for casualties when people venture out in stormy weather. Low-income communities are not covered by any insurance, so reconstruction after a natural disaster becomes difficult.

3.12 Vulnerability and resilience to flood

Aspects of vulnerability and resilience in Mauritius are mostly addressed in economic and environmental terms (Ministry of Environment and National Development Unit, 2005a). The focus on economic growth and competition in the global market increases the pressure on the environment and land resources. Unplanned land use and the encroachment on land with fragile ecosystems for urbanisation with poor drainage systems further exacerbate environmental hazards such as floods (Lynch, 2012). These conditions had been occurring in many parts of the island over the last decade, and several cases had been reported in the media (Appendix 5). It is projected that the frequency of hazards such as floods will increase as a result of climate change (IPCC, 2007), and the island’s population will be more at risk of hazards due to associated phenomena such as sea level rise and beach erosion. In the light of the growing vulnerability and exposure of various sectors of the population to hazards, building resilience would be one way to ensure survival (Cutter et al., 2008).

3.13 Choice of case studies

Floods are occurring in an increasing number of localities in Mauritius. While flood risks are highlighted during the preparedness phase ahead of every rainy season, people still associate them with cyclones. In the absence of cyclone warnings over the last decade, the risk of flooding has been minimised by the vast majority of the population. The social dimension of flooding is being virtually neglected as communities continue to live with flood risks from one event to another and from one year to the next. A major objective of the research, therefore, is to study the vulnerability and the resilience of the population affected by flood events in specific localities. Out of the numerous localities affected, three were selected for case studies, namely, Cité la Cure (CLC), Le Hochet (LH), and Grand Bay (GB) (Figure 3.2). A detailed description of the sites is given in the following sections.

This section provides a brief presentation of the geography, population migration, and land occupation that led to the slow build-up of heterogeneous communities in the three localities of CLC, LH, and GB shown in Figure 3.2. The background information makes it possible to understand better why the communities were chosen for the case studies.

According to a survey report carried by the Ministry of Housing Lands and the Environment in 2001, some 315 flood risk areas were identified over the whole of Mauritius (Fagoonee, 2005). The three localities used in this study were chosen as they have several characteristics similar to those found in other flood-affected regions of Mauritius. They made it possible to conduct a comparative study of the vulnerability and resilience of the three sites and their location facilitated data collection. The case study areas are all in the north and north-west of Mauritius but present some contrasting features in terms of the characteristics of the communities and the geography.

The descriptions of the sites highlight their specific characteristics in relation to flooding as well as the representativeness of the community groups that are commonly affected by flood events. The characteristics of the communities made them particularly suitable for answering the research questions of the study.

Another important consideration in the choice of the localities was the familiarity of the researcher with the areas, the availability of social workers and other known persons to assist, and the readiness of the residents to participate in the research. The preparatory

work was facilitated by the fact that the researcher lived in one of the areas (LH) and was thoroughly familiar with the residents and, in addition, had been involved in post-disaster activities in support of flood-affected inhabitants (Section 1.5). It was therefore relatively easy to start off the project with a pilot study at LH. The experience served as a grass roots level approach to explore the feasibility of the study and to design the main questionnaire. The questions were formulated bearing in mind the researcher's involvement with the households and their recent experience of flooding. Their perception of flood risk, assistance, warning, vulnerability, resilience, and patterns of recovery after a flood were thus built into the questionnaire from the start.

THE CASE STUDY SITES

This section provides the background information on why communities exposed to flood in CLC, LH, and GB were chosen for the case studies. Since there is no known publicly available literature for CLC and LH, information on their historical development, land use, and social evolution are complemented by the informal discourses of the local inhabitants. However, some literature was available on GB.

3.13.1 Case Study One: CLC

Figure 3.11 illustrates an aerial view of CLC. Its altitude is between 75 and 100 m above mean sea level (AMSL), and it is the highest of the three localities. The shaded part outlines broadly the major section of the zone where the household survey was carried out. River Latanier is found meandering through the area and can be seen in the bottom left corner of the figure, just outside and to the left of the shaded residential area.

CLC is situated in a valley known as Vallée des Prêtres between Long Mountain Range and the Port Louis Mountain Range. The land slopes quite steeply (Figure 3.11). Part of CLC is on a wetland site, and part of it is drained by Rivière Latanier and small streams.

There is no known written official document describing the development of the area. However, information was obtained from the narrative accounts of the inhabitants. Once a grassland area, the region underwent development in the late 1960s and 1970s to accommodate the growing population from other regions of Mauritius and mostly from

the suburbs of Port Louis, the capital city. A few families had farms and employed several people.

Following the major cyclones of the 1960s and 1970s, the government built relatively low-cost housing in the area to provide accommodation for the victims. Many lower middle income people settled in the area as the land was affordable. In the last decade, along with a number of poor Mauritian families, some 200 families from Rodrigues (an outer island which forms part of the Republic of Mauritius) have settled in the CLC



Scale: 1:8000

Source: Maps /Aerial Imagery. Ministry of Housing and Lands (2010)

Red line indicates River Latanier flowing northward from mountainous region and then seaward

Figure 3.11 CLC - Shaded area showing approximate area where case study was carried out

area on government property, also known as Crown land, situated along the river bank and on nearby mountain slopes. They live precariously in temporary houses that are often deprived of basic utilities such as electricity and a water supply. Those who live in CLC are found mostly in the capital city of Port Louis. In 2010, the population of CLC

was estimated at 17,334 (Statistics Mauritius, 2010). The socio-economic characteristics of the inhabitants range from very low to middle income groups. Aerial maps show the changes in land use from the 1960s to late 1990s (Appendix 7). The area was initially covered with grass and shrubs, which have been replaced by houses, roads, and other infrastructure.

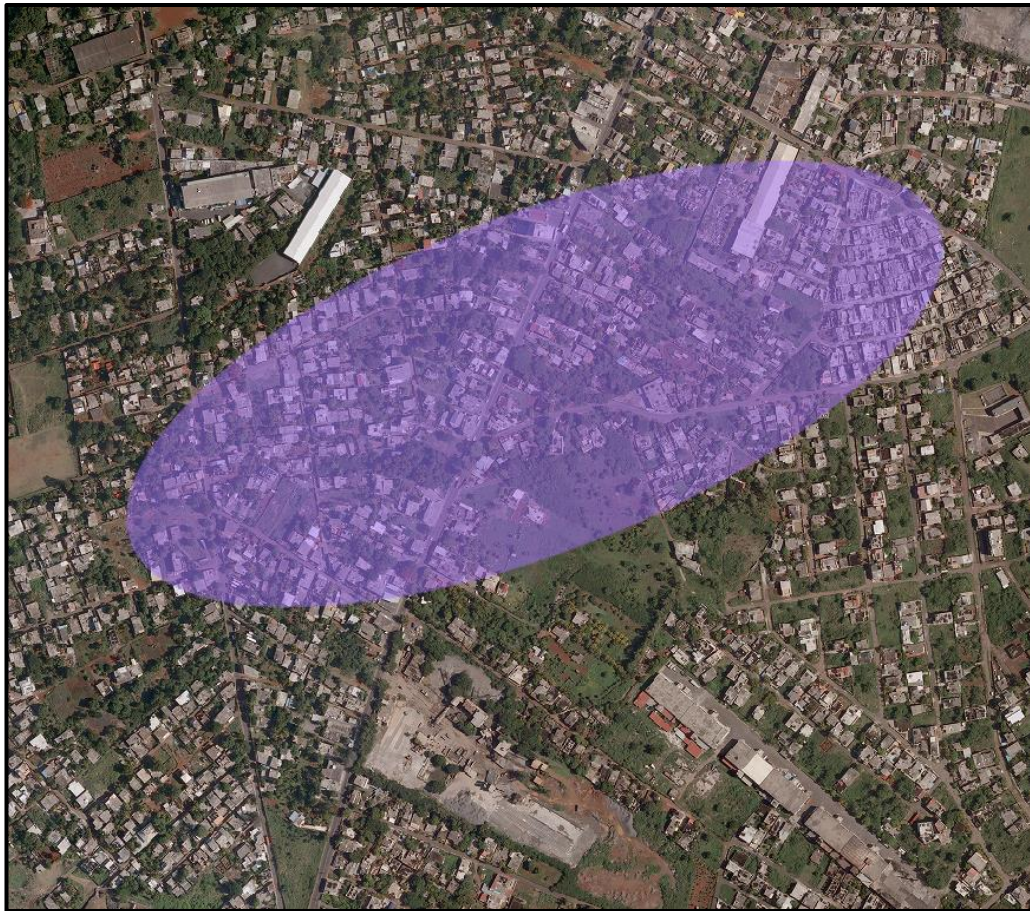
CLC was chosen as it met the conditions for a case study. The topography of the locality in a valley is well known to be highly conducive to frequent flooding. In spite of the threat from flooding, the poor and low income groups still occupy the land as most probably they cannot afford land elsewhere after investing in the current locality. The case study approach required that local residents were accessible and were prepared to collaborate in the study and that assistance from local social workers was available in the conduct of the survey, focus group interviews, and participatory activities.

3.13.2 Case Study Two: *Le Hochet*

Figure 3.12 gives an aerial view of LH village. The shaded part outlines a major part of the area where the household survey was carried out. Parts of storm drains exist among the developed areas, but they are not easily visible in the image as the areas have been occupied by inhabitants.

LH is situated at the foot of the northern end of Long Mountain range and is relatively flat at about 40 m AMSL. River Terre Rouge flows through the lower reaches of the village. At least three natural storm drains cross the village. The streams at the foot of the hill flow through patches of wetlands, but these are not marked in official topographical maps. Agricultural activities in the late 1950s and the subsequent wholesale construction of houses over small parcels resulted in the filling-in of the swampy areas. As a result, the conditions for flooding were aggravated. Even where drains were built, they did not take into consideration the large volume of water that extreme weather events such as cyclones and flash floods, augmented by the mountain topography, can produce over a relatively short time. While the River Terre Rouge and the flood streams form a network that drains away the flood water, this happens much more slowly than previously.

LH has been a land of migration and has known three major waves of immigration in recent times. The earliest inhabitants that moved to the locality were primarily those working in Port Louis as dock-dock workers, artisans, and labourers in the sugar cane industry. In the early 1970s, economic transformation was already under way. Sugar cane was still the main economic activity in the country, and to, and to take advantage of the economies of scale, the centralisation of sugar factories was initiated. Some of the factories, such as Labourdonnais and the Mount in the District of Pamplemousses in the



Scale: 1:8000

Source: Maps /Aerial Imagery. Ministry of Housing and Lands (2010)

Figure 3.12 LH - Shaded area showing approximate area where case study was carried out

north, were sold to countries in Africa and many of the technicians took up contractual jobs there. As most of the field workers and artisans had always lived on the land belonging to the factory owners, their immediate reaction was to attempt to own a piece of land. As land was readily available at LH, a large number settled there. Land was

available at an affordable price and had the added convenience of accessibility and closeness to the city with its amenities and facilities.

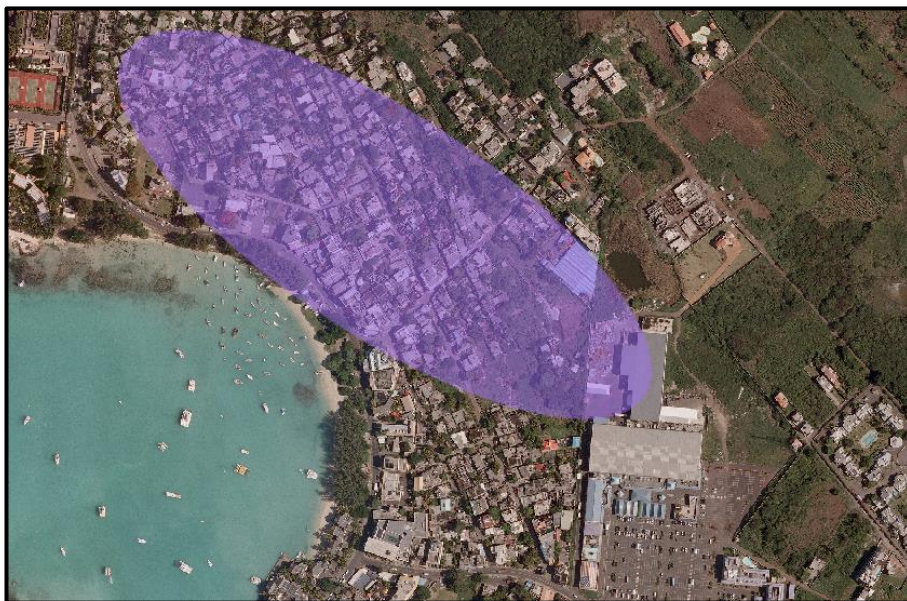
In the 1990s, the village welcomed the third wave of new inhabitants. It had become costly to work the agricultural lands near the foot of the mountain and, furthermore, the planters' children had not been trained to take on agricultural activities. At that time, there was also a growing demand for land. Soon, the whole stretch of the agricultural land was converted into a residential area and sold in small portions of about 350 m², bringing in some 300 families or an estimated 1200 new residents. An aerial image of the land use (Appendix 8) shows the transformation from an agricultural to a residential area.

There was already an awareness of the serious flooding of the relatively flat lands and the existence of natural dry streams in LH. However, three major flood streams that cross the village and form wetland spots were not marked in official topographical maps. Many of the people who moved in were unaware of the threat of floods as the natural storm drains were not represented in their title deeds. As was fashionable, the new inhabitants built concrete walls and fences around their houses. The rapid increase in the built-up area with a significant increase in domestic water waste and a reduction in agricultural lands reduced the soil's capacity to drain the excess flood water. As no drainage system was built, flooding was inevitable with even the slightest amount of rain. The characteristics of the village with its largely middle-- income inhabitants combined with its location at the foot of a hill, the rapid population growth, and the inappropriate construction without due regard to natural water drainage systems, made the area suitable for a case study on vulnerability and resilience building.

3.13.3 Case Study Three: Grand Bay

Figure 3.13 provides an aerial view of GB with a touristic beach area. It is situated in the plains at the northern extremity of the island. The land is generally less than 25 m AMSL. The shaded part in Figure 3.13 outlines the major part of the area where the household survey was carried out. Part of GB up to the northern extremity is interspersed with patches of wetlands. Most of the houses surveyed lie in backfilled wetland areas.

GB was initially a fishing village. The first major wave of residents dates back to the mid-20th century when immigrants and a new community of planters left the sugar estates and settled in emerging villages in the island (Nujjoo, 2007). Nujjoo (2007) related that in 1960, powerful cyclones, named Alix and Carol, destroyed 80% of the houses. In the aftermath of these cyclones, the Ministry of Housing and Lands through the local village council, a locally elected body, distributed some 100 plots of land on lease in GB. Within a year, hundreds of small houses had been constructed and a significant proportion of the surrounding wetlands was encroached upon by further leases and by squatters.



Scale: 1:8000

Source: Maps /Aerial Imagery. Ministry of Housing and Lands (2010)

Figure 3.13 GB: Shaded area showing approximate area where case study was carried out

A report on the Study of Environmental Risk in GB (Ministry of Environment and National Development Unit (NDU) (2002) revealed that the natural water table was just 300 mm below the ground surface in that locality, and no amount of backfilling would be sufficient to ensure that the houses would be protected against flooding from even relatively minor flood events. The report also noted that in the last three decades, the development of the tourist industry and the demand for more space for infrastructure and housings had had a negative impact on the fragile ecosystem.

The report of the Ministry of the Environment and National Development Unit (2002) also estimated that the total area of wetlands had decreased by 66% between 1975 and 2002. The following extract on a study of the environmental risks in GB in 2002 reported:

'Flooding of residential area is noted as well as the overflow of septic tanks. The cause is attributed to the area being on marshy land as well as a high water table. It is also noted that the existing drainage system is inefficient and blocked at several locations and at outlets. The result of the flooding taking place is damage to private property (25 - 30 houses are affected) and health hazards owing to septic tanks overflowing'. (Ministry of the Environment and National Development Unit, 2002, p. 12).

As could be observed, and as was revealed in accounts gathered from local residents, construction brought in more water from domestic and tourist activities, thus raising the water table and reducing further the carrying capacity of the land. No suitable and large-scale drains had been built, and with the increase in population, the situation grew worse. Existing natural and man-made drains were often filled with refuse and were poorly maintained. Floods occurred during even slight to moderate rains. Houses were affected and residents were exposed to health hazards.

The report also noted that the land near the coast was subject to storm surges and flooding as the sea water pushed inland, and no system for the evacuation of the flood water had been built. An aerial image of land use (Appendix 9) shows the considerable impact of the encroachment on the wetlands and the coastal area.

3.13.4 Comparing the characteristics of the three sites

The geography and the inhabitants of the three sites present different characteristics. The three studies made it possible to take a closer look at these characteristics and provide a comprehensive set of data to answer the research questions and meet the objectives of the study. A summary of the specific characteristics of the three locations that made them suitable for the study is given in Table 3.5 below.

Table 3.5 The different characteristics of three case studies

	CLC	LH	GB
Geography	Down a valley, over a relatively steep landscape, suburban-outskirts of Capital city	Rural, lowlands on foothills of mountain	Coastal tourist area
Physical feature	Partly wetland, drained by Rivière Latanier	Small wetland areas Natural storm drains mostly filled in	Flat coastal wetland
Population (2010) Mixed ethnicity	17,332	16,000	11,512
Socio-economic characteristics	Very low to middle income Some 200 families	Low to middle income	All income groups. Tourists
Main Occupation	Artisans, factory workers	Civil service, labourers, artisans and small businesses	Hotels, business, recreational activities

3.14 Summary of chapter

This chapter has explained how the geographical position of Mauritius determines its climate and the occurrence of different types of hazards, in particular floods of various origins. The historical background highlighted the reasons why mixed communities occupy hillsides, flat plains, coastal regions, and wetlands that are poorly drained and subject to recurrent flooding. The frequency of flood events has been increasing as observed from media reports. More people are becoming exposed to flood hazards due to the encroachment onto wetlands and flood risk areas because of an increase in the population. The increase in human use-environment interaction is seen as a major factor in the growing occurrence of flood events in areas that had been flood-free. The vulnerable groups are mostly the lower-income sector of the population who live in flood conditions from one event to the next. As an NGO worker who was helping flood victims in the last flood events, the researcher is aware of the socio-economic conditions and especially poverty as a major factor of vulnerability. Three communities in three different localities were selected. These were used as case studies to answer the research questions and fulfil the objectives of the study, which is aimed at understanding why certain community groups are vulnerable and considering what could be done to reduce their vulnerability and improve their resilience to flood conditions.

Chapter 4 Methodology

4.1 Introduction

This chapter presents the methodology, procedures, and techniques used to investigate and assess the vulnerability and the resilience of communities from three case study sites. First, the philosophical traits of the quantitative and qualitative approaches that are commonly employed in this stage of enquiry are examined in Section 4.2, which thus provides an understanding of the philosophical underpinnings of mixed methods research (MMR) as a research paradigm. This is followed in Section 4.3 by a discussion of the MMR approach, the rationale for using it, and how it fits the overall research design of this study. The framework for the design and an outline of the sequences in the conducting of the overall study is highlighted in Section 4.4. In the context of the design, Section 4.5 discusses the merits of using a case study approach to collect data on the perceptions of households in response to the research questions. Examples are given of similar studies from the literature review where a case study approach was used. As continuous data on flood events from official sources were not available, secondary data sources in particular the media archives were accessed. This is discussed in Section 4.6. Then, Section 4.7 examines specific methods of sampling for data acquisition at the three localities where the case studies were conducted. Section 4.8 introduces the conduct of a pilot study whose findings are used in the design of the main questionnaire survey. Next, Section 4.9 discusses the questionnaire structure, data collection, problems encountered, and ethical considerations. The collection of data using the questionnaire for quantitative analysis is considered in Section 4.10. For qualitative analysis, data collection was carried out through focus group interviews, participatory activities, and semi-structured interviews with agency stakeholders are discussed in Section 4.11. The interviews with agency stakeholders focus on ‘*what is done*’ by the authorities and the NGOs. Section 4.12 summarises the main elements of the methodology that was used in answering the research questions.

4.2 Methodology in research design

Methodology is a research strategy that determines *what* is to be studied and *how* it is done. What is to be studied is basically determined by the nature of the research questions that address the specific problem under investigation. How it is done is

determined by the techniques used to elicit the information that will give conclusive answers to the research questions. The general procedures or stage of enquiry and techniques are generally carried out through two common approaches, namely, *quantitative* and *qualitative* (Creswell, 2003). In the following sections, each approach is examined in terms of its philosophical underpinnings to a research strategy.

4.2.1 *Quantitative approach*

The quantitative methodology relies exclusively on numerical data. It uses a variety of statistical techniques that allows the exploration of relationships between variables (Gilbert, 2011). This method tends to be associated with ‘*objectivity*’ and is independent of the researcher’s involvement (Denscombe, 2007) once the data has been collected. The philosophical approach of this method lies in *positivism*, which means that it embraces the notion that ‘*social reality is out there*’ and that the best approach to prove it is through data collection and hypothesis testing (Creswell, 2003; Davies, 2007).

The quantitative approach is helpful in studying statistically the characteristics of the people and in analysing spatial issues, providing information on ‘*who*’ and ‘*where*’ are the people at risk, but the approach does not specifically address their concern. The approach makes possible the analysis of large data sets and gives the correlation between various parameters. It also provides the exploratory tools for making inferences, but it does not explicitly explain the ‘*why*’ or specify the cause and effect. Neuman (2006) found that the objectivity of the quantitative approach is often not convenient for exploring the complexities of the social world. Quantitative surveys are undertaken on a large scale to generate statistical data, but they do not help to understand people’s emotions and behaviour. A qualitative approach is therefore preferable when people’s perceptions are the focus of the study (Walliman, 2006).

4.2.2 *Qualitative approach*

In contrast to the quantitative, the qualitative approach to research relies more on language and description and the interpretation of the meaning of the findings. Davies (2007) considered that people explain and shape the world in the light of their own experiences, attitudes, and beliefs. This phenomenological approach takes into account the perspectives and lived experiences of an individual in an everyday world. Data

collection for qualitative analysis tends to involve close social contact. It is a non-linear and iterative research path that enables the researcher to create and develop new theories (Neuman, 2006). A qualitative methodology would thus enable the researcher to gain insight into the social world and to study its complexities and subtleties through the use of different tools such as questionnaires, interviews, notes, photographs and audio/video recordings, case studies, focus group interviews, and other participatory activities.

A report of the *Bureau for Crisis Prevention and Recovery* (Office of the United Nations Resident Coordinator Mauritius, 2000) underlined the importance of considering the social context in which risks occur because people do not necessarily share the same perception of risks and their underlying causes. In this case, it is easier to follow *cause and effect* by collecting qualitative data through interviews and personal accounts of an individual's life history (Gilbert, 2011). However, qualitative approaches may have some limitations. For example, the data collected might not be fully representative but instead might be subjective and value-laden. In addition, the researcher might influence the interviewee and inadvertently introduce his/her own viewpoints, values, and beliefs (Denscombe, 2007). Moreover, it is often difficult to gather the right people in one specific location for conducting focus group interviews or participatory activities. The success in carrying out of the activities depends on the time factor, the suitability of a location, and the convenience, availability, and representativeness of the participants.

4.2.3 *Relationship between quantitative and qualitative approaches*

In recent years, there has been much debate about the dichotomy of quantitative and qualitative research designs in social sciences (Gilbert, 2011). Quantitative approaches tended to be dominant in the early 1950s (Newman and Benz, 1998) until new epistemologies emerged around 1960 that accounted for the value-laden nature of human social interaction. A shift from science-dominated statistical views to a more qualitative approach for understanding human behaviour and the complexities of the social world subsequently occurred. However, quantitative and qualitative approaches remained at the two ends of the spectrum in research strategies on the assumption that each approach had a different view about the nature of knowledge (ontology) and the means of generating it (epistemology). This distinction still remains debatable among

the quantitative and qualitative purists on the basis that the two forms of approaches have different types of knowledge claims. The gap between the two approaches was later bridged by a third paradigm, namely, the mixed-methods approach (Denscombe, 2008) on the basis that researchers often incorporate their subjectivities into their empirical observations to address their research questions, describe data, and perform analyses during the research process (Johnson and Onwueghuzie, 2004). Accordingly, quantitative data types can be converted into narratives that can be analysed qualitatively, and qualitative data types are converted into numerical codes that can be analysed statistically (Tashakkori and Teddlie, 2003). This combination of approaches was supported by Creswell (2003, p.12) who, regarding philosophical basis of pragmatism, claimed that researchers are '*free*' to choose the approaches that '*best suit their needs and purposes*'.

4.3 Mixed methods approach

Mixed-methods research is defined as '*research in which the investigator collects and analyses data, integrates the findings and draws inferences using both qualitative and quantitative approaches or methods in a single study or programme of inquiry*' (Teddlie and Tashakkori, 2006, p. 15).

Thus, mixed-methods research can be viewed as an approach that draws upon the respective strengths and perspectives of the quantitative and qualitative approaches (Östlund et al., 2011). As such, it provides the following benefits:

- Quantitative research can provide statistical power and generalizability while the qualitative element captures data that are detailed and rich in context and depth (Teddlie and Tashakkori, 2009).
- Quantitative and qualitative data can be mixed for the purpose of illustrating a more complete understanding of the phenomenon being studied (Mertens and Hesse-Biber, 2012).
- Mixed-methods research helps in *triangulation* by using the results of one approach for planning the next approach (Johnson et al., 2007a, b). If this approach were to lead to the convergence of results from the different methods used, the validity of those results would be enhanced (Modell,

2009). In this study, a similar approach would be applied. Quantitative data from household responses would be gathered to provide the baseline information and then this could be backed up and researched in more depth by the collection of a combination of qualitative data from the perspectives of the various stakeholders.

4.3.1 Application of mixed-methods research approach to address the objectives and research questions

This study on ‘*community recovery and resilience-building in the aftermath of flood hazards in Mauritius*’ has the following objectives (Section 1.5):

- i) to investigate and assess the range of factors that determine vulnerability and resilience building in various sectors of the communities in the aftermath of flood events
- ii) to critically examine the roles and responsibilities of all stakeholders in the recovery phase and in promoting resilience against flood hazards
- iii) to propose a framework for flood disaster risk DRR management.

In order to meet the above objectives, the following research questions were formulated (Section 1.6). These were reiterated and examined to identify which methodology or research strategy would be most appropriate to answer those questions.

Question I: *What is the vulnerability of different sectors of a community in Mauritius to flood hazards and how does it relate to recovery and resilience building?*

It was decided that this question would be best answered by a quantitative approach *to identify the range of factors* that determine vulnerability, recovery, and resilience building in various sectors of communities in the aftermath of flood events. A questionnaire survey was considered the most suitable mechanism to collect quantitative data. Issues of vulnerability, recovery, resilience, and EJ are not measurable *per se*, but these could be examined in terms of sets of the variables that define the characteristics and the stakeholders’ perception of them.

A statistical analysis was carried out of p -value at less than 0.05 level to establish possible relationships between household characteristics and the variables from the questionnaire. This technique could add more power and reliability to the answer in question 1.

Question II. *What are the stakeholders' perceptions of what can be done to reduce community vulnerability and promote resilience in the recovery phase of the disaster response model, with particular attention paid to the current and potential role of science and technology?*

The objective of this question is to examine the roles and responsibilities of all stakeholders in the recovery phase and in promoting resilience against flood hazards. The elements of recovery as a long-term process are identified. It was decided that this question warranted a qualitative approach where the feelings, opinions, attitudes of people would be gathered and analysed, meaning it would therefore take into account all the stakeholders (members of the communities as primary stakeholders and all agency stakeholders and NGOs as secondary stakeholders). Focus group interviews were carried out with representatives of vulnerable households identified from the survey carried out to answer Question I, followed by participatory activities. In addition, semi-structured interviews were carried out on agency stakeholders to explore their role in flood disaster risk management.

Question III. *How is the conceptual framework of 'environmental justice' useful in understanding variations in vulnerability and resilience in groups of communities?*

In order to understand and identify issues of EJ, quantitative data gathered with respect to Question I and the qualitative information obtained from answers to Questions II and III during in-depth interviews and participatory activities was analysed. The nature and extent of environmental injustice was examined with regard to their influence on the variations in vulnerability among the groups in the communities and how they act as impediments to the strengthening of the resilience of flood-affected communities.

Question IV. How can the above critiques of community vulnerability, resilience, and environmental justice in the recovery phase inform the development of a framework for DRR management in Mauritius?

Key findings resulting from the quantitative and qualitative approaches were combined, corroborated, and validated using triangulation techniques. The findings that determine community vulnerability, resilience and EJ were then used to develop a DRR model during the recovery phase. It is thought that the resulting framework will provide a new approach to flood mitigation management in Mauritius and could possibly be applied in other SIDS.

4.3.2 Rationale for mixed methods approach

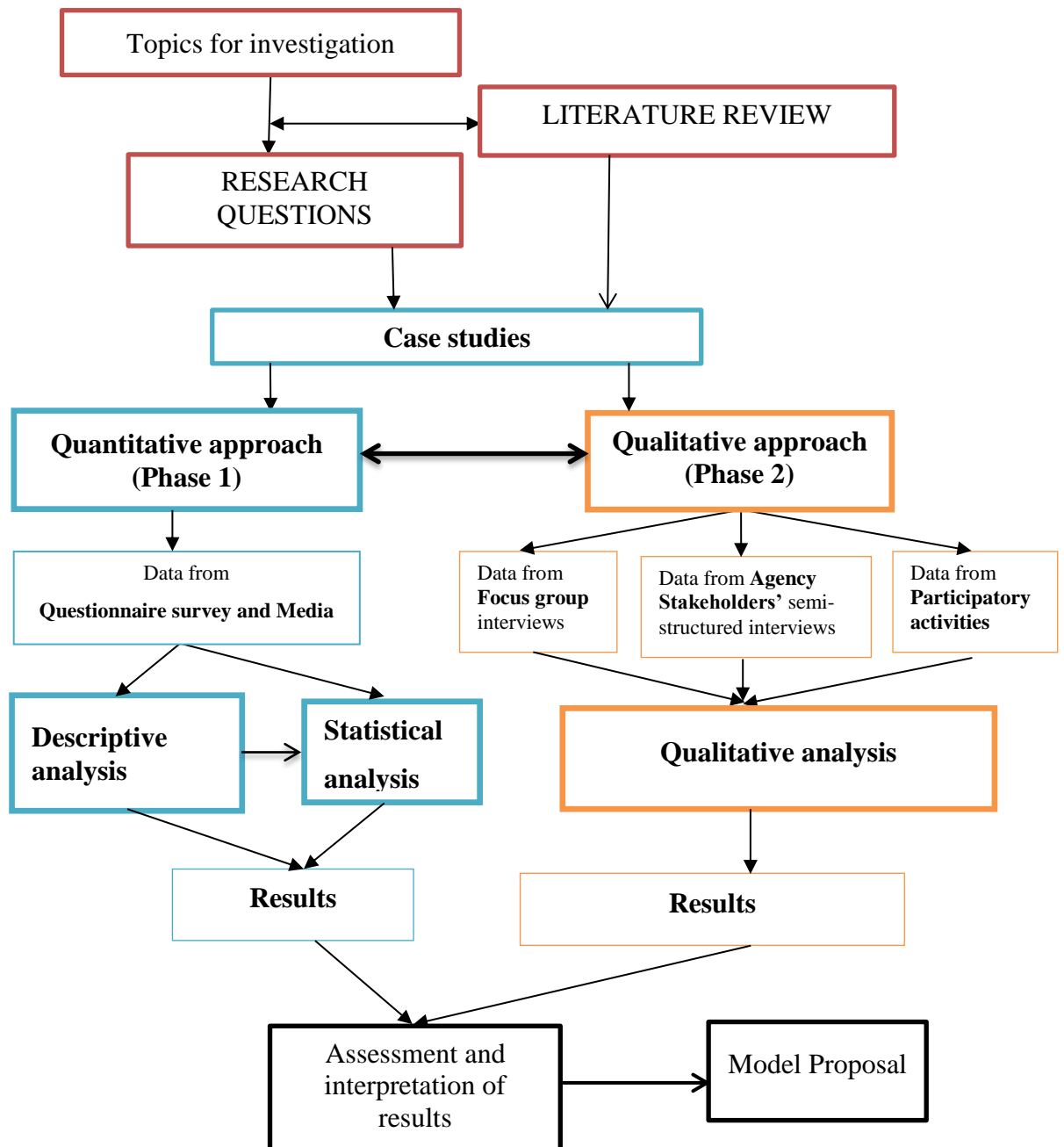
The set of research questions examined in the above section embraces complex and interrelated social problems that needed to be investigated with a broad and holistic outlook of the human use-environment interaction system. The following strategies were used in the study to answer the research questions:

- A case study approach is effective when conducting a holistic in-depth investigation of the social issues in a real-life situation. In the context of this study, three groups of communities, each from a different locality, were chosen as illustrative case studies. The case studies were well-suited to the collection *in situ* of data on the demographic and socio-economic conditions as well as on the householders' perception of various issues related to this study. The aim was to obtain a wide range of information that would enhance the understanding of the topic under investigation.
- Underscoring the benefits of mixed-methods approach, which included a combination of quantitative and qualitative approaches, data were collected and analysed, and the findings were integrated and interpreted, thus making it possible to draw inferences using both approaches in a single research study.

4.4 Framework design of research methods

The flowchart in Figure 4.1 below summarises the procedure that was followed and the activities undertaken by the researcher in order to provide answers to the research questions.

Outline of overall research methods applied to the study



Source: Author

Figure 4.1 Flow diagram of research methods used in the study

In this framework, it is noticed that the mixed methods approach was carried out in two *sequential phases*

Phase 1: A quantitative approach was employed to explore the perceptions of households on their vulnerability and resilience in the recovery phase of flood hazards. A statistical analysis then identifies possible relationships between the vulnerable households and other variables that are found in the questionnaire.

Phase 2: A qualitative approach was used to conduct an in-depth study of the affected households from their own perspectives using the techniques of focus group interviews and participatory activities among groups of householders from the three case study areas. Semi-structured interview were performed to provide information from the perspectives of stakeholders and to obtain their views on flood risk disaster management. The findings from different methods were then integrated and checked for consistency by triangulation.

Triangulation is a technique that is used by surveyors, but it has been adopted by social scientists to assess and enhance the validity of research findings (Modell, 2009). It enables the researcher to verify and draw inferences from qualitative and quantitative findings (Östlund et al., 2011) that can be converged and assessed, meaning that plausible conclusions can be drawn (Figure 4.1).

4.5 Case study approach

A case study is defined as a study *‘in which the researcher explores in depth a programme, an event, an activity, a process, or one or more individuals. The case(s) are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time’* (Stake, 1995, cited in Creswell, 2003, p. 15). According to Qi (2009), a case study offers a powerful research tool that enables the researcher to explore interrelating issues of complex social systems.

In most cases, a case study method selects a small geographical area or a very limited number of individuals as the subjects of study. Yin (2014) considered that it is better to concentrate case studies on areas that have high generalizability and that involve

sampling from specific sectors of the population under study. In this study, case studies of community groups were chosen from the three different locations.

The aim is to gather as much information as possible so as to answer the research questions. The case studies were selected based on the following criteria:

- Knowledge of the areas and the communities as an NGO worker during previous flood events: Therefore, the communities appeared to be representative groups suitable for doing this research project.
- Diversity of geographical settings of flood risk areas: (Section 3.3.3). At CLC, the community is found along a river bank and at LH, the selected community occupies a seasonal dry stream that gets flooded in rainy seasons, while in GB, the flood-affected community lives mostly in a coastal wetland.
- Accessibility to the areas so that visits to the inhabitants for data collection could be frequent and cost-effective.
- Time span limitation for visiting all households for data collection.

Some examples of case studies were examined in the literature review, and the variety of approaches adopted for research purposes is given in Table 4.1. Only a few of the studies selected applied both the qualitative and the quantitative methods. Nevertheless, the examples highlight the broad range of methodologies that may serve as a guide when developing a suitable mixed methods research strategy for this study.

Table 4.1 Examples of case studies used by a sample of authors in relation to flood hazards

Author(s)	Title of Research	Methodological Approach
Werritty et al., (2007a)	Exploring the social impacts of flood risk and flooding in Scotland.	<ul style="list-style-type: none"> • Qualitative and quantitative methods • Questionnaire survey of households • GIS applications • Focus group interviews • Semi-structured interviews with institutional stakeholders
Wood et al. (2009)	Community variations in social vulnerability to Cascadia-related tsunamis in the U.S. Pacific Northwest	<ul style="list-style-type: none"> • Quantitative method • Development of social vulnerability index
Cottrell (2005)	Community participation in improving flood mitigation in the Townsville region, Australia	<ul style="list-style-type: none"> • Qualitative method • Participative approach
Manntay and Maroko, (2009)	Mapping urban risk: Flood hazards, race, & EJ in New York	<ul style="list-style-type: none"> • Quantitative methods • Use of GIS framework to calculate potentially impacted populations
Gaillard et al., (2008).	Living with increasing floods: insights from a rural Philippine community	<ul style="list-style-type: none"> • Qualitative method • Questionnaire-based survey, informal group discussions, passive and stationary • Observations and photographic documentation
Carroll, et al. (2010)	Flooded homes, broken bonds, the meaning of home, psychological processes and their impact on psychological health in a disaster	<ul style="list-style-type: none"> • Qualitative method • Individual and focus group interviews.
Heitz et al. (2009)	Local stakeholders' perception of muddy flood risk and implications for management approaches; A case study in Alsace (France) 2008	<ul style="list-style-type: none"> • Qualitative method • Questionnaire survey • Individual interviews • Local stakeholders
Tunstall, et al. (2006)	The health effects of flooding: Social research results from England and Wales.	<ul style="list-style-type: none"> • Qualitative method • Questionnaire survey • Focus group interviews.
Linnekamp et al. (2011)	Household vulnerability to climate change: Examining perception of households of flood risks in Georgetown and Paramaribo	<ul style="list-style-type: none"> • Quantitative method • Use of household survey in two urban areas
Lopez-Marrero and Tschakert (2011)	An integrative approach to study and promote natural hazards adaptive capacity: a case study of two flood-prone communities in Puerto Rico	<ul style="list-style-type: none"> • Qualitative method • Semi-structured interviews with community
Adelekan (2011)	Vulnerability assessment of an urban flood in Nigeria: Abeokuta flood 2007	<ul style="list-style-type: none"> • Qualitative method • Questionnaire survey • Interview of residents • Documented and published data from various sources
Ferdinand et al. (2012)	Vulnerability and resilience assessment in the Windward islands in the Caribbean	<ul style="list-style-type: none"> • Quantitative and qualitative methods
Schelfaut et al. (2011)	Resilience in flood communities in Europe	<ul style="list-style-type: none"> • Quantitative and qualitative methods
Miceli et al. (2008)	Exposure to hydrogeological risks to residents in nine communities in an Alpine Valley of North Italy.	<ul style="list-style-type: none"> • Quantitative and qualitative methods • Questionnaire survey
Pelling (1999)	The political ecology of flood hazard in urban Guyana	<ul style="list-style-type: none"> • Qualitative method • Descriptive approach

4.6 Secondary data

As published data from the three regions were very limited or unavailable, it was necessary to support the case studies with secondary data related to socio-demographic profiles, flood risk zones, and the frequency and severity of floods and their impacts. Such data were obtained from the following sources:

- (i) The Central Statistics Office of Mauritius: It provided the socio-demographic profile, such as the population in each location, average household size, and the level of literacy and income level of inhabitants.
- (ii) Ministry of Housing and Lands (2010): The Ministry provided flood risk area zones and land use maps/aerial imagery of the study site.
- (iii) Ministry of Public Utilities and Water Resources Unit (2002): The Ministry provided a survey on flood conditions.
- (iv) The Meteorological Services: This service provided information on weather and on cyclone and flood warning systems.
- (v) Local news media: Reported cases of flooding were obtained from the archives of local newspapers in Mauritius. This method of data collection on floods is discussed further in Sections 3.8 and 4.6.1.

4.6.1 Data from other sources – the media

Reliable and continuous data on floods events were not available or accessible. It seems no institution has been entrusted with the responsibility of compiling records of flood events across the island. However, records of such events may be laboriously established by corroborating sectorial information from relevant institutions, such as local authorities, the Meteorological Services, the Water Resources Unit, and the Ministry of Environment. An alternative source of information regarding flood events could be reports from daily newspapers. It is understood that the media cover mainly the major events that severely affect inhabitants. As the island is small, any significant weather event is likely to cover large parts or the whole of the country. Hence, reports of flooding in a few localities that the journalist may choose to cover can be interpreted as indicating that flooding may be occurring in large parts of the country. Flash floods

tend to have a dramatic impact, as do the coastal inundations due to sea swells or high waves, and so they are almost invariably reported in the press. Therefore, access was obtained to the archives of a daily newspaper, and all reports of flooding for the period 2003 to 2011 were catalogued (Appendix 5). These reports were analysed in the context of flooding as a result of human use-environment interaction and were presented in Section 3.8.

4.7 Sampling method

The sampling frames for the choice of case studies were determined by the nature of the research questions that were reviewed in Section 4.3, and the areas chosen are illustrated as shaded areas in Figures 3.11, 3.12 and 3.13. The three case studies were selected on the assumption that they would provide more in-depth information from various stakeholders, which would effectively answer the research questions via a range of techniques, namely, questionnaire survey, interviews, and participatory activities.

The sampling method was based on the researcher's knowledge of the three communities who were living in a flood risk zone. It was therefore more appropriate to use a purposive sampling technique where specific groups of people are selected according to specific characteristics, such as, in this case, vulnerability to and resilience against flood risks.

In this study, the sampling was done at three levels in the communities representing the case studies - flood-affected households, participants for the focus group interviews, and those involved in participatory activities. Table 4.2 shows the variations in the sample size in terms of the number of households for organising data gathering at the different levels. The results from the survey where a large sample was used helped in the screening of participants for the focus group interviews and for the participatory activities. It is noted in the table below that the percentage of the population in the sample for all three case studies is relatively small (between 5% and 8%). However, it is recalled that purposive sampling was specifically chosen for the case studies as the community population includes a high percentage of households that are not directly affected by floods. In addition, no figures are available on the totality of those affected directly by flood. In the context of the study, experience confirms that with respect to

those affected directly by floods, the samples used are large enough to answer the research questions.

Table 4.2 Number of households surveyed in each community

Community	Number of population inhabitants (2010 figure)	Number of households in sample used for quantitative analysis	Percentage of total population in sample	Number of households in focus group	Number of households in participatory activities
CLC <i>(5.5 members per household)</i>	17332	236	7.49%	7	15
LH <i>(5.3 members per household)</i>	16000	131	5.53%	7	12
GB <i>(4 members per household)</i>	11512	216	7.90%	5	not available

It is understood that given the comparatively small size of the samples, each sample is unrepresentative of the whole population of the locality. This method of sampling has its limitation, as it would be impossible to extrapolate the results to the whole population. However, the sample is representative of those affected by flood and is ideal in a case study of an issue affecting a community.

4.8 Pilot study

The main objective of designing a pilot study was to investigate and collect data from a group of individuals regarding their perception of the risks of flood hazards. The study by Houston et al. (2007) referred to in Section 2.6.3, was first used as a guide to design the pilot questionnaire. For example, the questionnaire focused on the following themes of the study:

- household experience of being flooded
- tangible and intangible impacts of floods
- coping with floods
- knowledge about flood warnings
- support from local and government authorities

The initial draft pilot questionnaire was designed to ensure the suitability and clarity of the questions and decide whether the sequences in the questioning were appropriate. After an initial attempt, additional questions were developed to gather information as efficiently and effectively as possible on aspects covering the recovery phase, which included resilience building activities. The questionnaire for the pilot survey is attached as Appendix 10.

4.8.1 *Conduct of the pilot survey*

The purpose of the *pilot survey* is to test the questionnaire using a small sample of individuals living in one of the case study areas. The survey was conducted among 25 inhabitants from the general flood zone of LH. They were chosen among neighbours, friends, social workers, and individuals mostly recommended by NGOs. They may or may not have been affected directly by recent flood events.

At the beginning, the broad context of the survey was explained to each of the participants to put them at ease. Generally, people who receive government and NGO assistance or live on government property or reside in poverty-stricken areas where drug-related activities may be common are wary about political agents, security officers, and the authorities. Thus, it had to be made clear at the outset that the questionnaire was exclusively for research purposes for a university and was designed to obtain anonymously the views of households on flood hazards, so no follow up in the form of assistance or other forms of action were to be expected.

The questionnaire, drafted in English, was subdivided with self-explanatory headings for each section covering a major area of the study. Most of the questions used a Likert-type five-point scale with boxes to be ticked. The wording of the questions was kept simple and straightforward so that they could be easily understood by the respondents. On a one-to-one basis, the replies were filled in by the interviewer, who was accompanied by a social worker from the area. Throughout, the reactions of the respondents to each of the questions were noted. In particular, the researcher paid attention to the following:

- (i) understanding of the questions
- (ii) adequacy and appropriateness of the questions

- (iii) logical sequencing of the questions
- (iv) overlapping questions and those that may be missing
- (v) motivation to answer all the questions
- (vi) embarrassment that could be caused by certain questions or the length of the questionnaire.

Each survey lasted between 15 to 30 minutes.

A subjective assessment was made throughout of whether the questions were suitable for the large scale survey in the three localities, whether the instructions were clear, and whether the persons were at ease in providing the information requested. The questions were read out in English for those who understood the language, but in most cases, the questions were asked in Creole (the local language in Mauritius). Every attempt was made to ensure uniformity in translating the words from English, but too detailed paraphrasing was avoided. To this end, prior to the survey, the words to be used in Creole had been rehearsed in order to ensure uniformity. Similarly, throughout the survey, it was ascertained whether the words and terms used were well understood and whether the respondents interpreted the questions in a uniform way. After completion, the overall questionnaire was discussed with the respondents, and their queries and observations were noted.

4.8.2 *Design of the main questionnaire using outcomes of pilot study*

The information gathered from the pilot survey was entered into an Excel table, and a preliminary analysis was made to extract some useful information about the characteristics of the sample data that could be applied to improve the main questionnaire. A brief description of the major changes and the reasons for these changes in the design of the main questionnaire are given below:

- This section under *Respondent's personal information* in the pilot questionnaire was renamed 'Household characteristics' to include explicitly 'membership of household' and 'tenure'. Questions on education level and employment were added in the main survey.

- The part of the questions dealing with nature of hazards and the action taken prior to a flood event were deleted or were assimilated into other questions as the research question related to actions after the flood. Information on where the households were at the time of flooding and who warned them of the event were not included in the main survey as the responses to these questions were poor, implying that people could not clearly remember. In addition, the study emphasised the recovery phase rather than the preparedness phase.
- The questions related to impact were retained and were largely unchanged, as the respondents found the questions relevant and easy to answer.
- This section on vulnerability was retained as it drew considerable interest from the respondents. Vulnerability encompassed exposure to risk and socio-economic conditions as well. The questions were accessible, and the issue of vulnerability was part of the research questions.
- In the pilot questionnaire, the section on ‘After the Flood’ included ‘Recovery’ and ‘Assistance’ only. In the light of the replies, the section was recast and a separate section on resilience building to include coping and support mechanisms was added. The added focus on resilience building was also required by the research questions.
- The issues of resilience, coping mechanisms, and recovery drew less enthusiastic attention. However, it was found necessary to retain these important issues while rephrasing the questions significantly. The respondents were prepared to express their views, though with caution, on the support offered by the government and by NGOs.
- There was considerable interest in the questions related to awareness-building. Those on the measures taken were revised and included elsewhere, and a few were developed further, such as whether they aware of living in a flood-risk zone.
- Some questions required rewording to facilitate a better understanding. It was observed that most households had limited fluency in English and were not used to filling in questionnaires. Door-to-door visits and personal interaction with the respondents was planned for the full survey.

It was not possible to contact all households in a systematic way as some houses were closed, or the residents were unwilling to open their doors or respond. The survey at household level in all three locations was done from August 2010 to April 2011. It also provided the researcher with an opportunity to become better acquainted with the residents and build a relationship of trust.

Since a large number of households were unable to fill in the questionnaires by themselves, each statement had to be translated in the local Creole language. The exercise took the form of a dialogue between the interviewer and the respondent. The information gathered was then fed back into the questionnaire in English. The approach to attitude measurement based on the Likert-style format was problematic because of the range of attitudes collected. Therefore, every effort was made to note down the responses exactly as they were provided.

Access to households presented other problems. The presence of someone who knew the people located within the affected area was important. Having been introduced in the locality, it became easier for the researcher to contact other households as well since they were on the lookout and expected the visit from the researcher. In the case studies of LH and GB, it was preferable to contact a social worker who was known to the inhabitants.

The pilot questionnaire was also used to test the project design and evaluate whether the questions and the responses were appropriate to gather and analyse the required information. The questionnaire format was revised in the light of the above considerations, but the overall structure was maintained. However, the title of the pilot questionnaire was changed to include explicitly recovery and resilience building. It was decided that where additional information would be required, appropriate questions would be fielded through other activities, such as focus groups, participatory activities, and interviews with agency stakeholders.

4.9 The main questionnaire

On the basis of the outcome of the pilot survey, it was felt that with careful preparation, the main questionnaire (Appendix 11) could be used efficiently and effectively in the

three localities. The surveys were carried out at household level with the assistance of a social worker who lived in the area and who acted as a gatekeeper.

4.9.1 *Structure of the questionnaire*

The questionnaire was drafted along these major themes in order to facilitate the process of collecting data relevant to the study:

- (i) household characteristics (age, family size, house ownership, education level, household's occupation) These factors influence the capacity of households to cope with, resist and recover from the impacts of natural hazards
- (ii) experience of flood hazard - frequency over the past three years. Three years was reasonable period over which things could be remembered
- (iii) impact of flooding (*tangible impact*: damage to materials, housing, household items and the garden; *intangible impact*: psychological, trauma of living in flood water, and stress)
- (iv) exposure to flood hazards
- (v) socio-economic conditions of households
- (vi) recovery (getting back to normal, short- and long-term assistance)
- (vii) resilience – coping strategies and adapting to floods
- (viii) awareness of flood hazard (role of science and technology in communication, warnings, and awareness to flood hazards)
- (ix) Community's perception of government and NGOs role in flood risk reduction measures
- (x) Role of the government, NGOs, and community in flood management and environmental decision-making.

The issue of EJ was not explicitly included in the questionnaire, but some of the questions (e.g. theme (ix)) touched on the issue. Given its sensitive nature, the bulk of the data gathering on the subject was planned to be in the qualitative part of the study.

4.9.2 *Process of collecting data from questionnaire survey*

Table 4.2 gives the number of households surveyed in each of the three communities. The numbers in CLC and GB were comparable. In LH, a smaller number of inhabitants

were affected or agreed to respond to the questionnaire. The analysis of the households surveyed in the three localities was carried out independently, and the results were compared.

The questionnaire was completed at households that were found in the three selected flood zones regardless of the gravity of the impact of flooding. In all three cases, the researcher was accompanied by a gatekeeper, who facilitated contacts with the residents. In LH, a few questionnaires were left in some houses to be filled out by a household member, but retrieving them turned out to be a difficult process. In GB, some inhabitants were first contacted by phone, and then on-site visits were arranged.

As with the pilot survey, it was not possible to contact all households in a systematic way. However, responses from a total of 583 households were gathered from three communities living in flood prone areas. The survey at household level in all three locations was done over a period of 9 months (August 2010 to April 2011). Again, carrying out the survey meant the researcher was able to become better acquainted with the residents and build a relationship of trust among them.

4.9.3 *Problems encountered during site visits*

Once the questionnaire had been designed, it had to be printed in batches of 100 copies. Problem of logistics and transport were often encountered. In one instance, the gatekeeper at CLC fell ill, and the survey process had to be postponed for a while. Since most people were at work during the day and were busy in the evening with household chores, it was most appropriate to meet them in late evenings or over the weekend. Door-to-door visits were therefore mostly carried out in the evening and during weekends.

4.9.4 *Ethical consideration*

The ethical issues as stated in the Handbook of the University of Gloucestershire Appendix 6, namely, Articles 3.1 and 3.2 of the *Research Ethics: A Handbook of Principles and Procedures* (University of Gloucestershire, 2008) were strictly adhered to. The confidentiality and the anonymity of the households were ensured. The householder's name, age, income and ethnicity were not asked during the survey, thus

reassuring the interviewees of privacy and respect. The principle of informed consent, whereby the person should be free to take part or refuse to answer, was observed throughout this study.

Recruiting participants for focus group interviews and for participatory activities can be challenging when working with different social groups in a community. Rabiee (2004) suggested that quite often participants from low income groups exhibit a lack of confidence and low self-esteem. In this study, this was overcome by the researcher making frequent site visits as a way to build a relationship of trust with the community groups and to assure participants of confidentiality. In some ways, it also helped the researcher to feel confident to proceed with further work, as the localities were not considered safe.

4.10 Data collection using questionnaire for quantitative analysis (Research Question I)

The majority of respondents across three case studies were found to be women, with poor male representation. This can be explained firstly by the fact that it is a cultural norm in Mauritius that it is the woman who will come out to speak to someone of the same gender. Secondly, as it is mostly the women who manage their households, they are better prepared to provide information on the family.

As discussed above, the questions were read out in the local language, and the answers filled in by the researcher. A Likert-style format was used to indicate to what extent the respondents would 'strongly agree', 'agree', 'neutral', 'disagree', or 'strongly disagree' to a question or statement. However, the approach to attitude measurement via a Likert-style format may be influenced or distorted by the presence of the researcher.

For each locality, the questionnaires were numbered separately and verified for completeness. The data were compiled on a table and transferred onto an Excel sheet, and the entries were verified for perfect replication from the questionnaire through cross checking with the help of another person. Some aspects of consistency were checked. For example, the number of family members in each age group should have added up to the number of family members stated while the number of elderly persons should

normally have been not more than two. After these simple verifications, the questions were suitably coded and then transferred to an SPSS format for quantitative analysis.

4.11 Data collection from interviews for qualitative analysis (Research Question II)

The following sections present the qualitative phase of data collection to capture information from participants and agency stakeholders. The methods or techniques employed were focus group interviews, participatory activities, and semi-structured interviews. Such techniques enabled the researcher to answer the second research question: *What are the stakeholders' perceptions of what can be done to reduce community vulnerability and promote resilience in the recovery phase of the disaster response model, with particular attention paid to the current and potential role of science and technology?*

4.11.1 Focus group interviews

Focus group techniques were developed in the 1920s in the US when sociologists wanted to conduct studies of communities (Krueger and Casey 2009). In the 1950s, these techniques were used in social sciences by market researchers to find out how best to sell a company's product to potential customers. Focus group techniques were subsequently applied by the academic community in the 1980s when the data obtained from questionnaire surveys yielded limited information, especially in the study of human interaction with society and with the environment.

Walliman (2006) noted that in view of the complexities of human-oriented studies, a qualitative approach, such as a focus group interview, was generally preferred. A focus group enabled the researcher to explore participants' views and experiences on a specific issue in depth (McLaughlin, 2012, p. 27). Organising focus group with from 6 to 10 participants was preferred, since it was found to be more manageable (Krueger and Casey, 2009).

Focus group interviews with householders were held at the community centres at CLC, LH, and GB. Prior to the interviews, arrangements had to be made to obtain authorisation to use the meeting places. In all three cases, participants were contacted by

the gatekeepers who had helped with the questionnaire survey. At CLC and LH, seven participants turned up and at GB, only five. The time set for conducting the focus group sessions was an important issue as it depended on the participants' schedule and the availability of a meeting place. However, every effort was made to gather participants. At CLC, the session was held in the evening, and at LH and GB, in mid-morning. It was also found that some of the respondents living in the wetlands in GB and who were supposed to attend the focus group meeting had been relocated elsewhere since the time of the survey.

After welcoming the participants and describing the purpose of the meeting, the moderator reassured them that anonymity would be strictly observed and that their responses would be audio recorded solely for research purposes. Each session was started with the participants relating their experiences with flooding. Whenever the pace of the conversations slowed, the participants were encouraged by the moderator to voice their opinion on various themes, such as coping strategies, recovery, resilience, assistance, and their perception of various issues related to the research questions stated in Section 1.6. Mutual respect and confidentiality, as essential ingredients of research ethics, were maintained throughout the meetings. Interviews were audio-recorded, and the information was transcribed and processed using the NVivo 9 software.

4.11.2 Participatory activities

A participatory approach is an ethnographic study that involves working 'with' the people, making use of their local knowledge and generating information on their living situation (Fielding, 2011, p. 267). This contrasts with focus group interviews, which fully explore participants' views and experiences on the range of issues being investigated. .

This activity is viewed from a holistic perspective where flood hazards are considered as a result of a human use-environment interaction system (Section 2.2.2). Affected communities are regarded as *primary stakeholders*, who participate in solving their own flood-related problems (Davies, 2007, p. 272). In the context of this research, participants were selected on the basis of their knowledge of the issues and their experiences of flood hazards. The purpose of the meetings was primarily to stimulate

collaborative discussions and to allow the participants to voice their opinions on their vulnerability to flood events.

Silver (2011) argued that this process is beneficial and necessary and that it can serve as a mechanism for empowering local groups of people. In this research, the participants were given prominence and were actively involved with the researcher in proposing solutions for early recovery and resilience building. This activity was therefore meant to involve members of the local community, especially those who were found to be disadvantaged or marginalised, and to ensure their involvement in identifying their own problems and highlighting ‘*what would work best*’ in order to reduce the community’s vulnerability to flood hazards. The methodology used for participatory activities at CLC and LH is described below:

a) Participatory activity at CLC (Case Study 1)

Recruitment was done using the ‘snowballing’ technique, whereby one known reliable person in a household contacts other households in the community. A group of 15 persons were thus informed of the meeting, which was to be held at 16:00. Since the community centre was not available on that day, the meeting was held in the living room of one of the participants. With the exception of two older persons, they were mostly young women with young children; indeed, three of the women brought their babies. The absence of male participants was noted. It is also important to note that all the participants claimed to have been affected by recurrent flood hazards, and all had poor living conditions. The researcher introduced the procedure of the participatory activity, including an assurance of the anonymity and confidentiality of the conversations, which were to be audio-taped for further analysis.

i) Design and tools

The following items were used during the session to enable the participants to identify their vulnerability to flood hazards and to propose solutions:

- A3 sheets of paper
- writing material (pencils, pens)
- an audio-recorder

ii) The activity

The exercise was based on the participatory methods and approaches used by Chatty et al. (2003) in the co-management of natural resources in the Middle East. It also drew on the researcher's experience with a similar activity in Mauritius where the participants were involved in finding solutions to their problems on environment pollution. In the context of the current study, all the participants were involved in carrying out the following exercises:

- i) **Exercise 1:** Assess the perceived frequency and impact of flood hazards.
- ii) **Exercise 2:** Analyse flood-related problems and formulate solutions.

Exercise 1

For Exercise 1, a matrix table was drawn, as shown in Figure 4.2 below. The horizontal axis was labelled '*frequency of flood hazards*' while the vertical axis was labelled '*impact*' to represent the intensity of the hazards. The purpose of this exercise was to involve the participants in identifying and evaluating the intensity at which they experienced flood hazards and the impact incurred.

Exercise 2

Exercise 2 was carried out to enable each group to examine the problems at each flood event and "trace back" to the underlying root causes and in turn devise methods for flood prevention.

	Low	Moderate	High
High			
Moderate			
Low			

Figure 4.2 Matrix table for recording perceived flood frequency and impact

For Exercise 2, the participants were involved in:

- a) identifying the problem caused by the flood hazard

- b) reflecting on the problem
- c) identifying the root cause(s) of each problem
- d) proposing a solution for each root cause so as to prevent this particular problem from recurring
- e) assessing the effectiveness of the proposed solution and reaching a decision on the actions that each of the identified stakeholders should take.

iii) Problems with the participatory activity at CLC

Some of the possible problems identified were as follows:

- There was a risk of collusion amongst the participants who knew each other. This could manifest itself in a tendency to share the same preconceived ideas. Diversity of experience could be limited despite preparatory efforts to warn the participants against this risk.
- It was difficult to group the participants unless they were given an in-kind assistance. In addition to some snacks and refreshments, some cash was provided as an inducement to each participant.

b) Participatory activity at LH (Case Study 2)

Recruitment was done by contacting a social worker in the region. Some 12 households, all women with children, were recruited and gathered in the local community centre. The exercise was the same as that carried out at CLC. The outcomes from both locations are presented in Chapter 7.

One weakness of this exercise at LH was that it was difficult to filter out households who were victims of flood hazards from those who were not. A couple of participants attended just to obtain the token of 100 Rupees (£2) promised for their participation. In addition, the noise and distraction from children prevented the exercise from being undertaken thoroughly.

c) Participatory activity at Grand Bay (Case Study Three)

It was not possible to hold a participatory activity at GB (Case Study Three) due to the lack of participants. Only the five persons who had helped in the recruitment of householders for the focus group turned up at the community centre, which had been booked in advance. Although households were contacted individually on a number of occasions, they showed reluctance in joining the group. There was also an atmosphere of various political viewpoints and a sense of rivalry amongst the groups of participants, which prevented households from getting together for this exercise.

Overall, the households who participated in the focus group interviews and participatory activities were women with children, who came mostly from the low-income group and most of whom lived in crowded conditions in the flood prone areas. Their participation and recorded evidence helped in confirming or contradicting the results obtained from the analysis of the questionnaire survey.

4.11.3 Agency stakeholders' semi-structured interviews

This section aims to present the views of the authorities as agency stakeholders on how they operate to reduce vulnerability, ensure rapid recovery, and develop community resilience to future disasters. These stakeholders were representatives from the NPU, local authorities, Meteorological Services, Health Services, Ministry of Environment and Sustainable Development, the Relief and Emergency Unit, and a non-governmental organization (NGO). Semi-structured interviews were carried out to find out their specific responsibilities with regard to recovery and resilience building measures and understand why the communities were generally dissatisfied with the flood mitigation programmes of the authorities and the NGOs. The semi-structured interviews contained open-format questions where stakeholders were free to give an account of their involvement in the recovery phase of a flood disaster and their role as stakeholder in flood disaster management.

Each stakeholder was asked list of questions. The replies were recorded using a voice-recorder, and the recordings were transcribed into a Word document for analysis using Nvivo 10. The results are presented in Chapter 7.

Table 4.3 indicates the dates when the various activities were carried out and their sequence in the three locations. The survey was followed by focus group interviews and participatory activities. The agency interviews were held last so that the concerns of the primary stakeholders could be considered.

Table 4.3 Periods over which the questionnaire survey, the focus group interviews, the participatory activities and the semi-structured interviews were carried out

Locality	Period of survey	Focus group interviews	Participatory activities	Semi-structured interviews
CLC	Aug to Sept 2010	Dec 2010	August 2011	May to August 2011
LH	Oct to Nov 2010	Feb 2011	August 2011	
GB	Dec 2010 to Feb 2011	Apr 2011		

4.12 Summary of chapter

This chapter has described and justified the methodologies used in this study. Case studies, together with a mixed methods approach, were found to be most suitable to answer the research questions, as had been done for similar studies. A framework of the research design was developed to illustrate the different steps to be taken during the course of the research project.

The choice of purposive sampling was primarily influenced by the known characteristics of the communities in each case study and the requirements of the research questions. On the basis of a pilot study, the main questionnaire was designed to obtain information on flood hazards and their impact, and on the stakeholders' perception of vulnerability, recovery, resilience, support, and awareness regarding flood hazards. Some information relating to EJ was also deduced from the data.

The survey was done at the household level, and in this chapter, the problems encountered as well as the ethical issues is described briefly. Focus group interviews were organized for participants who were affected by flooding. Responses from the participants were voice-recorded and transcribed for qualitative analysis. Further

information was obtained from participatory activities of participants from CLC and LH who were directly affected by flooding. Semi-structured interviews were also carried out with other stakeholders to identify their responsibilities and elicit their views on emergency and rehabilitation measures after a flood hazard. The results of the quantitative data obtained from the questionnaire survey are presented in Chapter 5 and 6. While the results of the focus groups, participatory activities and stakeholders' interviews are provided in Chapter 7.

Chapter 5 Descriptive analysis of the questionnaire survey

5.1 Introduction

This chapter presents a descriptive analysis of the data that were obtained from the questionnaire survey. The complete results of the analysis of the three case studies (CLC, LH and GB) are found in Appendix 12. The results of the case study at CLC are given in Section 5.2, those of LH in Section 5.3, and those of GB in Section 5.4. The results are compared and discussed in Section 5.5. A summary of the overall findings is given in Section 5.6.

The answers provided by the households reflect mostly the perceptions of the respondents and relate mainly to Research Question I, namely:

What is the vulnerability of different sectors of a community in Mauritius to flood hazards, and how does it relate to recovery and resilience building?

The major themes explored in the questionnaire are as follows:

- (i) household characteristics, which influence the capacity of households to cope with, resist and recover from the impacts of natural hazards
- (ii) flood experience and characteristics
- (iii) impacts - tangible and intangible
- (iv) exposure to flood conditions
- (v) socio-economic conditions of households
- (vi) recovery (getting back to normal, short- and long-term assistance)
- (vii) resilience - coping strategies and capability to adapt to flood
- (viii) awareness (warnings, nature of flood, and awareness of living in flood zone)
- (ix) community's perception of the role of government and NGOs in flood risk reduction measures
- (x) role of the government, NGOs, and the community in flood management and environmental decision-making

There were 232 variables in the questionnaire covering the above themes. Data were collected from some 583 households at the three survey sites. The task of handling and analysing such a large amount of data was made easier by using SPSS Version 19 (*Special Package for Analysing Social Science Data*).

The results presented in this chapter relate to the patterns of vulnerability, recovery, and resilience of households after a flood hazard in the three communities. For some questions, especially those related to personal information or to their opinion on actions by the government or NGOs, the respondents appeared to be cautious, and some preferred to maintain a neutral attitude. For example, over 40% of the respondents expressed no opinion on any of the questions related to action by the government and NGOs. At GB, over 60% of the respondents were neutral on the issue of relocation, over 55% on long-term assistance, and over 50% on their possible involvement in environmental decision-making (EDM). The section in the questionnaire survey on the ethnicity of households was not used for ethical reasons.

5.1.1 Household defined

According to a report on Mauritius Housing and Population Census 2011 (Statistics Mauritius, 2011, Section 7, p. iii), a *household* is defined as follows:

- *a one-person household*, i.e., a person who makes provision for his own food or other essentials for living without combining with any other person to form part of a multi-person household; *or*
- *a multi-person household*, i.e., a group of two or more persons living together who make common provision for food or other essentials for living. The persons in the group may pool their incomes and have a common budget to a greater or lesser extent; they may be related or unrelated persons or a combination of both.

In view of the difficulty of contacting the head of the household, who was generally a male member of the family, the respondents tended to be the spouse, who could be contacted more easily at any time during the period of the survey. Given the nature of the questions, the respondent was either the householder or a sufficiently senior family member who was fully aware of the family situation with regards to socio-economic

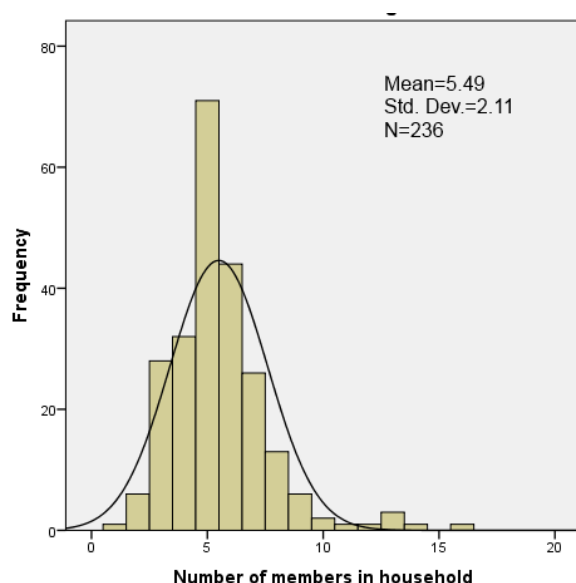
and flood-related conditions. In this survey, a household member, such as a spouse living in the same household and who made *common provision* (from the above definition) and was the respondent to the questionnaire was taken as the household.

5.2 CASE STUDY ONE - RESULTS OF SURVEY AT CLC

This case study at CLC was carried out in August and September 2010. A full description of the geography of the site and the selection of communities for this case study is found in Section 3.13.1.

5.2.1 Household characteristics

This section explores the household characteristics of the flood-affected group or community from CLC that was selected for the case study. The number of households in the sample is 236, which comprises 1191 members.



Source: Author's survey

Figure 5.1 Frequency distribution of the number of members in CLC households

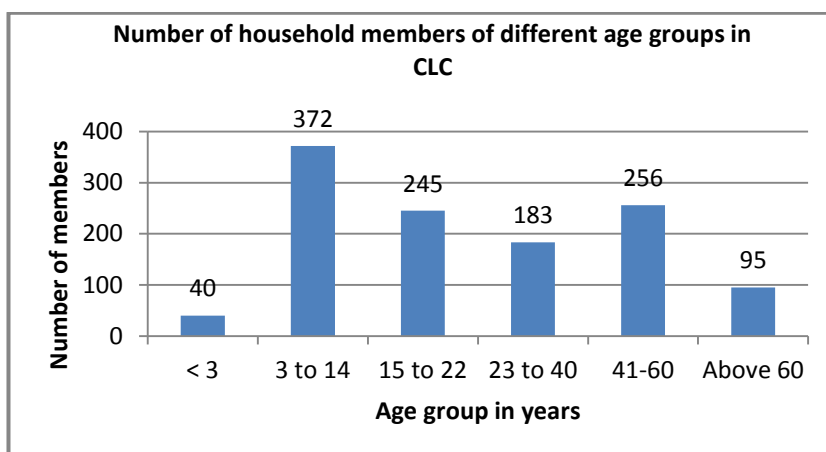
((i) Distribution of number of members by households

The results of the analysis of the questionnaire survey found that the average number of members in each household was 5.5, with 72% (n=169) of households having more than 4 members (Figure 5.1). However, according to the 2006/2007 population survey by the Mauritius Central Statistics Office (2007), the average household in Mauritius consisted of about 4 members; thus there were a relatively high proportion of households in CLC

with families with more than the average number of members, which are henceforth described as ‘*large*’ families.

(ii) *Age-group of household members*

The distribution of number of members by age group is given in Figure 5.2, which shows that 34.6% of members were children below the age of 14 years and 7.9% were elderly persons above 60; both groups are generally considered as vulnerable.



Source: Author’s survey

Figure 5.2 Number of CLC household members within different age groups

(iii) *Householders’ level of literacy*

Of those who replied to the survey (Table 5.1), a large majority (62%) had at least primary education and a significant number had secondary education. Education is compulsory and has been free up to secondary level since 1988. The level of literacy for

Table 5.1 Level of literacy of CLC householders

Level of literacy of householder	Number of respondents (n)	% of responses
Primary	92	61.7
Secondary	42	28.2
Tertiary	14	9.4
Other	1	0.7
Total respondents	149	100

Source: Author’s survey

the year 2007 for Mauritius was 88% (UNICEF, 2009, p.89). It is said that informed people interpret risk communication differently from ordinary people (Haynes et al., 2008), so this information can be used to investigate how households’ level of literacy

could influence their understanding of warning systems, preparedness, and coping capacity, and the use of science and technology in recovery, awareness, and resilience-building.

(iv) Occupation and income level of householders

Table 5.2 indicates number of respondents according to their occupation. It is likely that many of those who responded were stating the occupation of their spouses while those who answered ‘none’ were likely to be unemployed, looking for work, or doing petty jobs. Based on the salary scale of the 2013 Government Pay Research Bureau (PRB), it could be assumed that 146 (Factory (factory, artisans, housewife, and none), representing about 60% of the households surveyed, were in the low-income category.

Table 5.2 Occupation of CLC householders

Occupation of household	Number of respondents (n)	% of responses
Factory	33	14.0
Private sector	33	14.0
Government service	31	13.1
Professional	26	11.0
Artisan	43	18.2
Housewife	25	10.6
None	45	19.1
Total respondents	236	100

Source: Author’s survey

5.2.2 Experience of flood hazard

(i) Frequency of flood hazard

The survey was carried out during August/ September 2010, more than two years after the historic flood disaster of 26 March 2008, which caused the loss of four lives. Such a loss had not occurred in the previous four decades. The event was therefore a memorable one, and most households still remembered it during this survey.

The experiences of flooding over the period of three years prior to the survey, as recalled by the 233 respondents, were: more than 95% of householders that responded agreed or strongly agreed to having experienced a flood during the period, 70% agreed or strongly agreed to having experienced more than one flood, and about the same percentage agreed to having experienced a flood every year.

(ii) *Type and extent of flood experienced*

The types of floods experienced were those arising from cyclones and heavy seasonal rainfall (Appendix 12, Table 1).

Of the 136 householders that replied, about 90% agreed and strongly agreed that their houses had been inundated (Appendix 12, Table 2). The extent of flooding varied with the height the flood water reached. In cases where houses and gardens were flooded, the water level often reached up to ankle height and sometimes up to knee height. The results indicate that households were differentially exposed to flooding.

5.2.3 Impact of flood

(i) *Tangible impact*

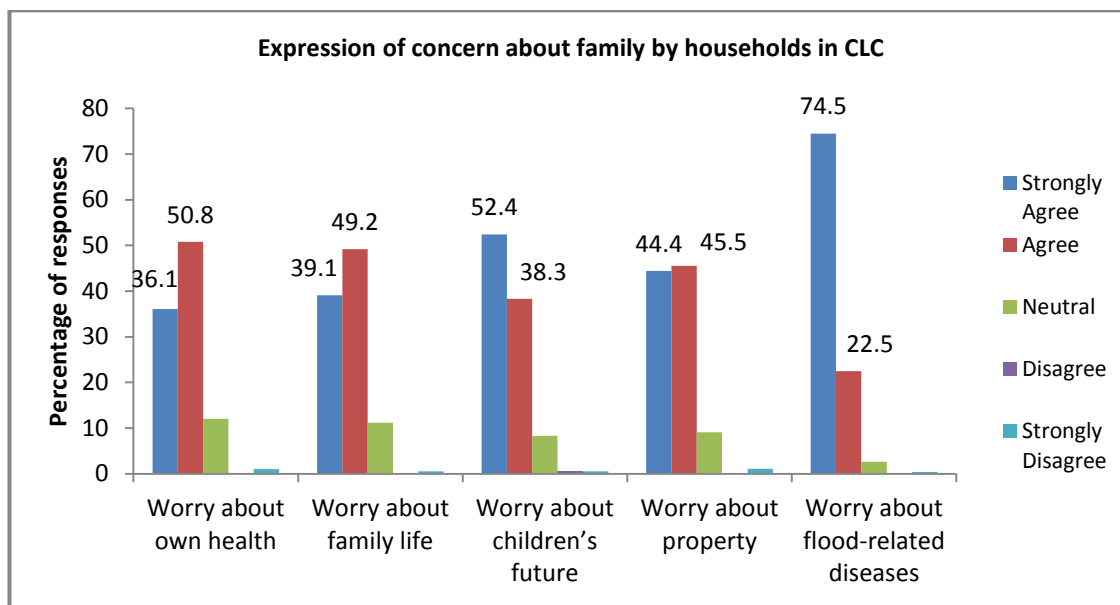
The extent of tangible or material damage caused by the flood water varied from household to household; a significant proportion of respondents (53% of n=125 respondents) reported damage to flooring and personal belongings as a consequence of the flood (Appendix 12, Table 3). More than 60% had had their garden damaged (Appendix 12, Table 4); fruit trees and especially vegetable patches had been destroyed. Of the 136 respondents, some 60% perceived that the water supply had been interrupted temporarily. Roads were very adversely affected, and over 90% of households reported that schools had been closed for one day (Appendix 12, Table 5).

(ii) *Intangible impact*

About 75% of the respondents were upset about the damage caused by the flooding since it took them time, effort, and resources to return to normal. Emotional impacts resulted from families being disrupted, children missing school, and the loss of sentimental items (Appendix 12, Tables 7). Carroll et al. (2010) found that disasters often result in people suffering from psychological health issues and from severe disruption in their lives. The lasting tangible impact is given in Appendix 12, Table 8.

Lasting intangible impacts among households resulted from anxiety about the future of their families and the recurrence of flood-related diseases after a flood (Figure 5.3). It is

noted that during the 2005/2006 rainy seasons, there was an outbreak of chikungunya⁴, a disease caused by mosquitoes (Beesoon et al., 2008; Goorah et al., 2008). This may partly explain the very high level of responses expressing anxiety about flood-related diseases.



Source: Author's survey

Figure 5.3 Lasting flood aftermath emotional stress as expressed by CLC households

5.2.4 Exposure

Table 5.3 Reasons for living on site as expressed by CLC householders

Reasons given by households for living on site	Number of respondents (n)	% of Responses
Job proximity	17	7.0
Access to amenities	11	4.5
Close to relatives	50	20.7
Same community	12	5.0
Own choice	152	62.8
Total	242	100

Source: Author's survey

⁴Chikungunya is an emerging mosquito-borne viral disease that has affected Mauritius, with two recent outbreaks in 2005 and 2006

About 90% of the households claim to live on inland wetland (Appendix 12; Table 9). An overwhelming 62% (152 households) of the respondents claimed that they came to live on that site through their own choice (Table 5.3). For 21% of the respondents, being close to their relatives was an important factor that probably could influence their social resilience. Fewer respondents claimed to live there for job purposes.

5.2.5 *Socio-economic conditions of households*

(i) *Land occupation and house ownership*

Nearly 60% of households owned property with housing on it. About 27% of households (n=62) lived on state lands (Table 5.4). Temporary houses were defined as those made of precarious materials that were vulnerable to adverse weather conditions. The types of houses the households occupy are given in Appendix 12, Table 10. Some 20 % of the households live in fragile houses covered with tin sheets.

Table 5.4 Land and house ownership in CLC

Ownership	Number of respondents (n)	Percentage of respondents
Own land	133	58.6
Own house	147	64.6
Live in low-cost housing¹	42	18.5
Live on governments property	62	27.3

¹concrete, partly tin/concrete or wholly tin material

Source: Author's survey

The issue of land ownership and the choice of location may be related to the historical factors of land use and population movement over the years. In order to accommodate the increase in the population in Mauritius since 1965, many agricultural land areas have been transformed into urban spaces (Lutz and Holm, 1993). The region of CLC has been developed with the construction of many low-cost housing schemes, enabling more settlements of medium- to low-income groups to be built.

As regards the social factors that influence living conditions, about 90% of those who replied agreed or strongly agreed that they were living in an unsafe neighbourhood with drug addicts and the risk of exposure to flood-related diseases (Appendix 12, Table 11).

Some 80% agreed or strongly agreed that they were living among disrupted families, and about 30% were of the opinion that they were living in crowded conditions. This analysis illustrates the poor socio-economic and environmental conditions, which may account for the vulnerability of the households.

5.2.6 *Recovery*

(i) *Getting property back to normal after flood*

Of the 130 responses, nearly 60% of households restored their houses to normal immediately after a flood event. Some took a longer time to recover, while a significant 35 (27%) households never got their houses back to normal.

Table 5.5 shows the perception of the householders of being exposed to damp conditions in a flooded environment. A higher percentage of householders stayed in damp conditions for a day or more compared to those who stayed in such conditions for a short while. A smaller proportion of the householders (15%) agreed that they never lived in damp conditions. Exposure to living in damp conditions was disproportionately distributed amongst households.

Table 5.5 Perception of householders in CLC of living in damp conditions

	Number of respondents (n)	n as % of total households	Agreement scale in percentage					Total
			strongly agree	agree	neutral	disagree	strongly disagree	
Short while	76	32.6	5.9	90.6	1.2	1.2	1.1	100
Whole day	20	8.6	0	81.0	0	14.3	4.8	100
Many days	102	43.7	55.0	39.4	1.8	2.8	0.9	100
Not at all	35	15.0	14.3	48.6	25.7	8.6	2.9	100

Source: Author's survey

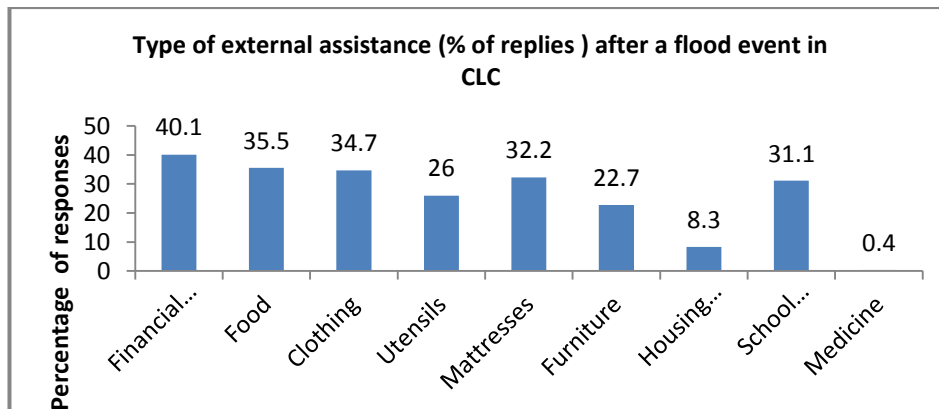
(ii) *Perception of householders of living conditions after a flood*

The perception of living conditions after a flood varied among householders. Of the 202 householders who responded, some 37% agreed or strongly agreed that their living conditions had improved after the flood (Appendix 12, Table 12). However, of these, the majority felt that the improvement was only slight. For 49 householders (20%), the living conditions of their family had remained mostly unchanged in the recovery phase

of a flood hazard. Only a very small percentage felt that the living conditions had deteriorated.

(iii) Forms of assistance given in the recovery phase

After a flood, some of the householders received short-term assistance from their relatives and from external sources including the government authorities (Appendix 12, Table 13). Various forms of assistance were received (Figure 5.4): 75 householders (31% of the replies) received school materials for their children, and 97 households (40%) received financial help while other forms of assistance included food and household items. Some 76% of 107 respondents agreed or strongly agreed that the assistance from the government was insufficient (Appendix 12, Table 14). Nearly 80% of those who replied were worried as they had no insurance against hazard risk.



Source: Author's survey

Figure 5.4 Forms of external assistance received by households in CLC

(iv) Relocation after flood

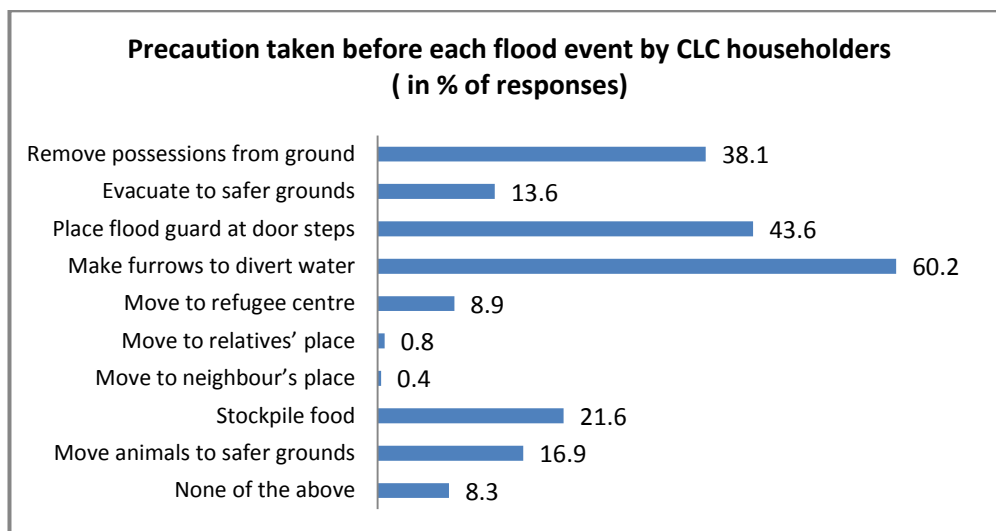
Of the 113 responses, only 20% of householders agreed to be relocated elsewhere by the government (Appendix 12, Table 15). This low percentage for the relocation strategy among the flood victims may be due to households not being willing to leave their personal belongings, to live away from their community, or for various other reasons.

5.2.7 Resilience - coping and adapting to flood

(i) Precautions taken before a flood

As regards actions taken ahead of a flood event, 142 householders (about 60% of the total households) responded that they made furrows to divert flood water from coming

into their houses. Around 44% placed flood guards at their doorsteps. However, only about 10% of households were willing to move to safer places (Figure 5.5). This could be because householders were afraid of losing their personal belongings or for various other personal reasons.



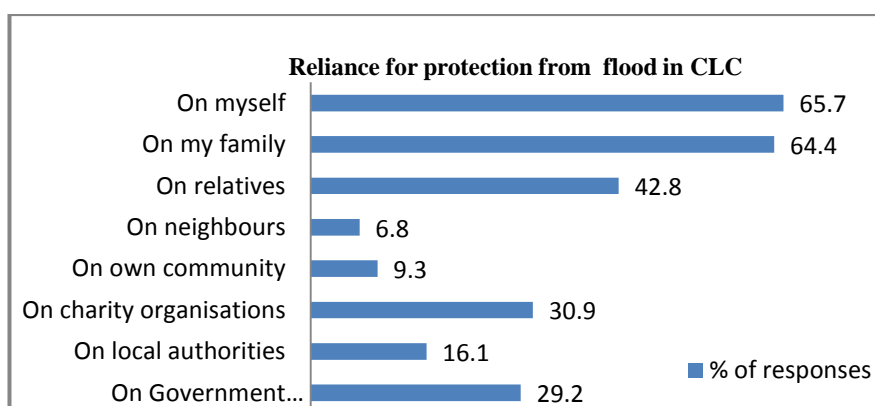
Source: Author's survey

Figure 5.5 Types of precaution taken ahead of each flood event in CLC

(ii) *Adapting to flood hazards*

One of the most common adaptive measures taken by 35% of the 83 householders who responded to this question was to raise the floors above the previous water mark (Appendix 12, Table 16). Some 20 householders who did not raise the floor level agreed or strongly agreed that they accepted things as they were and lived through the event.

(iii) *Reliance for flood protection*



Source: Author's survey; n=155

Figure 5.6 Reliance for protection from floods in CLC

About 65% of the 155 householders who responded said that they relied on themselves and their families for protection against flooding (Figure 5.6). In addition, some 75% of households also relied on various external sources (charities, local authorities, and the government) for protection during flood events. Less than 10% relied on neighbours or their own community for flood protection.

(iv) Collaborating with the community

About 80% (n=187) of all householders responded that they collaborated with their neighbours by providing them with moral support, and some 40% provided food and short-term assistance (Appendix 12, Table 17). About 85% of householders participated in helping neighbours or in collaborating with them in planning to mitigate the impacts of flooding. However, only 47% were prepared to participate in cleaning debris, and 35% were ready to collaborate with local authorities and NGOs in flood mitigation planning (Appendix 12, Tables 18 and 19).

5.2.8 Awareness of flood hazard

(i) Awareness of living in a flood zone

Most householders who responded stated that they were aware or slightly aware of occupying a flood-risk zone (Table 5.6) and of the increase in flood hazards in recent years (Appendix 12, Table 20).

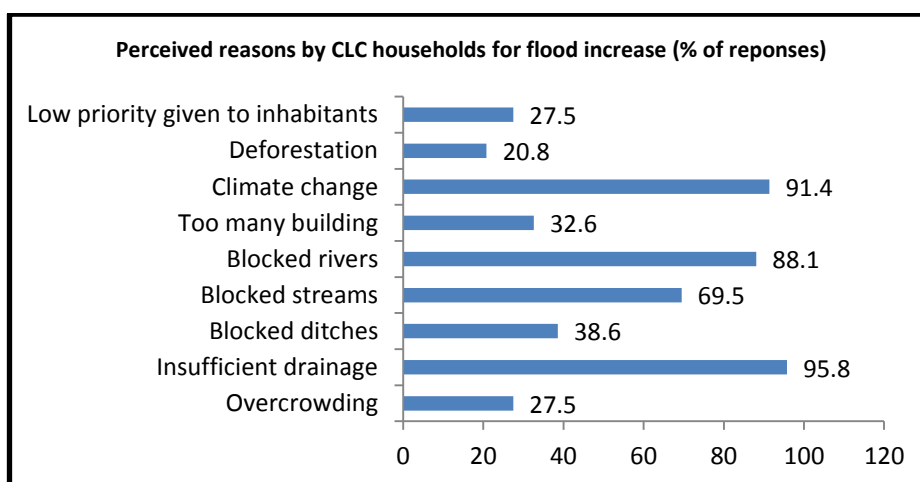
Table 5.6 Awareness of CLC householders of living in a flood-risk zone

	Number of respondents (n)	% of total respondents
Very much aware	133	56.8
Slightly aware	95	40.6
Not aware	6	2.6
Total	234	100

Source: Author's survey

According to the householders, flooding had increased due to blocked waterways and the lack of sufficient drainage (Figure 5.7). Some households felt that the flood increase was due excessive development, with buildings replacing the natural vegetation in the area and resulting in, overcrowding and deforestation. This raised the issue of

government policies on land-use planning. About 90% of the respondents felt that the increase in flood events was due to climate change. This reflected the awareness and local knowledge on such issues of householders living in the flood risk zone.



Source: Author's survey

Figure 5.7 Households' perception of the reasons for the increase in flood events

(ii) *Flood warning sources*

Over 90% of households responded that they received flood warnings from the radio while some 45% received them from the television. Other sources of flood warnings were mobile phones, the internet, and hearing the news from neighbours (Appendix 12, Table 21). Table 5.7 shows that about 45% of households listened regularly to warnings. An equal percentage mentioned that they listened to warnings only some of the time. Only a few householders rarely or never listened to flood warnings (Table 5.7).

Table 5.7 Frequency of listening to flood warnings by CLC households

Frequency of listening to flood warning	Number of respondents (n)	% of respondents
Regularly	102	45.9
Sometimes	99	44.6
Rarely	18	8.1
Never	3	1.4
Total	222	100

Source: Author's survey

(iii) Householders' opinions on warnings

About 50% of householders agreed that warnings were delivered in time for them to act, and over 70% agreed that they fully understood the warning issued. However, over 90% of the respondents agreed or strongly agreed that flood warnings should be further improved (Appendix 12, Table 22).

5.2.9 Opinion on flood risk reduction measures

(i) Householders' opinion on government support

About 90% of householders agreed or strongly agreed that the government should improve emergency services and structural measures in flood protection and should take other measures besides flood warnings to mitigate flooding (Appendix 12, Table 23). A high percentage of householders agreed or strongly agreed that in order to raise awareness of flood hazards, the government should invest in flood-awareness programmes in schools, youth clubs, and community centres (Appendix 12, Table 24).

About 35% of householders agreed or strongly agreed that there were differences in government support during and after a flood event. They also voiced their concern regarding differences among communities regarding the government's support in relief and emergency services, in building flood defences, and in helping them to improve their quality of life. Significantly, about 45% of those who replied did not express any opinion on these issues (Appendix 12, Table 25).

(ii) Households' opinion on NGOs' support

Some 20% of householders agreed that there were differences in NGOs' support among communities regarding relief operations, in building flood defences, and in helping them to improve their quality of life. As in the case of the government, about 44% of those who replied did not express any opinion on these issues (Appendix 12, Table 26).

(iv) Householders' perception Householders' perceptions on participation in decision-making (DM)

About 40% of householders agreed or strongly agreed that they felt 'left out' after a flood event, and more than 60% felt that the government should allow them and the community to participate in the decision-making (Appendix 12 Tables 27 and 28).

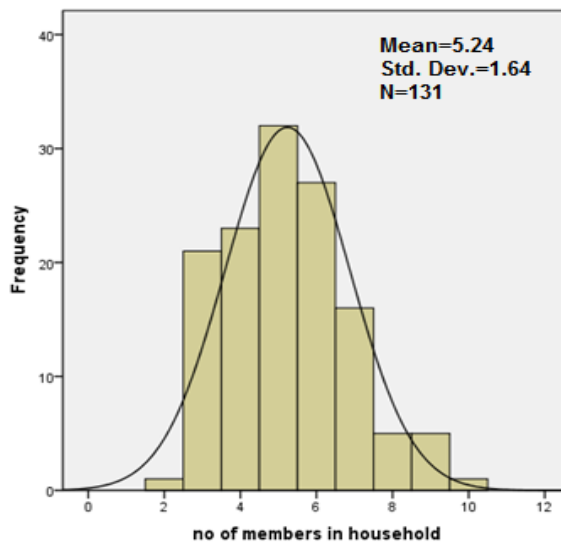
5.3. CASE STUDY TWO: RESULTS OF SURVEY AT LH

This case study was carried out during October and November 2010. A full description of the geography of the site and this case study can be found in Section 3.13.2.

5.3.1 Household characteristics

(i) Distribution of household members

The number of households surveyed in LH was 131, comprising a total 691 family members (Table 5.11). The average number of members per household was 5.3. Of all the households, 67% (n=89) had more than 4 members in their family, the average for the country (Figure 5.8).



Source: Author's survey

Figure 5.8 Frequency distribution of members in LH households

(ii) Age-group of household members

Over 70% of households had members aged less than 14 years while some. Some 29% had elderly persons aged more than 60 years. These family characteristics make them particularly vulnerable to the onslaught of a flood (Table 5.8).

Table 5.8 Total number of members in different age groups in LH

Age group (years)	Number of respondents	% of total households	No of individuals in each age group
< 3	27	20.6	28
3 to 14	90	68.7	193
15 to 22	65	49.6	103
23 to 40	93	71.0	144
41 to 60	98	74.8	167
Above 60	38	29.0	56
Total number of individuals			691

Source: Author's survey

(iii) Respondents' level of literacy

Out of the 76 households who responded, 71% had a level of literacy of up to primary level, 21% of up to secondary, and a few of up to tertiary level (Table 5.9). As mentioned 5.2.1 (iii), free education had given all Mauritians the opportunity to study up to university level.

Table 5.9 Level of literacy of LH householders

Level of literacy householder	Number of respondents	% responses
Primary	54	71.1
Secondary	16	21.1
Tertiary	5	6.6
Other	1	1.3
Total	76	100

Source: Author's survey

(iv) Occupation and income level of households

The occupation of households covers various sectors (Table 5.10). This reflects the heterogeneity in wage earnings, which can be broadly grouped into 'high-income' and 'low-income' groups. Based on the current salary scale of the 2013 Government (Pay Research Bureau, 2013), it can be inferred that a total number of 105 (factory, artisans, housewives or none) that is, about 80% households, were in the low-income category. These groupings can be tested to find their relationships with other variables.

Table 5.10 Occupation of LH householders

Occupation of household	Number of respondents	% responses
Factory	20	15.6
Private Sector	7	5.5
Government Service	10	7.8
Professional	6	4.7
Artisan	14	10.9
Housewife	22	17.2
None	49	38.3
Total	129	100

Source: Author's survey

5.3.2 *Experience of flood hazard*

(i) *Frequency and type of flood hazard*

Nearly all householders (n=130, 98%) in the survey agreed to having experienced a flood hazard in the past three years. Of the 130 respondents, less than 5 % agreed to having experienced a flood hazard more than once and every year in the past three years (Appendix 12, Table 29). But nearly all agreed that they had experienced flooding over the last three years. The type of flood experienced originated from heavy rain brought by tropical cyclones (Appendix 12 Table 30).

(ii) *Extent of flooding experienced*

The extent of flooding varied from one household to another. Most householders responded that their garden and neighbourhood had been inundated. For those whose houses had been inundated, the water level had reached or up to or above ankle height (Appendix 12; Table 31).

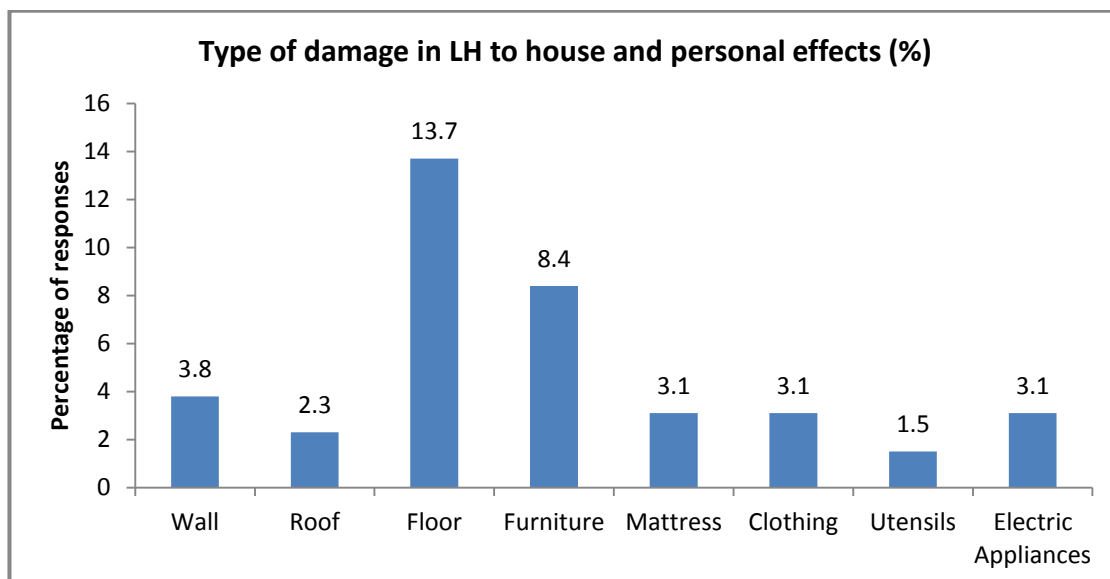
5.3.3 *Impacts of flood*

(i) *Tangible impact*

The flood had a tangible impact on householders' property, and belongings. Some 30% of the respondents (n=32) reported that their house structures, primarily floors, and a few personal belongings had been damaged (Figure 5.9).

The majority of respondents (95%) agreed or strongly agreed that the flood event had had no significant impact on utilities and services, such as power supply,

communication systems, and road and transport accessibility. As a precautionary measure, schools had been closed temporarily (Appendix 12; Table 32).

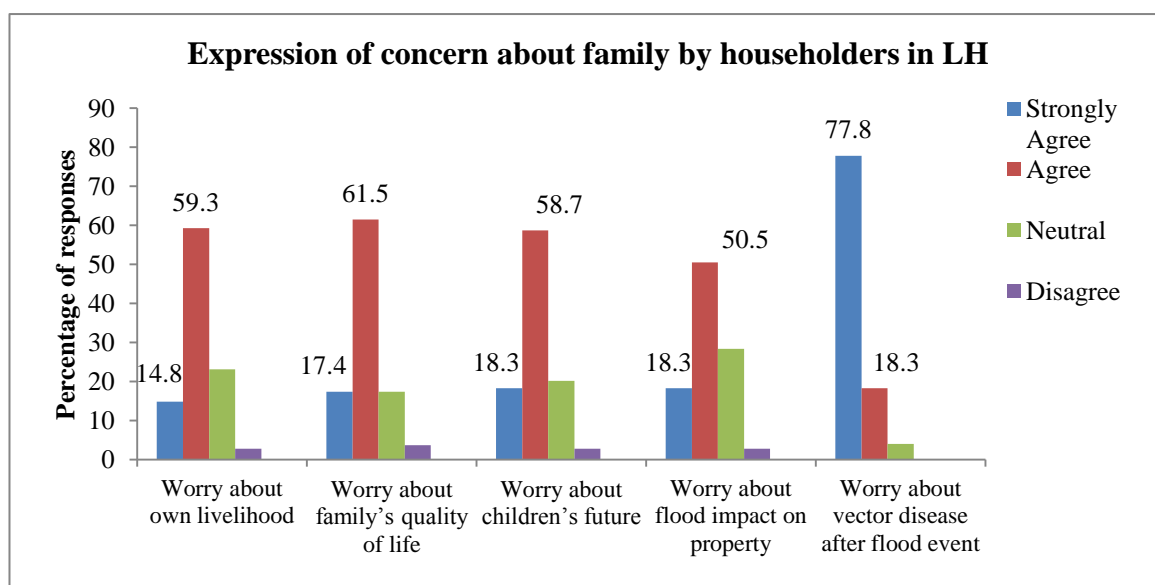


Source: Author's survey

Figure 5.9 Damage to house and personal effects

(ii) *Intangible impact*

Of the 123 householders that responded, some 40% agreed or strongly agreed that they were upset about the damage (Appendix 12, Table 33). Worry and concern about the well-being of families were among the most predominant sources of distress



Source: Author's survey

Figure 5.10 Lasting emotional stress in the aftermath of flood as perceived by households in LH

for the majority of householders (Figure 5.10). Out of 126 households, over 90% expressed worry about recurrence of vector-borne diseases after a flood event. Respondents still remembered the outbreak of *chikungunya* (viral fever caused by mosquitoes) in the summer of 2005/2006, which affected more than 3500 people across the island (Beesoon et al., 2008).

5.3.4 *Exposure*

(i) *Living with flood risk*

A high proportion of households (96% of the n=126 respondents) in the survey occupied an inland wetland area (Appendix 12; Table 34). The reasons for the choice of such locations varied, for example, ranging from job proximity to being close to relatives and to communities; 87 householders (66% of the total households) responded that they had settled in the area through their own personal choice (Table 5.11).

Table 5.11 Reason for living on site given by households in LH

Choice of location	Number of respondents	% of total households
Job proximity	13	9.9
Access to amenities	12	9.2
Close to relatives	48	36.6
Same community	15	11.5
Own choice	87	66.4

Source: Author's survey

5.3.5 *Socio-economic conditions of households*

(i) *Land occupation and house ownership*

Over 70% of the householders (n=90 respondents) surveyed in the sample owned houses and lands (Table 5.12) and had houses constructed from concrete. In Mauritius, lessons learnt from past cyclone disasters had driven householders to construct better houses (Padya, 1989). However, while better houses may mean resistance to one type of hazard, such as the violent cyclonic winds, they still may not be resistant to other types of hazards, such as flooding.

A few householders lived in partially concrete and tin houses and very few in unstable housing made of tin sheets (Appendix 12; Table 35).

Of the 126 householders that responded, a significant proportion agreed or strongly agreed that they lived in unfavourable social conditions, such as in a crowded neighbourhood (30%) and an unsafe environment (42%) with a large number of unemployed persons (58%); Appendix 12; Table 36.

Table 5.12 Land and house ownership in LH

Ownership	Number of respondents	Percentage of respondents
Own land	90	73.4
Own house (concrete)	94	77.0
Live in low-cost houses ²	32	26.0
Live on government property	None	0

Source: Author's survey

² Partly tin/concrete or wholly tin material

5.3.6 Recovery

(i) Getting property back to normal after flood

Over 90% (n=116 respondents) of households got their house and garden back to normal almost immediately after a flood event. Only 6% felt that it took them weeks to return to normal.

(ii) Perception of living in damp conditions

Over 90% of the 85 households that replied agreed or strongly agreed that they lived in damp conditions for a short while after flood events; 16% perceived that they lived in damp conditions for many days (Appendix 12, Table 37).

(iii) Households' perception of living conditions after a flood

Some 50 householders agreed and strongly agreed that their own quality of life and that of their family had improved significantly after a flood event (Appendix 12, Table 38).

(iv) *Forms of assistance given in recovery phase*

Very few householders responded that they were affected by the last flood event and that they relied on outside assistance. Short-term assistance involved financial and household materials. About half of the householders (n=13 respondents) agreed that the assistance from the government was not enough (Appendix 12, Table 39).

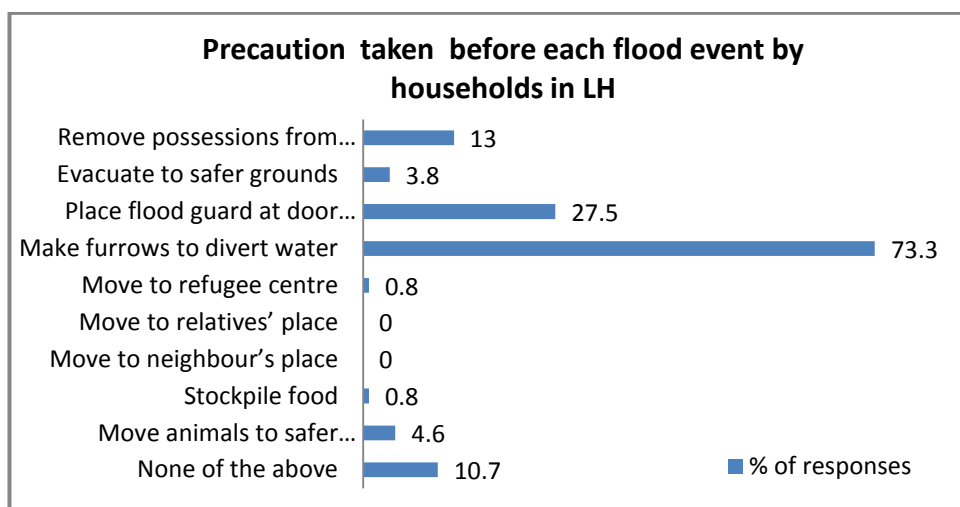
5.3.7 Resilience: coping and adapting to flood hazard

(i) *Precaution taken before the flood*

Over 70% of householders (n=100) responded that they had made furrows to divert flood water, and some 28% (n=36) had placed flood guards at their doorsteps (Figure 5.11) before each flood event. The act of diverting water to other places results from ‘not in my backyard syndrome’ where reducing the impact in one place increases the risk elsewhere most specifically at neighbours’ houses (Etkin and Stefanovic, 2004). Only a very small proportion of households (10%) accepted moving out to safer places, as most of them were afraid of losing their possessions or for other reasons, such as their standing in society.

(ii) *Adapting to flood hazard*

Raising the floor above the water mark or building higher floors were among the most common long-term adaptive strategies taken by some 35% of the householders (n=44) (Appendix 12, Table 40).



Source: Author's survey

Figure 5.11 Precautions taken by households in LH before each flood event

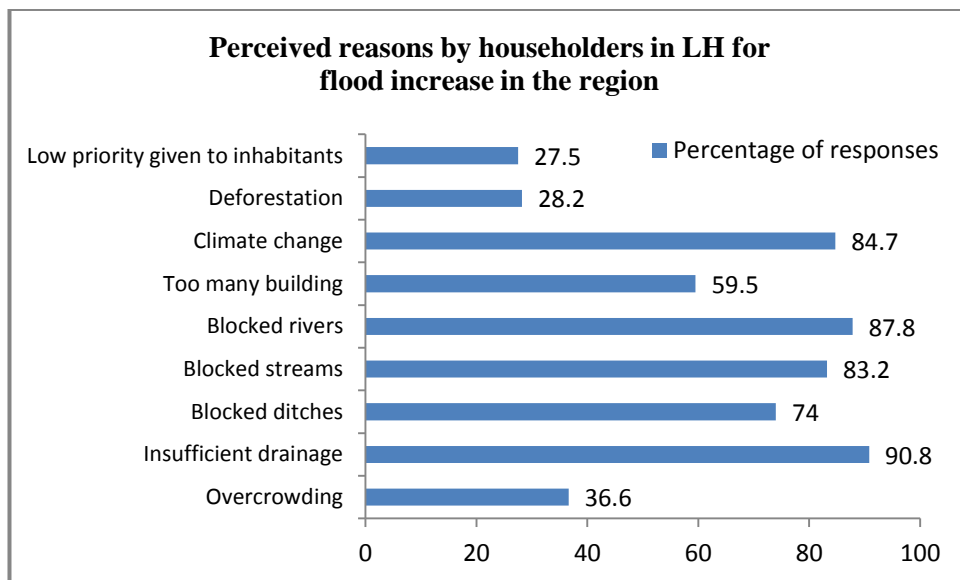
(iii) *Reliance for flood protection and collaborating with the community*

Most householders agreed or strongly agreed that they took responsibility for avoiding harm being done to the family and damage to their personal effects. About 50% of householders (n=67) responded that they provided moral support to their neighbours and helped in cleaning up after a flood (Appendix 12, Table 41). This reflects the sense of community network that predominates in many rural areas where people tend to know each other.

5.3.8 Awareness of flood hazard

(i) *Awareness of living in a flood zone*

Of the 95% households exposed to flood risks, some 80% were aware to various degrees of the increase in flood events in recent years (Appendix 12, Table 42). Householders suggested various reasons for this increase (Figure 5.12 and Appendix 12, Table 43). About 90% responded that the main reasons were the insufficient drainage of flood water and blocked streams and rivers. Over 80% of householders that responded were aware of the issue of climate change and blamed it for the recurrence of frequent flood hazards.



Source: Author's survey

Figure 5.12 Perception of householders in LH of the reasons for increase in flood events

(ii) *Flood warning sources and householders' opinion on warnings*

About 80% of householders responded that they obtained flood warnings from the radio and the TV, and from other sources (Appendix 12, Table 44). Those who listened to flood warnings agreed or strongly agreed that warnings were delivered in time for them to act, but they wanted an improvement in future flood-warning system (Appendix 12, Table 45).

5.3.9 *Opinion on flood risk reduction measures*

(i) *Householders' opinions on government support*

Of the 125 householders who responded, over 90% agreed or strongly agreed that emergency services should be improved (Appendix 12, Table 46). Over 90% of households also agreed or strongly agreed that the government should invest more in flood awareness programmes in schools, youth clubs, and community centres (Appendix 12, Table 47).

About 20% of the respondents perceived that there were differences in the government's support to their community during and after a flood event in their area. Over 60% of householders remained neutral in their responses (Appendix 12, Table 48).

(ii) *Householders' opinions on NGOs' support and on decision-making*

Though most of the opinions were neutral (Appendix 12, Table 49), a small percentage of householders, that is, some 13% of those who responded (n=126), agreed that NGOs' support to the community during and after a flood event was not enough. They perceived that NGOs should help more regarding the provision of emergency services and in minimising flood risks by investing in better flood defences and thus contributing to the improvement of the quality of life of the whole community. However, they did not feel they were being 'left out'. In addition, over 60% of householders that responded (n=126) agreed that the government should allow their community to participate in environmental decision-making (Appendix 12, Table 50).

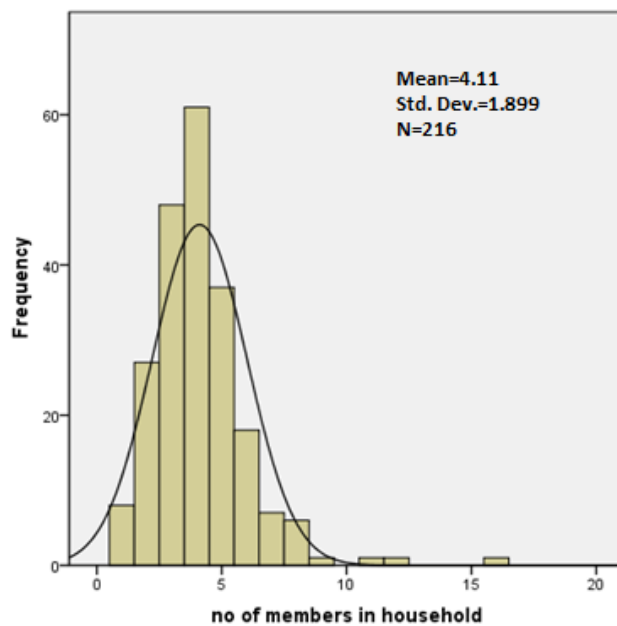
5.4 CASE STUDY THREE: RESULTS OF SURVEY AT GB

The survey at GB was carried out between December 2010 and February 2011. A full description of the geography of the site and this case study were described in Section 3.13.3.

5.4.1 Household characteristics

(i) Distribution of household members

The number of households surveyed in GB was 216, comprising 888 family members, representing an average of 4 members per household. From Figure 5.13, it is found that 33% (n=72) of households had more than 4 members in their families and so are considered to be large households.

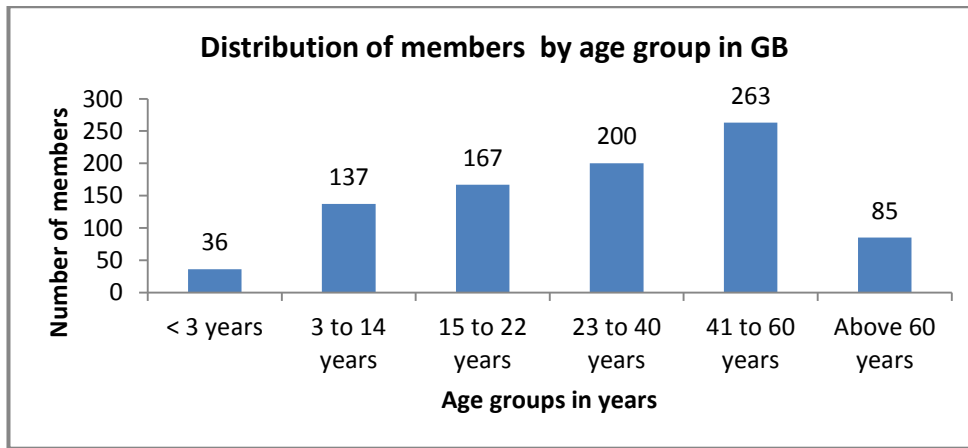


Source: Author's survey

Figure 5.13 Frequency distribution of households in GB by number of members

(ii) Age-group of household members

Households were made up of members of different age groups (Figure 5.14). There were only a few households with children of less than three years old. Over 40% of households (n=89) had older children. Nearly 30% of the persons were aged below 14 years or above 60 years. These families with young children and elderly persons may be considered as vulnerable in the event of flooding.



Source: Author's survey

Figure 5.14 Representation of number of individuals in different age groups in GB

(ii) *Respondents' literacy level*

Nearly half of the total number of householders surveyed had at least a primary level education (Table 5.13). About 30% (n=61) had studied up to secondary level, and 24% (n=51) had attended technical schools.

Table 5.13 Level of literacy of householders in GB

Householders' level of literacy household	Number of respondents	% of total respondents
Primary	99	46.7
Secondary	61	28.8
Tertiary	1	0.5
Other	51	24.1
Total respondents	212	100

Source: Author's survey

(vii) *Occupation and income level of households*

As GB is a highly developed tourist area, it was expected that a greater percentage of households would work in the tourist industry, which is largely in the private sector (Table 5.14). However, a high proportion responded 'none' as their occupation. This might be explained by the fact that some persons often did not want to give information about their occupation or might be doing temporary petty jobs. Considering the salary scale (Pay Research Bureau, 2013), it can be deduced that a total number of 160

(factory workers, artisans, housewives, and ‘none’ occupation) or about 74% households were in the low-income category.

Table 5.14 Occupation of households in GB

Occupation of household	Number of respondents	% of total respondents
Factory	3	1.4
Private sector	49	22.7
Government service	2	0.9
Professional	5	2.3
Artisan	19	8.8
Housewife	41	19.0
None	97	44.9
Total respondents	216	100

Source: Author’s survey

5.4.2 Experience of flood hazard

(i) Frequency and type of flood hazard

Depending on their exposure and location, households had different experiences of flooding. Of the 216 householders surveyed, 50% had experienced a flood in the past three years (Table 5.15). However, some 30% (number of replies n=200) of householders had experienced flood hazards more than once in the past three years. Flooding occurs during cyclones and rainy seasons, and as GB is a coastal area, the risk of having a storm surge was also evident (Appendix 12, Table 51).

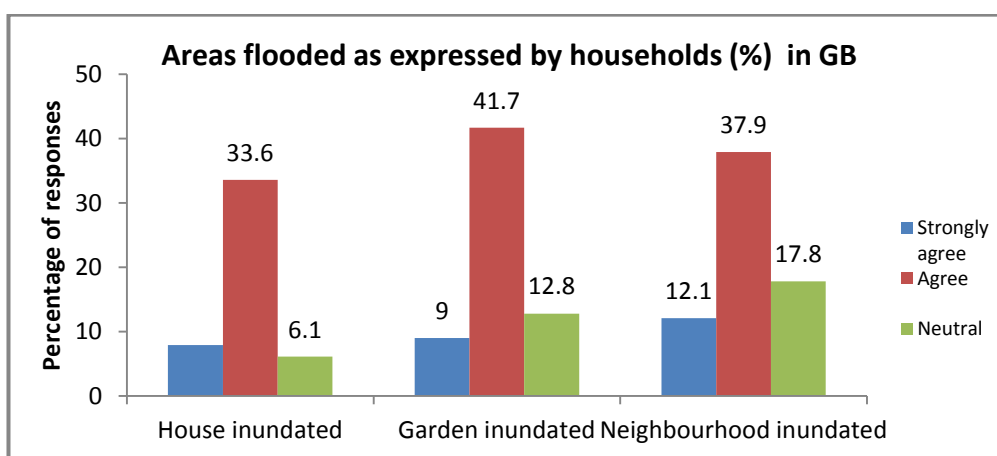
Table 5.15 Experience of flooding as expressed by households in GB

Experience of flood	Number of respondents	% of total households	Agreement scale in percentage					Total
			strongly agree	agree	neutral	disagree	strongly disagree	
In past 3 years	216	100	10.2	48.1	8.3	31.9	1.4	100
More than once in past 3 years	200	92.6	8.0	22.5	11.0	35.5	23.0	100
Every year in past 3 years	196	90.7	2.0	8.7	21.9	41.8	25.5	100

Source: Author’s survey

(ii) *Extent of flooding experienced*

The extent of flooding varied as a function of the sites where houses had been built on backfilled wetlands. Of the 214 householders who replied, 40% agreed or strongly agreed that flood water had entered their house while some 50% (n=211) agreed or strongly agreed that their gardens and neighbourhood had been covered with water during flooding (Figure 5.15). Of those whose their houses had been inundated, some mentioned that the water level had come up above ankle height, some up to knee height, and a few above knee height (Appendix 12, Table 52). Other households (n=126, 58%) had water over their feet or up to ankle height in their garden and in their neighbourhood.



Source: Author's survey

Figure 5.15 Extent of flooding at GB in house and surroundings

5.4.3 *Impact of flood*

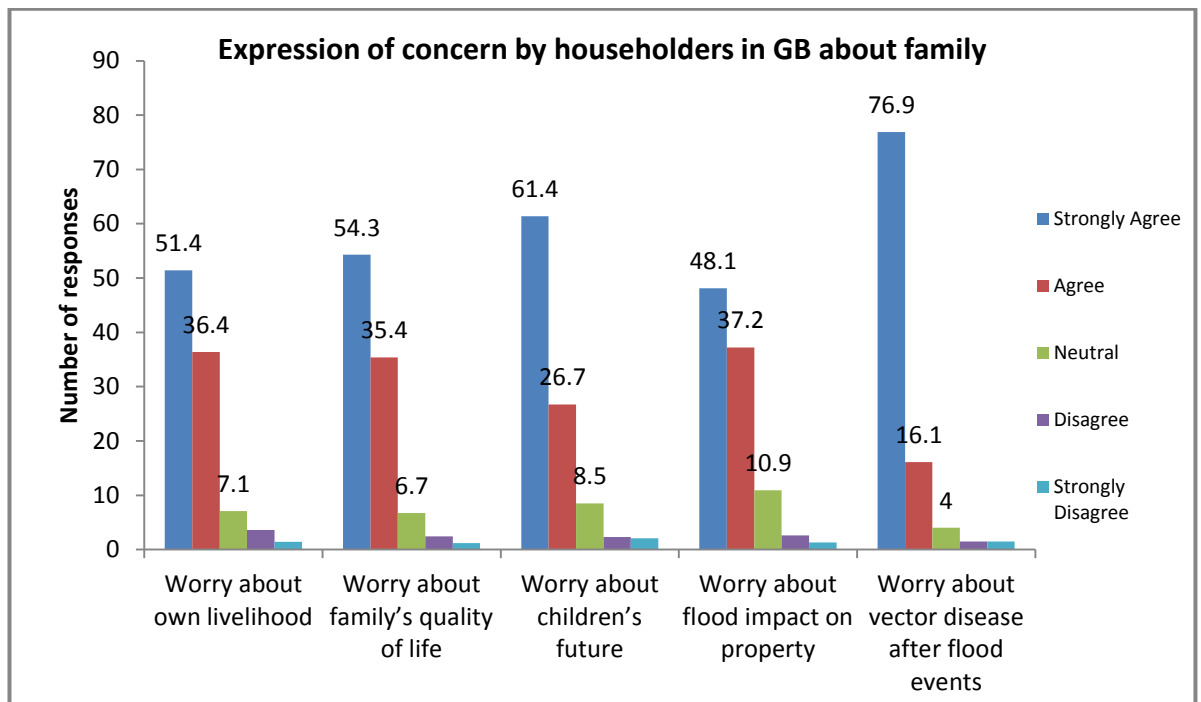
(i) *Tangible impact*

Of the 212 householders that responded, the nature and extent of damage to their property and personal effects varied considerably (Appendix 12, Table 53). Other adverse effects of the flood were on utilities and on infrastructure. Water and power supply and telecommunication network was interrupted temporarily. Transport facilities were affected and school were closed for a day at most (Appendix 12, Table 54).

(ii) *Intangible impact*

About 60% of householders who responded (n=213) were upset about the damage caused by the flooding (Appendix 12, Table 55).

Of the 212 householders who responded, some 12% agreed or strongly agreed that they could not get back to normal (Appendix 12, Table 56). About 90% of householders (n=164) agreed or strongly agreed that they were worried about their quality of life and the future of their families. They also showed concern about the future impact of recurrent flooding on their property and about the increase of vector-borne diseases after flood events (Figure 5.16).



Source: Author's survey

Figure 5.16 Lasting emotional stress in the aftermath of flood as perceived by householders in LH

5.4.4 Exposure

(i) Living with flooding

Most of the householders in the sample surveyed had different reasons for living in a coastal wetlands area (Table 5.16). Some lived there because of job proximity, others due to the closeness of relatives and to be among their communities. A high proportion of householders (48% of n=104 respondents) settled there through their own choice. As

GB was a fast developing tourist resort and with there were many job opportunities, many people settled in the surrounding wetland areas. At that time, the wetlands were taken to be of little market value; hence, little or no investment was needed. Once

settled, the communities hoped that with time, the government would build the necessary infrastructures in their areas.

Table 5.16 Reason given by GB householders for living on site

	Number of respondents	% of total households
Job proximity	37	17.1
Access to amenities	3	1.4
Close to relatives	58	26.9
Same community	38	17.6
Own choice	104	48.4

Source: Author's survey

5.4.5 Socio-economic conditions of households

(i) Land occupation and house ownership

Of the 116 householders that responded, some 54% owned land, and about 70% (n=151) had built concrete houses (Table 5.17). About 40 householders (20% of all householders) lived in rented houses or in temporarily built shelters on state lands. Nearly 15% of the houses were built of fragile tin sheets (Appendix 12; Table 57).

Table 5.17 Land and house ownership in GB

	Number of Respondents (n)	% of total households
Own land	116	54.2
Own house (concrete)	151	70.9
Live in low-cost houses¹	40	18.8
Live on state lands	22	10.3

¹ partly tin/concrete or wholly tin material

Source: Author's survey

Out of 188 householders who replied, about 23% agreed or strongly agreed that they were living in crowded and unsafe conditions. Most of these respondents felt that they were also at risk of catching flood-related diseases. Some 50% of householders that responded (n=215) perceived a lack of support from the local authorities. In addition, some 60% of the respondents (n=208) felt there was a lack of community cohesion (Appendix 12, Table 58).

5.4.6 Recovery

(i) Getting property back to normal after flood

Households got back to normal at different rates after a flood event. Over 75% of the householders (n=159) responded that they got their houses and gardens back to normal immediately after a flood event. A few householders (n=47, 23%) said it took longer to return to normal.

(ii) Perception of living in damp conditions

The perception of living in damp conditions varied among households (Table 5.18). Some 60% of householders (n=133) perceived that conditions remained damp for a short while or for many days after a flood. About 80 householders (40%) agreed or strongly agreed that they were not at all affected.

Table 5.18 Perception of households in GB to living in damp condition

	Number of respondents	% of total households	Agreement scale in percentage					Total
			strongly agree	agree	neutral	disagree	strongly disagree	
Short while	66	30.6	43.9	51.5	3.0	1.5	0	100
Whole day	22	10.2	13.6	72.8	4.5	4.5	4.5	100
Many days	45	20.8	73.3	20.0	2.2	2.2	2.2	100
Not at all	80	37.7	26.7	68.9	1.1	2.2	1.1	100

Source: Author's survey

(iii) Householders' perceptions of living conditions after a flood

Of the 108 householders who replied, about 80% agreed or strongly agreed that the quality of their own life and that of their family had remained largely unchanged since the last flood event (Appendix 12, Table 59). A small proportion of householders (n=28, 15%) perceived that the living conditions of their families deteriorated significantly after a flood.

(iv) Forms of assistance given in recovery phase

Nearly 80% of those who replied expressed their strong concern about the flood risk. Only 22% of the replies indicated that government assistance was adequate while 45% felt otherwise. Significantly, a third of the respondents did not express their views.

(v) *Relocation after flooding*

Over 100 householders (48%) claimed to have received support from their relatives, a few others from their own community, and hardly any from local charities, social organisations, or from the government (Appendix 12, Table 60). In terms of long-term assistance, most of the respondents felt that they did not receive enough in terms of building materials, financial grants, and soft loans (Appendix 12, Table 61). A significant finding is that over 55% of the respondents were neutral in their response. Hardly any of the householders who responded considered relocation to other places favourably. Here also, over 60% of the respondents remained neutral (Appendix 12, Table 62).

5.4.7 Resilience - coping and adapting to flood hazard

(i) *Precautions taken before a flood and adapting to flood hazards*

In order to minimise the adverse impact of a flood event, households had developed a number of coping strategies. About 40% of householders (n=88) took essential precautions, such as stockpiling food and removing possessions from the ground, while about 15% placed flood guards at doorsteps or made furrows to divert flood water away from the house (Table 5.19). Very few householders were willing to move to safer places.

Table 5.19 Precautions taken by householders in GB before each flood event

	Number of respondents	% of responses
Remove possessions from ground	88	40.7
Evacuate to safer grounds	16	7.4
Place flood guard at doorsteps	31	14.4
Make furrows to divert water	28	13.0
Move to refugee centre	5	2.3
Move to relatives' place	9	4.2
Move to neighbour's place	3	1.4
Stockpile food	87	40.3
Move animals to safer grounds	11	5.1
None of the above	36	16.7

Source: Author's survey

Long-term adaptive strategies involved the raising of floors to above the watermark or the building of another level. Of the 65 householders who responded, 70% lived through flood events and accepted things as they were (Appendix 12, Table 63).

(ii) Reliance for flood protection

Of the 195 householders who replied, about 90% responded that they relied on themselves for flood protection. While around 27% relied on the family, very few relied on external support, such as NGOs, and charity organisations and local and government authorities (Appendix 12, Table 64).

(iii) Collaborating with the community

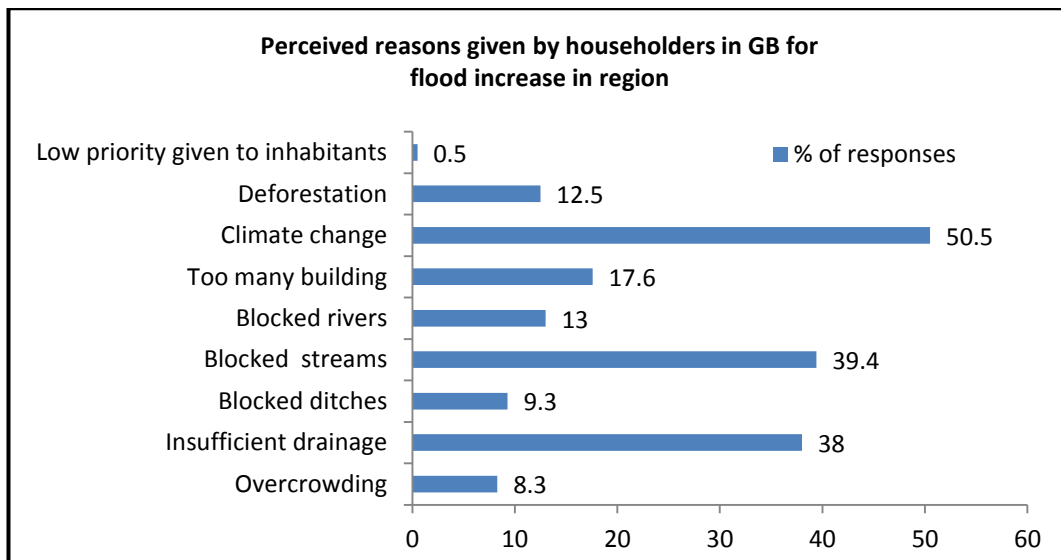
Of the 134 householders who responded, over 60% helped their neighbours and around 35% (n=75) collaborated with their communities to clean up after a flood. However, very few liaised with local authorities in planning measures to reduce the impact of flooding in their localities (Appendix 12, Table 65).

5.4.8 Awareness of flood hazard

(i) Awareness of living in a flood zone

About 63% of those who responded (n=136) were aware to varying degrees that they were living in a flood risk area and that there had been flood events in recent years (Appendix 12, Tables 66).

Among the reasons given for the increase in flooding in their locality were blocked drainage systems and haphazard development over the area (Figure 5.17 and Appendix 12, Table 67). A majority of householders claimed that the increase in flood frequency was due to a change in weather patterns or climate change, an issue that had become very popular in media coverage.



Source: Author's survey

Figure 5.17 Perception of householders in GB for increase in flood events

(ii) *Flood warning sources*

Most householders responded that the radio and the television were the most common media sources of flood warnings. About 50% of householders (n=108) listened to warnings some of the time, 40% listened regularly, and a few never listened to them (Table 5.20).

Table 5.20 Frequency of listening to flood warnings by householders in GB

Frequency	Number of respondents	% of responses
Regularly	87	40.3
Sometimes	108	50.0
Rarely	11	5.1
Never	10	4.6

Source: Author's survey

(iii) *Householders' opinions on warnings*

Of the 214 householders who responded, 86% agreed or strongly agreed that warnings were delivered in time for them to act and that they were fully understood. On the other hand, 61% of householders who responded (n=215) were of the opinion that flood warnings should be improved further (Appendix 12, Table 68).

5.4.9 Opinion of flood risk reduction measures

(i) Householders' opinions on government support

Householders gave diverse opinions on government support for flood risk reduction measures. About 60% of householders who responded (n=214) agreed or strongly agreed that the government should improve emergency measures after a flood. Furthermore, about 70% agreed that the government should improve and strengthen flood proof structures (Appendix 12, Table 69).

Over 90% of householders who replied strongly agreed that the government should invest in flood awareness programmes in schools, youth clubs, and community centres (Appendix 12, Table 70). Of the 187 householders who responded, some 40% were of the opinion that there were differences in government support to their community during and after a flood event. About the same proportion of householders agreed that the government should help them in improving their quality of life (Appendix 12, Table 71).

(ii) Householders' opinions on NGOs' support

About 30% of householders who responded agreed that there were differences in NGOs' support from one sector of the community to another after a flood. About 15% felt that NGOs should help with emergency services and with investing in flood prevention structures in their locality. It was also thought that they should furthermore help the community in improving their quality of life. Significantly, about 70% did not respond to the question relating to NGOs (Appendix 12, Table 72).

(iv) Householders' perceptions of participation in environmental decision-making (EDM)

Of the 213 householders who responded, 50% agreed or strongly agreed that they were 'left out' by the government in participating on decision-making concerning flood management in their locality. Some 30% of householders, however, agreed that the government should allow them to participate in EDM (Appendix 12, Table 73).

5.5 Comparison of findings amongst the three communities

(i) Characteristics of households

The analysis of the questionnaire survey showed that the characteristics of the households in the three communities varied in several ways. Compared to LH and GB, there were more households with a large number of family members in CLC, with a high percentage of dependent persons under one roof. Although the levels of literacy of households were about the same in all three communities, there was a relatively high number of households belonging to low-income groups in CLC and GB.

Householders' experiences of flooding varied, but in all three locations, householders responded that they had experienced flooding after every heavy rainfall. Houses and neighbourhoods were flooded, and the water level reached different heights with associated damage to houses, property, and infrastructure in CLC, LH, and GB. Intangible impacts, such as being upset about not being able to recover immediately after the flood and anxiety about living conditions and about recurrent flood-borne diseases were prevalent in all three cases.

(ii) Social conditions of households

It was found that nearly all householders surveyed occupied flood risk zones through their own choice or in order to live in their own communities. Making their own choice may mean that households might have taken their own risk or might have had only limited options available to them. Virtually no investments were needed as flood risk zones had little or no land value. In CLC and GB, households occupying government lands live in precariously built houses. Environmental factors, like overcrowding and living in unsafe neighbourhoods, could have contributed to the vulnerability of households in the three communities.

(iii) Recovery and resilience-building

Patterns of recovery varied over a time scale in CLC, LH, and GB. Some householders could not get the household back to normal due to a lack of financial resources or a lack of insurance cover. The variation of living in damp conditions over a longer period had an adverse psychological impact on some householders.

Most of the householders took the responsibility to protect their own families from future harm rather than relying on authorities or others. Fewer householders relied on social protection from outside sources in LH and GB than in CLC. Making furrows and placing flood guards to divert water at the doorstep were common strategies in all three locations. Longer-term adaptive strategies were to build floors higher than the previous water mark, implying that past experience of households played an important role in building resilience against flooding. Strengthening the community network and liaising with local authorities were also taken as social protection measures in all three locations.

Most householders declined the opportunity to move out to other locations; this could be from a fear of losing their belongings. Householders occupying government land might be afraid that they might not be allowed to come back and reclaim their property. This could explain why some householders in CLC and GB adapted themselves to flood conditions by accepting things as they were and living through each flood event.

Most householders in all three communities were aware that they were living in a flood risk zone, and they gave a number of reasons for the increase in the number of flood hazards in their areas. The insufficient drainage systems resulting from unplanned land use to accommodate a growing population, blocked waterways, and a change in weather patterns in recent years were seen as factors contributing to the increase in the frequency of flood hazards.

(iv) Attitude of local and national institutions

Not all householders were regular listeners to flood warnings, but most of them felt there was a need to improve the flood warning systems. Opinions on flood risk reduction measures were similar in all three cases. Most householders thought that the government should improve the flood risk reduction measures by investing in flood awareness programmes, improving emergency services, and reinforcing flood protection structures. Some householders thought the government and NGOs should support them in improving their quality of life. This was more evident in households in CLC and GB, who had a sense of being 'left out' by the authorities.

5.6 Summary

This chapter provided the results of the exploratory analysis of all the data obtained from the questionnaire used in the survey that was carried out in the three communities. The findings provided valuable information on the household characteristics, patterns of vulnerability, and coping strategies, and on householders' perceptions of local authorities' policies on flood risk disaster risk management. A summary of the overall findings is listed below:

- *Social resilience*: Households varied in their level of vulnerability/resilience in accordance with the social parameter considered. Among the communities studied, CLC was the least socially resilient when all of the parameters are taken into account. GB was more resilient than CLC, and LH was the most resilient of the three.
- *Economic resilience*: Socio-economic conditions and living in crowded conditions indicated conditions of poverty, which were most marked amongst households in CLC. This also indicated the difficulties that underprivileged groups of households encounter in the recovery phase of flood hazards; poorer households are more vulnerable and show least resilience. The CLC community was found to be the least resilient economically followed by GB and LH.
- *Infrastructural/environmental resilience*: Land occupation issues and the economic and social factors that influenced householders to live in flood risk zones contributed to households' vulnerability and weak resilience in the event of flooding. The quick restoration of infrastructure and communication systems was a crucial element in the effective and timely relief and emergency operations after a flood. This, in turn, depended on the effectiveness of the arrangements made at the institutional level to increase resilience to flooding within the community.
- *Institutional resilience*: The degree of support the government provided to households in the three locations was found to be inadequate for rehabilitation purposes. On the other hand, giving assistance to affected households in the

aftermath of floods could be counter-productive and could lead to lower resilience. Likewise, relocation programmes could also reduce the resilience of the relocated households.

- *Psychological resilience*: Most householders were worried about the living conditions of their families. They lived in fear of catching flood-related diseases.
- *Community competence*: There was a reasonable degree of community cohesion, particularly among households in CLC, though this was far less noticeable in GB and LH. Hence, though CLC is the least endowed location socially and economically, community solidarity should help in building resilience in times of need. There was also some feeling of marginalisation and environmental injustice among the CLC households. This condition could explain the sense of social cohesion among some households.

The next chapter examines the possible association of vulnerability-related responses with specific characteristics of household groups.

Chapter 6 - Statistical Analysis of Quantitative Data from Questionnaire Survey

6.1. Introduction

In this chapter, the primary focus is to examine, using statistical methods, the possible association of vulnerability-related responses with specific characteristics of household groups. The statistical analysis is meant to increase the conciseness, clarity, and objectivity with which the results are presented and interpreted. The results also complement the descriptive results of Chapter 5 when answering Research Question I: *What is the vulnerability of different sectors of a community in Mauritius to flood hazards, and how does it relate to recovery and resilience building?*

6.1.1 *Independent or explanatory variables - Household groups and characteristics*

Independent or explanatory variables are obtained by reducing or collapsing selected household socio-economic characteristics (Section 5.2.1) into two elements or sub-groups that can be used to test possible associations with the *dependent* variables. Several studies have identified socio-economic groups with specific characteristics as being vulnerable to disasters: families with children and elderly members (Cutter, 2003); children (Wisner et al, 2006); families with children and families with low income level (Houston et al., 2007); age, education level, employment level and household size (Ferdinand et al., 2012); older adults (Tuohy and Stephens, 2012); and children/young adults (Whittle et al., 2012). Therefore, five explanatory variables were selected from the above that best describe the socio-economic characteristics of the households in the three locations, namely:

(i) **Independent variables**

a) *Household size*

Household size was divided into two sub-groups: (a) families with four or fewer members, and (b) those with more than four members. The limiting value is based on

the 2010 Census in Mauritius, which gave the average number of members per household as 3.9. The census period was close to the period of the questionnaire survey, namely, August/September 2010 for CLC, October/November 2010 for LH, and December 2010/February 2011 for GB. However, since then, the average number of members per family has decreased to 3.6 (Housing Census, 2011).

b) Level of literacy

The two sub-groups were householders with (a) a low level of literacy, and (b) a high level of literacy. The low-literacy sub-group was considered to be those who had received up to six years of schooling or had completed the Certificate of Primary Education (CPE). It was assumed that the other sub-group had at least attended a technical school or acquired secondary or higher level of education.

c) Income level

The two sub-groups were (a) low income, and (b) high income householders. The low-income sub-group comprised those who claimed to be factory or manual workers or who were unemployed or partly employed. Their monthly salary was estimated at Rs7, 055 (about £110 at July 2007 rate) or less. The high income group comprised those with a monthly salary of more than Rs7, 055. This group included householders employed as skilled workers, either in public service or as professionals. The salary was the average monthly income of household categories indicated in *Poverty Analysis 2006/2007* by the Central Statistics Office (2007), Ministry of Finance and Economic Empowerment. This was the most up-to-date figure on salaries available at the time of the survey.

d) Household without/with children

This variable was divided into two sub-groups: (a) households with no children, and (b) households with children younger than 14 years. The children younger than 3 are generally under the care of parents and those between 3 and 14 years are at pre-primary or primary, or at the first year of secondary. Both sub-groups are highly dependent on their parents.

e) *Household without/with old persons*

The two sub-groups were households (a) with no persons above 60 years, and (b) with persons above 60 years. The 60-year age limit was chosen as it marked the age of retirement, and retirees benefit from a universal pension scheme. They stay mostly at home and are dependent on the householders for their overall well-being. At the time of the survey, the mandatory retirement age in both public and private sectors was 60 years. Since then, the retirement age has been raised to 65 years.

(ii) **Structure and characteristics of the groups**

The chapter explores statistically how far the vulnerability of householders could be associated with family size, education level, income level, and being households with children and with elderly persons. Table 6.1 gives the frequency (and corresponding % to facilitate comparison across regions) of households in each of the sub-groups used in the *statistical test of independence*.

Table 6.1 Breakdown of the survey data into two sub-groups of households for each of the five sets of independent variables of the three communities in terms of frequency and percentage

Region	CLC		LH		GB	
Independent variables (10 Subgroups)	Number of households surveyed					
	236		131		216	
	Number	%	Number	%	Number	%
Size of family ≤ 4	67	28.4	77	58.8	176	81.5
Size of family > 4	169	71.6	54	41.2	32	14.8
Literacy low	93	39.4	55	42	149	69.0
Literacy high	56	23.7	21	16	62	28.7
Low income	123	52.1	43	32.8	157	72.7
High income	113	47.9	85	64.9	56	25.9
Without young children	56	23.7	37	28.2	113	52.3
With young children	174	73.7	94	71.8	103	47.7
Without elderly	170	72.0	93	71	151	69.9
With elderly	65	27.5	38	29	65	30.1

From Table 6.1, the total number of questionnaire replies received was least for LH (131) while those for CLC and GB were comparable (236 and 216, respectively). A brief examination of the table gives the following comparative socio-economic data for the three locations:

- i) In CLC, there were three times as many large families as small ones. In LH, smaller families were about 1.5 more numerous than large ones, but in GB, there was an overwhelming number of small families.
- ii) In both CLC and LH, a significant number of householders (35% at CLC and 42% at LH) did not specify their level of education. At GB, nearly all specified their level of education. At CLC, the proportion of those with a higher level of education to the lower level group was 0.6 while the corresponding figures for LH and GB were about 0.4.
- iii) In CLC, the numbers with low and high incomes were similar; in LH, the number with a high income was twice the number of those with a low income, and in GB, the number with a low income is three times those with a low income.
- iv) In CLC and LH, three times as many families had children compared to those who did not. However, in GB, the number of householders with children was about the same as those who did not have children.
- v) In all three regions, the proportion of households without/with elderly was about the same for all three regions at 2.5.

(iii) Dependent variables

In the statistical analysis, 220 *dependent variables or response variables* were identified in the questionnaire. These were grouped into nine broad themes (Section 4.9.1) along the conceptual framework of vulnerability. The theme 'household characteristics' was applied as an independent variable. The grouping used throughout the study ensures uniformity and ease of interpretation.

The use of Pearson's chi-square test for the different types of variables and the conditions of its applicability are discussed in Appendix 12 along with the procedures used for obtaining the corresponding values. The complete set of chi-square values as calculated using SPSS for the possible association between independent and dependant variables is given in Appendix 13.

RESULTS OF THE STATISTICAL ANALYSIS AT CLC, LH and GB

In order to answer Question I comprehensively, statistical analysis using chi-square tests was performed at a confidence level of $p < 0.05$. The aim was to identify the vulnerable sectors of the community by finding possible relationships between the ten sectors of the community (independent variables, as discussed above) and various components (dependent variables, as discussed above) of vulnerability. Where the statistical analysis between the variables gave significant results, an attempt is made to discuss possible causality between them and thus determine the vulnerable sector of the community and how they could be related eventually to recovery and resilience building.

The results for each of the three case studies are discussed under various themes, namely: experience of flood hazard; impact of flooding; exposure to flood hazard; socio-economic conditions; recovery; resilience; awareness; role of the government, NGOs, and community in flood management and environmental decision-making; and the opinion of householders on the support and action of the government, local authorities and NGOs on flood risk reduction measures (Section 4.9.1). These themes comprise sets of dependent variables. Accordingly, the following sections (Case Study One, Two and Three, below) present the results obtained from the tests that show which independent variables (household characteristics) appear to affect different aspects of vulnerability as reflected by certain groups of dependent variables.

CASE STUDY ONE: Assessing the vulnerability of groups from CLC

6.2 Experience of flood hazard

6.2.1 Experience of flooding

In case A (Table 6.2), nearly all the respondents (99%) with low income were likely to have experienced flooding in the previous three years more severely than others. In cases B and C (Table 6.2), a higher fraction of the low income group (80% against 60% for high income group) recalled that floods had been more frequent during the last three years.

Table 6.2 Statistics defining relationship between household income level (in %) and experience related to flood hazard in CLC significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with low income (%)		Households with high income (%)	
					agree*	disagree*	agree*	disagree*
A	Experience of flood hazard in the past 3 years (NR=123/112)	10.753	2	0.005	99.2	0	95.1	0
B	Experience of more than one flood for the last 3 years (NR=122/111)	15.718	4	0.003	79.2	3.6	60.6	9.8
C	Experience flood every year in the last 3 years (NR=122/111)	14.967	4	0.005	78.3	3.6	60.6	9.0

Source: Author's survey

Note: agree* = sum of 'strongly agree' and 'disagree*' = sum of 'strongly disagree' and 'disagree'; df = degrees of freedom; NR = number of respondents (low/high income households)

Any severe flood is a near-traumatic event, and therefore, the low-income groups tended to remember them more vividly. Often, the low-income groups had no other choice than to occupy marginal lands that are more prone to hazard risk. The majority of the households surveyed in CLC lived on wetlands, with some on the mountain slopes, and others along the river banks (Appendix 12; Table 89). One possible reason for the low-income households congregating in such areas could be that flood risk zones have a low market value, and settling there requires virtually no investment. Often these were government lands from which it was often difficult to dislodge the squatters for political and humanitarian reasons. Households with a low income had few assets and thus were limited in their choice of residential locality (McEntire, 2011). For both groups,

proximity to job areas and living among one's own community could be other reasons for settling in flood and other hazard risk zones.

6.3 Impacts – tangible and intangible

(i) Family disruption

Among the low-income group, nearly half of those who replied felt that flooding caused family disruption (dependent variable D, Table 6.3). In this regard, Clemens et al. (1999) observed that family disruption might result from a significant level of anxiety, resentment, and disappointment related to disaster relief among low income communities. However, family disruption could also be the result of other emotional factors after a flood event, as was mentioned in Section 5.2.3 (ii).

Table 6.3 Statistics defining relationship between household income (in %) and impacts in CLC significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary Statistics			
		χ^2	df	p-value	Households with low income (%)		Households with high income (%)	
					agree*	disagree*	agree*	disagree*
D	Family was disrupted (NR=120/108)	16.417	4	0.003	47.2	34.3	24.2	56.7

Source: Author's survey

Note: Agree*= sum of 'strongly agree' and 'agree' and 'disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (low/high income households)

6.4 Socio-economic factors

Table 6.4 Statistics defining relationship between household literacy (in %) and socio-economic variables in CLC significant at $p < 0.05$ level

Response Variables		Chi-square test results			Summary statistics			
		χ^2	df	P-value	Households with low level of literacy (%)		Households with high level of literacy (%)	
					agree*	disagree*	agree*	disagree*
A	Mosquitoes infested area (NR=92/56)	16.232	4	0.003	51.1	26.1	60.7	25.0
B	Lack of community cohesion (NR=91/56)	9.980	4	0.041	29.7	50.6	51.7	42.9

Source: Author's survey

Note: Agree*= sum of 'strongly agree' and 'agree' and 'disagree'*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; (ii) NR= number of respondents (number with low/high level of literacy)

i) **Health issues** (dependent variable A in Table 6.4)

Overall, some 60% of householders replied to the question. Of those who replied, 61% with a high level of literacy were more conscious of the likelihood of the adverse impact on health of exposure to mosquitoes and possibly other vector-borne diseases than were households with a low level of literacy. Still, about 51% of those with a low level of literacy were aware that they lived in mosquito-infested areas.

The greater awareness of health issues among households with high level of literacy can be explained by the fact that they have generally better living conditions and greater access to information (Statistics Mauritius - Housing Census, 2011). Tobin (1999) considered that the level of education is an important factor that contributes to the understanding of environmental issues including exposure to health risks. In a study by Few and Pham Gia Tran (2010) households with a low level of literacy were not able to understand information and communications on health risks and health protection. Often those with a low income level are not enthusiastic about accessing information regarding health and disease and are thus more vulnerable.

ii) ***Lack of community cohesion*** (dependent variable B in Table 6.4)

The statistical analysis indicated that there was a significant difference in the perception of community cohesion based on the household level of literacy. A majority of those with a low level of literacy felt that there was cohesion among the community members with regard to coping with hazards. About half of those with a high level of literacy that replied felt that there was lack of cohesion, but a significant number (42%) disagreed.

The discrepancy in the perception regarding community cohesion may be influenced by changing social processes, such as modernization and better living conditions. Schwarz et al. (2011) found such a change in the rural society of the Solomon Islands in the Pacific. The social and economic transformation brought changes in intra-community solidarity and collective support that have been the norm in the social fabric of the communities. However, collective action was still regarded as a critical factor influencing their community's ability to build resilience and cope with hazard risks. This is probably the case with those at CLC who have a low level of literacy.

(iv) *Type of fabric used for housing*

Table 6.5 Statistics defining relationship between income level (in %) and type of house fabric in CLC significant at $p < 0.05$ level

Income level and house fabric	Concrete	Concrete/tin	Tin	Total %
% within low income level (NR=113)	44.2	26.5	29.2	100
% within high income level (NR=113)	67.3	21.2	11.5	100
Total (%)	55.8	23.9	20.4	100

Source: Author's survey

Pearson's chi-square value 14.727; $df=2$; $p\text{-value}=0.001$; NR=number of respondents

From Table 6.5, about 67% of the households with a high income had concrete houses, which were more wind resistant and were more expensive to build. Only about 11% had tin houses, which were relatively less costly but were least resistant to winds and strong flood currents. Less than 45% of the low income households had concrete houses while 25% had concrete/tin houses and 30% had tin houses.

As found in Section 5.2.5, about 20% of households in CLC lived in precarious temporary houses built on government property. A study on *Common Country Assessment in Mauritius* (Office of the United Nations Coordinator Mauritius, 2000) found that households with a low income were usually an underprivileged group living in unsafe neighbourhoods with disrupted family structures and with a high unemployment rate. Overcrowded settlements and a greater risk of successive hazard events with poor housing and poor sanitary conditions exposed them to various diseases (Pelling, 2003). Under crowded conditions, family structures were found to be more vulnerable when households were no longer able to cope and recover easily from hazards.

(iv) *House ownership*

Table 6.6 Statistics defining relationship between income level (in %) and house ownership in CLC significant at $p < 0.05$ level

Income level and house ownership	Own the house	Rented	Rented on low cost	Temporarily occupied	Total %
% within low income level (NR=115)	67.3	3.5	5.3	26.5	100
% within high income level (N=113)	65.2	18.3	6.1	10.4	100
Total (%)	64.5	11.0	5.7	18.4	100

Source: Author's survey

Pearson's chi-square value 20.396; $df=4$; $p\text{-value} < 0.001$; NR=number of respondents

From Table 6.6, it appears that both groups claimed in equal number to own their own houses. Those with a low income claimed to be occupying the houses temporarily, which may be because they had built on government land. In this sense, a slightly higher fraction of the low income group was vulnerable to flood conditions.

(v) Land occupation

From Table 6.7, it is noted that a slightly higher proportion of households with a high income owned land while a large number of households from the low income group occupied government property. Frequently, they had built fragile temporary houses out of necessity as they could be aware from experience that it was often difficult to eject squatters from government property because of political and humanitarian reasons.

Table 6.7 Statistics defining relationship between income level (in %) and land occupation in CLC significant at $p < 0.05$ level

Income level and land occupation	Own the land	Rented	Government property	Total %
% within low income level (NR=114)	56.6	8.0	35.4	100
% within high income level (NR=113)	60.5	20.2	22.0	100
Total (%)	58.6	14.1	27.3	100

Source: Author's survey

6.5 Recovery

(i) Getting house back to normal

Table 6.8 Statistics defining relationship between time required to return house to normal and the income level of the household in CLC significant at $p < 0.05$ level

Getting house to normal	Immediately after flood	Weeks later	Months later	Never returns to normal	Total %
Household with low income (%) (NR=111)	49.5	12.6	14.4	23.4	100
Household with high income (%) (NR=111)	67.6	18.0	6.3	8.1	100
Total (%)	58.6	15.3	10.4	15.8	100

Source: Author's survey

Pearson's chi-square value 15.915; $df=3$; p value=0.001; NR=number of respondents

Another indication of the capacity to recover can be deduced from Table 6.8. Those with a low income invariably took longer to recover or get back to normal though some 50% of low income group claimed that they got their house back to normal immediately after a flood event. Significantly, 23 % of the low income group and only 8 % of the high income group claimed that they never got back to normal.

The results reflect the situation whereby the high income group were probably residing in somewhat safer locations away from the heavily flooded areas. They also had the resources and probably the appropriate political connections that enabled them to take remedial measures immediately after the flood.

Table 6.9 Statistics defining relationship between household without/with elderly persons (in %) and getting back to normal in CLC significant at p<0.05 level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with no elderly persons (%)		Households with elderly persons (%)	
					agree*	disagree*	agree*	disagree*
A	House did not get back to normal since last flood event (NR=163/59)	9.632	4	0.047	27.6	63.2	45.8	45.8

Source: Author's survey

Note: agree*= sum of 'strongly agree' and 'agree'; 'disagree'*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (without/with elderly persons in households)

In the case of variable A, Table 6.9 households with elderly persons were slightly more inclined than those without elderly persons to perceive that their houses did not get back to normal than those without. Households with no elderly persons may not have had long standing experience of floods and hence limited coping strategies. They may also have fewer goods that are generally hoarded over the years by elderly persons. A report on *Poverty Analysis in 2006/07* (Central Statistics Office, 2007) showed that households without elderly persons were more likely to be in poverty than those with elderly persons. In Mauritius, every elderly person receives national pension (Rs3000/month about £65, July 2009 rate). In this way the pension ensures that extra financial help is available to the family. The additional help might be inadequate to cater for the larger family and therefore those with elderly members were still vulnerable.

6.6 Warning (*Awareness*)

Table 6.10 Statistical association between household size (in %) and delivery of warnings in CLC significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Small households ≤ 4 members (%)		Large households > 4 members (%)	
					agree*	disagree*	agree*	disagree*
Warning was delivered in time to act (NP=66/168)	9.521	3	0.023	63.7	19.7	45.3	37.5	

Source: Author's survey

Note: agree* = sum of 'strongly agree' and 'agree'; disagree* = sum of 'strongly disagree' and 'disagree'; df - degrees of freedom; NR= number of respondents (households with ≤ 4 and with > 4 members)

The timely delivery of warning is seen as a component of awareness which is an element of vulnerability. The statistical association with household size is discussed.

6.6.1 *Timely delivery of warnings*

Table 6.10 shows that a higher proportion of the large families perceived that warnings were not delivered in a timely manner. It could be that they found that the lead time necessary to ensure their security was inadequate leaving them in vulnerable conditions in the advent of the flood.

In addition, the difference in perception may be largely related to the better living conditions of small households. It was found that in Mauritius, households with fewer persons had more living space available to each member and hence had better living conditions with access to a better communication network and a greater awareness of any warning bulletins issued (Mauritius Central Statistics Office: *Poverty Analysis, 2006/2007* and *Housing Census: Statistics Office, 2011*). The Census also reported that over 90% of the population had televisions or radio sets, which were the most common sources of warnings (5.2.8 ii). Access to alerts through a communication network could ensure greater awareness and facilitate resilience by helping people make better-informed decisions (Collins et al., 2008). Smaller households tended to be more educated and better informed and with greater ability to interpret risk (Haynes et al., 2008). They were thus less vulnerable to flood risk.

6.7 Government and NGO support

(i) *Government support to flood hazard victims* (dependent variables F, G and H, Table 6.11)

A significant number from both groups, especially the high income group (50%), did not wish to express an opinion on government actions (dependent variables F, G and H Table 6.11). Among the low income group, up to 40% maintained a neutral position though a greater proportion of the low income group perceived differences in government support during relief and emergency situations or in building flood defences. However, the proportion was smaller and similar when it came to improving quality of life.

Table 6.11 Statistics defining relationship between household income (in %) and other dependent or response variables in CLC significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with low income (%)		Households with high income (%)	
					agree*	disagree*	agree*	disagree*
F	Differences in government support to different communities in relief and emergency services (NR=121/111)	10.044	4	0.040	44.1	22.5	28.9	19.0
G	Differences in government support to different communities in building flood defences (NR=121/111)	9.996	4	0.040	44.1	23.4	29.7	19.0
H	Differences in government support to different communities in helping to improve quality of life (NR=120/111)	11.658	4	0.020	31.4	26.1	28.3	19.1
I	Differences in NGOs support to the community after a flood hazard (NR=121/111)	13.599	4	0.009	28.8	30.6	11.6	41.3
J	Differences in NGOs support to the community in relief and emergency services (NR=121/111)	11.772	4	0.019	26.1	31.5	11.6	42.2
K	Differences in NGOs support to the community in helping to improve our quality of life (NR=121/111)	11.772	4	0.019	26.1	31.5	11.6	42.2

L	Differences in NGOs support to the community in building flood defences (NR=121/111)	11.491	4	0.022	25.2	31.5	11.6	43.0
M	Community feeling of being abandoned at every flood hazard (NR=121/111)	12.200	4	0.016	51.3	39.6	32.2	56.2

Source: Author's survey

Note: agree* = sum of 'strongly agree' and 'agree'; disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (low/high income households)

Their opinion on government support may be framed by the past experience of such households. For example, during the major flood event of 2008, the only external aid the flood victims received was in the form of cash from the government of around Rs 500 (equivalent to £10) per household. It was found that households from a low economic background often used that money to buy their immediate basic necessities for a few days. Thus, such assistance could lead to more vulnerability and could impede resilience (Tobin, 1999). Furthermore, expectations could be high in view of the high demand of those seriously affected. These might not be adequately satisfied, thus reinforcing the perception held by low income households that there are differences in government support.

(ii) *NGOs support to flood hazard victims* (dependent variables I, J, K and L, Table 6.11)

As in the case of the government, a significant number from both groups, especially the high income group (50%) did not wish to express an opinion (dependent variables I, J, K, and L, Table 6.11). Among the low income group, up to 40% maintained a neutral position. The low income group invariably perceived that there were differences in NGO support to the community in various aspects. The high income householders were less concerned. However, within each group, especially among the high income group, a higher percentage disagreed rather than agreed that there were differences in the support given to the community.

The disparity in NGOs support as seen by low income households could be explained by the working methods of NGOs when working with vulnerable groups. As stated by a study on in the *Common Country Assessment Mauritius* (Office of the United Nations

Coordinator Mauritius, 2000), there could be a lack of coordination between vulnerable groups and the authorities. Indeed, Pelling (1998) mentioned the following factors that contributed to the lack of coordination in Guyana in the aftermath of a flood hazards:

- (i) limited resources
- (ii) inequality in providing support to the needy vulnerable groups
- (iii) political affiliation may contribute to disparity in support of households of low economic background
- (iv) elites chosen at the local level as leaders may have political contacts and they may give priority to those they know

These factors show some similarity in the context of Mauritius and could be further explored in the focus groups.

(iii) Lack of support from local authorities (dependent variable E, Table 6.12)

Income group

Table 6.12 Statistics defining relationship between household income (in %) and support from local authorities in CLC significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with low income (%)		Households with high income (%)	
					agree*	disagree*	agree*	disagree*
E	Lack of support from local authorities (NR=120/111)	16.989	4	0.003	53.1	25.2	35.0	41.7

Source: Author's survey

Note: agree* = sum of 'strongly agree' and 'agree'; disagree* = sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (low/high income households)

Among those who replied to the question related to support from authorities (dependent variable E, Table 6.12), about 53% of the low income group and 35% of the high income group felt that there was a lack of support from the authorities. About 20% from each group did not express an opinion on the subject.

The low income householders were generally needy and came to expect ready assistance from the authorities. However, these needs were not always fully satisfied, leaving householders with the feeling that the authorities did not support them. In

addition, the financially better off neighbours might be well connected, and this might also give the feeling that the authorities were partial to them.

(iv) Relation between literacy level of household and local authorities

Some 60% of the householders replied to the question, of whom about 63% were those with a low level of literacy. Those with a high level of literacy expressed a stronger feeling of lack of support from the authorities (dependent variable C in Table 6.13). This could be because the more literate group tended to have higher expectations and were more confident in expressing their opinion and criticise the authorities. This group was generally better off and were less dependent on the authorities for their basic needs. Only 15% from the group made neutral responses. Those with a low level of literacy viewed the authorities with some degree of awe and were less prepared to give negative opinions about them as they were aware that they had to interact more closely with the authorities for their various needs. Significantly, some 30% did not express any opinion about the nature of the support they received from the authorities.

Table 6.13 Statistics defining relationship between household literacy (in %) and support from local authorities in CLC significant at $p < 0.05$ level

Response Variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with low literacy level (%)		Households with high literacy level (%)	
					agree*	disagree*	agree*	disagree*
C	Lack of support from local authorities (NR=92/54)	9.973	4	0.041	41.3	29.4	50.0	35.2

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (Low/high literacy of households)

6.8 Role of community in flood management and environmental decision-making

Among those who replied to the question, nearly half of the low income group felt that they were abandoned compared to a third of the high income group. This could be part of the general perception as they consistently expressed concern about differences in the amount and type of support received from the government and NGOs. Here, only 10% from each group did not reply as the question was of a more general nature and did not pinpoint any specific authority.

Feeling of being abandoned at each flood event (Dependent variable M, Table 6.14)

Table 6.14 Statistics defining relationship between household income (in %) and other dependent or response variables in CLC significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Household with low income (%)		Household with high income (%)	
					agree*	disagree*	agree*	disagree*
M	Community feeling of abandon at every flood hazard (NR=121/111)	12.200	4	0.016	51.3	39.6	32.2	56.2

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (low/high income households)

CASE STUDY TWO: Assessing the vulnerability of groups from LH

As with CLC, this section presents the results of tests that show the extent to which the independent variables (household characteristics) appear to influence the different aspects of vulnerability as indicated by certain groups of dependent variables. The households were generally less inclined to respond to the various questions. This may explain the lower number of associations that were statistically significant at $p < 0.05$ level between the independent and the response variables when compared to CLC.

6.9 Impacts - tangible and intangible

In Table 6.15, only a small proportion (between 20 and 35%) of the households replied to both questions.

Table 6.15 Statistics defining relationship between household size (in %) and socio-economic factors at LH significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Small household ≤ 4 members (%)		Large household > 4 members (%)	
					agree*	disagree*	agree*	disagree*
A	House inundated (NR=18/14)	6.472	1	0.011	33.3	66.7	78.6	21.4
B	Personal effects damaged (NR=17/30)	9.020	1	0.003	29.4	70.6	84.6	15.4

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households with ≤ 4 /with > 4 members)

Based on the replies, it is noted that on the issue of 'House inundated' (dependent variable A), a significant proportion of larger households perceived that their houses had been inundated. In line with the above, larger households who claimed that their

houses had been inundated also claimed that they had suffered significant damage to their personal effects (dependent variable B).

Households with large families are generally poor and live in a small living space, as noted in the reports on *Poverty Analysis* (2006/2007) and *Housing Census* (2011) of Mauritius (Mauritius Central Statistics Office, 2007). Households with fewer members in the family are likely to be better off and have the means to afford a television and other communication devices. They tend to be more educated and better informed and with a greater ability to interpret risk (Haynes et al., 2008).

Smaller households are able to protect their houses by building away from the heavily flooded zones. In addition, they might take preventive measures, such as raising the floor level or building concrete walls round their properties to divert flood water. However, practices such as diverting the water to other places results in a '*not in my backyard syndrome*' where reducing the risk in one place increases it elsewhere, most specifically, for the neighbours (Etkin and Stefanovic, 2004). For smaller households, the greater threat is from the flooding of the neighbourhood, which affects the whole community.

6.10 Socio-economic factors

(i) Land occupation

Table 6.16 Statistics defining relationship between household level of literacy (in %) and land occupation in LH significant at $p < 0.05$ level

Level of literacy and land occupation	Own the land	Rented	Total (%)
Low level of literacy (NR=33)	67.3	32.7	100
High level of literacy (NR=16)	90.5	9.5	100
Total %	74.3	25.7	100

Source: Author's survey.

Pearson's Chi-square value 4.117; $df=1$; p value=0.042; NR=number of respondents

Only about 1/3 from each of the two groups – low and high level of literacy - replied to the question on land occupation. A significantly higher proportion of those with a high

level of literacy claimed to own land; very few rented land or houses (Table 6.16). However, fewer among the low literacy group owned land. They primarily lived on rented land. This may be explained by the fact that the high literacy group was better off and preferred to own property rather than pay rent.

6.11 Awareness

From Table 6.17 (dependent variables A and B), it can be observed that about 90% of those with a low income group were generally aware that they lived in a flood zone or of increases in the number of flood events, while only 75% among the high income

Table 6.17 Statistics defining relationship between household income level (in %) and awareness in LH significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics					
		χ^2	df	p-value	Households with low income (%)			Households with high income (%)		
					Very aware	Slightly aware	Un-aware	Very aware	Slightly aware	Un-aware
A	Awareness of living in a flood zone (NR=40/83)	6.251	2	0.044	25.0	65.0	10.0	10.8	65.1	24.1
B	Awareness of increase in flood events (NR=40/84)	7.410	2	0.025	25.0	65.0	10.0	10.7	61.9	27.4

Source: Author's survey

NR= number of respondents (households with low/high income)

group were aware of such conditions. Those adversely affected by successive flood events, namely, households with a low income, were generally more conscious of the events and the changes. Some of these issues are discussed in the following paragraphs.

(i) *Living in a flood zone* (dependent variable A, Table 6.17)

Households with a high income might prefer to live near a river in good housing, mainly for the view (Wisner et al., 2006). Alternatively, they might be new to the area and probably not aware of the extent of the flood. Older residents might not have the means of moving to other places that are less prone to flooding. There are other householders whose living conditions might have improved over the years but they might still find it difficult to move out because of established social networks and the growing price of residential areas elsewhere. Being aware of living in a flood zone, they

could develop coping strategies, such as building at a higher level or enclosing their property using brick walls.

(ii) Increase in flood events in recent years (dependent variable B, Table 6.17)

Households from the high income group were more likely to have a better education and hence be better informed of their environment than were householders from the low income group, who generally had a lower educational achievement (Poverty Analysis of 2006/2007, Mauritius). As their well-being was dependent on their awareness of hazards, they might be able to afford more sophisticated communication technologies and thus access information more readily. As mentioned in Section 5.2.1(iii), informed people interpret risk communication differently and more advantageously than do low income groups (Haynes et al, 2008). The households from the high income group were therefore typically more aware from the media of the increase in flood events due to environmental factors. The reasons were that they had more valuables including electronic and electrical equipment. They were, therefore, more anxious to take precautionary measures ahead of a flood event.

CASE STUDY THREE: Assessing the vulnerability of groups from GB

As for CLC and LH, this section presents the outcome of tests that show the degree to which the independent variables (household characteristics) appear to affect different aspects of vulnerability as indicated by certain groups of dependent variables.

6.12 Impacts - tangible and intangible

(i) Children missed school

Table 6.18 Statistics defining relationship between household size (in %) and dependent or response variable ‘children missing school’ significant at p<0.05 level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Small household ≤4 members (%)		Large household >4 members (%)	
					agree*	disagree*	agree*	disagree*
A	Children missed school (NR=172/30)	12.860	4	0.012	32.0	26.7	63.3	23.4

Source: Author’s survey

Note: agree*=sum of ‘strongly agree’ and ‘agree’ and disagree*= sum of ‘strongly disagree’ and ‘disagree’; df- degrees of freedom; NR=number of respondents (household with ≤4members/>4)

Some 63% of the large families and only 32% of the smaller families agreed that their children missed school (Variable A, Table 6.18). The large families were more likely to have children of a school-going age or to be more attentive to the impact of flooding on children, such as susceptibility to flood-borne diseases.

(ii) Worry about family's quality of life (dependent variable A Table 6.19)

Most households expressed an opinion on the question. Those with a high income tended to be slightly more worried about the quality of life of their families (dependent variable A Table 6.19), perhaps because they were more aware of the value of education and health issues. Households may still worry about their families if they have persons who are disabled, elderly, or in poor health. Absence from work is another cause for worry as there may be wage cuts that could adversely affect their family life.

Table 6.19 Statistics defining relationship between household income (in %) and worry about quality of life of the family significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Household with low income (%)		Household with high income (%)	
					agree*	disagree*	agree*	disagree*
A	Worry about my family quality of life (NR=123/38)	9.656	4	0.047	87.8	3.2	94.7	5.2

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households with low/high income)

(iii) Neighbourhood flooded (dependent variable A Table 6.19)

Table 6.20 Statistics defining relationship between household without/with young children (in %) and flooding of neighbourhood significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households without young children (%)		Households with young children (%)	
					agree*	disagree*	agree*	disagree*
A	Neighbourhood was flooded (NR=111/103)	11.723	4	0.020	40.5	36.0	60.2	28.2

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households without/with children)

A significant proportion of households with children (60%) compared to those without children (40%) perceived that their neighbourhood was inundated dependent variable A Table 6.20); this may be because they were more likely to be more aware of the safety of their children. They were especially concerned about the environment they lived in and about the health risk from flood water.

6.13 Socio-economic factors

(i) *Lack of community cohesion*

Some 68% of respondents from the low level of literacy group felt that there was no social cohesion among them while only 46% from the high level of literacy group expressed the same opinion (dependent variable A, Table 6.21). This may be because in any community, households with a low level of literacy often feel that they are socially excluded or marginalised. It could be that those who were less literate tended to rely more on the government authorities than on their relatives for support.

Table 6.21 Statistics defining relationship between level of literacy of householder (in %) and lack of community cohesion significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with low level of literacy (%)		Households with high level of literacy (%)	
					agree*	disagree*	agree*	disagree*
A	Lack of community cohesion (NR=142/61)	15.430	4	0.004	67.6	26.8	45.9	34.4

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households with low/high level of literacy)

In the recovery phase of the Indian Ocean tsunami disaster in 2004, Frankenberg et al. (2013) stated that the better educated were in better psychological health, and hence were far more able to build resilience in the long-term. However, in this study, those who were less literate tended to rely more on the government authorities than on their relatives for support. Moreover, they might not have received the help and understanding from neighbours that they expected, and hence felt there was a lack of community cohesion.

6.14 Recovery (Assistance)

Table 6.22 Statistics defining relationship between household income (in %) and other dependent or response variables significant at $p < 0.05$ level

Response variables		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households with low income (%)		Households with high income (%)	
					agree*	disagree*	agree*	disagree*
B	Lack of support from local authorities (NR= 156/56)	9.985	4	0.041	52.6	21.1	37.5	19.7
C	Provision of financial grant (NR=	13.007	3	0.005	7.5	15.4	4.6	46.9

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households with low/high income)

(i) *Lack of support from local authorities*

Some 40% from each group did not express an opinion. The high level of neutral answers is common when it comes to expressing an opinion about the authorities. However, the low income householders were slightly more inclined to state that there was a lack of support from local authorities (dependent variable B, Table 6.22). It is also noted that the wetlands were usually government property or cheap land that would require significant investment if flood conditions were to be minimized. Communities moved there and occupied the land in the hope that the government authorities would build the necessary infrastructures even if it was in the distant future. However, the high density of residents meant the roads were narrow and badly maintained. Garbage was not regularly collected with the result that drainage systems had become blocked, leaving poorer households more prone to flood conditions.

The village householders do not pay municipal taxes with the result that all resources come from the central government. These conditions make political affiliation an important factor in obtaining support from local authorities. As mentioned in Section 6.4.6 (ii), disparity in the amount of support received by the underprivileged was often due to local elites giving priority to people they knew. In small communities, there is often strong animosity among inhabitants. Very often, they might not wish to take part in community activities or join groups (Ferdinand et al., 2012). In view of such a disunited approach, the authorities are not compelled to act with urgency to meet the needs of the community.

(ii) Provision of financial grant

Some 15% of the high income group who replied felt that they had not been offered any financial grants (dependent variable B Table 6.22). Such grants are often tied to income level and family responsibility. In such cases, loans at a low rate of interest are generally offered. However, the householders were likely to reject loans as it often meant additional financial burden.

(iii) Family conditions deteriorated

In the case D from Table 6.23, a slightly higher proportion of households with elderly persons (18%) compared to those with no elderly persons felt that the family conditions had deteriorated after a flood event. The presence of elderly persons in the household could mean that successive flood events had a negative impact on their health or living conditions, and they needed special support.

Table 6.23 Statistics defining relationship between household with no/ with elderly persons (in %) and other dependent or response variables significant at p<0.05 level

		Chi-square test results			Summary statistics			
		χ^2	df	p-value	Households without elderly persons (%)		Households with elderly persons (%)	
					agree*	disagree*	agree*	disagree*
D	Family conditions deteriorated after the flood	11.371	4	0.023	10.3	71.3	17.8	61.3

Source: Author's survey.

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households without/with elderly persons)

(iv) Lack of support from local authorities

Table 6.24 Statistics defining relationship between household with no/with elderly persons (in %) and other dependent or response variables significant at p<0.05 level

Response variables		Chi-square test results			Summary Statistics			
		χ^2	df	p-value	Households without elderly persons (%)		Households with elderly persons (%)	
					agree*	disagree*	agree*	disagree*
B	Lack of support from local authorities (NR=150/65)	16.524	4	0.002	43.3	24.0	60.0	13.9
C	Assistance from government was enough (NR=147/63)	13.074	4	0.011	19.1	42.8	28.5	50.8

Source: Author's survey

Note: agree*=sum of 'strongly agree' and 'agree' and disagree*= sum of 'strongly disagree' and 'disagree'; df- degrees of freedom; NR=number of respondents (households without/with elderly persons)

From Table 6.24, it can be noted that a proportionately higher percentage of households with elderly persons perceived that there was a lack of support from local authorities (dependent variable B) and that assistance from government was not enough (dependent variable C). Households with elderly persons were more fragile in the event of flooding, and therefore they required more assistance. Often, it was observed that elderly persons had invested their retirement benefits in building new homes and subsequently found they were unable to rebuild or repair their homes after flood damage due to a lack of resources. However, although elderly persons in Mauritius receive an old age allowance from the national pension scheme every month and health services and transport are free for them, but the sum received is minimal (about £100 a month); it is just enough to buy the basic necessities and certainly is not enough to rebuild their housing structures after a flood event. Masozera et al. (2007) suggested that people who were totally dependent on social services for survival were already economically and socially marginalized and required additional support in the post-disaster period.

6.15 Comparative findings from the three communities

A total of 49 possible associations were obtained. These comprised 35 response variables for CLC, 5 for LH, and 9 for GB. Though the number of associations, especially in the case of LH and GB, are very few, they are useful in complementing the descriptive statistics discussed in Chapter 5. The low number of associations in LH and GB may be because a significant number of households did not reply to several of the questions or did not provide answers to a number of the questions at all five levels in the Likert-scale.

In the case of CLC, most of the associations were related to income and households with elderly persons. Some of the major issues that were highlighted mostly by the low income group were related to the lasting effects of flood hazards, the poor state of the environment, the time taken to get back to normal, the disruption of families, the lack of community cohesion, the lack of support from local authorities, the deficiency in facilities and amenities, the lack of support from local authorities, and the general perception that the government and NGOs appeared to be discriminatory in the support they provided. Households with elderly persons in CLC were more concerned about not getting the houses back to normal soon after the flood events, the loss of personal effects, and the differences in government support in most phases of the disaster cycle.

A significant perception that sums up in many ways the feelings of desperation was that the community felt abandoned at every flood event.

Significantly, no statistically significant association could be obtained at $p \leq 0.05$ for LH in the case of income, children, and elderly persons. For LH, three of the five associations were related to literacy; a significant number did not state their level of education. The concerns were mostly related to awareness. As regards household size, the associations were on the inundation of houses and damage to personal effects.

In the case of GB, the association with household size was related to children missing school; that with literacy was related to lack of community cohesion; that of income was related to lack of support from local authorities and worry about family quality of life; and for households with children, the associations were related with flooding of the neighbourhood and the differences in government support to communities regarding relief and emergency situations. Association in the case of elderly persons were related to the deterioration of family conditions after flood events, the lack of support from local authorities, and the adequacy of assistance from the government.

None of the dependent variables was associated with the same independent variable at the three locations. This may reflect the fact that the structure of the households and their perception of the dependent variables at the three locations differed considerably. The results, though limited, made it possible to explore the effect of hazards on different groups of communities in Mauritius and provided an assessment of the related cumulative impact of sequential environmental hazards. In the light of the above results, the vulnerability of the different groups of households within the communities in the three location sites was defined through the associations. Though the number of associations was limited, they still made possible the identification of household groups in the recovery phase of a flood hazard that were vulnerable to flood events..

For each of the associations, possible explanations were provided. These issues were then explored through focussed and semi-structured interviews with the stakeholders (affected communities, the government authorities, and an NGO representative) to gain a better understanding and further insight into the perspectives of the participants. This information forms the subject of the next chapter.

By identifying the relationships between groups of households and other variables, it had been possible to establish a baseline that could then be used for carrying out complementary qualitative analysis, such as focus group interviews and participatory activities (which will be described in Chapter 7) and to integrate the information thus obtained into a proposal of a model for a disaster risk reduction management system for Mauritius.

6.16 Summary

The groups with low income, large households, and with elderly persons were found to be more socially vulnerable to flood conditions to varying degrees according to the community. The low income group at CLC was found to be the least *socially resilient*. The low income group at CLC was most at risk from flood hazards, and recovery was slow and difficult. For expediency, they had fragile houses that had been built on government property. The households with a low level of literacy and with elderly people were equally vulnerable. While those at LH with large families and the group with elderly at GB were vulnerable, it was the groups at CLC that were weakest with regard to *economic resilience*.

The low-income group in CLC occupied marginalised land in crowded conditions, the households with elderly people suffered damage to belongings, and those with children were concerned about missing school and being affected by flood-related diseases. In LH, households with elderly members were keenly aware of living in a flood risk zone. In GB, it was the group without elderly people that felt the need for structural as well as non-structural improvements. These groups showed the least *infrastructural/environmental resilience*.

In CLC, groups with a low level of literacy, with a low income and with elderly people were concerned about the lack of support from the local authorities, the government, and NGOs. The need was for direct support from the government during flooding and in the government providing relief and emergency services as well as in building flood defences, investing in flood risk and mitigation programmes, and helping the community regarding long-term recovery and rehabilitation. Such concerns were also expressed by groups with low income and with elderly people in GB. Another concern was the timely delivery of warnings, as expressed by small households and low income

groups in CLC and the group with elderly people in LH. These groups required institutional support in applying science and technology to improve the warning system and communications. These groups showed weak *institutional resilience*.

Households in CLC belonging to the low income group and those with children, as well as small households and those with elderly persons in GB, were most concerned by the psychological and general health impacts of flooding. These groups were found to have the least *psychological resilience*.

In GB, groups with a low level of literacy and those with small families and without elderly persons were more likely to rely on their families and relatives in the event of flooding. In CLC, household groups with a low level of literacy felt that cohesion was present in the community. However, the low income group and those with elderly persons in CLC and those with elderly persons in GB had the feeling of being abandoned in the event of flooding. These groups had the weakest *community competence* to deal with flooding.

Chapter 7 Results of Qualitative Analysis

7.1 Introduction

This chapter presents the analysis of the information obtained from the *focus group interviews* of the three case studies in Section 7.2. The information is extracted from the transcripts of the interviews, and the procedure used is described in Section 4.11.1. This chapter also reviews the outcomes of brief *participatory activities* with vulnerable groups in Section 7.3. Key findings from focus groups and participatory activities are given in Section 7.4. Results from the semi-structured interviews of agency stakeholders and an NGO representative are given in Section 7.5; they provide a complementary and contrasting view to that of the primary households regarding actions and expectations during the recovery phase of a flood event.

Key findings are presented in Section 7.6, and a summary of the whole chapter is given in Section 7.7. Descriptions of the procedures used in collecting information for qualitative analysis are given in Section 4.11. Transcripts of focus groups in CLC, LH, and GB are given in Appendix 15 to 16 respectively, and transcripts of interviews with agency stakeholders and the NGO representative are found in Appendix 19 to 26.

The analysis of the information collected through focus group interviews, participatory activities, and semi-structured interviews provides a holistic picture of flood mitigation efforts and contributes to addressing the research questions II and III listed in Section 1.6:

- *What are the stakeholders' perceptions of what can be done to reduce community vulnerability and promote resilience in the recovery/rehabilitation phase of the disaster response model, with particular attention to the role and potential of science and technology?*
- *How is the conceptual framework of 'environmental justice' useful in understanding variations in vulnerability and resilience in groups of communities?*

7.1.1 Time line of interviews and participatory activities

The various types of data were collected for the three case studies. Focus group interviews were carried out shortly after the questionnaire survey. This sequence of events made it possible to identify representatives of the groups exposed to flood events. Building on the trust established during the survey, it was possible to organise focus group interviews among a few households from each of the localities. Thereafter, it took time to organise the participatory activities. The agency interviews were held last so that the concerns of the primary stakeholders could be considered.

7.1.2 Representing the views of the community and of the national institutions

An issue that arises from the focus group interviews and the participatory activities is whether, collectively, they reflect the views of the community. The interviews were conducted with small groups of individuals from households affected by flood events, but the discussions covered a broad range of issues ranging from the experience of floods in the locality to resilience building actions by the authorities in the aftermath of flood hazards. Likewise, the participatory activities were conducted well after the focus group interviews and provided another opportunity for in-depth discussions on all aspects of flooding in the locality and any possible solutions. In the case of the agency stakeholders, the representatives were senior officers in various departments. Thus, it can be assumed that they represented the position of their institutions, and the interviews reflect their actions and their interaction with the affected communities. Overall, it can be deduced that the results of the interviews and activities reflect the conditions of the respective flood-affected communities.

7.1.3 Grouping of variables along types of resilience from results of qualitative analysis

The concept of community resilience was explored in the literature review (Section 2.8) and its types and corresponding variables or themes were given in Table 2.4. Table 7.1 provides a list of the types of resilience and the corresponding variables, themes, or nodes. These variables have been redefined in the light of the results of the interviews of the various stakeholders, local conditions and the outcome of the questionnaire survey. Mauritius is a multicultural country (Section 3.5.1) and social networking is as an

important element in building *social resilience*. Land ownership is perceived as an essential component in building *economic resilience*. As for *institutional resilience*, the needy communities have come to rely heavily on the authorities for assistance. Hence, their perspective on the assistance received from the Government, local authorities and NGOs constitutes is an essential element in resilience-building. Under local conditions, community ties and values/beliefs contribute to *community resilience/competence* in view of the multicultural make-up of the communities that have been constituted over the last generation mainly.

Table 7.1 The types of resilience as defined by Cutter et al. (2008) and those redefined and adapted for the study

Types of community resilience		Definition of forms of resilience (Cutter et al., 2008, p. 604)	Re-definition of the types of resilience adapted from Cutter et al., 2008
1	Social	Demographic characteristics of the community, access to resource	Household characteristics, social network, equality, access to communication
2	Economic	Measure of property loss, business disruption	Property ownership, employment status, loss of belongings
3	Institutional	Organisations, communication technology, emergency response plans, leadership, 'command and control' measures	Engagement with local institutions for flood recovery, views on flood governance, community flood experience, flood characteristics
4	Infrastructure/Environmental	Include the physical system, pipelines, road miles etc.	House type, access to services, built environment, land use development, coping strategies
5	Community competence	Highlights population wellness, quality of life and well being	Living with flood risk, neighbourhood relationship, values and beliefs, local knowledge on flood
6	Psychological	-	Living with flood trauma, stress and uncertainties about the future

In Table 7.1, the variables obtained from the survey are grouped along the types of resilience (Appendix 3). In this chapter, the variables drawn from the focus group interviews (Figure 7.1) and those from the interviews with agency stakeholders (Figure 7.4) are grouped and discussed along the six types or indicators of resilience, namely, social, economic, infrastructural/environmental, institutional and psychological, and community competence.

7.2 Focus Group Interviews

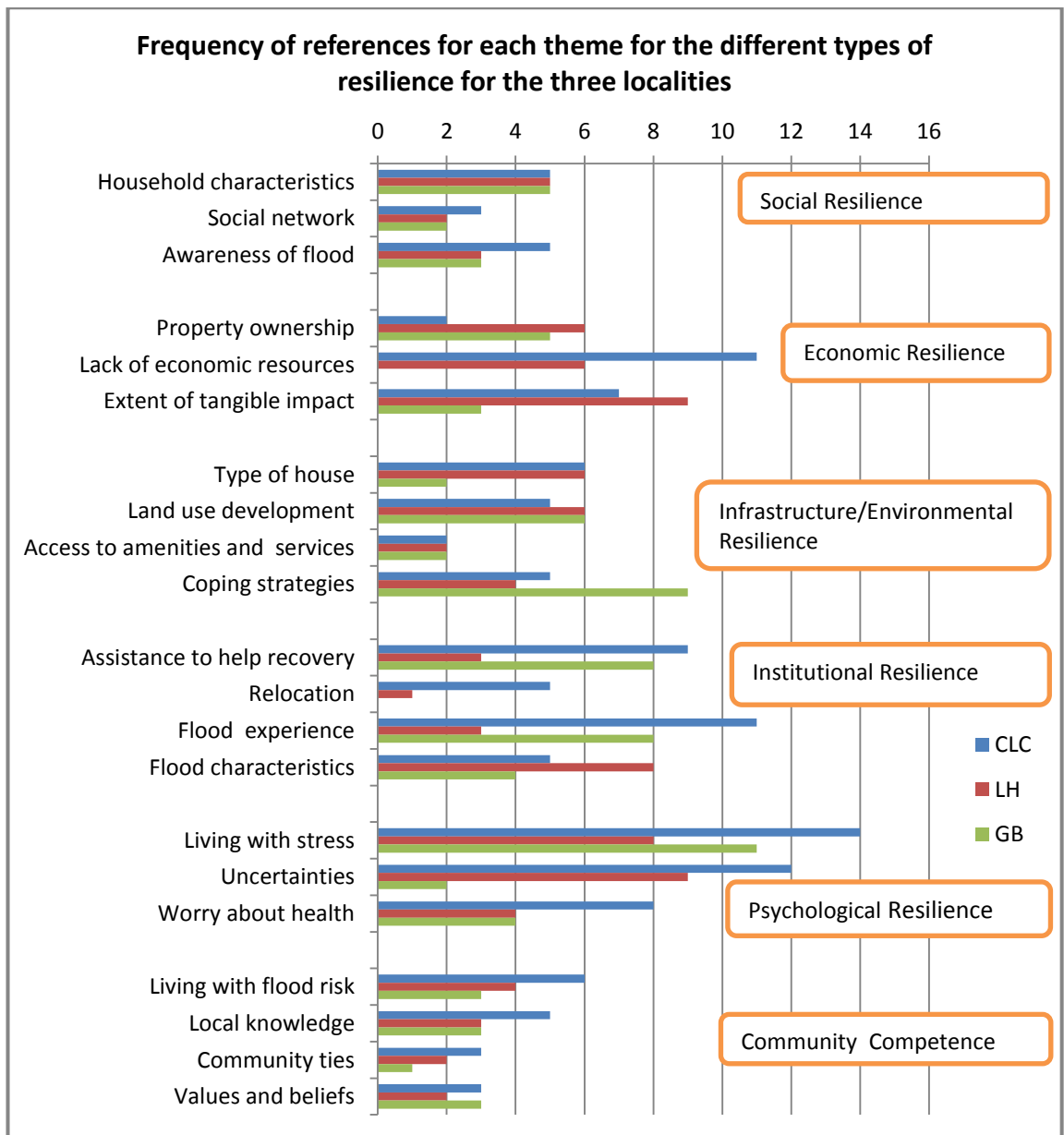
7.2.1 *Comparative analysis from transcripts*

The transcripts for CLC, LH, and GB (Appendix 14, 15 and 1617, respectively) were analysed on the basis of the pre-defined *nodes or themes*. The nodes were coded and assigned to a particular type of community resilience. The number of references falling under each of the nodes was collected using NVivo 9 software. The comparative frequency of references at each node is shown in Appendix 18 and is represented graphically in Figure 7.1. Relevant verbatim quotations from the participants of the focus group interviews are highlighted throughout this chapter to give an in-depth ‘touch’ to the findings. They also add weight in determining the degree of relevance of each type of resilience for each of the study areas. To keep the anonymity of the participants and for ethical reasons, only their locations are mentioned after each quotation.

The findings from the analysis of the data from the focus group interviews are discussed in the context of the types of resilience in the following sub-sections.

7.2.2 *Social resilience*

The three variables (household characteristics, social network, and awareness) were discussed in the context of social resilience are given in Figure 7.1. Overall, the household groups in the three communities show low resilience during households’ recovery from flood hazards. Similar household characteristics were found in all three locations. Those who had these characteristics were essentially the most underprivileged households with large families, low income, and low level of literacy and with no elderly persons. The results from the quantitative survey (Chapters 5 and 6) had shown that such households were mostly from CLC and GB but fewer were from LH. Overall, the household groups in the three communities that showed low resilience are given in Figure 7.1



Source: Author' survey

Figure 7.1 Frequency of references for each of the themes or variables for the types of resilience for the three case studies

The expression of solidarity, such as helping out neighbours and assisting more vulnerable members, that prevailed in CLC was absent in LH and GB. This is shown in the following quotation from a participant in GB where the pervading negative attitude towards neighbours seemed to be slowly eroding the social network:

'Previously we were not flooded; now the drains get blocked, people have built houses on the natural waterways; we dare not speak to them.' (GB)

(i) Awareness of flood

Flood warning systems were not well developed in Mauritius, and flood warnings were often understood in terms of cyclone warnings, which the population had got used to over many years. The participants in CLC stated:

'By the time we are aware that warning has been issued, before I can take any precautions, flood water has already reached my house.' (CLC)

It should be noted that some parts of CLC are situated on a mountain slope, and when it rains, inhabitants hardly have time to rush for safety before flooding happens. In this regard, dissemination and timely responses to flood warning systems are important issues that should be addressed in any flood mitigation system.

7.2.3 Economic resilience

The three variables (property ownership, lack of economic resources, and extent of tangible impact) that were discussed in the context of economic resilience were given in Figure 7.1. In terms of property ownership and resources, CLC was perceived to be the least economically resilient. Participants in LH and GB claimed to be somewhat better provided for in terms of resources and housing systems.

(i) Property ownership

As stated in the above sections, participants in the focus group interviews were mostly from low-income backgrounds, occupying state lands with no building permit. They were the most exposed to flood hazards and the most vulnerable, and were faced with administrative challenges to obtain a land permit:

'We do not have a contract (land permit); we have no right to build a room or consolidate our houses and improve our quality of life. When the government gives us a house, then we can bring in a table [and] other furniture, and then we will manage. If the house is in a poor state, nothing can be done.' (CLC)

'My house has a tin roof and it leaks everywhere during heavy rains, and moreover, water collects on the floor.' (LH)

In GB, the participants occupied wetlands that are government property. Those who had lived there for a long time paid an annual fee to the government. They had a legal status as occupants but despite this, they complained about their poor living conditions, which were rarely addressed by authorities:

‘The authorities refused to hear our complaints since we were not supposed to build on the wetlands. It is crown land, but we pay a fee to the government every year.’ (GB)

(ii) *Extent of tangible impact and its implication on recovery*

The extent of the tangible impact had an effect on the recovery process, and hence on the resilience of those communities exposed to floods. In CLC, the extent of the damage was more significant due to the poor living conditions. The houses, floors, and belongings were often damaged by mud carried by the flood water (Figure 7.2).



Source: L'express.mu (Sunita Beezadhur) (*accessed September 2011*)

Figure 7.2 Living in damp conditions following floods at CLC

The families had to live in humid conditions for several days. In LH, flooding from the nearby stream also caused damage to belongings. Those who had built near storm drains or on the bank of the rivers often found themselves knee-deep in water and their entire

vegetable patch destroyed and under water. In the wetland areas, flood events occurred with even the slightest rain. In the case of extended periods of rainfall, the flood water caused permanent damage to furniture and utensils:

'Our furniture is spoilt. When the rains fall over a long period, the furniture starts to rot. We have to throw them away. They have a bad smell.' (GB)

(iii) *Lack of economic resources*

In LH, the lack of economic resources and the poverty were underscored in the following quotations from participants and were linked to unemployment or poor job conditions, health problems, and family disruption, leading to low resilience to recovery from flood hazards.

'I do not work. I receive a modest government allocation. I have lived here since my childhood. If they ask me to leave this place, I have nowhere to go. I have lived here for too a long time. My whole property gets damaged. My husband is sick, and I am too old to take up a job.' (LH)

The participants at CLC mentioned the lack of resources as a strong limiting factor in building robust houses. Houses comprised tin roofs with virtually no permanent flooring. The fact that many of the household chores were performed outdoors, as explained in Section 7.2.4 (i), indicated the level of poverty and the lack of economic resources. The overall analysis showed that as regards economic resilience, the low-income sub-group at CLC was the least resilient when compared to those of LH and GB (Figure 7.1).

7.2.4 *Infrastructural/environmental resilience*

The four variables (type of house, land-use development, access to amenities and services, and coping strategies) that were discussed in the context of infrastructural/environmental resilience are given in Figure 7.1. The land-use development variable is closely related to the problem of limited space in SIDS countries, such as Mauritius (Briguglio, 1999).

(i) *Type of house*

Most of the participants were from low-income backgrounds and had limited resources. Their houses were not in a suitable condition to withstand severe weather. Indeed, they lived in precarious conditions, as expressed one participant despairingly:

'The tin roof and the flooring have not been fixed. We wash our dishes outside, our clothes outside. All the tasks are performed outside the house. We have no electricity. Once in a while, we get a sum of Rs300 (about £10) for repairs from the government– how far will that amount go? What materials would such an amount buy?' (CLC)

Poor housing conditions, the lack of electricity, and the lack of facilities that compelled them to perform many of the household chores, such as cooking and cleaning dishes, outside indicate the high level of vulnerability of such households. These conditions were linked to poverty, especially in CLC. However, in CLC more than in other localities, the participants mentioned the word 'we' and 'us', implying a sense of community concern.

Many of the participants lived on state lands, with no building permit, and hence with no electric or water supplies. However, having lived there for more than ten years, they felt a sense of social injustice when other inhabitants, who had come after them, managed to obtain building permits, running water, and even street lighting. If authorisation could be obtained from the Ministry of Housing and Lands then it would be possible for the inhabitants to build or consolidate their houses and improve their quality of life. Participants, however, were aware of the legal issues surrounding land occupation. One participant in CLC claimed on behalf of the community that occupies state lands:

'We have lived on Crown (state) marginal lands for the last 10 years - we do not have a land contract, and we know that we have no right to build a house on land that does not belong to us. We still wait, yet others have got it; they can build, have electricity, a water supply. Some occupy higher ground, the water goes around them; those staying on the lower ground are more affected.' (CLC)

Participants from LH declared that they came from a low-income background and lived in precarious housing conditions, indicating their vulnerability and very low resilience to facing adverse situations.

'I live with my two children. My house has a tin roof, and it leaks. Water runs in from above. It spreads over the floor. Everywhere... Our house is built of tin. We do not get loans as our salary does not exceed Rs4000 (£80).' (LH)

'My house leaks like a sieve. At every rainy season, the water in my house reaches up to my ankle. All my furniture and beds get spoilt.' (LH)

In GB, some signs of poverty included living in houses made of tin or in unfinished houses. Better-off households had raised floors and property enclosed by concrete blocks. This may be attributed to the better job opportunities offered to residents by the economic development of the tourist industry in the area.

(ii) *Land use*

As stated in the previous section, many of the houses in CLC had been constructed haphazardly on state or crown lands by squatters without any authorisation or land use planning. Over the years, the authorities have come to tolerate the situation and found it increasingly difficult to evict the squatters or to provide them with the necessary amenities.

In the flooded zones in LH, the housing conditions were poor as there were too many buildings in a limited space and with limited facilities. Several newcomers to the community had constructed buildings over the storm drains, which did not show up in their title deeds. Thus, when the drains were blocked, the authorities found it difficult to clear the waterways:

'I have built upstairs and move there in flood events and have also erected walls all around the property: no problem.' (LH)

'Construction over the stream is due to the lack of space. They have placed an enclosure making the situation worse as the water entering the yard cannot flow out'. (LH)

Some participants were concerned about the values in their community.

'We should observe civic duties and not throw waste in the canal.' (LH)

In GB, the drainage system had been installed on wetlands. Poor maintenance of the system, waste from over 200 houses in a limited space, and construction in waterways due to a shortage of land often led to flooding even with only slight rain. Other factors, such as job opportunities in the tourist industry, had attracted many newcomers to occupy a land area that required considerable investment. However, over time, living with the burden of environmental 'bads' had become overwhelming, as the following quotation from a participant in GB revealed.

'During heavy rains, the water level rises. The manhole is supposed to allow the flood water to drain away.. Yesterday, I called the officer, and he explained that he had closed the floodgate. They often close it. Thus, during rainfall, the manhole is filled up and the excess flood water seeps through the area. The inhabitants have had to call the officer several times and have discussed the situation with him, asking him to open the floodgate. Once the floodgate is open, the water collecting at the surface drains through the manhole. It is only when the manholes are full, that the floodwater overflows into the houses.' (GB)

'We have been having problems for the last ten years. We have to stay in unhealthy conditions until the water level goes down. We have to place sand bags in front of the door to stop water from getting inside so that we can go out to work. We cannot move to another location since we work here.'(GB)

(iii) *Access to amenities and services*

Flooding also affects the amenities and services that are available to the inhabitants. They had to wade through flooded neighbourhoods to reach the nearest relief centre to

ask for help. The concern was more about the threat to the health of children and the poor state of some roads during floods:

'The road gets flooded, and the water drains away quickly since my house is on a slope but children walk about in muddy waters to attend school.' (LH)

'Children are unable to go to school. Often they wear boots to protect themselves from catching flood-related diseases. The other day, when you came, there was so much rain and flood water everywhere that I told my children not to go to school.' (GB)

(iv). *Coping strategies*

Participants from all three focus groups stated that the most common coping strategies deployed before and during flood events were moving their belongings and foodstuffs to higher ground, moving to neighbours' houses, or sometimes taking shelter in government refugee centres. Helping out neighbours in difficulty was an accepted practice in close-knit communities as was stated by one participant:

'In the absence of the mother, three children were at home, and the neighbours had to break in to pull out the children with mud all over them.' (CLC)

Communicating with local radio stations and voicing their concerns in an effort to obtain assistance in relocating a distressed family with children was an indication of the solidarity amongst the participants (Section 7.2.5 (iii)). This attitude shows that communities in CLC often built strong community ties by taking care of themselves and helping each other in times of adversity. Elderly persons, who had seen the area develop over the years, showed most concern about the impact of human use on the environment and its impact in exacerbating the flood risk in the area.

'The area is wetlands. The government is not concerned. It claims that we insisted on building in spite of its advice.' (GB)

Structural measures, such as building walls around one's property in LH, raising floors, and placing sand bags at doorsteps, were common practices in GB to cope with rising

flood water. Otherwise, the most vulnerable households did nothing but accepted, often passively, to live with risk:

'We can't do anything, and we have to learn to live with floods. I continue my activities if the water level is not too high. Otherwise, I wait for the water level to go down before I continue.' (GB)

7.2.5 Institutional resilience

In the analysis, flood characteristics and experiences of flood events were integrated as they were deemed to be interlinked. This section also deals with participants' views on the actions taken by national institutions in mitigating flood risks. The actions may include preparedness for flooding, issue of warnings, evacuation and rescue operations, and longer term assistance, such as relocation and the building of flood-proof structures. From Figure 7.1 it can be seen that the CLC community experienced more flood events than did the other two localities. At LH, the community experienced the least number of flood occurrences.

(i) Flood experiences and flood characteristics



Source: LExpress.mu (Sunita Beezadhur) Accessed September 2011

Figure 7.3 House flooded at CLC

Households in CLC live on marginal lands, on the slope, on river banks, and on wetland areas (Figure 7.3). They also live near storm drains that overflow during the rainy seasons, as shown in the picture. The water remains stagnant over a period of several days and poses serious threats to health and accessibility.

Households in CLC stated that they are exposed to river overflow that brings in mud, sewage, and other pollutants. Often the communities have little or no time to take precautions. By the time they are aware that a flood warning has been issued, water has already rushed into their homes. The communities often experience flooding even with slight rain as the water table in the wetland areas and the densely occupied lands is just below the surface. In some localities, such as GB, the community is also exposed to overflow from manholes of drainage and sewage pipes installed in the area.

'We have flooding during heavy rains. When the water level rises, the drainage pipes that have been installed for the nearby hotels cross our area, [the water] overflows and gets into the houses and the neighbourhood.' (GB)

(ii) *Assistance to help recovery in the aftermath of a flood hazard*

Several of the participants acknowledged receiving short-term assistance in the form of household items, foodstuffs, school materials, and limited cash to meet their immediate needs.

'We receive help mostly from charity organisations and also from the local authorities.'(CLC)

When flood water rises to dangerous levels, fire services, when alerted, come to pump out water from homes in CLC and LH.

Participants claimed that they received virtually no assistance as local authorities say that they are not concerned:

'I had requested assistance from the government; it refused since we were not supposed to build over the wetland area. It is crown (state) land, but we pay a small fee for occupying this land.'(GB)

The lack of timely intervention in times of greatest need and the apparent attitude of indifference shown by the authorities at all the three locations have shaped negative attitudes of 'being left aside':

'The authorities concerned do not turn up. Visits come well after a disaster, but no action is taken to improve our conditions.' (CLC)

'My son has been to see the authorities, but they do not listen; he gets skin disease because of the dirty water from the canal. We have no choice. My husband has a temporary job. The government of this country has forgotten us.'
(LH)

Assistance in the form of loans was not accessible to the neediest as they were seen to be the least creditworthy:

'There is no assistance since my salary does not exceed the Rs 4000 (£80) needed to obtain a loan and to construct [a home].' (LH)

The communities were often exasperated and blamed the authorities for neglecting land-use planning.

'If government were to help, then no problem...Whether the drain gets blocked or not, it's the same story. Formerly, there were not many families. It's the way the houses have been built.' (CLC)

(iii) Relocation

From Figure 7.1, it is clear that generally, inhabitants do not like to be relocated. In GB, there was no interest in relocation most probably because most households had job security, were familiar with the area, and owned their property. Only a few from CLC were in favour of relocation. In general, households preferred receiving assistance to rebuild their house rather than being relocated:

'Assistance in terms of cash to rebuild - not enough: once in a while, we receive a sum of 300 rupees (about £10) - how far will that go? It is not enough to buy materials to repair the house.'(CLC)

However, an example from CLC of positive action in favour of re-location was described thus by a participant:

‘Maison Petit Bonheur’ to accommodate one family – was built by Radio Plus (note: a private radio station that called for donations) – we do not know what will happen next; we will know only when the rains come, the house is beautiful– on higher ground – move them away from areas that area usually inundated.’
(CLC)

Outside sources other than the government were contacted as a way to provide shelter and improve the living conditions of a family with children. While the CLC community may have weak resilience, this demonstrates how the local community have the skills required to undertake self-help projects. However, relocation can also have an adverse effect on displaced families by increasing the risk and vulnerability as related by one participant:

‘My neighbour has stayed here for 12 years on Crown land. The land gets heavily inundated. The government has moved the family to a new place, but the new location is hit worse than the original place. My neighbour has obtained title deeds, but we have not yet received any. How is that possible?’ (CLC)

The above statement also suggests that there is some disparity in the allocation of land permits among the vulnerable groups. In this regard, it has some implications for the issue of social inequity.

7.2.6 Psychological resilience

The three variables (stress, uncertainty, and health worries) that were discussed in the context of psychological and emotional resilience are given in Figure 7.1. The uncertainty node is a new element that came out of the focus group interviews. At CLC, the proportion of intangible effects is higher than is found in the communities at LH and GB, making it the least resilient. At LH, a higher proportion of interviewees than at GB claimed to be living with uncertainties.

(i) *Living with stress*

The focus group interviews were carried out a few months after the communities had experienced flood events. It was found that psychological and emotional issues were still a major concern among the participants from the three focus groups. In CLC, this situation may be linked to many factors but mainly to poor housing conditions and a lack of basic facilities. In contrast, in LH and GB, the major factor causing emotional stress, such as ‘frustration’, was the concern about being exposed to flood conditions every time it rained somewhat heavily. Because of the poor drainage, flooding may persist for a period of one week or more, conveying the feeling that the affected households were experiencing flooding most of the time. In these circumstances, it is natural for them feel ‘exhausted’ of living in poor environmental conditions:

‘I am not able to live a normal life because I am always exposed to flood conditions. We stay inside until the water flows away. I work as a mason now. I stay at home to look after my son. I am really frustrated with this life. I have built my house right on the canal. This was not in the land shown in the title deeds when I bought it.’ (LH)

(ii) *Living with uncertainties*

Among the participants, there was a general feeling of uncertainty about their situation as they did not believe that the authorities would take timely action to protect them in case of extreme flood situations. Expressions such as ‘do not know what will happen next’, which were indicative of vulnerability or weak resilience, were often cited:

‘When our house gets flooded at night, we get worried; we do not know what will happen next. We just stay like that – we have to take care of ourselves. We do not know what will happen when the rains come.’ (CLC)

‘The authorities concerned often do not turn up, or if they do, by the time they come, children have already got scabs.’ (CLC)

As a way of coping with unexpected flood events, the community had adopted a passive attitude of living through the events:

'We cannot do anything but to learn to live with flood. I continue with my activities when the water level is not too high. Otherwise I wait for the level of water to come down before I continue.' (LH)

The key point here is that households that have 'to live with flooding will always be vulnerable, but this implies the *inherent* vulnerability of those people to flooding who may also have *inherent* resilience in terms of having enough personal skills to build up and recover, in other words, their adaptive capacity to a threat.

(iii) *Worry about health*

The impact of floods on health was a major concern for all three communities. Several types of health problems occur due to exposure to flood water laden with pollutants, including sewage overflow:

'I live higher up, so I do not have any problem, except that water comes into the yard, but we get itching, skin disease, asthma, humidity, disease of the foot.'
(CLC)

Worry about health was therefore a major concern most particularly among households with children who enjoyed playing in polluted flood water. They were often left unattended:

'Children walk about in muddy water to attend school. We have come to accept living in such conditions - it forms part of our life. They get skin disease with dirty water from the canal.' (LH)

'Emotionally, we are exhausted, especially with the bad odour from the manholes. The waste water pipes start from the hotel and cross near our houses and end in a large manhole where lorries carrying waste water dump the waste in front of people's houses. People are worried when rain falls.' (GB)

The affected communities were living with psychological and emotional stress. Therefore, it took them longer to get back to normal after each flood event. This

situation has to be considered during policy-making and regarding the need to extend health facilities to deal with such stress in order to enhance resilience.

7.2.7 Community competence

In this section, the four variables (living with flood risk, local knowledge, values/beliefs, and community ties) that indicate community competence were analysed and represented in Figure 7.1. They were used in assessing the extent to which they contribute to community resilience in the three locations. The overall view on community competence is that CLC has the highest score compared to the other two localities and hence the highest potential for contributing to resilience-building is supporting each other in times of flood hazards. This may be due to population characteristics and the historical development of the area.

(i) Living with flood risk

In CLC, the participants occupied marginal lands and were aware that they were living in flood risk zones. Being poor, they had no choice but to accept the existing living conditions as a way to face flood conditions.

‘Two days, three, one week. Humidity stays on – may take three weeks.’

‘When the mattress gets wet, we turn it upside down – we then sleep on it. We place gunny bags [bags made of jute] on it. Life is not easy, but we accept things as they are - it forms part of our lives. We have no choice.’ (CLC)

This statement illustrates the strength and determination of the participants to accept their living conditions and to develop a positive attitude of taking care of themselves in the face of adversity.

In LH, the flood risk has been caused by factors like rapid and intensive land use for residential purposes, employment opportunities, and access to amenities. Participants who had been occupying the land for a long time reported:

'I have lived there since my childhood. My father bought the land, and he knew it was a flood risk zone. We have stayed there for a long time. We are flooded every time it rains. Having lived there for a long time, if I were asked to move out, there would be no place to go.' (LH)

This statement indicates that the participants also had local knowledge of their environment and after living there for a long time, must have developed some coping strategies and resilience to flood events. In GB, the participants living in the wetland areas with perceived risks of flooding have learnt to cope with flood water.

(ii) *Local knowledge, values, and beliefs*

The participants claimed to have lived through recurrent flood events over many years in the area. Having experienced the worst conditions, they should therefore be able to face any flood, whatever its severity. The participants in all three locations reported that vulnerable persons, such as the disabled and the elderly, were unwilling to leave their homes or relocate, most probably because they were strongly attached to their homes and to their belongings. In GB as well, the participants claimed that they had good local knowledge after having lived in the same place for many years. There was also an indication of ownership and a desire to preserve one's cultural norms.

Concern for ethical values was found among the participants in the three focus groups. They expressed concern for the environment, which had deteriorated over the years:

'There are many buildings. The neighbours have no respect; they have built right on the stream. I think people should be taught not to throw waste in the waterways.' (LH)

'I have remained in this location for 40 years, but we never had such problems [before].problem. People have built their houses on the wetland areas; they have. They filled the marshy area with boulders and soil, changing the natural drainage system. Now flood water reaches up to the knee. I have raised the foundations, but still flood water flows into the house during heavy rains.' (GB)

The above statement suggests that people who had occupied the land area for a long time had memories of their coping strategies for flooding. Some inhabitants had no other option but to ‘live with flood’ and adapt themselves even under difficult conditions. A quotation from the transcript illustrates their situation:

‘Manholes get blocked and sewage water overflows on rainy days; we had to wait until someone unblocks the manholes. They pump off the water, but the situation reverts back to the original state. We stay just like that; we have to take care of ourselves.’ (GB)

Integrating local knowledge of past flood experience and of flood memories from the inhabitants with that of ‘expert knowledge’ could help to better understand the problem of local inhabitants and at the same time enforce community resilience. This would require the integration of the local people in decision making processes.

(iii) Community ties

In CLC, there appeared to be a greater degree of community cohesion than in LH or GB. This was noticed during the interview when the participants talked more in terms of ‘we and us’ and showed sympathy to their neighbours in difficult situations:

‘A mother had gone out to work; her children were at home, and the neighbour had to break in to pull out the children to safety.’ (CLC)

The community solidarity was more prevalent when the community had to take their case to the authorities. Otherwise, they claimed, they had learnt to take care of themselves. In view of political affiliations, they were afraid of cooperating with neighbours. Many of the areas had been occupied over the last generation only. Over the relatively short period, people with diverse backgrounds, cultures, and religions moved into a relatively small flood-risk neighbourhood. It took a long time to build trust with new neighbours. The result of poor communication among the neighbours was that instead of looking within the community to solve many of the problems that contributed to and aggravated flooding, the inhabitants had to look for outside support. In LH, most inhabitants had moved into their own property over the last two to three decades. They had developed a sense of belonging to the place and were concerned about the

environment but were still uneasy with their neighbours. Thus, they took all possible measures to be independent of the neighbours and the community:

'We stay inside until the water flows away. I get frustrated living like this. The neighbours have no respect; they build on the canal. We should observe civic duties and not throw waste into the canal. During the rainy season, it got flooded, but it is more frequent now. People use the canal for waste disposal resulting in mosquitoes, pollution, and illness.' (LH)

'Previously we were not flooded; now, the drains get blocked. People have built houses on the natural waterways; we dare not speak to them. Those who are not affected do not want to cooperate.' (GB)

7.2.8. Problems encountered during focus group interviews

Recruitment of participants was difficult in all three locations. The paucity of themes in LH and GB (Figure 7.1) was also due to the lack of participants. However, those who agreed to participate provided sufficient evidence that could be applicable to the situation in their respective communities. In general, those who participated were flood victims and most had come from a low-income background.

7.3 Participatory activities at CLC and LH

This section gives the results from the participatory activities at CLC and LH. The result from GB is excluded as there were few participants and these were unrepresentative. However, it is considered appropriate to include the outcomes of the participatory activities from CLC and LH in the study as they complement some of the findings from the focus group interviews and contribute to a better understanding of the issues and of resilience building as seen by the householders themselves. As discussed earlier, most of the floods in all three cases, but mostly in LH and GB, are the result of the human transformation of the environment. As flood victims, the participants were considered as *primary stakeholders*. In this context, they had legitimacy in expressing their views in a democratic country (Baber and Bartlett, 2007) like Mauritius and in applying their local knowledge in the management of their environment. The procedures applied in the conduct of this activity were described in Section 4.11.2. Though limited to two of the

three localities, the participatory activities threw some light onto the issues raised by the research questions (Section 1.6).

7.3.1 Outcomes of participatory activities at CLC

The exercise was based on the participatory methods and approaches used by Chatty et al. (2003) in the co-management of natural resources in the Middle East. It also drew on an exercise using a similar approach that was carried out by the researcher in a community centre during an NGO activity in Mauritius where the participants were involved in finding solutions to their problems on environment pollution. However, the current exercise was designed to suit the context of flood hazards. The process of conducting is highlighted in Figure 7.4.

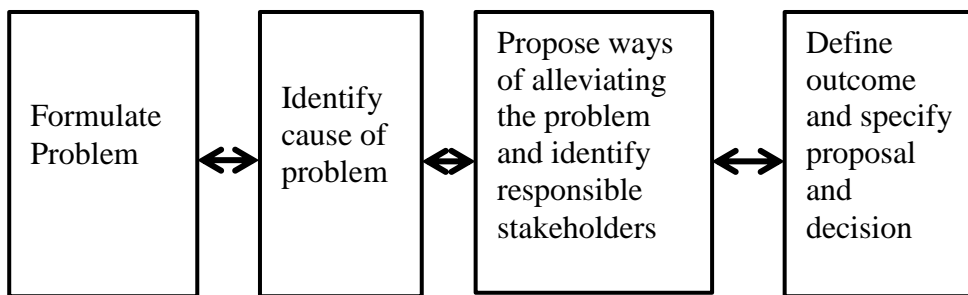


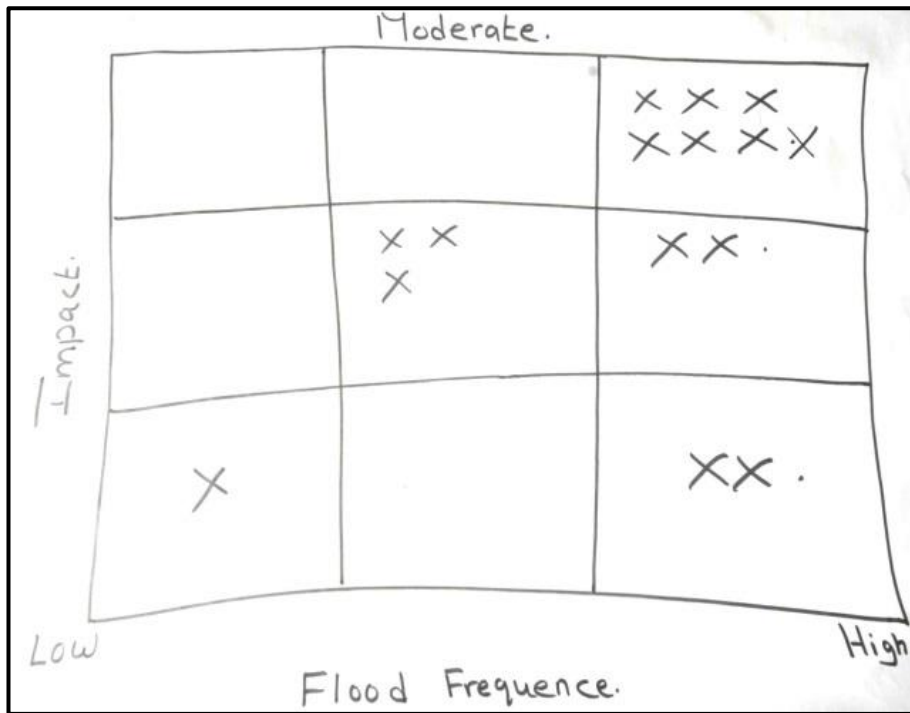
Figure 7.4 Flow diagrams showing iterative process of participatory approach

The participants were all involved in carrying out the following exercises.

- i) **Exercise 1:** Assess the perceived frequency and impact of flood hazards.
- ii) **Exercise 2:** Analyse flood-related problems and formulate solutions.

i) Exercise 1

For Exercise 1, a matrix table was drawn, as shown in Figure 7.5 below. The horizontal axis was marked '*frequency of flood hazard*' while the vertical axis was marked '*impact*' to represent the intensity of the hazard. The purpose of this exercise was to involve participants in identifying and evaluating the intensity at which they had experienced flood hazards and the impact incurred.



Source: Author

Figure 7.5 Participatory activities at CLC – Assessing the perceived frequency and impact of flood experienced

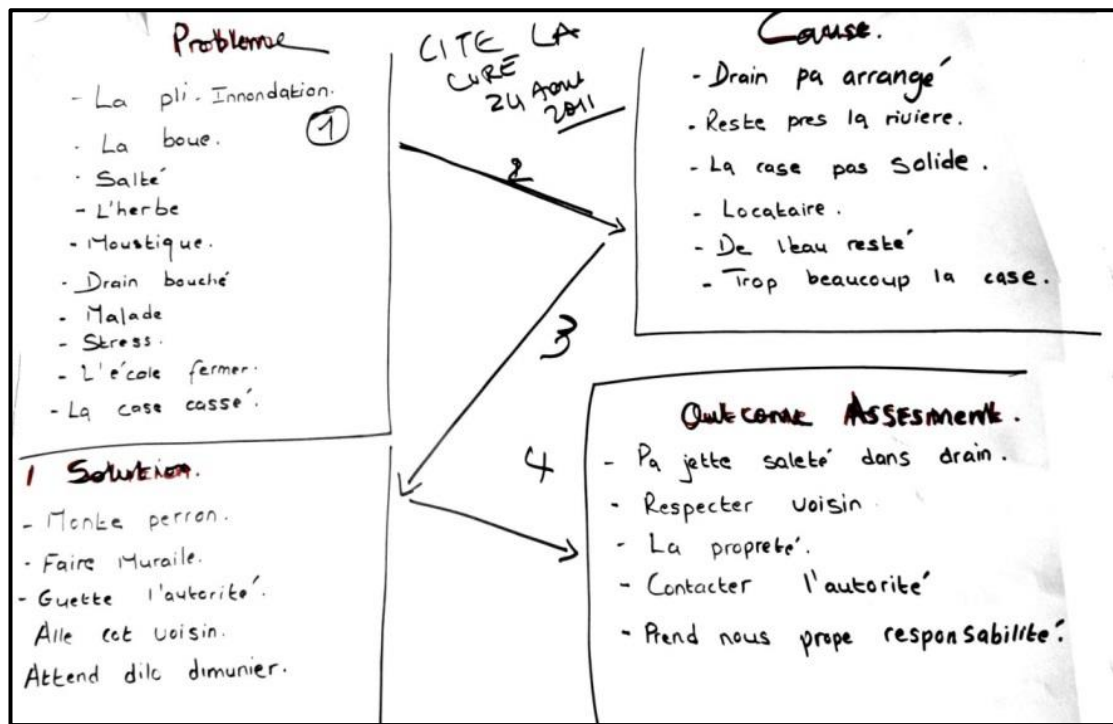
As shown in Figure 7.5, each of the participants was invited to place a cross in a suitable box. The total score was counted to find out how the participants were affected. For example, of the 15 participants, 7 had experienced high impact frequent flooding. Most of the participants had experienced moderate to frequent flooding, the impact of which was mostly moderate to high.

ii) Exercise 2

In order to allow the groups to express their ideas, an A3 sheet of paper was provided with a diagram to capture the flow from problem identification to the formulation of a solution (Figure 7.6). It required reflection and frequent iteration in between the boxes.

The problem

The problem of flooding arises due to frequent and heavy rainfall. Invariably, such occurrences transport mud into residential areas affecting roads, gardens, and houses. The flood water carries with it waste materials, plastics, and grass that often block the drains, thus aggravating the flood conditions. The houses are severely affected, and



Source: Author

Figure 7.6 Illustration of participatory activities at CLC – Problem solving by participants

some are inundated or damaged meaning householders' belongings are ruined. After a couple of days, there is an invasion of mosquitoes that may cause malaria, thus leading to concerns about health. Schools may be closed, and children may be left alone while the parents have to leave them, often unattended, for work. All these lead to a stressful situation.

The cause

Some of the major causes of such a situation are that suitable drains have not been built, that people live close to the river, that the houses are rented rather than owned, and generally, the density of houses is very high and the houses are fragile. In addition, the area remains flooded for many days.

The solution

Solutions would be to build higher up and construct steps to reach the house and building walls to keep the flood water away. In addition, the authorities should be contacted so that they can address the situation, and in the case of serious flooding,

householders could look for shelter at a neighbour's house. Another solution would be simply to wait for the level of the flood water to go down.

The outcome

The session ended with the following major outcomes:

- i) *Self-reliance*: The participants felt that they should rely on themselves in overcoming the problems caused by flood events.
- ii) *Civic action*: The participants were aware of their civic duty of not throwing garbage on the road and of keeping the area and the drains clean. They also felt that they should develop good neighbourliness and reinforce community ties. These were seen as important elements in vulnerability reduction and resilience building.
- iii) *External support*: The participants should maintain contact with the authorities. Instead of being relocated elsewhere, they would like to receive some help from the government, such as assistance in the construction of better houses with raised floors and good sanitation facilities. They also wished to be visited by the authorities and ensure that the authorities' concern does not wane after the flood event. The authorities should not be partial, but rather should address the concerns of all inhabitants equally, giving priority attention to the most needy.

7.3.2 Outcomes of participatory activities at LH

In the case of LH, an exercise similar to the one at CLC was carried out. The major outcomes of the participatory exercise were as follows:

Civic action: The households felt strongly that the inhabitants should be responsible for keeping their environment clean.

- i) *Building community ties*: Communities should cooperate in addressing the many problems rather than wait for the authorities to attend to every concern; for example, they could avoid building on or across canals, streams, or storm drains.

- ii) *Need for external support:* The government should show more concern for their needs and improve their social conditions.

7.3.3 Summary of participatory activities

The need for external support to the communities after a flood hazard was an important issue in both CLC and LH. This need is implied in what the householders viewed as the disparities households in the support that the authorities provide different groups in the same community. This feeling of injustice was more prevalent in CLC, but self-reliance was highlighted on several occasions in both communities. One aspect that was brought out at LH was the need to develop community ties as a priority to fight the adverse impacts of flooding. A significant and unexpected finding in both places was that participants agreed that they should be responsible for keeping their environment clean and avoid the obstruction of canals and waterways.

One weakness of this exercise was that it was difficult to filter out households who were regular victims of flood hazards and those who were exposed solely to the inconvenience of facing flood conditions around their residence.

7.4 Key findings from focus groups and from participatory activities

This analysis identified that the groups identified as vulnerable in all three communities were households with children or with disabled or elderly persons; the unemployed; and those with a low income.

- i) This analysis also showed that communities in CLC were the most vulnerable to flood hazards and had low economic, psychological and institutional resilience. In LH and GB, communities faced more environmental problems, which required the strengthening of the infrastructure as well as institutional resilience. Overall, the issues of EJ and marginalisation were found to be more predominant in both GB and CLC where underprivileged sectors of the community lived in poor environmental conditions.
- ii) A certain level of resilience was noticed among the poorer sector of the community in CLC as they developed solidarity through social networking in

times of adversity. This condition was less prevalent in LH and GB. This may be linked to the historical and economic development of the areas. However, elderly persons in LH and GB were found to have a long experience of flood events, which was translated into some resilience through their local knowledge.

- iii) The outcomes from participatory activities showed that participants were conscious of their responsibility as well as their ethical values in keeping their environment clean and reducing the risk of flooding and vulnerability.
- iv) There were strong inter-linkages among the components of community resilience as each type of resilience seemed to be influenced by the others. As deduced from focus group interviews, a weakness in economic resilience, which was invariably attributed to poverty, could compel the poorer households to occupy overcrowded marginal flood zones. A lack of institutional support could lead to a poor infrastructure and hence to a greater threat from flooding. Living under stress could cause weak psychological resilience, which would further have an adverse impact on social and economic resilience. Likewise, a decrease in community competence might lead to a reduction in social capacity and in the ability to overcome their vulnerability until the next flood disaster.

7.5 Results of analysis of semi-structured interviews with agency stakeholders

The section explores the perspectives of *agency* stakeholders, which include ministries, government institutions, and NGOs, on reducing vulnerability and in building the short- and long-term resilience of the *primary* stakeholders that make up the community. The semi-structured interviews were also meant to examine the responsibilities of the agency stakeholders, the arrangements they make, and the actions they take to reduce vulnerability and build resilience during the recovery phase. Their views on the role of science and technology and what the community itself could undertake to mitigate the impact of flooding were also sought. Overall, the interviews were meant to answer research question II in Section 1.6, namely:

Question II: *What are the stakeholders' perceptions of what can be done to reduce community vulnerability and promote resilience in the recovery/rehabilitation phase of the disaster response model, with particular attention paid to the role and potential of science and technology?*

Representatives of institutions as agency stakeholders, and those who were most concerned with the recovery of the affected residents, were interviewed. These were grouped as follows:

a) Coordination and flood warnings

- National Disaster Preparedness Committee (Coordination) and Meteorological Services (Warning services) (Appendix 19)

b) Emergency and relief

- Fire Services (Appendix 20)
- Police (Appendix 21)
- Ministry of Social Security (Appendix 22)
- Ministry of Health (Appendix 23)
- NGO (Appendix 24)

c) Flood alleviation measures: short- and long-term

- Local authorities (Village and District Councils) (Appendix 25)
- Ministry of Environment and Sustainable Development (Appendix 26)

Transcripts of the interviews (Appendices 19 to 26) were analysed using NVIVO 10 software, and the themes highlighted were grouped along the components of community resilience. The results are presented graphically in Figure 7.7. The factors that contributed to the different types of resilience are discussed in Sections 7.5.1 to 7.5.6. As perceived by the agency stakeholders, the components that contributed most to community resilience (Figure 7.7) were institutional, infrastructural, and community competence followed by economic and social and, lastly, psychological.

7.5.1 Social resilience

From the analysis of the agency stakeholders' interviews, it could be deduced that nearly all the stakeholders were focussed on providing assistance and saving the lives of vulnerable persons during and immediately following a flood event (Appendix 27).

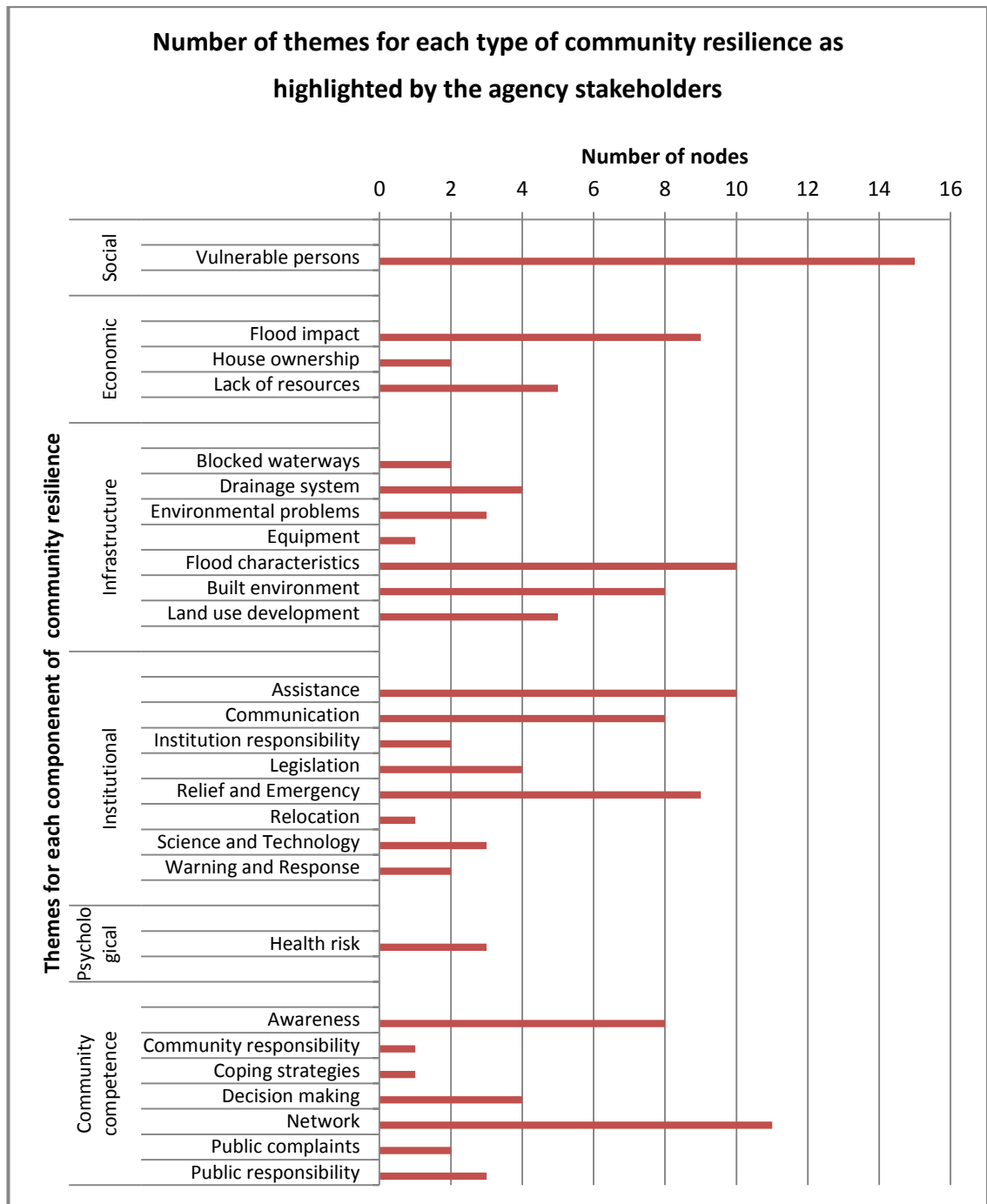


Figure 7.7 Frequency of themes mentioned by agency stakeholders for each type of community resilience

Those that were considered most vulnerable and least resilient to flooding were households with a low income and those with large families and children, or with sick or disabled persons (Section 6.12). The priority was on saving lives, as highlighted in the following statement:

‘Yes, first save human life, then pump water. We are generally the first to intervene; we ascertain whether there are people trapped inside. If so, we intervene immediately; at times we have to break in doors to remove people. Sick and handicapped persons are removed on stretchers. Children are taken out and brought to their parents.’ (Fire Services)

7.5.2 Economic resilience

Nearly all the stakeholders considered that addressing the adverse impacts of flooding was an important factor in building economic resilience among the communities. However, it was mainly the local authority and the NGOs that gave priority to other factors, such as house ownership and resource availability, as part of the resilience building effort (Figure 7.7).

As stated by the representative of the local authority, those who were least economically resilient were more likely to live in flood risk areas. A lack of resources made their recovery process long and it was often still incomplete when the next flood event arrived, so that their vulnerability increased. To make matters worse for the economically weak, those who had the means to do so often built walls, sometimes even across waterways. On rainy days, the accumulated flood water flowed from one house to the next unprotected house, thus increasing the risk of flooding and hence aggravating the human-induced vulnerability. This condition was gathered from the following extract:

‘When the new land owners realise the situation first hand, they often wall themselves in or even build walls on the natural waterways, which had been conveniently left out of the title deeds by the developer. Water from one house is transferred to another house’s living room or kitchen. People become desperate, and much ill will is generated among neighbours.’ (Local authority)

The local authorities asserted that the resources allocated to them to keep the drainage systems and waterways clean as required by official guidelines were totally inadequate. The representative of the local authority further believed that some of the responsibility for the drains being blocked by debris also rested with the local inhabitants, who disposed of waste indiscriminately:

'The lack of resources is the main concern. However, the constant call for a change of priorities and the stretching of the available resources does not always allow for systematic cleaning of the drains. According to existing guidelines, all the drains must be cleared ahead of the rainy season. The available resources allow only for a partial adherence to the stated requirement.' (Local authority)

This concern can be addressed only if additional resources are made available to the local authorities to enhance the resilience of inhabitants exposed to flood conditions. The agency stakeholders stated that their resource allocation was insufficient to meet the demands of the communities. They felt that some of the concerns regarding the environment could be addressed by the community through greater participation in sustained civic action, such as the proper disposal of waste. However, during the participatory activities (Section 7.3.1) especially at CLC the residents clearly signified their role regarding the environment and their civic responsibilities. There is clearly a lack of dialogue between the agency stakeholders and the community.

7.5.3 *Infrastructural/environmental resilience*

As perceived by the authorities, infrastructural/environmental resilience was a major contributor to the overall community resilience. It comprised issues such as the drainage system and environmental issues, flood characteristics, and land use (Figure 7.7). The major elements are considered in this section.

a) Drainage system and environmental issues

It was primarily the local authority representative who expressed concern about infrastructural and environmental problems (Figure 7.7) as the local authority is directly concerned with aspects such as drainage system construction and maintenance,

providing construction permits, and addressing environmental problems, such as waste disposal. The waterways and the environment in various locations were in a deplorable state, and the residents living nearby dump waste that blocks the water courses. The representative felt that the primary stakeholders should develop a sense of solidarity as well as a suitable mechanism for monitoring and advising the authorities on the state of the environment including the drainage system of the locality. They should assume responsibility and undertake activities that could contribute to strengthen community resilience.

The representative of the ministry stated, *'The ministry and the other authorities will never have the resources to keep all waterways clean all the time.'* As a result, all stakeholders, including the residents, should assist. The following statement conveys the perception of the authorities of the ways that the communities could help themselves and the authorities:

'As a community, they should ensure that the local authorities are duly informed of any flooding and subsequently monitor any actions taken to mitigate flooding. If they constitute an NGO, they may have a stronger voice vis-à-vis the authorities. They could also contribute to the sensitisation of their fellow citizens.' (Ministry of Environment and Sustainable Development)

This statement also implied that community resilience could be built by networking with all stakeholders. However, analysis of the focus group interviews with vulnerable communities suggested that support from local authorities was lacking, hence the difficulty they had in voicing their concern.

The cleaning up of the environment was previously carried out on an *ad hoc* basis, but at the time of the research, it was organized in a more co-ordinated and systematic manner by the local authorities. In view of the widespread nature of poor drains and the degraded environment, the Ministry for the Environment and Sustainable Development had extended its actions to include clearing and dredging the silted and obstructed rivers, streams, and natural drains. Some of this work was carried out at the request of local and regional authorities (village councils, district councils, and municipalities) and the public. Many rivers were blocked for a number of reasons during torrential rains.

The waste, especially plastic objects thrown by the inhabitants, and the branches, leaves, and silt carried by the torrents, obstructed the drains. The officer was forthright in claiming that it was basically the responsibility of each and every citizen of Mauritius to preserve and enhance the quality of life by assuming responsibility for the natural environment.

In addition to environmental enhancement, the aim of the authorities was to prevent the proliferation of diseases and mitigate the impacts of natural disasters. Fixed penalties for littering and for degrading the environment had also been introduced, and the authorities were enforcing environmental legislation more strictly:

‘The government has recently made new regulations with higher levels of fines to deter people from littering and from dumping waste. These measures have so far been successful to a certain extent in altering the habits of people and have contributed to a cleaner Mauritius.’ (Ministry of Environment and Sustainable Development)

As a complementary measure to legislation, the authorities were also organising regular awareness-raising campaigns targeting all levels of the population and the corporate sector.

b) Flood characteristics

The nature of floods was perceived as an important factor by most institutions when considering institutional resilience. Apart from those generated by cyclones, floods may also be caused by other weather disturbances resulting in flash floods. As an island, coastal flooding due to heavy swells must be addressed. Some of the characteristics of flooding also include seasonality, location, intensity, and frequency (UN/ISDR, 2004).

In Mauritius, the only criterion for torrential rain that might cause flooding is *‘100 millimetres of widespread rains in less than 12 hours and that this heavy rain is likely to continue for several hours’* (Mauritius Meteorological Services, 2011). This criterion was found to be inadequate and had to be revised as amounts of rain less than 100 mm had been causing flooding across the island. Households in some localities, such as GB,

had reported the occurrence of flooding and their exposure to flood conditions even with slight rains.

c) Land use

According to the representative of the local authority, the built environment had been degraded in the recent past, thus aggravating flood conditions. Furthermore, the Ministry of Environment and Sustainable Development commented regarding improper land use:

'Land developers, as well as individuals, have been allowed to build on low lying areas and even on wetland areas, such as GB. The land is accessible to low-income families, and the developer backfills the land and levels the ground. At the slightest rainfall, residents are exposed to flood conditions. Complaints are constantly filed. Residents reach a state of desperation living with risk. The authorities find it difficult to provide ready solution.' (Ministry of Environment and Sustainable Development)

This quotation implicitly indicates that the flood hazards were caused as a result of human use of their environment and that underprivileged families were disproportionately exposed to flood conditions. Living with the risk of flooding also adversely influenced the psychological health of residents and lowered their resilience.

7.5.4 Institutional resilience

Factors contributing to institutional resilience were the most numerous compared to the other types, as perceived by the institutions. A few of the factors that were considered included assistance, relocation, the role of science and technology, and the flood warning system and response (Appendix 27).

a) Assistance and Relocation

Several institutions were involved in providing assistance, which could be short- or long-term. It was considered as an important element in resilience building; however, most of the assistance was short-term in nature, primarily during the relief and emergency stage.

The role of the *Social Security Officer* is to provide shelter to flood victims, but the response varies according to the severity of the event. Fewer people were moving to shelters during a flood event compared during a cyclone, and the reason evinced was that during a cyclone, houses could be blown down, and the risk of injury and loss of life was greater, whereas during a flood, people were primarily concerned with keeping the family in dry conditions and ensuring that the food and their furniture were not spoilt and their animals were unharmed. Based on their experiences, the stakeholders felt that they could take the risk of living through flood events with some measures that might alleviate the impact. Relocation could be quite problematic for the families when they had to adapt in terms of social networking and schooling.

In the relief and emergency stage of the recovery phase, a modest amount of assistance was provided to households with a low income. Those who had lost some or most of their belongings were referred to the Ministry of Social Security by the police. They were provided with some basic necessities and a small amount of cash to ‘get back to normal’. However, after the initial support, they were left to themselves to meet long-term needs to complete the recovery process.

b) *Warning system and response*

Warning/response systems in operation in Mauritius were developed for cyclones in the 1960s. The same approach as for cyclones was in operation in the case of flood events. In such cases, the national coordinating NPU had proposed a prescriptive connotation with regard to the mitigation of the risk of flooding as it called primarily for the flood-affected communities to act responsibly:

‘The contingency planning that is applicable to flood hazards is not so developed. People also have to be responsible for their own safety during floods. For example, they should refrain from building walls and infrastructures across water courses, which leads to greater adverse impact and more serious and widespread damage.’ (Meteorological Services)

There was also a call by the NPU to involve the local community in flood risk reduction programmes, which specified how it could be achieved:

‘Local community participation through adequate sensitization, information, exposure, and training so that it is pro-actively involved in the preventive, remedial, rescue, and relief operations put in place by the authorities to ensure the participation of the local community, more especially in flood risk areas in all relevant aspects of the operations.’ (NPU)

Unfortunately, these ‘top-down’ approaches had not contributed significantly to the mitigation of flooding as communities had become more used to responding to one specific type of hazard, such as cyclones:

‘The system is very well prepared for cyclones and is very well understood by the population, who have come to trust the system of warnings and act accordingly. The public and private sectors receive the warnings promptly through all channels of communication and heed the warnings and advice almost to the letter. It is understood that each institution or individual applies them in accordance with its own specific situation or condition.’ (Meteorological Services)

This suggests that over the years, communities have built resilience for cyclones but not for flood hazards. It could also mean that other approaches in flood hazard mitigation are needed for building community resilience to flood.

c) Agency stakeholders’ opinions on the role of science and technology in disaster mitigation and resilience-building

Science and technology were considered by the representative of the National Preparedness Unit and Meteorological Services as having an important role to play in the preparation, timely dissemination, and reception of warnings. Regarding efficient and timely warnings, the following points were raised:

‘A good warning draws on reliable data from an appropriately dense network of monitoring stations, especially in the flood-prone areas. The data should be available in a timely manner through a robust telecommunication system.’ (Meteorological Services)

Commenting on the effectiveness of flood warning systems, it was stated:

‘Increasingly, it is realised that the system is inadequate to meet the demands of flood warnings. The Mauritius Meteorological Services has to review thoroughly its flood warning system and develop new products in collaboration with other ministries that meet the evolving needs of the population.’ (Meteorological Services)

‘The product should be available to the authorities and the public immediately and regularly. The latest facilities – SMS etc. – should be used.’ (Meteorological Services)

‘A database and research facilities with suitable personnel are essential if the warning system is to live up to the fast evolving requirements of a modern nation. The areas subject to flooding should be updated and a watch system instituted.’ (Meteorological Services)

Likewise, to be effective during the emergency and relief operations, science and technology had to provide tools, such as sophisticated and efficient pumps, which would enable emergency and relief operators to intervene in the case of emergencies. Increasingly, people were accessing weather information through various channels of communication from service providers worldwide as complementary to those offered by the National Meteorological Services (Section 7.5.4 (b)). These developments were becoming key elements in prevention measures and especially in saving lives in the case of disasters and in resilience building.

Other aspects of resilience building where science and technology could be applied were effective preparedness measures, which included the delineation of flood risk zones using GIS and aerial and satellite mapping on a regular basis. Such information would be important in land-use planning and in implementing measures that did not expose citizens to flood risk.

7.5.5 Psychological resilience

The question of what can be done to reduce vulnerability and enhance the wellbeing of the community was often raised in the general context of health. After a flood, affected communities and those exposed to poor conditions were often subject to health problems. The recurrence of diseases as a result of drinking contaminated water during flood seasons was prevalent, but it was not specifically pointed out which sectors of the communities were affected. However, there was an outbreak of vector-borne disease in 2007, which struck a large number of people as can be seen from the following statements from the Health Services:

'There were 3500 suspected cases of chikungunya in 2007. On 26 March 2008, as a result of heavy rainfalls, there were several fatalities and casualties' (Ministry of Health).

'It is found that in the event of a natural disaster, assistance given to communities is geared primarily to conventional medicine therapy. No group psychological therapy measures are taken on a routine basis. The ministry may put in place therapeutic measures to address such needs in the event of natural disasters with the help of psychologists, psychiatrists, and community physicians and rehabilitative programmes to assist people in distress.' (Ministry of Health)

The authorities were aware of the psychological impacts of flooding, but no suitable mechanism to address the issue was in place.

7.5.6 Community competence

A most important aspect of overall resilience building is related to community competence. It includes many aspects of self-help, awareness, community cohesion, cultural values, ethics, and collective action (Table 2.4). The perspectives of stakeholders in these areas in strengthening community resilience are considered under the following sub-sections:

a) *Awareness building and involving local NGOs*

In addition to the statement made by the stakeholders on the need for the sensitisation of communities on cleaning up their environment, other actions were suggested by the NGO representative:

‘Our NGO could meet individually with the families concerned and reiterate the advice. It could monitor the situation more closely and keep in contact with the families during the whole flood cycle. The NGO could do more regarding the long-term assistance to enhance resilience. For example, the local NGOs could collaborate, draw up a plan, and develop a watch system in the event of flooding and other disasters. They could act as a platform for interacting with the local and national authorities as well as with national firms and other NGOs.’ (NGO)

Moreover, it was noted that no mechanism existed to involve the residents in decision-making at a district or national level:

‘The local community is involved through the members of the NGOs familiar with the flood-affected inhabitants. There is no specific mechanism to involve the affected inhabitants in the decision-making process on the spur of the moment.’ (NGO)

b) *Networking and taking responsibility*

A rather well-synchronised and an operational network existed amongst the institutions, mostly during the warning/response stage of flood disasters. On the other hand, NGOs and the private sector appeared to assume their own responsibilities, mostly independently of the authorities. As a result, decision-making appeared to be ‘top-down’ with practically no participation of local communities in the operational measures taken by the authorities.

The semi-structured interview with the local NGO representative showed that NGOs were in a better position than the authorities to liaise effectively with flood-affected inhabitants but there was no official specific mechanism to involve the affected inhabitants in the decision-making processes either at civil society or official levels. In

addition, NGOs were not directly represented in the National Disaster Preparedness Committee as they were seen to operate at the local or regional level. However, they were encouraged and even invited to be involved at the local level. Their views were channelled upwards to the Preparedness Committee and were taken into consideration in the decision-making process.

7.6 Key findings from the analysis of agency stakeholders' interviews

Some of the key findings from the analysis could be summarised as follows:

- Each institution from the agency stakeholders appeared to focus primarily on its own area of responsibility.
- Those most concerned with the social aspects of community well-being were the local authority and the NPU followed by Fire Services and NGOs and lastly by the Ministry of Health and the Police Services.
- Most of the actions of nearly all the institutions were short-term response measures. This explains why they moved out of the community in distress once flood conditions were over.
- Most of the authorities agreed that they did not have the resources to meet all the needs of the communities. Thus, their efforts should be coordinated and supplemented by those of the communities, who should share the responsibility to reverse the deplorable state of the environment. The feeling of distrust would have to be addressed if synergies between the authorities and the community were to be achieved for mutual benefit.
- The Meteorological Services and the National Disaster Preparedness Committee considered that science and technology could be an important tool in communication, in sensitising vulnerable communities, and in building their resilience against future flood events.

- Overall, most stakeholders were concerned about vulnerable persons (social), the impact of flooding (economic); relief and emergency and communication elements (institutional); and awareness and networking elements (community competence).
- From the agency stakeholders' perspectives flood hazards were viewed as discrete physical hazards that required a 'top-down' approach to achieve vulnerability reduction and to build resilience, though there was an indication that flood hazards were increasing as a result of the indiscriminate human use of the environment in Mauritius (Section 2.2.2).

7.7 Summary

Quantitative research generates factual, reliable outcome data that are usually generalizable to some larger populations, and qualitative research produces rich, detailed and valid process data based on the participants' perspectives and interpretations rather than those of the investigator.

This summary of the outcomes from the agency stakeholders' semi-structured interviews highlighted that their approach to reduce vulnerability and enhance community resilience was of a top-down technocratic nature. In contrast, the findings for the focus group interviews showed that there was a lack of social equity and EJ among the vulnerable groups in all the case studies and that these were not adequately addressed by the government in the long-term view of the recovery process. The findings from the short participatory activities revealed that the participants had some civic duties regarding safeguarding their environment and helping to reduce the risk of flooding, but they considered that the government agencies should be more concerned with their needs and aim to improve their social conditions. These issues are further examined in the next chapter, which provides a discussion.

Chapter 8 – Discussion

8.1 Introduction

This chapter reviews and discusses the key findings of this study. It examines the extent to which the research questions have been answered and the objectives of the project have been met (Sections 8.2 to 8.5). Section 8.2 discusses the findings obtained from the analysis of data in Chapters 5, 6, and 7. Section 8.3 focuses on the research questions and discusses the findings obtained from semi-structured interviews with the agency stakeholders in Chapter 7. Section 8.4 focuses further on the concepts of vulnerability and resilience in relation to the issues of social equity and EJ. The appraisal of these issues is combined with other research findings to develop a framework for flood risk disaster mitigation and management for Mauritius (Section 8.5). The extent to which the knowledge, concepts, and issues gathered from the review of the literature and the degree to which they influenced their incorporation and provided guidance in this study are likewise analysed in Section 8.5.2. In Section 8.6, the options for policy makers are proposed on the basis of the findings from the study. A comparison of this study with some other recently published works is made to show the uniqueness in the approaches used to understand community resilience building in relation to flood hazards (Section 8.7). A summary of the main points of the chapter is given in Section 8.8.

8.2 Reducing vulnerability and building resilience of community sectors in the recovery phase of flood hazards - an integrated framework

This section discusses the findings from the analysis of the quantitative and qualitative data as responses to Research Question I. The concept of vulnerability was widely used, as it had been found to be useful in disaster management and it was described as the *'states of susceptibility to harm, powerlessness and marginality of people'* (Adger, 2006, p. 268). However, it does not explicitly bring out the concept of communities' resilience. Hence, an integrated framework of vulnerability and resilience was considered essential in defining the actions aimed at reducing vulnerability and building long-term resilience for the recovery of communities at risk. The following sub-sections discuss the research findings of the study in terms of the types of resilience in order to integrate them within an overall framework of flood disaster risk management.

8.2.1 Social resilience

Several aspects of household characteristics were considered, such as household size, education and income levels, and whether the household included children or elderly persons. It was found from the survey that the majority of households in each community fell within the low-income group, constituting the sector of the community that was most vulnerable to flood risks. In all three cases, most households had a good basic level of literacy of up to at least six years of schooling. In general, the groups that were more educated were found to be less vulnerable to flood hazards due to their stronger economic position and greater awareness of flood risks compared to those with a lower educational level

Responses from the questionnaire survey showed that most householders occupied flood risk zones largely by choice and were aware of their vulnerability (Section 5.2.8). Some coping strategies were practised during flood events, but their effectiveness depended mostly on the availability of resources. Some households in all the case studies took a long time to recover; however, others did not recover by the time the next flood event occurred, thus further entrenching their vulnerability. Further statistical tests on the data showed that the groups more vulnerable to the effects of flooding included households (Section 6.15) with

- a) a large number of family members at CLC and LH
- b) a low income at CLC
- c) a low level of literacy at LH and GB
- d) children at LH and GB
- e) no elderly persons at CLC, but some elderly persons at GB and LH.

In addition to the low-income group at CLC, those with large families at CLC and LH and those with a low level of literacy at LH and GB were mostly associated with poverty and were the least able to recover after a flood event. In all three cases, the statistical analysis of the questionnaire survey (Sections 6.4, 6.10 and 6.13) showed that community groups with a high level of literacy had a better quality of life, meaning that they had a good income and better living conditions, and were thus more secure from the effects of flooding. These findings have implications for policy-making in areas

such as identifying the groups that could benefit most from flood-related education and awareness building and in establishing priorities for focused action to achieve social resilience in a given community.

8.2.2. *Economic resilience*

The results of the survey showed that the low-income groups in the CLC and GB communities were more likely to experience flooding as they lived in flood risk zones, wetland areas, and marginal lands along river banks. They were thus more vulnerable and more liable to encounter both tangible and intangible impacts. It was found that some of the low-income families remained in damp conditions for many days and suffered social disruption and economic stress, as they were constantly concerned about not having enough resources to improve their housing conditions. In some households in CLC and GB, living conditions remained unchanged or deteriorated after a flood event, a situation that added to the '*ratchet effect*' of vulnerability (Pelling, 2003). As a result, it was mostly the low-income groups that became least resilient and least able to recover from one flood event to the next. Verbatim quotations from participants in the focus groups at CLC supported these views. In LH, however, most householders claimed that they got their houses back to normal soon after a flood.

The statistical analysis of data (Sections 6.4 (iii) and 6.4 (iv)) showed that a relationship existed between the socio-economic conditions of the low-income groups and their housing conditions. Additional information from the focus group interviews further indicated that groups with poor socio-economic conditions lived in fragile houses built on state lands. These groups took an inordinately longer time to recover. In comparison, the majority of the community in LH lived in houses they owned but were equally exposed to flood conditions. In LH, the vulnerable groups were those with large households and who lacked the financial resources necessary to build flood-resistant houses or to move out of the flood zone. In GB, most of the householders surveyed claimed to occupy wetlands and householders preferred to stay in crowded and unsafe conditions rather than move to other places; this was for reasons of job proximity and in order to live among their relatives. On their own, underprivileged groups were found to take several years to recover if floods were frequent unless they received outside help from the government or from aid agencies. Poorer households were thus more vulnerable and showed the least resilience to flood hazards over extended periods. The

survey data showed that the CLC community was the least resilient economically followed by those of GB and LH.

8.2.3. *Infrastructural/environmental resilience*

In Mauritius, the pressure on land is compounded by the need to provide for the growing population and the increasing tourist trade. The wetland areas in GB had been reduced from 38.5 ha in 1975 to 11.5ha in 2002 (Ministry of Environment and National Development Unit, 2002). In other places, agricultural land had been converted for residential use and other infrastructure development purposes (Section 3.6.2), resulting in an increased intensity of human use--environment interaction, which had exacerbated flood conditions (Section 3.9). The survey analysis of all three cases showed that land transformation through extreme land-use change had resulted in entrenched vulnerability, often making community resilience-building costly.

In order to cope with flood events, the majority of households in all three case studies made furrows to divert water during and after a flood hazard as a means of reducing their exposure to associated risks (Section 5.3.7). Building higher floors and constructing walls around the property were used as longer-term adaptive strategies, but these could be afforded only by households that were economically well-off. One drawback of building protective structures against floods was that it could divert the flow of water into the neighbourhood and thus cause more harm to others and increase the overall vulnerability of the community. As a last resort, household groups with limited means in CLC and GB adapted to flood conditions by accepting things as they were and aimed to live through the events. Such an approach to flooding would further add to their vulnerability and lessen their likely resilience to future events. The enforcement of existing laws and greater civic responsibility among residents were considered by respondents as essential elements of resilience-building (Sections 7.3.1 and 7.3.2).

The results of the focus group interviews showed that in some cases, the inhabitants were exposed to the inconvenience of an ill-conceived infrastructure implemented by government agencies in the area. In GB, participants in the focus group stated that drains for the evacuation of waste overflowed during heavy rains, and the accompanying foul odour was a health risk to their family members. A feeling of

environmental injustice was found to prevail among underprivileged groups of households. This reinforces the views of McEntire (2001), Houston et al. (2007), and Walker (2012) on disproportionate exposure and social inequality, which further exacerbated the vulnerability of low-income groups. Marginalised and underprivileged groups, mainly households with children and elderly persons within the communities, who were differentially exposed to flood risk areas, were threatened by higher levels of health hazards. These groups were found to be the most vulnerable and the least able to recover between events.

8.2.4. *Institutional resilience*

The findings from the descriptive analyses revealed that the householders from all three localities had negative attitudes about the support given to them by the local and government authorities and NGOs. There was perceived to be a serious lack of government support. The roles of NGOs in collaborating with the affected communities in all three case studies were very weak, but generally, the communities did not expect their support for long-term recovery. The extent to which support was provided to households by the government in the three localities was found to be equally inadequate for rehabilitation purposes and for long-term recovery. Such feelings were prevalent in all three case studies, particularly among low-income groups and among large households with dependents. The results from the focus groups further validated these findings although some households at CLC had acknowledged having received limited government assistance for their immediate needs in the wake of floods. However, assistance from outside sources was found to be helpful for poorer households, who needed to solve their immediate problems, but this did not seem to reduce their vulnerability in the long-term (Pelling, 1999; Tobin, 1999). Relocation programmes by the government were not considered as a viable solution by the communities from flood risk zones. It was generally felt that moving out to other places could further disturb the person's livelihood both economically and socially. Ingram et al. (2006) cited a similar pattern in Sri Lanka, soon after the 2004 Asian Tsunami, when poor fishing communities were forced to relocate away from their source of livelihood and long-established community life.

Institutional resilience was found to be generally very weak as both structural and non-structural support to households were lacking especially in CLC and GB. In particular,

respondents perceived a strong need for improvements to the flood warning system so that they could understand the warnings and respond effectively. On their own, the affected communities were able to develop little resilience against flooding. While vulnerability and resilience were inherent characteristics of households, they did not apply equally to different types of hazards. For example, over the years, households all over Mauritius have developed resilience against cyclones but not against floods or storm surges (Section 3.7.5). Hence vulnerability/resilience had to be taken as being hazard specific. This finding was supported by the views of participants from the focus groups in all three localities. They were more used to responding to cyclone warnings than to flood warnings. They confirmed that the flood warning system was not so well developed and was little understood (Section 7.2.2 (i)).

8.2.5. *Psychological resilience*

The results of the descriptive analysis showed that psychological impacts were predominant among the communities in all three case studies (Sections 5.2.3 (ii), 5.3.3 (ii) and 5.4.3 (ii)). The most common type of long-term psychological and emotional vulnerability resulted from being upset about living in a flood risk area and suffering from anxiety about the unpredictable consequences of the next flood event. Other factors reported to have caused psychological distress were constant worry about the family's safety and the children's future, and concern about the risk of catching flood-related diseases. However, in all three localities, chronic psychological trauma and a lack of trust in local and government authorities further increased the vulnerability of households. Household groups with a high level of literacy were aware of the lack of support from local authorities and were worried about the family's quality of life due to exposure to flood-related diseases.

In LH and GB, the concerns were more related to environmental conditions. In GB, the psychological impact was mostly associated with households with large families, and with those with children, as the children had to walk in polluted flood water to attend school (Section 7.2.6 (ii)). Household groups with children in GB were also worried about flood-borne diseases. Concern about diseases and chronic stress has been found elsewhere to be factor that has led to reduced resilience (Pelling, 2003; Wisner et al., 2006; Linnekamp et al., 2011). Another cause of vulnerability at CLC reported in the survey was the reluctance to build strong houses and invest in flood proofing, as the

households occupied state lands without any authorisation. They continued to live with anxiety and the possibility of being evicted from the land at any time (Section 7.2.6(ii)). According to Whittle et al. (2012), psychological anxiety can result from the disempowerment of communities, who are then unable to make themselves more resilient.

8.2.6 Community competence

Community resilience at all three localities was found to be linked to the strength of networking, the building of relationships with neighbours, and the strengthening of community ties, and to taking active civic action, including contributing to keeping the environment clean. In this way, the inhabitants would cooperate in addressing the many problems caused by flooding rather than waiting for the authorities to attend to each and every concern. Participants from the focus group at LH stated that residents should avoid building on canals, streams, or storm drains, but there was little evidence that this was being translated into action. However, the concern expressed by the respondents suggested that they were keen to participate in actions aimed at addressing the environmental problems, and thus they demonstrated some aspects of community solidarity.

The participants who contributed to the participatory activities at both CLC and LH reported that helping neighbours and liaising with local authorities to clean up soon after flood hazards was a common action of solidarity. However, this attitude tended to diminish as the recovery phase wore on (Section 7.2.7 (iii)). The results from the statistical analysis showed that the respondents from the high-level of literacy group in GB perceived a lack of community cohesion, most probably due to the growing individualism arising from economic development and modernisation. In contrast, those from the low-level of literacy group in CLC who participated in the focus group, perceived that social cohesion existed among them when it came to coping with hazards and enhancing resilience. On one occasion, they had expressed their concern through a private radio network and had been able to raise funds and assist their neighbours in need (Section 7.2.5 (iii)). Ferdinand et al. (2012) indicated that communities in the Windward Islands in the Caribbean collaborated among themselves in building resilience. However, they noted that resilience building required broader multi-stakeholder partnerships and that working in isolation could further exacerbate

vulnerability. In this respect, the integration of other stakeholders in vulnerability/resilience management is essential.

Although Mohanty (2006) found that the disposition to help each other during flood events acted as a '*safety net*' and '*shock absorber*' and helped in reducing the vulnerability of the poor, the findings from this study showed that such solidarity existed to a lesser extent among the community groups in LH and GB, where the expression '*dare not contact neighbours*' was prevalent, as was demonstrated during focus group interviews (Section 7.2.2). Indeed, although a number of households from GB and LH said they would be willing to help their neighbours during a flood disaster (Section 5.4.7 (iii)), in general, they appeared to place more trust in their own families and relatives. In households with elderly persons at LH and GB, the experience and local knowledge gathered on flood events over the years indicated some degree of inherent resilience. Integrating the local knowledge of experience of flooding and of flood memories from the inhabitants with that of 'expert knowledge' could help to increase the understanding of the problems faced by local inhabitants and to reinforce community resilience (Mercer et al., 2009; McEwen and Jones, 2012). To achieve such resilience would require the integration of local people with other stakeholders in decision-making processes.

This study likewise found significant differences in the level of vulnerability among community groups arising from the availability of resources, the level of education, the community ties, and the attitude toward the authorities. These factors interacted in complex ways, as found by Norris et al. (2008), and on different scales, as observed by Gaillard et al. (2007). This analysis showed that reducing vulnerability and enhancing resilience in the recovery process was a challenging task that required the efforts of all the actors in disaster risk management. The next section will address the second research question and will principally refer to the findings from the interviews with stakeholders in Chapter 7.

8.3 Agency stakeholders' perceptions on reducing vulnerability and enhancing community resilience in the recovery phase

Information about the way the agencies saw their role and responsibilities in disaster management was obtained from the semi-structured interviews with selected agency stakeholders (Section 7.5). The findings are discussed in this section and assessed in

terms of types of resilience. Overall, most stakeholders were concerned about vulnerable persons (social), the impact of flooding (economic); relief, emergency, and communication elements (institutional); and awareness and networking elements (community competence). A few of the stakeholders saw science and technology as a key element in the long-term resilience building of the flood-affected communities.

8.3.1 *Social resilience*

The analysis showed that those who were most concerned with long-term social aspects of community well-being were the local authorities and the NPU. However, in terms of short-term relief and emergency assistance, a number of other stakeholders were involved. Stakeholders that are engaged in the relief and emergency operations, such as the fire brigade, gave priority to assisting vulnerable households, especially those with children, or with disabled, sick, and elderly persons from life-threatening floods. However, while these actions helped save lives, they were effective only as short-term measures during the recovery phase. In view of their mandate or due to a lack of resources for rehabilitation purposes, the stakeholders move out soon after floods recede, leaving the vulnerable communities to fend for themselves. Regarding long-term measures, the NPU was promoting the awareness of vulnerable communities and encouraging community participation in flood risk reduction and in building resilience (Section 7.5.1).

8.3.2 *Economic resilience*

In the relief and emergency stage of the recovery phase, a modest amount of assistance was provided to low-income households. Those who had lost some or most of their belongings were referred to the Ministry of Social Security by the police. They were provided with some basic necessities and a small amount of cash to 'get back to normal'. However, after the initial support, they were left to themselves to meet their long-term needs and to complete the recovery process. As referred to in Section 8.2.4, this situation arose due to the fact that the majority of the authorities claimed that they did not have the resources to meet all the needs of the communities. Such costs involved extra expenses for cleaning, repairing, and maintaining the drainage systems before the next flood events. The stakeholders believed that their efforts should be coordinated with and supplemented by those of the communities, who should share the

responsibility to deal with the deplorable state of the environment. Like the communities, the agency stakeholders felt that the distrust between them had to be addressed if synergy between the authorities and the community was to be achieved for mutual benefit.

8.3.3 *Infrastructural / Environmental resilience*

Infrastructure and environmental resilience were perceived by the stakeholders to be major contributors to the overall community resilience. These comprised issues about the state of the built environment, flood characteristics, and land use (Figure 7.7). Stakeholders from local government and environmental institutions perceived that flood hazards were increasingly seen as being caused by the encroachment on flood risk zones and the poor maintenance of drainage systems. However, they felt that the inhabitants also had a responsibility to keep the environment clean to avoid flooding occurring with the slightest rainfall.

It was found there were conflicting views between local communities and the institutions on who had responsibility for the maintenance of drains and waterways and of the environment, with each party blaming the other. Cottrell (2005) considered that community participation with other stakeholders was essential in hazard-mitigation planning in a small town in Australia. In this sense, conflicting views between communities and stakeholders on the environment could be resolved by incorporating community participation in the decision-making process. .

Stakeholders perceived that keeping the state of the built environment in good condition is a crucial element in fostering the quality of life of communities. A clean environment also has a beneficial influence on both the physical and psychological health of a community (Faber and Kreig, 2002). For the welfare of a community, a sound environment depends not only on the community but also on other forces, such as support from stakeholders. As a way to build community resilience, stakeholders from local and environment-related institutions have recently undertaken clean-up campaigns and the sensitization of local communities about the importance of keeping their environment clean. Other issues of importance that are considered essential in mitigating the impacts of flooding include judicious land use, regulating measures on

land-use development and the involvement of all stakeholders in land-use planning (Ministry of Environment and National Development Unit, 2010).

8.3.4 Institutional resilience

The analysis showed that the institutional element of community resilience scored the highest number of themes (Figure 7.7). From the viewpoint of agency stakeholders, the elements that contributed most to institutional resilience were the timely dissemination and awareness of flood warnings and the role of science and technology. The agency stakeholders agreed that well-structured procedures for disaster reduction had been developed primarily against cyclones by the National Disaster Committee Warning Systems - Emergency and Relief Operations generally referred to NPU. The Committee's guidelines were followed by all institutions, including government agencies, local authorities, and the private sector. However, warning systems specific to floods were still not well developed, understood, or applied by either the institutions or the communities.

The agency stakeholders viewed the contributions of science and technology as being crucial in developing community resilience against flooding (Section 7.5.4 (c)). The representative of NPU and the Meteorological Services stated that science and technology played a vital role in the real-time data collection; in the processing, dissemination, and sensitisation of data; and in the communication of flood warnings. Other areas where it was suggested that science and technology could contribute were remote sensing techniques that combine the use of GIS and GPS tools in an integrated disaster-management information system (DMIS) for studying zones that are potentially at risk from disasters including flooding (Fagoonee, 2005). Integrated hydrological modelling is utilized widely to delineate flood zone areas in Mauritius (Bhankaurally, 2010) and for flood control by building better flood preventive structures. However, it was found that the application of advances in science and technology retained a top-down approach to disaster mitigation. The NPU recognised that scientific knowledge would be most effective if expert knowledge were integrated with a community's local knowledge during the decision-making for risk reduction management.

8.3.5 *Psychological resilience*

The authorities were aware of the psychological impacts of flooding within community groups but recognised that no suitable mechanism to address the issue was in place. Based on the interview with the representative of the Ministry of Health, there was a perceived need to strengthen psychological resilience. For this purpose, there was a requirement to retain the help of psychologists, psychiatrists, and community physicians and promote rehabilitative programmes to assist people in distress. In this regard, the provision of psychological health support (Carroll et al., 2010) should be envisaged by agency stakeholders.

8.3.6 *Community competence*

The perspectives of the agency stakeholders focused on two key aspects of fostering community competence. These are:

- awareness building by involving local NGOs
- networking and taking responsibility.

The stakeholders recognised that they tended to stop their operation and assistance soon after a flood disaster. However, they indicated that government institutions and NGOs should collaborate on developing sensitisation programmes for communities at risk of flood hazards. They also agreed on the need for a more ‘*holistic*’ approach in flood risk management with an emphasis on community participation in decision-making for long-term resilience building. If implemented, this approach could help to address the social equity and EJ issues highlighted especially in the focus group interviews (Section 7.4 (i)) in long-term resilience building.

8.4 EJ – a framework for understanding variations in vulnerability and resilience in communities

The concept of EJ initially emerged in the US and was applied to people and social groups who occupied hazardous areas that were formerly used as a dumping site of toxic materials (Cutter, 1995). In the UK, the concept of EJ has been used in the context of environmental inequality and social justice (Walker and Bulkeley, 2006). This issue was explored in greater detail in Section 2.6. In this study, the concept of EJ is referred

to broadly in the context of people from a low-income background, as they were disproportionately vulnerable to risks of flooding and had difficulties in recovering from and building resilience against flood hazards. Therefore, the concept of environmental justice also embraced the element of marginalisation or social exclusion. The term 'marginalisation' has been used to denote social groups who are differentially vulnerable, as mentioned by Houston et al. (2007). As found from the study survey, the perception of marginalisation was profound among the low-income groups, who felt that the government and the NGOs treated other groups more favourably. This sentiment was more strongly echoed by the participants in the focus group in CLC.

Analysis of the data from the three case studies showed that the low-income groups within the communities exposed to flooding perceived environmental injustice in many aspects of their conditions and in their relationship with the authorities. The groups perceived that there were strong disparities in the way they were treated with regard to land allocation and the construction of flood-proof housing during the recovery and rehabilitation phase. In all localities, the low income groups stated that their complaints about environmental problems and poor living conditions during flooding were disregarded by the authorities. The feeling of environmental injustice seemed to grow with time, leading the community to adopt a fatalist attitude while its vulnerability increased from one flood hazard to the next.

Other considerations reinforced the feeling of environmental injustice, especially among the low-income groups. Their perception was that they were being marginalised, as they remained confined to areas exposed to flood risks and the overflow from waste discharges, which posed health hazards, especially to children and elderly persons. The communities felt that the authorities paid little or no attention to their plight as their exposure to flood water had intensified as the result of the overflow from blocked drains and nearby waterways, which had only a limited capacity to siphon off the excess water. In GB, the drainage pipes and sewage pumping stations had been installed by the government over the limited space across the living areas of underprivileged groups of the population after the settlements had been established. The foul odour and the risk of overflow from this infrastructure were perceived by the community as a health risk. In LH, a form of environmental injustice expressed by the community was that the authorities did not clamp down on the illegal construction of walls and flood-proof

structures by several residents across storm drains, which were currently diverting water, causing unexpected flooding and increasing the exposure of vulnerable inhabitants to the risk of flooding. Building longer term environmental resilience would require that such walls or drainage pipes be removed. However, such actions may not be possible as considerable resources would be required for building costly new infrastructure and providing compensation for relocating residents.

Another form of environmental injustice perceived by groups exposed to flooding was that they were treated differently from other groups in the locality with regard to assuming responsibility and having a say in the resilience-building measures undertaken by the authorities. The results from the participatory activities indicated that while vulnerable groups showed an interest in collaborating with the government authorities in decision-making, they were systematically left out. Including these groups in the decision-making process could be a way to address social inequity and EJ and to build the long-term resilience of the communities exposed to flooding. While the households recognised that the choice of living in a flood risk zone had been mostly theirs due to settlement requiring practically no investment (Section 5.2.4), their expectation had been that the authorities would alleviate the situation fairly quickly. The feeling of environmental injustice arose from the fact that their condition had continued to deteriorate with each flood event and that no improvement was in sight.

The findings from the interviews with agency stakeholders revealed that land use for economic development might have contributed to environmental injustice. Market forces had caused high-risk land to become cheaper, thereby concentrating settlement there, leading to the over-representation of low-income groups in flood-risk areas and heightening the feeling of environmental injustice. A consequence of this situation was that psychological stress was commonly reported, but this was rarely addressed by the health services in the recovery phase of flood hazards. As discussed above, the study showed that the concept of EJ was found to influence many aspects of vulnerability and resilience building among groups in the vulnerable communities. It is therefore taken into consideration in the framework for flood risk reduction (Section 8.5).

8.5 Critiques of community vulnerability, resilience, and EJ in the recovery/rehabilitation phase

The findings from the quantitative and qualitative analyses of the three case studies showed that vulnerability was invariably linked to the key characteristics of low socio-economic status of the community groups. The vulnerability of the communities was influenced by the lack of resources available to them to rebuild after a flood disaster, the continued exposure to health risks, and the poor quality of the living conditions, with the result that these communities were unable to recover from one flood hazard to the next. As noted by Wisner et al. (2006), vulnerability is driven by poverty among groups of people who live in precarious conditions, thus raising the question of EJ (Section 2.6).

The central issues of social inequity and environmental injustice that led to low community resilience were most evident from the discussions of the findings in Sections 8.2.3. In contrast, a certain level of resilience was noticed among the poorer sector of the community in CLC as they developed solidarity through social networking by helping each other in times of adversity.

This condition of solidarity was less prevalent in the other two case studies but was present amongst elderly persons, who had developed some resilience through their experiences and the development of coping strategies during past flood events. The issue of community involvement in decision-making was expressed forcefully in Section 8.3 where the agency stakeholders recognised the current deficit in engagement and the need to integrate vulnerable communities in decision-making.

8.5.1 *Overview on linkages among components of community resilience*

The issues related to vulnerability, resilience, and EJ were examined in the literature review (Section 2.7.3), specifically in conjunction with recovery after floods and community resilience. As such, economic, social, environmental and psychological conditions were highlighted as important determinants or components of community resilience.

It was also noted that there were strong inter-linkages among the components of community resilience, as boundaries between the various types of resilience were artificially defined. As found from the community focus group interviews, a weakness in economic resilience, which was invariably attributed to poverty, could compel the poorer households to occupy overcrowded marginal flood zones. The lack of institutional support could lead to a poor infrastructure and hence to a greater threat from flooding, due to low-income groups occupying areas at risk of flooding. In addition, living under stress could weaken psychological resilience and further affect social and economic resilience. A decrease in community competence might lead to a reduction in social capacity and affect communities' ability to overcome their vulnerability and their preparedness before the next flood disaster.

8.5.2 *Developing a framework for disaster risk mitigation management*

This research started by identifying the problem in certain community groups living in flood-prone areas of not recovering from recurrent flood hazards. Ideas from other published works, as discussed in the literature review, brought new insights into the disaster recovery process, bringing forward the concept of community resilience. The Hyogo Framework for Action 2005-2015: *Building the Resilience of Nations and Communities to Disasters* (UN/ISDR, 2005) sheds light on the concept of building community resilience as a way to reduce risk and vulnerability to disasters. Rather than considering the framework mainly from a vulnerability viewpoint, the thesis was developed from a community resilience perspective that integrated all broader aspects of resilience types. Elements of environmental injustice and social inequality evidenced from the literature review were found to be predominant concepts of community vulnerability and resilience building in the longer-term recovery process.

The various categories or types of resilience in community resilience discourse from Manyena (2006), Cannon (2008), Cutter et al. (2008), and Norris et al. (2008) brought an innovative outlook to this study. The application of some of these concepts in case studies from Cottrell (2005), Schelfaut et al. (2011), Lópes-Marrero and Tschakert (2011), Schwarz et al. (2011), Ferdinand et al. (2012), Ainuddin and Routray (2012,) and Akter and Mallick (2013) were often used as a reference guide for this study. As a result, the thesis developed a framework of combined vulnerability and resilience, as it was recognised that even the most vulnerable communities had inherent resilience, such

as community networks and experience, which enabled them to overcome some of the flood disasters. Furthermore, variables referring to vulnerability were found to be easier to handle, and it was easier to gather information especially when dealing with marginalised community groups. The findings from the analysis of the data obtained from the community groups were used in conjunction with those obtained from the analysis of the interviews with agency stakeholders to develop a framework for disaster risk mitigation.

8.5.3 *Proposal of an Integrated Framework of DRR Management*

Based on the findings from the study, a simplified framework is offered in Figure 8.1. This framework represents the recovery process in three phases: (i) assessment of the current situation (Box A), (ii) decision-making and action (Box B), and (iii) implementation with evaluation (Box C). The framework gives a clear road map from assessed inherent vulnerability and inherent resilience to community resilience and disaster risk management. The advantage of the simplified version is that it highlights the overarching structure of the model. The framework highlights both the vulnerability and the resilience approaches for reducing social inequity and environmental injustice. In Figures 8.1 and 82, the proposed mechanism for achieving social equity and environmental justice, is through networking, collaborating with local communities, agency stakeholders and through the sharing of local knowledge and expert knowledge

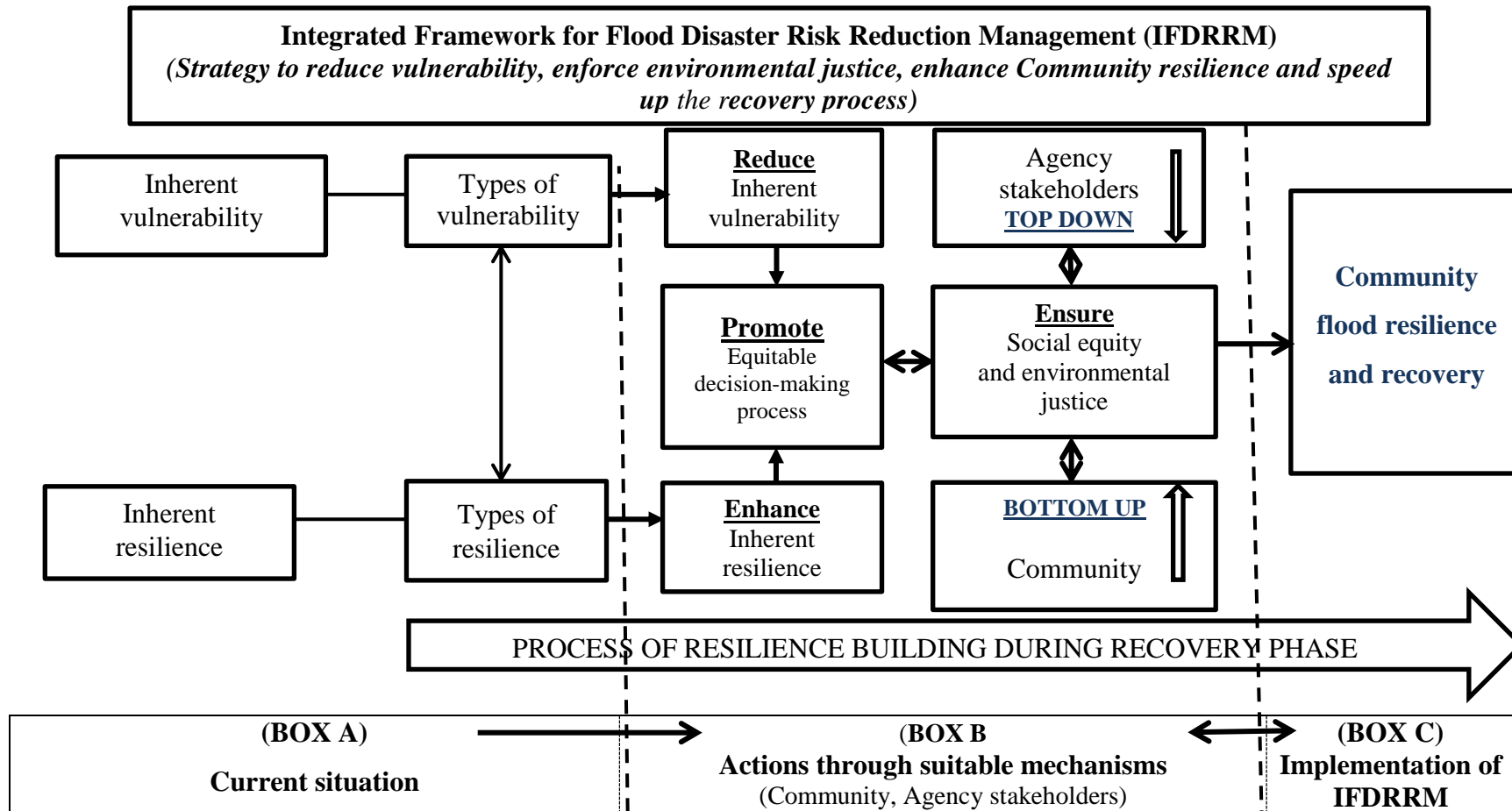


Figure 8.1 Simplified version of Integrated Framework for Flood Disaster Risk Reduction Management (IFDRRM)

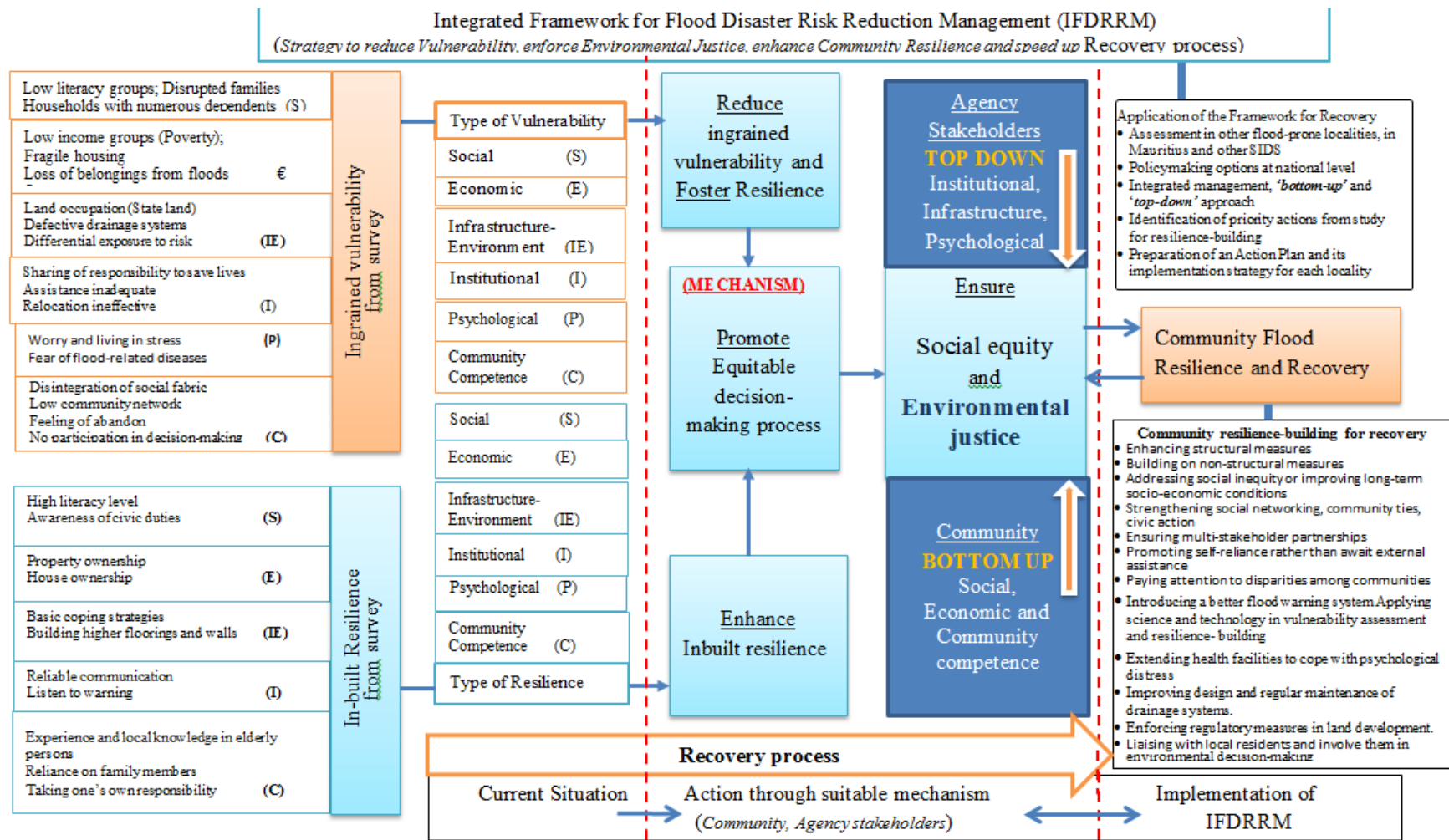


Figure 8.2 Integrated Framework for Flood Disaster Risk Reduction Management (IFDRRM)

Figure 8.2 Complete version of the Integrated Framework for Flood Disaster Risk Reduction Management (IFDRRM)

A detailed framework is illustrated in Figure 8.2. This framework lists the most significant findings from the analyses (Chapters 5, 6 and 7) on the perception of risk and the experience of households in three different localities and the inputs from agency stakeholders. This framework is identical to that of Figure 8.1. The main difference is that the additional boxes list the factors drawn from the study for each of the components of the framework, be it the current status, the actions required, the implementation and evaluation of the framework for a flood resilient community, the priority for action or for policy making. The mechanisms used in the implementation of the framework include networking, collaborating with local communities and agency stakeholders, and sharing local knowledge and expert knowledge.

(i) *Comparison with other frameworks*

A few relevant frameworks of existing systems on DRR management were reviewed in Section 2.10.1. Similar to the frameworks described in that section, this framework uses the wider concept of vulnerability in the risk reduction of natural hazards with the aim of ensuring a resilient community. However, in contrast to previous frameworks, this framework is based on the concept of vulnerability in conjunction with communities' resilience to flood hazards and has been developed from a holistic human use-environment interaction perspective. In this regard, Cutter et al.'s (2008) DROP model (Section 2.10.1 (iv)) provided guidance on the various types of resilience and is closest conceptually to that presented in this thesis. Specifically, the framework proposed in this thesis focuses on issues of social equity and EJ. However, this framework relates to conditions in a SIDS, while Cutter et al.'s was in a continental developed country. Unlike Cutter et al.'s model, this framework incorporates a mechanism that integrates the '*top-down*' approach generally adopted by institutions and the '*bottom-up*' approach of the community. In this way, the communities are involved in the decision-making. In addition, this research found inherent vulnerability as well as inherent resilience in the three communities. Each of these two aspects was subdivided into six components. This approach made it possible to identify the areas that required priority attention by agencies and communities.

(ii) *How should the framework be applied in community flood risk mitigation?*

The application of the framework, which includes the short- as well as long-term recovery process, could be envisaged in three steps:

- a) Assessment of the current situation of the community using a suitable participatory methodology, which may be similar to or be a selection of those used in the study: Each major finding relating to the community's vulnerability or resilience is classified according to whether it is considered a component of *inherent vulnerability* or *inherent resilience*.
- b) Development of a *mechanism or a multi-stakeholder group* including local community organisations, agency stakeholders, and NGOs: If detailed information on the variables was not available, the multi-stakeholder group could call for detailed information gathering as in (a) above and evaluate the variables. It could then draw up an action plan indicating priorities, time line, and resource requirements, identifying where efforts are most needed for building robust community resilience.
- c) Ensuring oversight of the implementation of the plan: The multi- stakeholder group should receive evaluation reports and adjust the plan and its implementation strategy.

The framework may serve as a management tool for decision- and policy-making. The multi-stakeholder group, including the community, should be in place even outside the flood season to ensure long-term recovery.

(iii) *Strengths and weakness of the framework*

The strengths of the model are as follows:

- a) It does not specify a hierarchy among the components and the associated issues.
- b) It does not take into account the specificity of the localities and, therefore, has a wider application and may be tested with and adapted to other SIDS.

- c) It takes into account the concerns at household level and of all stakeholders, and builds on a 'bottom-up' approach to disaster risk reduction.
- d) It focuses on resilience-building as a forward-looking and pro-active approach to disaster management rather than on the more static assessment of vulnerability.
- e) It takes into account the key issues of social inequity and EJ that had been hitherto disregarded in the disaster management processes. In the model, social inequity and EJ are seen in a broader context of vulnerability rather than of marginalised groups only.
- f) It incorporates local knowledge and expert knowledge in decision-making processes related to flood management.
- g) It enables the establishment of a hierarchy among the actions to be taken to build resilience in a given community.
- h) It can be used to develop an action plan in flood DRR in small communities.

The limitations of the framework are as follows:

- a) It is applicable to flood conditions primarily.
- b) It may lead to bias in information gathering and conflicts of interest when using a 'bottom-up approach', for example, when community-based participation may be undermined by local elites who are politically affiliated in giving the wrong information to government officials in order to retain their own power.
- c) It does not provide for uncertainties from other unexpected events, such as flash floods and landslides.

8.6 Options for resilience-building by policy-makers

One of the purposes of this research is that it should contribute to the substantive field of policy making. The findings suggested that to increase resilience to flooding in the researched communities requires the implementation of policy options that would include both 'top-down' and 'bottom-up' approaches to flood risk management. These are consolidated in this section, as they were found to be useful for policy options within the Integrated Flood DRR Management in Mauritius. The options are grouped as follows:

(i) Management-related policy options

- Set up a suitable mechanism for effective access to information between representatives of flood victims and those of local/national authorities and NGOs.

Promulgate participatory action and resources to overcome environmental injustice through the empowerment of vulnerable communities.

- For good governance, vulnerable sectors of the communities should be allowed to participate in decision-making processes regarding flood mitigation. In this way, the conflicting views between local communities and national authorities could be reconciled (Section 8.3.3).
- Enforce the land-use policy and enforce existing legislation while reinforcing awareness of living in flood risk zones (Section 8.3.3).
- Ascertain how local/lay knowledge might be applied (Sections 8.2.6 and 8.3.6) in decision-making processes.

(ii) Capacity building and support to health

- Include flood awareness in educational programmes as a way to build stronger community resilience to flood hazards (Section 8.2.1).

- Provide psychological health support to flood victims (Section 8.2.5).

(iii) *Science underpinning for policy option*

- Apply science and technology to update the delineation of flood risk zones; acquire real time data from flood risk zones and identify the amount of rainfall that might lead to flooding in each zone (Section 8.3.4).
- Review the criteria for torrential rain and thresholds of flood conditions for various localities (Section 8.3.4(ii)).
- Develop a flood warning system and link it with the well-understood cyclone warning system (Section 8.3.6 (i)).2.4)

8.7 Comparison of this study with previous studies in SIDS on vulnerability to hazards

This research was based on case studies in Mauritius that share characteristics similar to those of several other SIDS, namely, small size, insularity, remoteness, and proneness to natural disasters. In addition, features such as the pressure on the land, overpopulation, and rapid economic development, and their consequences, including an increase in the frequency of environmental hazards, such as floods, had some similarity with Pelling and Uitto's (2001) study of flood hazards in Barbados. The difference was that the authors focused on issues of increased urbanisation while this research was based on case studies from different geographical settings, namely, semi-urban, rural, and coastal.

In previous studies, vulnerability was mostly determined by the economic and social aspects of SIDS and was primarily related to climate change and the rise in the sea-level (Briguglio, 2004). Linnekamp et al. (2011) found that vulnerabilities were compounded by densely populated areas, including congested urban and coastal locations, which were exposed to flood risks due to climate change. He attributed the greater resilience to low-income groups, who took more preventive measures from floods than did higher-income groups. However, in this study, no such finding was observed for the two groups.

8.7.1 *Comparison with other studies using community resilience to flood hazard*

This thesis shows some similarity in certain aspects with the work of the authors listed in Table 8.1 regarding the use of components of community resilience. However, it has more affinity with the research study of Ferdinand et al. (2012) in Windward Island, which is also a SIDS in the Caribbean.

Table 8.1 Studies on themes similar to this study on community resilience to flood hazards

Types of resilience used	Methodology	Source
Social, economic, and community competence	Questionnaire survey, semi-structured interview	Ferdinand et al. (2012)
Social and community competence	Participatory	Cottrell (2005)
Social, institutional, and community competence	Participatory activities (mapping techniques)	López-Marrero and Tschakert (2011)
Institutional	Qualitative and quantitative	Schelfaut et al. (2011)

This study uses a combined vulnerability and resilience frame similar to that of Ferdinand et al. (2012) to explore community resilience, but it differs in the following aspects:

- This study has a greater number of types of resilience as components of community resilience.
- It takes into consideration the psychological component of resilience, which none of the previously discussed studies (Section 8.3.5) had specifically considered.
- The focus in this study is specifically on flood hazards.

8.8 Critiques of the methods applied in this study

8.8.1 *Case study and mixed method approaches*

The nature of the research questions listed in Section 1.6 required the application of case studies with a mixed methods approach. These were found to be the best approaches for the following reasons:

- i) Instead of using a single case study, three case studies were used for comparative reasons and to gain a 'bigger picture' of the realities of communities living in flood prone areas.
- ii) A mixed methods approach combining both quantitative and qualitative strategies was found to be the most appropriate to deliver plausible answers to the research problems. Sampling and gathering of data were effected from a variety of sources (questionnaire survey, focus group interview, participatory activities, and semi-structured interviews of agency stakeholders).
- iii) Other sources of data included government documents, the media, and local residents' narrative accounts. These were used as complementary information in the context of the case studies. The use of software (SPSS and NVivo) as data management tools further increased the reliability of the analytic results.
- iv) Quantitative and qualitative analyses of the data were conducted sequentially; the findings from the quantitative analysis were used broadly to identify suitable participants for the focus group interviews and participatory activities. The research process was iterative throughout the study. It increased the scope, reliability, and generalisation of the findings.

The benefits of using a mixed methods approach in this study are assessed with regard to the following key points:

- i) The strength of the quantitative approach lay in the collection and analysis of data from the responses from the 583 households surveyed. The method made it possible to offer generalisations based on the characteristics of the sample with a known level of statistical confidence at $p < 0.05$. The approach increased the credibility of the statistical findings about which groups of households were the most vulnerable.
- ii) The strength of the qualitative approach was due to the application of a variety of methods (focus group interview, participatory activities, and semi-structured interviews of agency stakeholders), which aimed to capture in-depth views of participants in real life situations. The approach could be a part of the validation process as well where a variety of methods were taken

at different levels to examine the same topic. The results were presented with appropriate quotations, which enhanced the credibility of the findings.

- iii) The approach offered valid ways of examining the vulnerability of local communities while uncovering different aspects, such as social, economic, environmental, psychological, or networking (solving their own problem) approaches. For example, the application of participatory activities makes it more likely that the voices of vulnerable groups are heard.

The report '*Quality in Qualitative Evaluation: A framework for assessing research evidence*' (Spencer et al., 2003) highlighted that, as a minimum, quality research should be endowed with the following two principles:

- (i) rigour in conduct (*that could be achieved through systematic and transparent collection, analysis, and interpretation of qualitative data*)
- (ii) credibility in claim (*through offering well-founded and plausible arguments about the significance of the data*) (Spencer et al., 2003; p. 7)

The evidence of rigorous and robust analysis in conjunction with criteria of evaluation of the findings in the qualitative research of this study is in agreement with the basic principles of qualitative research established by the UK government in 2003.

Combining the strengths of the two approaches (quantitative and qualitative) contributed to the elimination of the notion of bias, with both approaches being given equal value and weight; both approaches were given equal significance, and they played equally important roles in addressing the research problems. The findings were integrated and validated for consistency. They were ultimately formed into a model (Section 8.5.3).

Given the complexity of the study, the findings from each method provided 'snapshots' that contributed to giving a complete (holistic) picture of the realities of the communities living with flood problems. As such, the findings from the three case

studies could be generalised in order to provide illustrative insights about other cases that may present similar problems.

8.8.2 *Limitations of the methods used in the study*

The use of a mixed methods approach proved challenging for the researcher, as expertise in both quantitative and qualitative approaches was required to conduct and combine them appropriately. The gathering of data for analysis at each level had to be done within time constraints, and prolonged engagement with the community during field study was required.

Moreover, the researcher's past experience and knowledge provided additional valuable potential for deeper levels of analysis for the focus group interviews and the participatory activities. Gathering together sufficient people for the focus group interviews or the participatory activities proved to be challenging as initially, very few individuals turned up for the meetings at the three locations. If some reward was promised as a token for attendance, then the filtering out of *bona fide* participants presented difficulties as a large number of people turned up. This situation made reiterating and carrying out further exercises difficult, thus limiting the number of such exercises that could be carried out in optimum conditions.

The various methods used in the study generated an unwieldy amount of data, which proved difficult to handle and analyse. These issues were resolved by the use of software for the quantitative and qualitative analyses. Nevertheless, a reasonable amount of skill in operating the software as analytic tools was needed.

8.9 **Summary**

This chapter discussed the main findings in the light of the research questions and objectives set out in Chapter 1. The findings were discussed and assessed in terms of vulnerability and in conjunction with six types of resilience. As noted in Section 8.5, the central issues of social inequity and environmental justice was invariably linked to weak low community resilience among low income groups. A reinforcement of all the types of resilience was found to be essential in achieving the recovery and in the building of community resilience in those groups. This finding led to the proposal of including

community participation with other stakeholders in decision making and in policy making in order to achieve longer term recovery.

For this purpose, the concepts of vulnerability, resilience, and environmental justice were used to explore the data, and the findings made possible the development of an integrated framework for flood disaster risk reduction management (IFDRRM). This showed the situational conditions of vulnerability and resilience, the actions that contribute to enhancing and building community resilience, and the inputs to strategic and planning processes . A reduced version of the IFDRRM is given inFigure 8.1, and the complete version is given in Figure 8.2).

Some options for policy-making by national authorities to promote resilience building were proposed in Section 8.6. Existing knowledge of flood hazard studies in other SIDS countries showed some similarities with the findings from the three case studies. Some examples were given of the published literature on community resilience, and these were compared with this study. The importance of social networks and the combination of local knowledge with experts' knowledge were found to be crucial in building community resilience in the future. The chapter concludes by emphasising the value of a mixed method approach that captures the voices of different stakeholders in evaluating flood risk and community vulnerability and the potential for recovery and long-term resilience building in Mauritius in the aftermath of flood hazards.

Chapter 9 – Conclusions

9.1 Introduction

This study has provided the researcher with a unique opportunity to delve into the real life situation of three communities and investigate their vulnerability and resilience in the aftermath of flood hazards. In order to meet those objectives, a set of research questions were established, which drove the choice of approaches on how best to find answers to the research questions.

Due to the complexities of the topic, the best way to study the subject was from a holistic human-environment perspective, which could present a ‘big picture’ of the communities living in flood risk areas. On the basis of available literature related to the subject, mostly from developed countries and urban developing areas and SIDS, key concepts relevant to the study were identified, and these served as a guide to develop the theoretical framework of this study.

Three case studies in conjunction with a mixed methods research approach were found to be powerful enough in providing reliable and consistent findings. Quantitative research generated factual and reliable outcome data on the vulnerability and resilience of household groups while qualitative research produced rich, detailed, and valid processed data based entirely on the perspectives and interpretations of the participants rather than of the researcher’s. Together both research approaches provided valuable tools and techniques in answering the research questions and in meeting the objectives of this thesis.

The concept of community resilience was further examined in terms of six types of resilience, which were used as indicators to generate the factors that affect community resilience. They also represented valid ways of examining and assessing the ability of local communities to recover. An important outcome of the analysis of data was that there was a general feeling of social inequity and environmental injustice, which were mostly perceived among the low income groups in all three case studies. Evaluation of results in terms of the types of resilience revealed a number of factors that were gradually increasing their level of vulnerability and adversely impacting on their resilience. The findings of this study suggested that the various types of resilience had

to be reinforced in order to achieve recovery and community resilience. The key issues that were found to be essential to recovery and to reinforcing community resilience were: social networking, integration of local knowledge with that of experts and empowering community participation in decision-making. These issues were integrated in the formulation of an IFDRRM model, which has been illustrated in Figures 8.1 and 8.2.

9.2 Implications of the findings for other SIDS

As discussed in Section 8.8, the findings from the mixed methods approach underscored the strengths of applying both quantitative and qualitative research approaches in answering the research problems. The reliability and credibility in the findings from the three case studies could eventually be generalised and be illustrative of the situation, particularly in SIDS, where vulnerable communities are living with flood problems.

Many of the studies in SIDS have been carried out in islands in the Pacific and the Caribbean, but these have mostly addressed the impact on communities of flood hazards resulting from climate change and urbanisation. The key research findings of this study have broader implications for other SIDS that share the same physical characteristics regarding size, insularity, weather systems, and proneness to flooding. The vulnerability and resilience of SIDS have been mostly studied in terms of the economic and environmental aspects, but the social dimension has been little studied (Section 1.4). In most SIDS, the frequency and intensity of floods is increasing as result of human use-environmental interaction, and this is adversely affecting the unprivileged sectors of communities, increasing their vulnerability, lowering their resilience, and delaying their recovery, with further implications for the country. The application of different types of resilience that frame community resilience could be an innovative approach in studying issues of recovery in SIDS using the framework of EJ and social equity. The approach developed in the study could be useful in comparing results, deciding on priority actions, and choosing policy options for recovery from flood hazards using community resilience as a yardstick in SIDS.

9.3 Suggestions for further research studies

Building on this research, the following further research is proposed:

- i) Extend the study of social vulnerability, community resilience, and EJ to other exposed localities, such as urban areas in Mauritius with different demographic regimes: The study could incorporate more detail on the health impact on communities vulnerable to floods.
- ii) Extend this study on community resilience to a specific locality in Mauritius using more extensively participatory activities and community-based knowledge of risk for flood disaster risk reduction: This study has highlighted the importance of a bottom-up approach to risk reduction, but given the lack of participants, this aspect of the study could not be fully explored and its potential realised.
- iii) Study the impact of flooding caused by storm surges in coastal communities to evaluate whether comparable issues are identified: The village of Rivière des Galets on the Southern coast of Mauritius is often threatened by severe storm surges destroying houses and infrastructure. The projected sea level rise may increase the incidence of storm surge and adversely affect the hotel industry, jobs, and the economy of the country.
- iv) Undertake studies on social vulnerability and community resilience to flood hazards in islands such as Madagascar and Comoros, which form part of the Indian Ocean Commission: Such studies are not known in the region. They could provide comparative results on vulnerability and community resilience to flood hazards and so develop corresponding indices. So far, studies in SIDS have mostly focused on the impact of flood hazards on communities as a result of climate change and urbanisation.

9.4 Concluding thoughts

This research has identified many of the challenges faced by affected community groups in reducing vulnerability and in building resilience in the recovery phase of flood events in Mauritius. However, the problem remains of how to eradicate poverty and empower the most vulnerable groups to overcome the disastrous impact of recurrent floods and to build resilience. Relocating families who have lived in shanty houses and illegally

occupied state lands that are subject to flooding would prove problematic. Similarly, displacing families who have settled on wetlands over a period of several decades may prove unethical and could create further social problems. Vulnerable households might feel they can do nothing but ‘learn to live with flood’ (Section 7.2.4).

NGOs’ involvement with vulnerable community groups should extend well beyond just providing short-term assistance to flood victims in small community groups during flood hazards. They should ‘bridge the gap’ by liaising between vulnerable communities and government authorities. In this case, they should be represented in the National Disaster Scheme Programme and be able to point out policy recommendations on risk reduction and on improving the quality of life of vulnerable communities. This issue, however, demands a solid and integrated effort at individual, household, local community, regional, national, political, and institutional levels in the long-term. A sound policy framework and sustained implementation strategy, combined with determined actions by the government while applying the full potential of science and technology are considered essential to ensuring prompt rehabilitation and recovery.

The strategy should involve local communities as a way of ensuring that issues of environmental justice and social equity are adequately addressed in building strong and long-lasting community resilience to ensure effective recovery. These are encapsulated in the proposed IFDRRM model, which could be adapted in other flood prone areas in Mauritius and other SIDS that face similar flood disasters.

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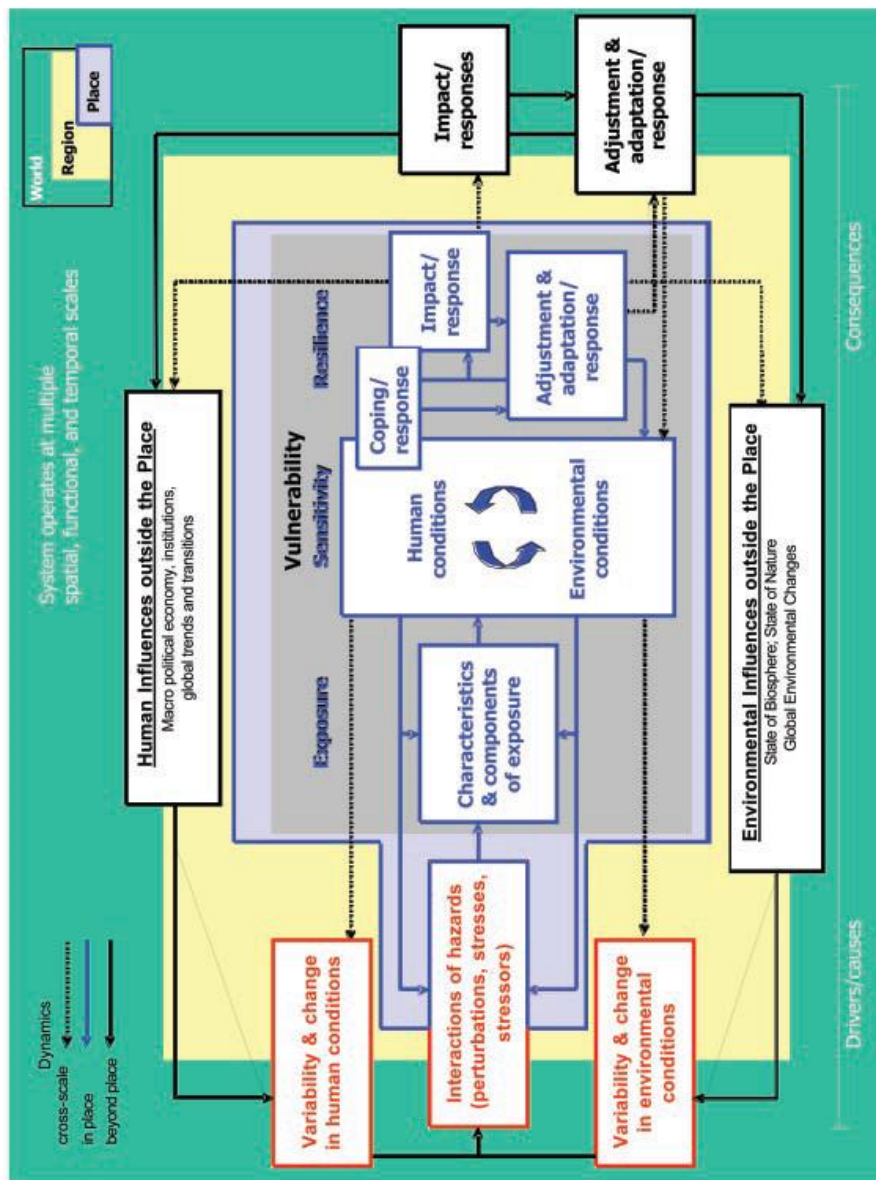
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Appendices

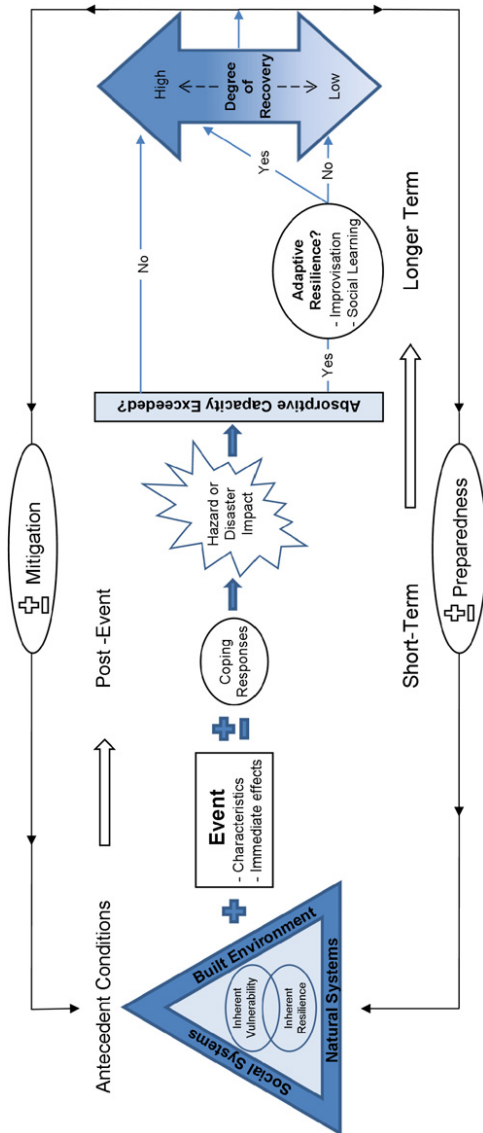
Appendix 1

Appendix 1 Turner's Vulnerability Framework: Components of vulnerability identified and linked to factors beyond the system of study and operating at various levels.



Source: Turner et al. (2003)

Appendix 2 Cutter's schematic representation of the disaster resilience of place - (DROP) model



Source: S.L. Cutter et al. (2008)

Appendix 3

Appendix 3 Grouping of variables under types of resilience with the figures in bracket referring to the sequential number of the variables as listed when coding the variables in the questionnaire (Appendix 14)

Type of resilience	Variables from questionnaire	Grouped variables along themes	Areas of focus
Social	Household characteristics (1-10) Occupation (12) Flood experience (14-19) Neighbourhood inundated (43) Get back to normal (66-71) Living in damp conditions (87-90) Getting back to normal (112-113) Improve quality of life (116-120) Change in quality of life (121-123)	<ul style="list-style-type: none"> • Household characteristics Household size, Age groups, Literacy level of households, Occupation • Flood experience • Living in damp conditions • Quality of life 	Focus on demographic variables that cause vulnerability
Economic	House ownership (11) Impact (20-23) Damage (24-42, 64,65) Affect (91-102) House fabric (103) House type (104) House ownership (105) Land ownership (106)	<ul style="list-style-type: none"> • Property ownership • House fabric • Impact of flood on property • Loss of belongings • Economic reasons for occupying flood risk zone 	Focus on variables which give an indication of and contribute to economic resilience
Infrastructure/ Environment resilience	Power (44) Water (46-48) Telecoms (49-50) Road practicable (51-52) Transport (53-54) School (55-57) Exposure (81-85) House situation (86) Reasons for flood increase (194-202)	<ul style="list-style-type: none"> • Public infrastructure • House type • Access to services (Utilities, road, transport) • Flood characteristics • State of built environment • Blocked drainage etc. 	<ul style="list-style-type: none"> • Focus on type of houses - What actions people take to increase their household resilience • Focus on the state of the physical infrastructure and built environment.
Institutional	Short-term support (134-136) Form of assistance (137-145) Relocation (146-148) Remedial measures (149-156) Warnings (203-213) Warning (214-215) Structural (216) Non-structural (217) Government invest in education (218-220) Difference in Govt. support (221-225) Difference in NGO support (226-229)	<ul style="list-style-type: none"> • Engagement with local civil society, NGOs, authorities and institutions • Communication technology (Science & Technology) • Relief and emergency plan • Assistance • Relocation • Warnings (Science & Technology) • Governance 	<ul style="list-style-type: none"> • Focus on arrangements at institutional level to increase resilience to flood within the community • Structural and non-structural measures. Identification of responsibility
Psychological	Intangible (58-63) Emotional (72-75) Worry (76-80) Lasting health problems (114) Psychological trauma (115)	<ul style="list-style-type: none"> • Worry about health • Exposure • Living with stress • Flood trauma (Living with flood risk) • Uncertainty about future 	Focus on the health and other intangible impact that increase vulnerability and decrease the wellbeing of the community

Community competence	Reasons for living in area (107-111) Self-Protection (124-131) Receive short-term support (132-133) Rely (155-161) Adapt (162-165) Responsibility (166-168) Coping (169-178) Help to neighbours (179-183) Helping others (184-187) Collaborate with others (188-191) Awareness of living in flood zone (192-193) Community feeling abandon (230) Environmental decision-making (231-232)	<ul style="list-style-type: none"> •Neighbourhood relationship and mutual help •Reliance •Coping strategies • Awareness of flood •Decision-making 	<ul style="list-style-type: none"> •Focus on neighbourhood network that ‘glues’ community together. •Beliefs and values that gives greater resilience to the community.
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Appendix 4

Appendix 4 Torrential Rain Warning System

The criteria for torrential rain vary from country to country. Torrential rain conditions is said to exist when the prevailing weather at Mauritius or Rodrigues produces 100 millimeters of widespread rains in less than 12 hours and that this heavy rain is likely to continue for several hours. Torrential rain can cause flash floods or urban floods in any locality while the most likely effect is water accumulations in flood prone areas. Heavy rain may also be responsible for the overflow of rivulets and streams or even major rivers leading to riverine flooding. Such floods usually occur downstream where it may not be necessarily raining heavily. Another hazard in the aftermath of heavy rain is landslide which can occur on hill or mountain slopes which are usually considered as high-risk areas.

Mauritius Meteorological Services provides flood warning of a general nature without being site specific or quantifying water level in rivers.

Torrential rain warning bulletin

As soon as the Meteorological Services has registered 100 mm of rain in a period of 12 hours at several stations over the Island, it will advise the Ministry of Education, Ministry of Tertiary Education and Human resources and the Police and will issue warnings at regular interval through the MBC and private radio stations. Whenever torrential rain conditions exist, all schools, pre-primary, primary, secondary as well as tertiary institutions will not be opened.

Source: Mauritius Meteorological Services (2011)

<http://metservice.intnet.mu/torrential-rain/torrential-rain-warning-system.php>

Appendix 5

Appendix 5 Media reports of flood events in Mauritius (2003-2011)

Date	Locality	Nature of hazard	Issues	Reference
2003				
9/4	Nouvelle France	Environmental	Living in flood .Health threat to children after flood. No assistance from sanitary officers	<u>La rivière sans détour... NOUVELLE-FRANCE</u>
12/6	Grand Sable	Environmental	Flood impact, Material. Problems not resolved. Inhabitants are exasperated. Authorities not helping	<u>La fureur des eaux GRAND-SABLE</u>
12/9	Sebastopol	Environmental	Blocked drains, No assistance. Inhabitants self-reliance to build flood guards.	<u>Inondation, boue et ornières SÉBASTOPOL</u>
24/10	Flic en Flac	Environmental	Fear of future flood. Rivers not properly widened, bad evacuation.	<u>Dragage du ruisseau de Maroussem MORCELLEMENT DE CHAZAL, FLIC-EN-FLAC</u>
26/12	Flic en Flac	Storm surge	Fear. Storm surge after heavy rain, flooding of land area. Unreliability on structural flood defences.	<u>L'appréhension du raz-de-marée FLIC-EN-FLAC</u>
2004				
19/1	LH	Environmental	Recent Floods. Impact on houses and belongings and roads. Worry and prevailing fear. Children missed schools	<u>Une dizaine de maisons inondées LH</u>
4/2	LH		Building of drains by NDU (National Development Unit). Relief of the inhabitants.	<u>Les travaux démarrent au morcellement Foondun INONDATIONS À LH</u>
16/3	Clemencia	Environmental	Mudslides and floods. Anger. Community work together in recovery. Drains absent, authorities blamed for not taking action.	<u>Coulée de boue et inondation CLÉMENCIA</u>
14/12	Dagotiere	Environmental	Living in flood. Road practicability poor. Problems lasted over a decade. Build drains in near future by NDU9 National Development Unit). Community awareness. Pollution, stagnant water, due to land development.	<u>Gagner le combat contre les eaux DAGOTIÈRE</u>
2005				
27/1	Ste Croix, Roche Bois, Mahebourg, GRSE	Natural hazard- Cyclone Hyacinthe	Flooding due to absence of drains, pollution. Fear of vector-borne diseases. Living in floods, obstructed drains in parts of island.	<u>Hyacinthe dérouté nos météorologues</u>
22/2	Camp Ithier	Environmental	Lack of confidence in authorities, delay in flood prevention measure (drains)	<u>Trottoirs et drains réclamés CAMP-ITHIER</u>
8/3	Cité Vuillemin	Environmental	Serious flood problem. Roads and property under 1ft water. Community self-help to solve flood problem.	<u>En l'absence de drains...CITÉ NHDC, VUILLEMIN</u>
11/3	Morcellement	Environmental	Floods, blocked drains. Inefficient in	<u>Après l'eau, les</u>

	de Chazal.		evacuation, Risk of vector borne diseases in southern and eastern parts of the island.	<u>moustiques MORCELLEMENT DE CHAZAL.</u>
15/3	Petit Verger	Environmental	Flood risk management- building of drains project.	<u>Finies les inondations PETIT-VERGER</u>
24/3	LH, Pereybère, Souillac	Environmental	Living in flood, location- Proximity to mountain slopes, geographical factors and bad infrastructure, Ineffectiveness of built drains, Community self-reliance to face flood hazards.	<u>La terrible montée des eaux...INTEMPÉRIE S</u>
25/3	Belle Mare	Natural hazard/Cyclone	Fear of flood water and diseases. Pollution, foul smell of stagnant water. Sick become more vulnerable. Authorities not caring. Crops damaged.	<u>Enfoui sous les eaux EST</u>
27/3	Mon Goût, Q.Bornes, Pereybère, GB, Flic en Flac.	Environmental	Flood risk management criticised, drains defective and poorly designed. Lack of civism. Environmental problem. Unplanned development, haphazard construction, land structure not safe. Promise of structural measures by NDU, local authority, Road Development Authority (RDA) not kept.	<u>INONDATIONSUNE CASCADE DE NÉGLIGENCES</u>
27/3	Petit Verger	Environmental	After hazard, damage to crops. Impact on children, risk of infection.	<u>INONDATIONSUNE CASCADE DE NÉGLIGENCES</u>
13/4	Poudre D'Or		Ethical- lack of civism, backfilling of a land by inhabitant, cause of flood	<u>La peau de banane...POUDRE-D'OR</u>
15/4	Baie du cap	Environmental	Anxiety and stress. Flood caused by obstructed drains. Exposure, Fear of children being drowned.	<u>Entre deux eaux...BAIE-DU-CAP</u>
24/4	GB	Natural hazard/Cyclone	Poverty. Wet land occupied by squatters. Living with electricity and water supply. Heavy flooding, high risk of vector borne diseases. Bad smell. Promise of relocation by authorities.	<u>Les délaissés d'une cité sans lumière PAUVRETÉ</u>
9/5	Amitié	Environmental	Long lasting exposure to floods, exposure to stagnant water, defective drainage system,	<u>L'eau est toujours dans des cours AMITIÉ5</u>
3/6	Rivière-Noire	Environmental	Post-hazard prevention measures promised by authorities. Funding problem,	<u>Après la pluie, les solutions RIVIÈRE-NOIRE</u>
25/6	Rivière des Créoles	Environmental	Government authorities' assistance to protect inhabitants' from flood hazards.	<u>Sur le terrain...RIVIÈRE-DES-CRÉOLES6</u>
1/9	Grand Bois	Environmental	Living in flood-Families affected by flood water at every heavy rain. Fear.	<u>Comme un cours d'eau...GRAND-BOIS</u>
5/12	Flic en Flac	Environmental	Formation of a Community group support and help each other to fight flood hazards and pollution	<u>Les inondations rassemblent les riverains OUEST — FLIC-EN-FLAC</u>
30/12	Tamarin	Environmental	Problems of drain evacuating flood water to the sea- impact on marine fauna and flora.	<u>Attention à la vase...TAMARIN</u>
2006				
4/1	All regions	Natural /Torrential rain	Beneficial effects of heavy rain on agriculture and reservoirs. Emergency service ready in case of floods. Slight flood in Port Louis due to drain obstruction.	<u>Les pluies annoncent une bonne récolte</u>

8/1	Port Louis, Terre Rouge	Torrential rain/ environmental	Frustration and anger after heavy rain. Blame on authorities of not cleaning the drains. Ethical issues lack of civism, drains blocked by garbage dumping. Authorities blamed for badly maintaining drains and rivers.	<u>Averses à l'horizon et craintes d'inondations</u>
9/1	Piton	Environmental	Lack of proper drains, concern of local authorities to build structures and to alleviate suffering of the inhabitants from recurrent flood.	<u>Une équipe sur la brèche INONDATIONS À PITON</u>
25/1	South and western regions	Torrential rain/ environmental	Community and local authority support, Coping with flood hazards.	<u>Ce mauvais temps qui dérange MÉTÉO</u>
26/1	Grand-Port/ Savanne	Environmental	Authorities concern of building evacuation structures	<u>Le casse-tête des drains GRAND-PORT-SAVANNE</u>
27/1	Tamarin, Bel Ombre. western regions	Torrential rain/ environmental	Flood impact Inhabitants suffering from impact. Defective drain construction. Living with flood.	<u>L'Ouest sous l'eau PLUIES TORRENTIELLES</u>
10/3	Baie du Cap	Environmental	Environmental, problem, land mismanagement, impact on inhabitants and children missing schools.	<u>La saison des pluies fait peur BAIE-DU-CAP</u>
14/3	Bois D'oiseaux	Environmental	Blocked drains. Roads submerged. Region being 'left out' as compared nearby regions which have over flood problem. Frustration	<u>Un problème qui coule de source BOIS-D'OISEAU</u>
13/4	Pont Ferney	Environmental	Frustration of inhabitants, Roads invaded during heavy rain.	<u>Sous l'eau dès qu'il pleut PONT FERNEY</u>
16/4	La Flora	Environmental	Health, Children affected, problem getting worse at every flood event. Appeal to authorities.	<u>Problème d'inondation LA FLORA</u>
25/4	Poste laFayette	Environmental	Social workers participation. Concern about flood alleviation.	<u>Trois amis font bloc pour leur village POSTE-LAFAYETTE</u>
17/7	Port Louis North/ Mt. Longue	Environmental	Politician view in helping to build structural measures and alleviate impact on flood hazards.	<u>"Beaucoup de projets ont été réalisés en un an "QUESTIONS À KAYLANEE JUGGOO DÉPUTÉE DE PORT-LOUIS-NORD-MONTAGNE-LONGUE</u>
31/7	L'Amitié	Environmental	Frustration of a flood victim. Living with recurrent flood. No assistance from authorities.	<u>Les tribulations d'un habitant de l'Amitié INONDATION</u>
28/8	Terre Rouge	Environmental	Village council's representative 's view on flood hazard affecting his region.Promise of building drains to evacuate flood water	<u>Sunil Somaroo représentant de Terre-Rouge au conseil des districts QUESTIONS À...</u>
1/9	Canot	Environmental	Health problem, chickungunia. Overflow of waste water from neighbourhood.	<u>Eaux stagnantes CANOT</u>
3/10	Ecroignard	Environmental	Inhabitants frustrated, road not practicable in rainy seasons, flood due to lack of drainage systems, risk of accidents to children.	<u>Le ras-le-bol des habitants ECROIGNARD</u>
2007				
5/2	Port Louis Ste Croix, Terre	Torrential rain	Living in flood, exposure Houses flooded, rivers overflow, roads flooded. Risk of	<u>Dimanche sous la pluie TEMPS</u>

	Rouge		disease, Precautions –as non-structural measures.	
22/2	Canal Dayot	Torrential rain	Fear of living in flood conditions defective flood protection structures. Villagers solidarity Coping with flood, building walls for protection.	<u>Canal Dayot dans la frayer d'une inondation INTEMPÉRIES</u>
1/3	Highlands, West coast, Southern regions	Environmental	Environmental hazards, flood hazards after cyclone, badly designed infrastructure and development. Post hazard risks and accidents. Need for joint effort of local people local authorities and government needed to solve problem.	<u>Ile fragile...ECLAIRAGE</u>
3/3	Highlands	Environmental	Complaint from inhabitants, emergency measures neglected, Exasperation, desperation and anger against security services.	<u>Pompiers : plongée en eaux troubles</u>
8/3	La Flora	Environmental	Flood proofing measures delayed, school children affected. Angry villages	<u>Quand la coupe déborde LA FLORA</u>
9/3	Flic en Flac	Environmental	Complaint, frustration and anger living in flood and stagnant water. Risk of disease, chikungunia. Blocked drains, garbage choked .Local authority's help inexistent.	<u>L'eau... et le ton montent MORCELLEMENT DE CHAZAL, FLIC-EN-FLAC</u>
16/3	Pte aux sable	Environmental	Living in flood. Appeal to authorities to build drains.	<u>Près d'un mètre d'eau dans les maisons POINTE-AUX-SABLES</u>
27/3	Morcellment Carlos, tamarin		Environmental –floods from waste water- Fear of invading neighbourhood, risks of disease	<u>Une "mystérieuse" source MORCELLEMENT CARLOS,TAMARIN</u>
16/8	Quatre Soeurs	Environmental	Flood risk management to fight against Climate change, sea level rise, risk of flood to building , Feasibility ,Evaluation study to manage environmental hazards, stakeholders Non-Governmental Organisation (ONG), United Nations Development Programme, of the Global Environment Facility Small Grants Programme.	<u>L'évacuation des habitants réclamée GLISSEMENT DE TERRAIN À QUATRE-SŒURS</u>
3/9	Grand Gaube	Environmental	Frustration of inhabitants living, in flood conditions for years. No assistance from government.	<u>La route Nelson toujours inondée GRAND-GAUBE</u>
16/10	Olivia	Environmental	Exasperation of villagers waiting for government help to build drains.	<u>Entre griefs et développement OLIVIA</u>
2008				
10/1	Towns areas	Environment	Flood risk management measures .solution to flood problems- maintenance problem.	<u>Drains : nettoyage et construction en prévision des grosses pluies INFRASTRUCTURE</u>
18/1	Flic en Flac	Torrential rain	Living in flood water for years-fear,location in backfilled sand quarry, Blocked drains	<u>L'appréhension de pluies diluviennes FLIC-EN-FLAC</u>
½	La Gaulette,	Storm Surge	Risk of storm surge, in cyclonic weather	<u>Un village vulnérable aux intempéries LA GAULETTE</u>
25/1	Caroline	Environmental	Role of gender in flood alleviation. Women group cooperate/Fear of flood/complaints not	<u>Débrouillardise féminine CITÉ EDC.</u>

			considered by authorities.	<u>CAROLINE</u>
30/3	All regions	Environmental	Failure of emergency system. Authorities blamed.	<u>Les failles du système d'alerte INONDATIONS</u>
¼	All regions	Environmental	Urbanisation, emphasis on maintenance and study of flood risk zones.	<u>Quand les drains font défaut INONDATIONS</u>
12/5	Grand Gaube	Environmental	Living in flood. Roads under water. No help from authorities.	<u>Route Nelson : statu quo !GRAND-GAUBE</u>
27/3	All Regions	Natural hazard/Torrential rain	Criteria for flood warning: more than 100 mm of rain registered in not more than 12 hours. Disaster committee concern to flood problems.	<u>La météo se noie dans sa difficulté à prévenir NATURAL DISASTERS COMMITTEE</u>
29/3	All Regions	Natural hazard-Torrential rain	Conflict among Disaster Committee members, whose responsibility in last flood disaster, emergency, forecasting services, warning not in time?	<u>A la recherche du bouc émissaire CATASTROPHES CLIMATIQUES</u>
¼	All Regions	Environmental	Drains used as dumping grounds. Irresponsible civil society .Ineffective land planning, increase in frequency and intensity of floods. Identification and mapping out of flood risk areas inappropriate due to early urbanization Problems of building drains.	<u>Quand les drains font défaut INONDATIONS</u>
4/1	Clémencia	Environmental	Fear and anger-defective flood preventive structures. Living with risk	<u>Peur et colère CLÉMENCIA</u>
4/1	All regions	Environmental	Fact Finding Committee. To evaluate damage done by recent flood.	<u>Inondations : le comité d'enquête démarre ses travauxEVALUATION4</u>
4/4	Flacq, Terre Rouge	Natural hazard/ torrential rain	Post flood hazard - recovery assistance	<u>Allocations : des régions en colère</u>
¼	Kewal Nagar	Natural hazard/ torrential rain	Living in flood, anxiety , trauma	<u>La GRSE déborde pour la première fois KEWAL-NAGAR</u>
5/4	Ste Croix, Bel Air , Flacq	Natural hazard/ torrential rain	Post hazard – recovery .Anger, flood victims , delay in receiving flood allocation.	<u>Ces allocations de la discorde...INONDATIONS</u>
8/4	Camp Thorel	Natural hazard/ torrential rain	Investing in building drains project-problems of lack of funds.	<u>La “New School Road” défoncée en plusieurs endroitsCAMP-THOREL4/8/2008</u>
9/4	Mon Gôut	Natural hazard/Torrential rain	Life loss, damage to houses Serious impact of flood on villagers. Overflowing reservoirs, blocked drains, narrow bridges, living too near the river the causes	<u>Elle court la rumeur...INONDATIONS A MON-GOUT4/9/2008</u>
15/4	Moka/ Quartier Militaire	Environmental	Flood management- dredging of rivers to allow evacuation.	<u>Vaste opération de dragage des rivièresMOKA-QUARTIER-MILITAIRE4/15/2008</u>
17/4	Gros-Billot and surrounding areas	Environmental	Risk of villages from recurrent floods. Structural measures defective. Fear of flood.	<u>La peur demeure...ENDROITS A RISQUES4/17/2008</u>
21/4	Grand Baie	Environmental	Exposure to recurrent flood hazards- wetland occupation and blocked drains. Help needed	<u>Derrière la façade...GRAND-</u>

			from authorities to mitigate flood risk.	<u>BAIE4/21/2008</u>
22/4	Quartier-Militaire	Environmental	Recurrent flood hazards- blocked drains. Villages exasperated. Help from authorities' non-existent.	<u>Un cahier de doléances chargéQUARTIER-MILITAIRE4/22/2008</u>
6/5	Chamouny	Environmental	Flood management, construction of bridge.	<u>Le pont Fayd'herbe sera reconstruit CHAMOUNY</u>
14/5	Mon Goût Curepipe	Environmental	CWA, water pipes blamed for obstructing water evacuation. Urbanization and haphazard construction in Curepipe.	<u>«Des tuyaux de la CWA ont obstrué la rivière à Mon-Goût» INONDATIONS</u>
20/5	Clémencia	Environmental	Living in fear of floods after last event. River dredging not effective. Help in terms of money from authorities for reconstruction.	<u>Trois familles sous la menace constante des eaux CLÉMENCIA</u>
6/6	Gros-Cailloux	Environmental	Flood prevention project delayed. Villagers live in mud. Feeling uncomfortable. Flood impact to existing infrastructure.	<u>Les drains se font attendre...GROS-CAILLOUX</u>
18/9	Terre Rouge, CLC, Mon Goût, Clémencia	Natural hazards/ torrential rain	Reconstruction after flood event, preventive measures-building of drains and bridges. To be more effective, need regular maintenance and good action from civil society.	<u>Une gestion améliorée PLUIES TORRENTIELLES</u>
18/9	Northern areas, GB, Pereybère, Flacq	Natural hazards/ torrential rain	Drain construction, problem solved but not in all areas, floods still happens. Roads not practicable.	<u>Ces routes source de craintes NORD</u>
21/9	Mon Gout, Ste Croix, GB	Natural hazards/ torrential rain	Post flood hazard- reconstruction phase Community help to clean after flood. Recovery. Water accumulation, drainage, , clogged rivers, Badly planned infrastructure	<u>Le jour d'après...INONDATIONS</u>
23/9	Dagotiere	Environmental	Defective infrastructure; flood water cannot evacuate. Inhabitants affected since more than 30 years of flood events, defective drainage by obsolete bridge.	<u>Un pont occasionne des inondations DAGOTIERE</u>
23/9	All regions	Natural hazards/Torrential rain	Aftermath of flood caused by torrential rain. Rise in price of vegetable. Impact on consumers.	<u>Ruée des consommateurs sur les légumes ALIMENTATION</u>
25/11	Flacq	Natural hazards/Torrential rain	Reconstruction. Weakness in structural measures in prevention of flood. Reconstruction.	<u>Deux ponts reconstruits... après le déluge FLACQ</u>
2009				
1/6	All areas	Environmental	Land planning, no regulation, people allowed to live anywhere. Encroachment of river banks, mountain slopes, wetlands areas. Exposure to flood risk.	<u>« Il est clair qu'on va voir de plus en plus de crues subites »</u>
27/2		Environmental	Construction land permit old and not updated, construction guidelines not respected, backfilling of wetlands, building on geomorphologically fragile land, exposure to risk houses crumbling down during floods	<u>Pas toujours propices à la construction</u>
20/3		Natural hazards/ Torrential rain	Warning system for torrential rain, 100mm of rain in 1 day criteria) in force. To contact emergency services to contact in case of flooding problem	<u>METEO Encore quelques heures sous de fortes pluies...</u>
20/3	Rivière du Rempart, Flacq	Environmental	Flood proofing structures neglected in other villages. Anger	<u>Les sinistrés oubliés</u>

30/3	Mon Goût, Bel Air	Environmental	Reconstruction since last year flood event. Village still in fear, tense. Flooding elsewhere, defective drainage	<u>PLUIES TORRENTIELLES</u> <u>Un an après, Maurice toujours en chantier</u>
21/4	Camp Thorel	Environmental	Problem of floods no solved after a year. Flood proofing installation not completed, problem is worsened.	<u>CAMP- THOREL Des problèmes avec les drains</u>
30/4	Tyack	Natural hazards/ Torrential rain	Fear of flood. Lack of flood proof structure. Villagers build self-reliance, helping in each other. No help from authorities.	<u>sud TYACK La grosse peur dans la nuit</u>
8/9	Olivia	Environmental	Fear and trauma .living in flood for a decade. Appeal to authorities but not heard..	OLIVIA Sous les eaux à chaque pluie
9/10	GB, Flic en Flac	Environmental	Backfilling of wetland for building purposes. 50% of wetland in Mauritius. 66% in GB. Increase in flood hazards. Application of law too late on land is private land.	ZONES HUMIDES NEGLIGEES Catastrophe en vue
9/4	Chamouny	Natural hazard/ Torrential rain	Fear of flood during torrential rain. Exposure , defective drainage system	CHAMOUNITY Un village dans la tourmente
4/6	Château - Benares	Environmental	Anger. Authorities not helping. Living in insecurity.	MORCELLEMENT CHÂTEAU-BÉNARÈS La peur pendant les grosses pluies
21/4	Clemencia	Environmental	Building of a bridge to alleviate flood.	PONT DE BELLE-ROSE, CLÉMENCIA Faire barrage aux inondations
21/4	Camp Thorel	Environmental	Roads inundated, Flood prevention work still lagging.	CAMP- THOREL Des problèmes avec les drains
30/10	Allbion	Environmental	Recurrent flood at each rainy season. Blocked Drains and lack of maintenance.	ALBION Deux jours de tergiversations autour d'un drain bouché
2010				
12/1	All flood risk areas	Environmental	Construction of drains started in certain flood risk areas allocation of funds by Local and government.	TRAVAUX Construction de drains dans plusieurs zones à risque
13/2	Gros Bois, Trois Boutiques	Natural hazards/ Torrential rain	Accumulation of rain water in houses and property. Important material damage	<u>Pluie de Dégâts Apres Les Averses</u>
22/2	Goodlands	Natural hazards/ Torrential rain	Construction of absorbing wells by local authorities	Goodlands Des puits pour canaliser les eaux
12/3	Ruisseau Créole	Environmental	Constant exposure to landslide and flood. Fear. Children vulnerable in schooldays.	Ruisseau- Créole Plusieurs familles sous la menace de la montagne
22/3	Péreybere	Environmental	Awareness / unwillingness to invest in flood prone area.	Péreybère] Réticences des investisseurs pour cause d'inondations
2011				
6/08	Rivière des Galets	Storm surge/ environment	Impact, flood, gabions destroyed Fishers' livelihood	Phénomène meteorologique: Nuit

				agitée pour les habitants
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(L'Express, 9 April 2003 to 6 August 2011) (<http://www.lexpress.mu/services>)

Appendix 6 Tropical Cyclone Warning System (Mauritius & Rodrigues)

Class I

Issued 36 to 48 hours before Mauritius or Rodrigues is likely to be affected by gusts reaching 120 km/h.

Class II

Issued so as to allow, as far as practicable, 12 hours of daylight before the occurrence of gusts of 120 km/h

Class III

Issued so as to allow, as far as practicable, 6 hours of daylight before the occurrence of gusts of 120 km/h

Class IV

Issued when gusts of 120 km/h have been recorded and are expected to continue to occur

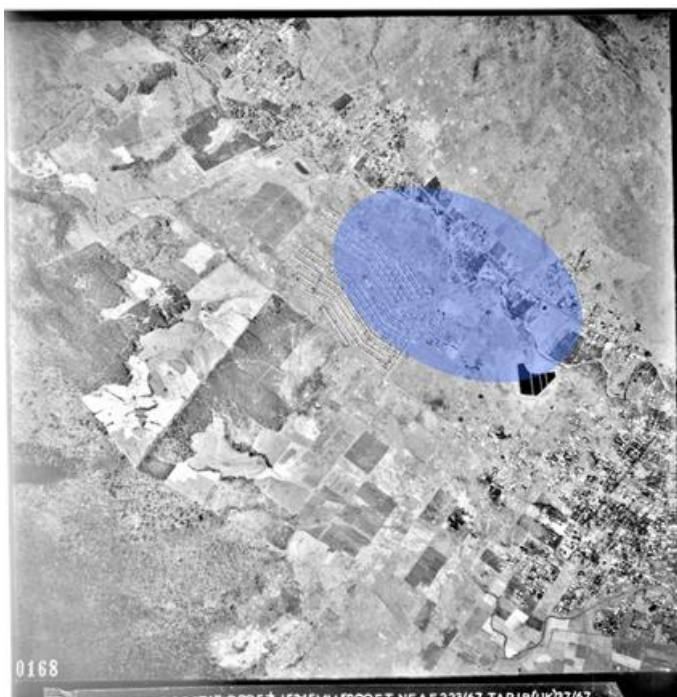
Termination

Issued when there is no longer any appreciable danger of gusts exceeding 120 km/h.

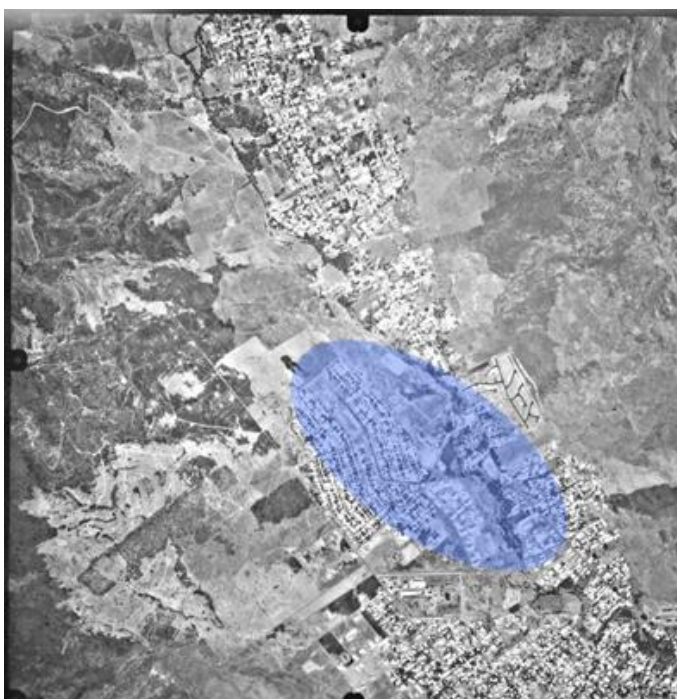
Source: Mauritius Meteorological Services (2012)

<http://metservice.intnet.mu/tropical-cyclone/warning-system.php>

Appendix 7 Aerial photographs of CLC 1967 and 1998

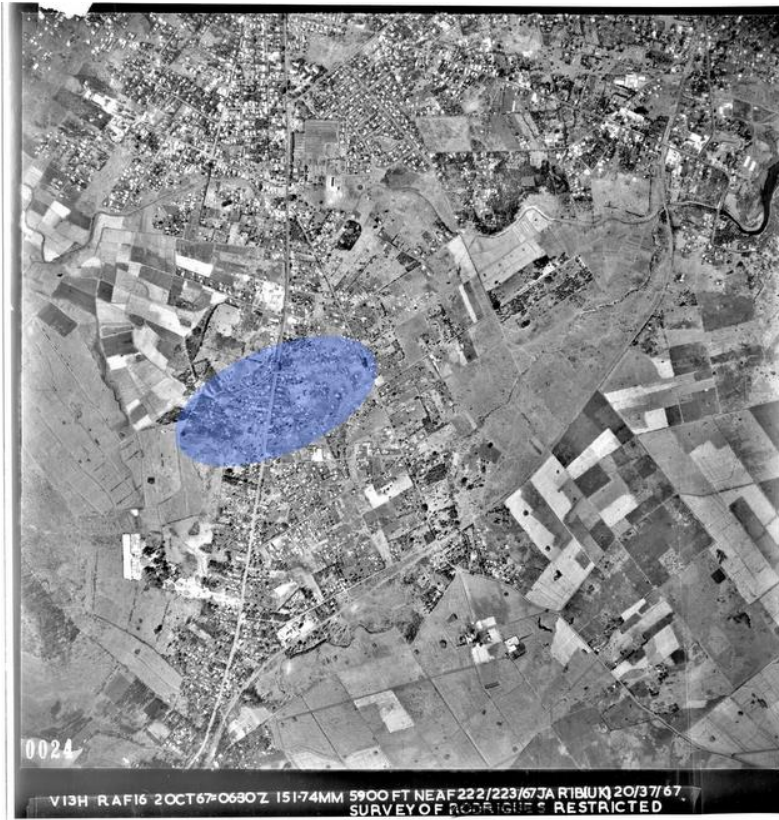


1967



1998

Appendix 8 Aerial Photograph of LH in 1967 and in 1997



1967

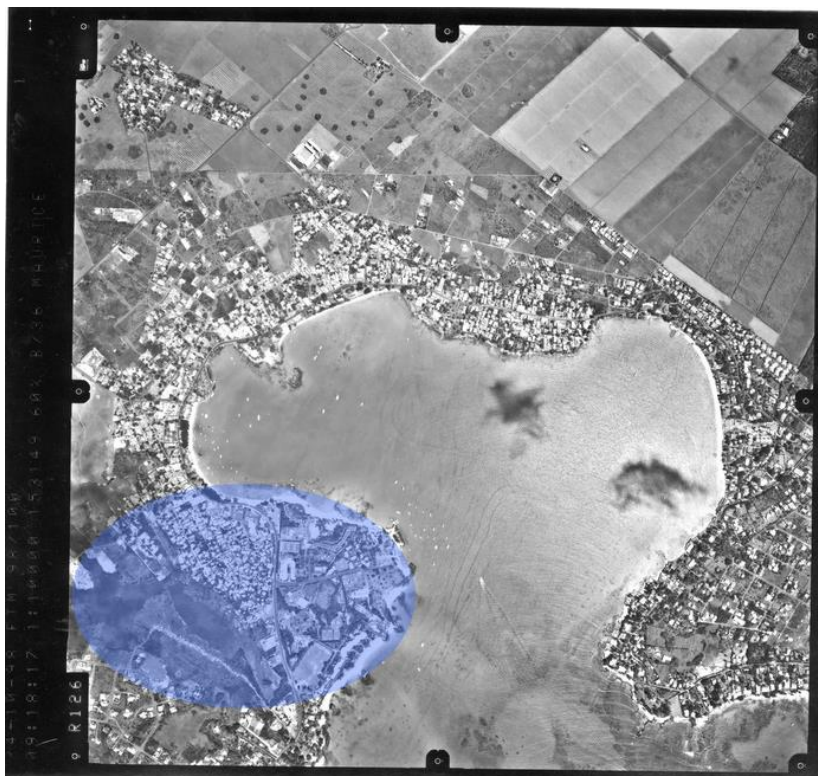


1997

Appendix 9 Aerial Photograph of GB in 1967 and 1998



1967



1998

Appendix 10 Pilot questionnaire survey of household vulnerability/recovery of flood hazard in the Republic of Mauritius

(03 December 2009)

Locality:

Questionnaire to be filled by the householder (The ‘householder’ is an adult family member living under the same roof and sharing the same income as the rest of other members).

1. ENVIRONMENTAL HAZARD

1.A. Experience with environmental hazard

(to be completed by those who have already experienced flood hazards and those who are at risk of being flooded)

Please tick (√), as appropriate.

1.1 In the last 3 years, I have been affected by environmental hazards:

Strongly agree Agree Neutral Disagree Strongly disagree

1.2 The type of environmental hazard that I have experienced during the last 3 years:

	1. Cyclone	<input type="checkbox"/>
	2. Flood hazard	<input type="checkbox"/>
	3. Storm surge	<input type="checkbox"/>

1.B Nature of hazard

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1.3	In the past 3 years I have been affected by floods that occurred					
	1. After a cyclone					
	2. During heavy rains					
	3. After a storm surge					
1.4	I have been affected by more than one flood event than once for the last three years.					
1.5	I have been affected every year for the last three					

	years.					
1.6	The flood occurred while:					
	a) I was at home					<input type="checkbox"/>
	b) I was not at home					<input type="checkbox"/>
	c) I went to work					<input type="checkbox"/>
1.7	I was trapped while:					
	a) I was in the house					<input type="checkbox"/>
	b) I was in the bus					<input type="checkbox"/>
	c) I was in the car					<input type="checkbox"/>
	d) I was on the road					<input type="checkbox"/>
	e) Other.....(<i>please specify</i>)					
1.8	I was warned of incoming flood water by					
	a) Members of my family					<input type="checkbox"/>
	b) My next door neighbour					<input type="checkbox"/>
	c) Relatives					<input type="checkbox"/>
	d) Passers-by					<input type="checkbox"/>
	e) Government authorities					<input type="checkbox"/>
	f) Others(<i>please specify</i>)					

1. C Action taken prior to flood event

1.9	I took the following actions prior to the flood event:					
	a) I rushed to ensure safety of my family					<input type="checkbox"/>
	b) I went to pick my children from school					<input type="checkbox"/>
	c) I organised myself to face the extent of flood events					<input type="checkbox"/>
	d) I move my furniture and other possessions to safe grounds					<input type="checkbox"/>
	e) I get ready to move out in case of any emergency					<input type="checkbox"/>
	f) I do not take any action prior to flood events.					<input type="checkbox"/>

2. IMPACT OF FLOODING

2. A Tangible Impact (Material/Economic Loss)

			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2.1	My house was damaged	Very damaged					
		Slightly damaged					
		Not damaged					
2.2	a) My belongings were damaged <input type="checkbox"/> b) Furniture <input type="checkbox"/> c) Clothes <input type="checkbox"/> d) Utensils <input type="checkbox"/> e) Bed and mattresses <input type="checkbox"/> f) Refrigerator <input type="checkbox"/> g) TV set <input type="checkbox"/> h) School materials <input type="checkbox"/> i) Car <input type="checkbox"/> j) Motorbike <input type="checkbox"/>						
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2.3	My belongings were damaged	1.Very damaged					
		2.Slightly damaged					
		3.Not damaged					
2.4	I lost my daily wage						
2.5	I lived without electricity supply						
2.6	Water supply was interrupted						
2.7	Water available for drinking was muddy and contaminated						
2.8	Communication was disrupted						
2.9	Transport was disrupted						
2.10	I lost items of great value						
2.11	My garden was damaged	a) Fruit trees <input type="checkbox"/>					
		b) Vegetable patch <input type="checkbox"/>					
		c) Flower / ornamentals <input type="checkbox"/>					

2.22	<p>I have not been able to get my house repaired due to:</p> <p style="text-align: center;">a) Lack of financial resources <input type="checkbox"/></p> <p style="text-align: center;">b) Lack of building material <input type="checkbox"/></p> <p style="text-align: center;">c) No insurance coverage <input type="checkbox"/></p> <p style="text-align: center;">d) Accumulated debts <input type="checkbox"/></p> <p style="text-align: center;">e) Chronic illness <input type="checkbox"/></p> <p style="text-align: center;">f) Others <input type="checkbox"/></p>
------	---

2.D. Lasting intangible impact

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2.23	I still suffer from psychological disorder because of recurrent flooding					
2.24	It took me some time and effort to return to normal after each flood event					
2.25	Since last flood event, members of my family have deteriorating mental health problem					
2.26	Since last flood event, members of my family have deteriorating physical health problem					

Worry about nature of impact of future floods

Economic impact

2.27	I am worried about the impact of future flood on my livelihood					
2.28	I am worried about the impact of future floods on my income					

Social impact

2.29	I am worried about the impact of future floods on my family's quality of life.					
2.30	I am worried about my future.					
2.31	I am worried about the future of my children.					

Environmental Impact

2.32	I am worried about the impact of future floods on my property					
2.33	I am worried about the impact of future flood on my family's health due to the increase of disease vectors after every flood event.					

3. VULNERABILITY

Exposure

3. A Environmental factors

3.1	I live on a flood zone	1. Wetland <input type="checkbox"/>
		2. Coastal area <input type="checkbox"/>
		3. Near river bank <input type="checkbox"/>
		4. Down a mountain slop <input type="checkbox"/>
		5. Near a dry stream <input type="checkbox"/>
3.2	I live	1.on a wetland <input type="checkbox"/>
		2.on the coast <input type="checkbox"/>
		3.close to a river bank <input type="checkbox"/>
		4.on a mountain slope <input type="checkbox"/>
		5.close to a dry stream <input type="checkbox"/>
3.3	My house is situated in	1.an urban area <input type="checkbox"/>
		2.a crowded urban settlement <input type="checkbox"/>
		3.a rural area <input type="checkbox"/>
		4.a crowded rural area <input type="checkbox"/>
		5.an Isolated rural area <input type="checkbox"/>

3.B Social Factors

			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
3.4	Members of my family stay in damp conditions during every flood event	For a short while						
		For a day						
		For many days						
		Not at all						
		1. Living in a crowded conditions						
		2. Large number of unemployment						
		3. Neighbourhood with drug addicts						
		4. Noise						
		3. Neighbourhood with drug addicts						
		5. Garbage not collected regularly						
		6. Mosquitoes and other pests infested area						
		7. Lack of community cohesion.						
		8. Isolated from public amenities centre	i. Community					
			ii. Health centre					
iii. Youth clubs								
9. Lack of support from local authorities								

3.C Economic factors

3.5	My house is made up of	1. Wholly concrete	<input type="checkbox"/>
		2. Concrete wall with tin roof	<input type="checkbox"/>
		3. Wooden wall/tin roof	<input type="checkbox"/>
		4. Tin wall/tin roof	<input type="checkbox"/>
		5. Other material (<i>please specify</i>)	
3.6	House occupation	1. Own the house	<input type="checkbox"/>
		2. Private rent	<input type="checkbox"/>

		3.Low cost housing renting Scheme (Cité type) <input type="checkbox"/>
		4.Temporary built accommodation on Crown land <input type="checkbox"/>
3.7	Land Occupation	1. Own the land <input type="checkbox"/> 2. Rented <input type="checkbox"/> 3. Government property <input type="checkbox"/>
	Type of house	1. Detached <input type="checkbox"/> 2. Semi-detached <input type="checkbox"/> 3. Two-storied <input type="checkbox"/>
3.8	I live here because of:	1. Job proximity <input type="checkbox"/> 2. Access to amenities <input type="checkbox"/> 3. Close to relatives <input type="checkbox"/> 4. Same community <input type="checkbox"/> 5. Own choice <input type="checkbox"/>

4. AFTER A FLOOD – RECOVERY/RESILIENCE BUILDING

4. A Recovery

4.1	I get my house to normal	1.immediately after the flood hazard <input type="checkbox"/> 2.weeks after <input type="checkbox"/> 3.months after <input type="checkbox"/> 4.never gets to normal <input type="checkbox"/>
4.2	My family caught	1.lasting health problems physical <input type="checkbox"/> 2.psychological trauma <input type="checkbox"/>

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4.3	My family situation since last flood event has improved significantly					
	My family situation since last flood event has improved slightly					
	My family situation since last flood event has not improved					
	Since last flood event, my quality of life has deteriorated significantly					

4.4	Since last flood event, my quality of life has improved significantly							
	Since the last flood event, my quality of life has improved a bit							
	Since the last flood event, my quality of life has deteriorated significantly							
4.5	I rely on the following for protection from flood	1. Self						
		2. Family						
		3. Community						
		4. Relatives						
		5. Charity organisations						
		6. Local authorities						
		7. Government						

4. B. Short-term assistance

4.6	I receive assistance from	Family						
		None						
		Community						
		Relatives						
		Charity organisations						
		Local authorities						
		Government						
4.7	I receive assistance in the form of	1. money						
		2. food						
		3. clothes						
		4. utensils						
		5. mattress						
		6. furniture						
		7. housing materials						
		8. school materials						
		9.						
		10. none						

4.8	I rely on the following for protection from floods on	a) myself					
		b) my family					
		c) my relatives					
	I rely on the following for protection from floods on	a) my neighbours					
		b) charity organizations					
		c) local organizations					
		d) Government					

4. C. Short-term assistance

4.9	I was relocated by local authorities to a Government shelter					
	I was relocated by local authorities to a relative's place					
	I was relocated by local authorities to a safer place					

4.D. Long-term assistance

4.10	I am not worried since I am insured from hazard risk.					
4.11	Assistance provided by the Government was enough					
4.12	Assistance provided by the Government was not enough					

5. MEASURES TAKEN AND AWARENESS BUILDING

5.A. Necessary precautions before each flood event

5.1	I take necessary precautions before each flood event by:	
	1. Remove possessions from ground floor	<input type="checkbox"/>
	2. Evacuate to safer grounds	<input type="checkbox"/>
	3. Place flood guards at doorsteps	<input type="checkbox"/>
	4. Make furrows in the garden to divert flood water	<input type="checkbox"/>
	5. Move to refuge centre	<input type="checkbox"/>
	6. Move to relative's place	<input type="checkbox"/>
	7. Move to neighbour's place	<input type="checkbox"/>
	8. Stockpile food and necessary items.	<input type="checkbox"/>
	9. Move animals and pets to safer ground.	<input type="checkbox"/>
10. None of the above	<input type="checkbox"/>	

5.2	<p>I am aware that I live in a flood risk zone.</p> <p>1. Very aware <input type="checkbox"/></p> <p>2. Slightly aware <input type="checkbox"/></p> <p>3. Unaware <input type="checkbox"/></p>
5.3	<p>I am aware that the frequency of flooding has increased in recent years</p> <p>1. Very aware <input type="checkbox"/></p> <p>2. Slightly aware <input type="checkbox"/></p> <p>3. Unaware <input type="checkbox"/></p>
5.4	<p>Floods have increased in my region because of</p> <p>1. Overcrowding <input type="checkbox"/></p> <p>2. Insufficient drainage <input type="checkbox"/></p> <p>3. Clogged ditches <input type="checkbox"/></p> <p>4. Clogged Streams <input type="checkbox"/></p> <p>5. Clogged Rivers <input type="checkbox"/></p> <p>6. Too many buildings <input type="checkbox"/></p> <p>7. Climate change <input type="checkbox"/></p> <p>8. Deforestation <input type="checkbox"/></p> <p>9. Low priority given to us from local authorities <input type="checkbox"/></p>
5.5	<p>I obtain flood warning from the following sources:</p> <p>1. Radio <input type="checkbox"/></p> <p>2. TV <input type="checkbox"/></p> <p>3. Learnt from neighbours <input type="checkbox"/></p> <p>4. Passers-by <input type="checkbox"/></p> <p>5. Mobile <input type="checkbox"/></p> <p>6. Internet <input type="checkbox"/></p>
5.6	<p>I listen to flood forecast:</p> <p>1. Regularly <input type="checkbox"/></p> <p>2. Sometimes <input type="checkbox"/></p> <p>3. Rarely <input type="checkbox"/></p> <p>4. Never <input type="checkbox"/></p>

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5.7	The warning was delivered to me in time for me to act					
5.8	I understand the flood warnings that are issued fully					
5.9	I do not understand the flood warnings at all					
5.10	In my opinion, the flood warnings must be improved					
5.11	Emergency services should be improved					
5.12	Authorities should take other measures besides issuing flooding warning					
5.13	Government should improve structural measures in flood prevention					
5.14	Government should improve other measures besides structural measures in flood prevention					
5.15	Government should invest more on educational programmes on flood risk and emergency services in a) School <input type="checkbox"/> b) Community centre <input type="checkbox"/> c) Youth clubs <input type="checkbox"/>					
5.16	There are differences in the Government support given to the communities in our country	a) During floods				
		b) After a flood hazard				
		c) In relief and emergency services				
		d) In building flood defences				
		e) In helping to improve quality of life.				
5.17	There are differences in the support of NGOs given to our community in during floods	a) After a flood hazard				
		b) In relief and emergency services				
		c) In helping to improve quality of life.				
		d) Building flood defences				
5.18	Our community has a feeling of being ' <i>left out</i> ' at every flood hazard event.					

5.19	Government allows us to participate in environmental decision making about how to manage risk					
5.20	Government should allow us to participate in environmental decision making about how to manage risk					

6. RESPONDENT'S PERSONAL INFORMATION

6.1	<p>Ownership of house</p> <p>a) I own the house <input type="checkbox"/></p> <p>b) I rent the house <input type="checkbox"/></p> <p>b) I share the house <input type="checkbox"/></p>
6.2	<p>My household is composed of</p> <p>a) Members <input type="checkbox"/></p> <p>b) Number of elderly persons <input type="checkbox"/></p> <p>c) Children <input type="checkbox"/></p> <p>d) Disabled persons <input type="checkbox"/></p>
6.3	<p>My spouse's educational qualification:</p> <p>a) Primary <input type="checkbox"/></p> <p>b) Secondary <input type="checkbox"/></p> <p>c) Technical school <input type="checkbox"/></p> <p>d) University level <input type="checkbox"/></p> <p>e) None of the above <input type="checkbox"/></p>
6.4	<p>Educational qualification of other members</p> <p>a) Primary <input type="checkbox"/></p> <p>b) Secondary <input type="checkbox"/></p> <p>c) Technical school <input type="checkbox"/></p> <p>d) University level <input type="checkbox"/></p> <p>e) None of the above <input type="checkbox"/></p>
6.5	<p>I am/My spouse is:</p> <p>1. Fully employed <input type="checkbox"/></p> <p>2. Partially employed <input type="checkbox"/></p> <p>3. Not employed <input type="checkbox"/></p>
6.6	<p>Other members of the family are:</p> <p>1. Fully employed <input type="checkbox"/></p>

	2. Partially employed	<input type="checkbox"/>
	3. Not employed	<input type="checkbox"/>
6.7	I am/my spouse is employed:	
	1 In industry	<input type="checkbox"/>
	2 Private sector	<input type="checkbox"/>
	3. In Government	<input type="checkbox"/>
	4 As a Professional	<input type="checkbox"/>
	5 As manual worker	<input type="checkbox"/>
	6. Self-employed	<input type="checkbox"/>
6.8	Age group in family	
	1. 0 – 5 years	<input type="checkbox"/>
	2. 6 – 14 years	<input type="checkbox"/>
	3. 15 - 24 years	<input type="checkbox"/>
	4. 25 - 40 years	<input type="checkbox"/>
	5. 41 - 55 years	<input type="checkbox"/>
	6. 56 - 65 years	<input type="checkbox"/>
	7. 66 - 75 years	<input type="checkbox"/>
	8. Above 75 years	<input type="checkbox"/>
6.9	According to the Mauritian Constitution, I identify myself as belonging to one of the following ethnic groups	
	1. Creole	<input type="checkbox"/>
	2. Indo-Mauritian	<input type="checkbox"/>
	3. Sino-Mauritian	<input type="checkbox"/>
	4. Franco-Mauritian	<input type="checkbox"/>
	5. Other (<i>please specify</i>)	

7. FURTHER PARTICIPATION IN THE STUDY

7.1 I will be interested to join you for a group interview Yes No

Thank you for your participation.

Appendix 11 Questionnaire survey on vulnerability, recovery and resilience building after a flood hazard

Questionnaire is to be filled by the householder who has experienced a flood hazard in his/her house or property or neighbourhood.

(The householder is an adult family member living under the same roof and sharing the same expenses as the rest of other members).

Locality:	Date of interview:	Time:
------------------	---------------------------	--------------

1. HOUSEHOLD CHARACTERISTICS

1 A Membership of Household

1.1	Number of members in household	<input style="width: 50px; height: 20px;" type="text"/>																					
1.2	Members of household by age group	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 45%; padding: 5px;">Age in years</th> <th style="width: 25%; padding: 5px;">Male</th> <th style="width: 30%; padding: 5px;">Female</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">Less than 3</td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">3-14</td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">15 – 22</td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">23-40</td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">41-60</td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> </tr> <tr> <td style="padding: 5px;">> 60</td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> <td style="text-align: center; padding: 5px;"><input type="checkbox"/></td> </tr> </tbody> </table>	Age in years	Male	Female	Less than 3	<input type="checkbox"/>	<input type="checkbox"/>	3-14	<input type="checkbox"/>	<input type="checkbox"/>	15 – 22	<input type="checkbox"/>	<input type="checkbox"/>	23-40	<input type="checkbox"/>	<input type="checkbox"/>	41-60	<input type="checkbox"/>	<input type="checkbox"/>	> 60	<input type="checkbox"/>	<input type="checkbox"/>
Age in years	Male	Female																					
Less than 3	<input type="checkbox"/>	<input type="checkbox"/>																					
3-14	<input type="checkbox"/>	<input type="checkbox"/>																					
15 – 22	<input type="checkbox"/>	<input type="checkbox"/>																					
23-40	<input type="checkbox"/>	<input type="checkbox"/>																					
41-60	<input type="checkbox"/>	<input type="checkbox"/>																					
> 60	<input type="checkbox"/>	<input type="checkbox"/>																					
1.3	No. of children between 5-18 attending school	<input style="width: 50px; height: 20px;" type="text"/>																					
1.4	Education level of householder :																						
	Primary school	<input type="checkbox"/>																					
	Secondary school	<input type="checkbox"/>																					
	Tertiary	<input type="checkbox"/>																					
	None	<input type="checkbox"/>																					

1. B House Tenure

1.5	a) I own a house	<input type="checkbox"/>	
	b) I rent a house	<input type="checkbox"/>	
	c) I share the house with other relatives	<input type="checkbox"/>	
1.6	My occupation	a) I work in industry	<input type="checkbox"/>
		b) I work in the private sector	<input type="checkbox"/>
		c) I work in government service	<input type="checkbox"/>
		d) I am a professional	<input type="checkbox"/>
		e) I am a manual worker	<input type="checkbox"/>
		f) I am self-employed	<input type="checkbox"/>
		g) I am a housewife	<input type="checkbox"/>
1.7	According to the Mauritian Constitution, I identify myself as belonging to one of the following ethnic groups:	a) Creole	<input type="checkbox"/>
		b) Indo-Mauritian	<input type="checkbox"/>
		c) Sino-Mauritian	<input type="checkbox"/>
		d) Franco-Mauritian	<input type="checkbox"/>
		e) Others	<input type="checkbox"/>

2. EXPERIENCE OF FLOODING

(Applicable only if house, property or neighbourhood is inundated)

2. A Personal flood experience

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
2.1	I have experienced flood hazards in the last 3 years					
2.2	In the past 3 years I have been affected by floods that occurred	1. After a cyclone				
		2. During heavy rains				
		3. After a storm surge				
2.3	I have been affected by more than one flood event for the last three years					
2.4	I have been affected by flood events every year for the last three years					

3. IMPACTS

3. A Tangible impacts

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
3.1	My house was inundated <i>(Please go to Section 3.5)</i>						
3.2	My house/personal effects were damaged <i>(Please go to Section 3.6)</i>						
3.3	My garden property was inundated <i>(Please go to Section 3.7)</i>						
3.4	My neighbourhood was inundated <i>(Please go to Section 3.8)</i>						
3.5	My house was inundated <i>(i) Height of flood water in my house</i>	a) Above my feet			<input type="checkbox"/>		
		b) Up to my ankle			<input type="checkbox"/>		
		c) Up to my knee			<input type="checkbox"/>		
		d) Above my knee			<input type="checkbox"/>		
3.6	My house was damaged <i>(i) Please specify the part affected</i>	a) Walls			<input type="checkbox"/>		
		b) Roof			<input type="checkbox"/>		
		c) Floor			<input type="checkbox"/>		
	<i>(ii) Please specify the belongings damaged</i>	a) Furniture				<input type="checkbox"/>	
		b) Mattress				<input type="checkbox"/>	
		c) Clothing				<input type="checkbox"/>	
		d) Utensils				<input type="checkbox"/>	
		e) Electrical appliances				<input type="checkbox"/>	
	<i>(iii) Please specify animals affected</i>	a) Cows				<input type="checkbox"/>	
		b) Goats				<input type="checkbox"/>	
		c) Poultry				<input type="checkbox"/>	
		d) Dogs				<input type="checkbox"/>	
e) Cats					<input type="checkbox"/>		
f) Others (pigs, etc)					<input type="checkbox"/>		

3.7	My garden was inundated: <i>(i) Water came up</i>		a) Above my feet	<input type="checkbox"/>			
			b) Up to my ankle	<input type="checkbox"/>			
			c) Up to my knee	<input type="checkbox"/>			
			d) Above my knee	<input type="checkbox"/>			
	<i>(ii) Flood water affected</i>		a) Fruit trees	<input type="checkbox"/>			
			b) Hedge/garden enclosure	<input type="checkbox"/>			
			c) Vegetable patch	<input type="checkbox"/>			
			d) Flower/ornamentals	<input type="checkbox"/>			
3.8	My neighbourhood was inundated <i>Flood water reached:</i>		a) Above my feet	<input type="checkbox"/>			
			b) Up to my ankle	<input type="checkbox"/>			
			c) Up to my knee	<input type="checkbox"/>			
			d) Above my knee	<input type="checkbox"/>			
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3.9	Impact on utilities, facilities and services						
	<i>(i) Power supply</i>	a) Not interrupted					
		b) Interrupted temporarily					
	<i>(ii) Water supply</i>	a) Not interrupted					
		b) Interrupted temporarily					
		c) Water flow was muddy					
	<i>(iii) Telecommunications</i>	a) Not interrupted					
		b) Interrupted temporarily					
	<i>(iv) Road practicability</i>	a) Not affected					
		b) Very affected					
	<i>(v) Transport facilities</i>	a) Not interrupted					
		b) Interrupted temporarily					
	<i>(vi) Schools</i>	a) Interrupted temporarily					
		b) Interrupted for one day					
c) Interrupted for more than one day							

3B. Intangible Impact (psychological/emotional)

3.10	I was upset about the damage caused by the flood					
3.11	My family was disrupted					
3.12	My children missed school					
3.13	I lost items of sentimental value					
3.14	I suffered from job loss					
3.15	Members of my family suffered from job loss					

3C. Lasting Tangible Impact

3.16	I have not been able to get my house back to normal after each flood event.					
3.17	My possessions were lost and could not be replaced					
3.18	I have not been able to get my house repaired due to:	a) Lack of financial resources				<input type="checkbox"/>
		b) Lack of building materials				<input type="checkbox"/>
		c) No insurance coverage				<input type="checkbox"/>
		d) Accumulated debts				<input type="checkbox"/>
		e) Chronic ill health				<input type="checkbox"/>
		f) Others				<input type="checkbox"/>

3D. Lasting Intangible Impact

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3.19	I still suffer from psychological disorder because of recurrent flooding					
3.20	It took me some time and effort to return to normal after each flood event					
3.21	Since last flood event, members of my family have deteriorating health problem					
3.22	I worry about nature of impact of future floods on:	a) My livelihood				
		b) My family's quality of life.				
		c) The future of my children				
		d) My property				
		e) My family's health due to the increase of disease vectors at every flood event				

4. VULNERABILITY

4A Exposure

4.1	I live in a flood zone	a) Wetland (inland)	<input type="checkbox"/>
		b) Wetland (coast)	<input type="checkbox"/>
		c) On a river bank	<input type="checkbox"/>
		d) Down a mountain slope	<input type="checkbox"/>
		e) Close to a stream	<input type="checkbox"/>
4.2	My house is situated in	a) An urban area	<input type="checkbox"/>
		b) A suburban settlement	<input type="checkbox"/>
		c) A rural area	<input type="checkbox"/>
		d) A crowded rural area	<input type="checkbox"/>
		e) An isolated rural area	<input type="checkbox"/>

4B. Social Factors

			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
4.3	Members of my family stay in damp conditions during every flood event:	a) For a short while						
		b) For a day						
		c) For many days						
	Members of my family live in social conditions that may be described as;	a) Living in crowded conditions						
		b) Large number of unemployment						
		c) Disrupted family structures						
		d) Neighbourhood with drug addicts						
		e) Garbage not collected regularly						
		f) Mosquitoes and other pests infested area						
		g) Lack of community cohesion.						
		h) Isolation from public amenities	i) Community centre					
			ii) Health centre					
			iii) Youth clubs					

			iv) Shopping centres					
		(i) Lack of support from local authorities						

4C. Economic Factors

4.4	My house is of	a) Wholly concrete	<input type="checkbox"/>
		b) Concrete with wall/tin roof	<input type="checkbox"/>
		c) Tin wall/ tin roof	<input type="checkbox"/>
		d) Other	<input type="checkbox"/>
4.5	Type of house	a) Detached	<input type="checkbox"/>
		b) Semi-detached	<input type="checkbox"/>
		c) Two-storeyed	<input type="checkbox"/>

4.6	House occupation	a) Own the house	<input type="checkbox"/>
		b) Private rent	<input type="checkbox"/>
		c) Low cost housing renting Scheme (Cité type)	<input type="checkbox"/>
		d) Temporary built accommodation on Crown Land	<input type="checkbox"/>
4.7	Land occupation	a) Own the land	<input type="checkbox"/>
		b) Rented	<input type="checkbox"/>
		c) Government property	<input type="checkbox"/>
4.8	I live here because of	a) Job proximity	<input type="checkbox"/>
		b) Access to amenities	<input type="checkbox"/>
		c) Close to relatives	<input type="checkbox"/>
		d) Same community	<input type="checkbox"/>
		e) Own choice	<input type="checkbox"/>

5. AFTER A FLOOD – RECOVERY AND ASSISTANCE

5.1	I get my house to normal	a) Immediately after the flood hazard	<input type="checkbox"/>
		b) Weeks	<input type="checkbox"/>
		c) Months later	<input type="checkbox"/>
		d) Never gets to normal	<input type="checkbox"/>
5.2	I get my garden to normal	a) Immediately after the flood hazard	<input type="checkbox"/>

		b) Weeks later								<input type="checkbox"/>
		c) Months later								<input type="checkbox"/>
5.3	My family caught	a) Lasting health problems physical								<input type="checkbox"/>
		b) Psychological trauma								<input type="checkbox"/>
5.4	The living conditions of my family since the last flood event has:	a) Improved significantly								
		b) Improved slightly								
		c) Remained unchanged								
		d) Deteriorated somewhat								
		e) Deteriorated significantly								
5.5		a) Improved significantly								
		b) Remained largely unchanged								
		c) Deteriorated significantly								
5.6	I rely on the following for protection from floods:	a) Myself								<input type="checkbox"/>
		b) My family								<input type="checkbox"/>
		c) My relatives								<input type="checkbox"/>
		d) My neighbours								<input type="checkbox"/>
		e) My community								<input type="checkbox"/>
		f) Charity organizations								<input type="checkbox"/>
		g) Local authorities								<input type="checkbox"/>
		h) Government authorities								<input type="checkbox"/>

5B. Short-term Assistance

5.7	I receive support from:	a) Relatives								<input type="checkbox"/>
		b) My own community								<input type="checkbox"/>
		c) Local charities								<input type="checkbox"/>
		d) Government								<input type="checkbox"/>
5.8	I receive assistance in the	a) Money								<input type="checkbox"/>

	form of:	b) Food						<input type="checkbox"/>
		c) Clothes						<input type="checkbox"/>
		d) Utensils						<input type="checkbox"/>
		e) Mattresses						<input type="checkbox"/>
		f) Furniture						<input type="checkbox"/>
		g) Housing materials						<input type="checkbox"/>
		h) Children school materials						<input type="checkbox"/>
		i) None						<input type="checkbox"/>
			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	
5.9	I was relocated by local authorities to a:	a) Government shelter						
		b) Relative's place						
		c) Other places						
5.10	I receive support from authorities for flood protection measures in the form of:	a) Building materials						
		b) Financial grants						
		c) Soft Loans						
5.11	I am not worried since I am insured from hazard risk.							
5.12	Assistance provided by the Government was enough							
5.13	Assistance provided by the Government was not enough							

6. RESILIENCE BUILDING

6A. Support Mechanisms

			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
6.1	I rely on the following for flood protection:	a) Myself					
		b) My family					
		c) My relatives					
		d) My neighbours					
		e) Charity organizations					
		f) Local organizations (NGOs)					

		g) Government authorities					
6.2	I adapt myself to every flood event and take the following structural measures:	a) Raise my floor above water mark					
		b) I accept things as they are					
		c) I live through the event					
6.3	I accept to take responsibility to take action to:	a) Avoid harm to my family					
		b) Protect my house					
		c) Avoid damage to my belongings					

6B. Coping Mechanisms

6.4	I take necessary precautions before each flood event by:	a) Remove possessions from ground floor					
		b) Evacuate to safer grounds					
		c) Place flood guards at doorsteps					
		d) Make furrows in the garden to divert flood water					
		e) Move to refuge centre					
		f) Move to relative's place					
		g) Move to neighbour's place					

			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		h) Stockpile food and necessary items					
		i) Move animals and pets to safer ground					
		j) None of the above					
6.5	During flood events, I am take the following measures in respect of my neighbours by providing:	a) Shelter					
		b) Food					
		c) Psychological/moral support					
		d) None					
6.6	After any flood event, when I am not seriously affected, I participate in:	a) Helping my neighbours					
		b) Clearing the debris					

		c) Liaising with local authorities and NGOs					
		d) None of the above					
6.7	In planning for preparedness measures to mitigate impacts of flood events I take the following measures:	a) Collaborate with my neighbours					
		b) Collaborate with local authorities					
		c) Collaborate with NGOs					
		d) None of the above					

7. AWARENESS BUILDING

7A Awareness building

			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
7.1	I am aware that I live in a flood risk zone	a) Very aware					
		b) Slightly aware					
		c) Unaware					
7.2	I am aware that there have been an increase in the number of in recent years	a) Very aware					
		b) Slightly aware					
		c) Unaware					

7.3	Floods have increased in my region because of	a) Overcrowding					
		b) Insufficient drainage					
		c) Clogged ditches					
		d) Clogged streams					
		e) Clogged rivers					
		f) Too many buildings					
		g) Climate change					
		h) Deforestation					
		i) Low priority given to us from local authorities					
7.4	I obtain flood warning from the following sources	a) Radio					
		b) TV					
		c) Learnt from neighbours					

		d) Passers- by					
		e) Mobile					
		f) Internet					
7.5	I listen to flood forecast	a) Regularly					
		b) Sometimes					
		c) Rarely					
		d) Never					
7.6	The warning was delivered to me in time for me to act						
7.7	I understand the flood warnings that are issued fully						
7.8	I do not understand the flood warnings at all						
7.9	In my opinion, the flood warnings must be improved						
7.10	Emergency services should be improved						
7.11	Authorities should take other measures besides issuing flooding warning.						
7.12	Government should improve structural measures in flood prevention						
7.13	Government should improve other measures besides structural measures in flood prevention						
7.14	Government should invest more on educational programmes on flood risk and emergency services in:	a) Schools					
		b) Community centres					
		c) Youth clubs					
7.15	There are differences in the Government support given to the different communities in our country	a) During floods					
		b) After a flood hazard					
		c) In relief and emergency services					
		d) In building flood defences					
		e) In helping to improve quality of life.					
7.16	There are differences in the support of NGOs given to our community	a) After a flood hazard					
		b) In relief and emergency services					
		c) In helping to improve quality of life					
		d) Building flood defences					
7.17	Our community has a feeling of being 'left out' from government support at every flood hazard event.						
7.18	Government allows us to participate in environmental decision making about how to manage risk.						

7.19	Government should allow us to participate in environmental decision making about how to manage risk					
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8. Further Participation in Study

8.1	I agree to join you in any Group Interview	YES <input type="checkbox"/>	NO <input type="checkbox"/>
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Thank you for your time and participation in this study.

Appendix 12 Tables of Analysis of data from surveys at CLC, LH and GB

The Appendix is subdivided into three sections, one for each region – CLC, LH and GB

TABLES OF ANALYSIS CLC (CLC)**Table 1 Type of flood**

Origin of flood	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Cyclone	236	100	24.2	72.0	3.8	0	0	100
Heavy rain	236	100	23.7	72.5	3.8	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 2 Extent of flooding

Extent of flooding	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
House inundated	136	57.6	40.4	49.3	7.4	2.2	0.7	100
Garden inundated	216	91.5	29.6	66.2	1.4	1.4	1.4	100
Neighbourhood inundated	235	99.6	74.0	24.3	0	0.4	1.3	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 3 Water level reached

	Number of respondents	n as % of total households	Agreement scale in percentage				Total
			Above feet	Up to ankle	Up to knee	Above knee	
House	124	52.5	31.5	41.9	23.4	3.2	100
Garden	208	88.1	14.4	58.2	19.2	8.2	100
Neighbourhood	229	97.0	0.4	38.9	38.0	22.7	100

Table 4 Tangible impacts on household effects

Damage done to personal effects	Walls	Roof	Floor	Furniture	Mattress	Clothing	Utensils	Electric Appliances
Number of respondents	51	76	125	77	80	77	65	92
% of total households	21.6	32.2	53.0	32.6	33.9	32.6	27.5	39.0

Table 5 Damage to garden

	Number of respondents	% of total households
Flood affected fruit trees	12	5.1
Flood affected garden enclosure	30	12.7
Flood affected vegetable patch	91	38.6
Flood affected flowers and ornamentals	150	63.6

Table 6 Impact of flood on utilities and schools

Impact on utilities	Number of respondents	% of total households
Power supply interrupted	4	1.7
Ware supply interrupted	136	57.6
Roads affected	125	29.7
Transport was affected	43	18.2
Schools closed for the day	233	98.7

Table 7 Intangible impact

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Upset about damage	232	98.3	22.4	53.0	18.5	6.0	0	100
Family disrupted	228	96.6	16.7	18.4	18.9	43.9	2.2	100
Children missed school	217	91.9	61.8	22.1	4.1	11.1	0.9	100
Loss of sentimental items	226	95.8	16.4	22.1	16.4	42.0	3.1	100
Respondent suffers from non-payment of wages	226	95.8	3.5	3.1	2.7	70.4	20.4	100
Family members suffer from non-payment of wages	224	94.9	2.7	2.7	0.4	72.3	21.9	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 8 Lasting tangible impact

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Not getting house to normal	222	94.1	7.7	24.8	9.0	45.5	13.1	100
Personal effects could not be replaced	222	94.1	8.6	20.7	11.7	45.0	14.1	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 9 Living in a flood zone

	Inland wetland	Coastal wetland	On a river bank	On a mountain slope	Near a stream
Number of respondents	213	0	40	24	1
% of total households	90.3	0	16.9	10.2	0.4

Table 10 Type of house

	Number of respondents	% of total households
Wholly concrete	126	55.8
Partly concrete and tin	54	23.9
Tin shed	46	20.4
Total	226	100

Table 11 Perception of household on living conditions

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Living in crowded conditions	219	92.8	2.7	29.7	26.9	39.3	1.4	100
Large number of unemployment	229	97.0	19.2	41.5	21.4	17.9	0	100
Neighbourhood with drug addicts	233	98.7	65.2	25.8	7.7	1.3	0	100
Disrupted family structures	233	98.7	63.9	26.2	8.6	1.3	0	100
Garbage not collected regularly	233	98.7	13.3	18.9	15.5	50.6	1.7	100
Mosquitoes and pest-infested area	234	99.2	19.7	31.2	21.8	26.5	0.9	100
Lack of community cohesion	232	98.3	15.5	20.7	13.8	48.7	1.3	100
Isolated community	233	98.7	1.7	15.0	9.9	72.1	1.3	100
No health centre	232	98.3	2.2	12.1	9.9	74.1	1.7	100
No youth centre	234	99.2	17.1	41.0	9.8	31.2	0.9	100
No shopping facilities	233	98.7	25.3	64.4	10.3	0	0	100
Lack of support from local authorities	231	97.9	17.7	26.0	22.5	31.6	2.2	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 12 Perception on living conditions of family since last flood event

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Improved significantly	35	14.8	5.7	54.3	14.3	0	25.7	100
Improved slightly	81	34.3	4.9	79.0	0	0	16.0	100
Remained unchanged	49	20.2	16.3	57.1	0	0	26.5	100
Deteriorated somewhat	23	9.5	8.7	34.8	0	0	56.5	100
Deteriorated significantly	14	5.8	7.1	0	0	0	92.9	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 13 Household receives external support after flood

	Number of Respondents	% of total households
Receives support from relatives	88	37.3
Receives support from own community	25	10.6
Receives support from local charity	62	26.3
Receives support from social organisations	80	33.9
Receives support from Government	83	35.2
Soft loans	115	48.7

Table 14 Perception on insurance and Government assistance

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Not worried since insured from hazard risk	114	48.3	0	3.5	16.7	14.9	64.9	100
Assistance from Government was enough	108	45.8	0	0.9	10.2	28.7	60.2	100
Assistance from Government was not enough	107	45.3	27.1	49.5	11.2	3.7	8.4	100

Table 15 Perception of household on relocation

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Relocation to a Government Centre	104	44.1	0	2.9	0	3.8	93.3	100
Relocation to relatives' place	105	44.5	0	1.0	0	3.8	95.2	100
Relocation to other sites	113	47.9	8.0	10.6	0.9	2.7	77.9	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 16 Adapting to every flood event

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Raise floor above water mark	83	35.2	28.9	71.1	0	0	0	100
Build higher floorings	82	34.7	25.6	74.4	0	0	0	100
Accept things as they are	6	2.5	83.3	16.7	0	0	0	100
Live through the event	15	6.4	86.7	13.3	0	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 17 Providing help to neighbours during flood event

	Number of Respondents	% of total households
Shelter	14	5.9
Food	94	38.9
Short-term assistance	98	41.5
Moral support	181	76.7
None of the above	30	12.7

Table 18 Participation in helping others after flood event

	Number of Respondents	% of total households
Helping neighbours	187	79.2
Clearing debris	112	47.5
Liaise with local authorities	18	7.6
One of the above	39	16.5

Table19 Measures taken in planning to mitigate flood impact

	Number of Respondents	% of total households
Collaborate with neighbours	204	86.4
Collaborate with local authorities	74	31.4
Collaborate with NGOs	87	36.9
None of the above	31	13.1

Table 20 Awareness of flood increase in recent years

	Number of Respondents	% of total households
Very much aware	131	56.0
Slightly aware	97	41.5
Not aware	6	2.6
Total	234	100

Table 21 Flood warning sources

	Number of Respondents	% of total households
Radio	218	92.4
TV	105	44.5
Neighbours	149	63.1
Passers-by	58	24.6
Mobile	50	21.2
Internet	23	9.7

Table 22 Household's opinion on warning

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Warning was delivered in time to act	234	99.2	3.0	47.4	17.1	32.5	0	100
Warning issued are fully understood	234	99.2	4.7	71.4	20.9	3.0	0	100
Warning issued are not understood	230	97.5	0	0.4	1.7	15.2	82.6	100
Flood warning should be improved	232	98.3	44.0	45.7	9.9	0.4	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 23 Household's opinion on Government action on flood mitigation

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Emergency services must be improved	232	98.3	43.1	46.1	9.9	0.9	0	100
Other measures should be taken besides flood warning	232	98.3	42.7	46.1	9.9	1.3	0	100
Structural measures in flood prevention should be improved	232	98.3	43.5	45.7	9.5	1.3	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 24 Opinion on Government's investment on flood awareness programme

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
In school programme	232	98.3	47.8	44.4	7.3	0.4	0	100
In community centres	232	98.3	48.3	44.0	7.3	0.4	0	100
In youth clubs	232	98.3	47.4	43.5	7.8	1.3	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 25 Households opinion on differences in Government support

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
During flood event	232	98.3	11.2	23.3	45.3	20.3	0	100
After flood event	232	98.3	11.2	22.8	45.7	20.3	0	100
In relief and emergency services	232	98.3	13.4	22.8	43.1	20.3	0.4	100
In building flood defences	232	98.3	14.2	22.4	42.2	20.7	0.4	100
In helping to improve quality of life	231	97.9	11.3	23.4	42.9	22.1	0.4	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 26 Household's opinion on differences in NGO's support

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
After flood event	232	98.3	6.0	13.8	44.0	34.5	1.7	100
In relief and emergency services	232	98.3	6.0	12.5	44.4	35.3	1.7	100
In building flood defences	232	98.3	6.0	12.1	44.4	35.8	1.7	100
In helping to improve quality of life	232	98.3	6.0	12.5	44.4	35.3	1.7	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 27 Household's perception on being left out during flood events

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Feeling of being 'left out' of decision-making	232	98.3	12.5	28.9	10.3	40.1	8.2	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table.28 Participation in environmental decision-making (EDM)

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Government allows community to participate in EDM	228	96.6	0	9.6	26.3	53.9	10.1	100
Government should allow community to participate in EDM	229	97.0	18.8	49.3	20.1	10.5	1.3	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

TABLES OF ANALYSIS LH

Table 29 Experience of flood

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
In the past 3 years	130	99.2	2.3	95.4	2.5	0	0	100
More than once in past 3 years	120	91.6	1.7	0.8	12.5	82.5	2.5	100
Every year in the last 3 years	120	91.6	1.7	2.5	10.8	82.5	2.5	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 30 Type of flood

Origin of flood	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Cyclone	130	99.2	9.2	88.5	2.3	0	0	100
Heavy rain	130	99.2	3.1	93.8	3.1	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 31 Water level reached

	Number of respondents	n as % of total households	Agreement scale in percentage				
			Above feet	Up to ankle	Up to knee	Above knee	Total
House	18	13.7	72.2	27.8	0	0	100
Garden	114	87.0	86.8	13.2	0	0	100
Neighbourhood	128	97.7	75.8	23.4	0.8	0	100

Table 32 Impact of flood on utilities and schools

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Power not interrupted	113	86.3	21.2	78.8	0	0	0	100
Water supply not interrupted	109	83.2	22.9	77.1	0	0	0	100
Telecoms not interrupted	127	96.9	29.1	70.9	0	0	0	100
Road not affected	125	95.4	26.4	73.6	0	0	0	100
Transport not affected	127	96.9	26.8	73.2	0	0	0	100
School interrupted temporarily	114	87.0	21.9	77.2	0.9	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 33 Intangible impact caused by flood event

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Upset about damage	123	93.9	4.9	39.8	36.6	18.7	0	100
Family disrupted	117	89.3	0	0.9	11.1	84.6	3.4	100
Children missed school	116	88.5	0.9	6.0	7.8	81.9	3.4	100
Loss of sentimental items	116	88.5	0	4.3	4.3	88.8	2.6	100
Respondent suffer from non-payment of wages	116	88.5	0	0	2.6	94.0	3.4	100
Family members suffer from non-payment of wages	116	88.5	0	0.9	0	95.7	3.4	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 34 Living in a flood zone

	Inland wetland	Coastal wetland	On a river bank	On a mountain slope	Near a stream
Number of respondents	126	0	0	0	3
Percentage of responses	96.2	0	0	0	2.3

Table 35 Type of house

Nature of house	Number of respondents	% of total households
Wholly concrete	96	76.2
Partly concrete and tin	27	21.4
Tin shed	3	2.4
Total	126	100

Table 36 Perception of household on living conditions

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Living in crowded conditions	126	96.2	8.7	21.4	35.7	32.5	1.6	100
Large number of unemployment in area	126	96.2	13.5	44.4	31.7	10.3	0	100
Neighbourhood with drug addicts	126	96.2	13.5	28.6	40.5	17.5	0	100
Disrupted family structures	111	84.7	8.1	25.2	37.8	28.8	0	100
Garbage not collected regularly	125	95.4	15.2	21.6	43.2	20.0	0	100
Mosquitoes and pest-infested area	126	96.2	0.8	7.9	29.4	61.1	0.8	100
Lack of community cohesion	126	96.2	7.1	0	32.5	60.3	0	100
Isolated community	126	96.2	0	3.2	6.3	89.7	0.8	100
Lack of support from authorities	124	94.7	1.6	6.5	34.7	56.5	0.8	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 37 Perception of household to living in damp condition

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Short while	85	64.9	0	90.6	8.2	1.2	0	100
Whole day	26	19.8	0	76.9	7.7	15.4	0	100
Many days	21	16.0	4.8	71.4	9.5	14.3	0	100
Not at all	4	3.1	0	0	25.0	75.0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 38 Perception of household quality of life of the family since last flooding

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Improved significantly	49	37.4	4.1	71.4	20.4	4.1	0	100
Remained largely unchanged	4	3.1	0	50	0	50	0	100
Deteriorated significantly	2	1.5	0	0	0	100	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 39 Perception on insurance and Government assistance

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Not worried since insured from hazard risk	13	9.9	0	0	23.1	76.9	0	100
Assistance from Government was enough	13	9.9	0	0	15.4	84.6	0	100
Assistance from Government was not enough	13	9.9	0	46.2	53.8	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 40 Adapting to every flood event

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Raising floor above water mark	20	15.3	80.0	20.0	0	0	0	100
Build higher floorings	24	18.3	62.5	37.5	0	0	0	100
Accept things as they are	38	29.0	86.8	13.2	0	0	0	100
Live through the event	10	7.6	80.0	20.0	0	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 41 Providing help to neighbours during flood event

	Number of respondents	% of total households
Shelter	4	3.1
Food	4	3.1
Short-term assistance	13	9.9
Moral support	67	51.1
None of the above	53	40.5

Table 42 Awareness of living in a flood-risk zone

	Number of respondents	% of total households
Very much aware	20	16.0
Slightly aware	81	64.8
Not aware	24	19.2
Total	125	100

Table 43 Awareness of flood increase in recent years

	Number of respondents	% of total households
Very much aware	20	15.9
Slightly aware	79	62.7
Not aware	27	21.4
Total	126	100

Table 44 Flood warning sources

	Number of respondents	% of total households
Radio	102	77.9
TV	70	53.4
Neighbours	97	74.0
Passers by	14	10.7
Mobile	32	24.4
Internet	11	8.4

Table 45 Households' opinion on warning

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Warning was delivered in time to act	126	96.2	1.6	34.1	54.0	10.3	0	100
Warning issued are fully understood	126	96.2	3.2	61.1	34.9	0.8	0	100
Warning issued are not understood	125	95.4	0	0.8	12.0	32.8	54.4	100
Flood warning should be improved	125	95.4	43.2	46.4	9.6	0.8	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table: 46 Household's opinion on Government action on flood mitigation

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Emergency services must be improved	125	95.4	44.0	46.4	9.6	0	0	100
Other measures besides flood warning	125	95.4	44.8	45.6	9.6	0	0	100
Structural measures should be improved	125	95.4	46.4	44.0	9.6	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 47 Households' opinion on Government's future investment on flood awareness programme

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
In school programme	126	96.2	40.5	46.0	13.5	0	0	100
In community centres	126	96.2	43.7	43.7	12.7	0	0	100
In youth clubs	126	96.2	42.1	45.2	12.7	0	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 48 Households' opinion on differences in Government support to flood affected areas

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
During flood event	126	96.2	4.0	15.9	66.7	13.5	0	100
After flood event	126	96.2	2.4	16.7	67.5	13.5	0	100
In relief and emergency services	126	96.2	2.4	16.7	67.5	13.5	0	100
In building flood defences	126	96.2	2.4	15.9	68.3	13.5	0	100
In helping to improve quality of life	126	96.2	2.4	15.9	68.3	13.5	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 49 Households' opinion on differences in NGO's support to flood affected areas

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
After flood event	126	96.2	2.4	10.3	66.7	19.8	0.8	100
In relief and emergency services	126	96.2	2.4	9.5	65.9	21.4	0.8	100
In building flood defences	126	96.2	2.4	9.5	65.9	21.4	0.8	100
In helping to improve quality of life	126	96.2	2.4	9.5	65.9	21.4	0.8	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 50 Participation in environmental decision-making (EDM)

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Feeling of being 'left out' in decision-making	126	96.2	0	4.8	15.1	74.6	5.6	100
Government allows community to participate in EDM	126	96.2	0	2.4	21.4	74.6	1.6	100
Government should allow community to participate in EDM	126	96.2	0	59.5	37.3	3.2	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

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Table 51 Type of flood

Origin of flood	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Cyclone	208	96.3	4.3	40.9	11.1	42.8	1.0	100
Heavy rain	209	96.8	9.1	55.0	5.3	29.7	1.0	100
Storm surge	82	38.0	0	6.1	4.9	18.3	70.7	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 52 Water level reached

	n	n as % of total households	Agreement scale in percentage				
			Above feet	Up to ankle	Up to knee	Above knee	Total
House	216	100	55.6	22.7	17.6	4.2	100
Garden	130	60.2	66.2	25.4	7.7	0.8	100
Neighbourhood	126	58.3	56.3	31.0	9.5	3.2	100

n= Number of respondents

Table 53 Tangible impacts on household belongings

Damage done to personal effects	Walls	Roof	Floor	Furniture	Mattress	Clothing	Utensils	Electric Appliances
Number of respondents	49	54	31	43	44	28	20	14
Percentage of responses	22.7	25.0	14.4	19.9	20.4	13.0	9.3	6.4

Table 54 Impact of flood on utilities and schools

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Power not interrupted	88	40.7	6.8	79.5	10.2	3.4	0	100
Water supply interrupted temporarily	70	32.4	40.0	52.9	5.7	0	1.4	100
Water supply muddy	10	4.6	60.0	20.0	10.0	0	10.0	100
Telecoms interrupted temporarily	66	30.6	18.2	40.9	37.9	1.5	1.5	100
Road affected	53	24.5	66.0	30.2	3.8	0	0	100
Transport affected temporarily	36	16.7	27.8	36.1	30.6	2.8	2.8	100
School interrupted temporarily	111	51.4	4.5	9.9	73.0	8.1	4.5	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 55 Intangible impact on family

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Upset about damage	213	98.6	17.4	40.8	16.9	21.6	3.3	100
Family disrupted	212	98.1	2.4	10.4	27.4	50.9	9.0	100
Children missed school	210	97.2	6.7	28.6	33.0	20.5	5.2	100
Loss of sentimental items	208	96.3	0.5	2.4	29.8	55.8	11.5	100
Respondent suffer from non-payment of wages	211	97.7	1.4	9.0	29.9	46.4	13.3	100
Family members suffer from non-payment of wages	210	97.2	0.5	8.1	26.2	52.9	12.4	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 56 Lasting tangible impact on house and personal effects

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Not getting house to normal	212	98.1	3.8	8.5	13.2	41.0	33.5	100
Personal effects could not be replaced	207	95.8	5.3	13.5	14.5	34.3	32.4	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 57 Type of house

	Number of Respondents	% of total households
Wholly concrete	144	66.7
Partly concrete and tin	38	17.6
Tin shed	33	15.3
Others	1	0.5
Total	216	100

Table 58 Perception of household on living conditions

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Living in crowded conditions	188	87.0	9.0	14.4	18.6	29.8	28.2	100
Large number of unemployment	195	90.3	3.6	14.4	39.0	20.0	23.1	100
Neighbourhood with drug addicts	193	89.4	3.6	8.3	41.5	21.2	25.4	100
Garbage not collected regularly	205	94.9	3.4	5.4	30.7	24.9	35.6	100
Mosquitoes and pest-infested area	208	96.3	8.2	6.3	2.9	47.6	35.1	100
Lack of community cohesion	208	96.3	30.8	29.8	10.1	15.4	13.9	100
No shopping amenities	142	65.7	13.4	28.2	11.3	31.7	15.5	100
Lack of support from local authorities	215	99.5	27.0	21.4	30.7	11.6	9.3	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 59 Perception on living conditions of family since last flood event

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Improved significantly	32	15.4	11.9	11.9	73.8	0	2.4	100
Improved slightly	40	19.2	30.2	58.1	11.6	0	0	100
Remained unchanged	108	51.9	44.9	40.7	13.6	0	0.8	100
Deteriorated somewhat	20	9.6	45.0	35.0	15.0	0	5.0	100
Deteriorated significantly	8	4	25.0	25.0	35.5	0	12.5	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 60 Household receives external support after flood

	Number of Respondents	% of total households
Receives support from relatives	103	47.7
Receives support from own community	30	13.9
Receives support from local charity	2	0.9
Receives support from social organisations	6	2.8
Receives support from Government	15	6.9

Table 61 Forms of long-term assistance received after flood

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Building materials	204	94.4	0.5	0	64.7	29.9	4.9	100
Financial grants	171	79.2	5.3	0	54.4	33.9	6.4	100
Soft loans	167	67.3	0.6	1.2	55.7	35.9	6.6	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 62 Perception of household on relocation

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Relocation to a Government Centre	199	92.1	0.5	0	72.9	23.1	2.5	100
Relocation to relatives' place	169	78.2	4.1	5.3	59.8	27.2	3.6	100
Relocation to other sites	157	72.7	0.6	1.3	63.7	31.2	3.2	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 63 Adapting to every flood event

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Raising floor above water mark	116	53.7	47.4	11.2	40.5	0	0.9	100
Build higher floorings	91	42.1	56.0	24.2	17.6	0	2.2	100
Accept things as they are	65	30.1	46.2	24.6	26.2	0	3.1	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 64 Reliance for protection from floods

	Number of Respondents	% of total households
On myself	195	90.3
On my family	59	27.3
On relatives	21	9.7
On neighbours	19	8.8
On own community	4	1.9
On charity organisations	2	0.9
On local authorities	2	0.9
On Government authorities	5	2.5

Table 65 Participation in helping others after flood event

	Number of Respondents	% of total households
Helping neighbours	134	61.6
Clearing debris	75	34.7
Liaise with local authorities	5	2.3
None of the above	62	28.7

Table 66 Awareness of flood increase in recent years

	Number of Respondents	% of total households
Very much aware	56	26.0
Slightly aware	80	37.2
Not aware	78	36.3
Do not know	1	0.5

Table 67 Perceived reasons for flood increase in the region

	Number of Respondents	% of total households
Overcrowding	18	8.3
Insufficient drainage	82	38.0
Clogged ditches	20	9.3
Clogged streams	85	39.4
Clogged rivers	28	13.0
Too many building	38	17.6
Climate change	109	50.5
Deforestation	27	12.5
Low priority given to inhabitants	1	0.5

Table 68 Households' opinion on warning

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Warning was delivered in time to act	214	99.1	5.6	55.6	32.7	6.1	0	100
Warning issued are fully understood	214	99.1	35.0	51.4	11.7	0.9	0.9	100
Warning issued are not understood	213	98.6	1.4	2.8	9.4	34.3	52.1	100
Flood warning should be improved	215	99.5	35.3	26.0	20.0	17.2	1.4	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 69 Households' opinion on Government action on flood mitigation

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
Emergency services must be improved	214	99.1	43.0	31.8	20.2	5.1	0	100
Other measures should be taken besides flood warning	212	98.1	24.1	14.8	29.2	1.9	0	100
Structural measures in flood prevention should be improved	210	97.2	28.6	42.9	26.7	1.9	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 70 Household opinion on Government's investment on flood awareness programme

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
In school programme	199	92.1	84.4	11.6	2.0	1.5	0.5	100
In community centres	149	69.0	73.8	18.1	5.4	2.7	0	100
In youth clubs	175	81.0	80.0	10.3	6.9	2.9	0	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 71 Households' opinion on differences in Government support

	n	n as % of total households	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
During flood event	187	86.6	25.7	16.0	41.2	11.8	5.3	100
After flood event	176	81.5	26.7	17.0	38.6	9.1	8.5	100
In relief and emergency services	154	71.3	16.2	14.3	49.4	9.7	10.4	100
In building flood defences	150	69.4	13.3	16.0	48.0	10.0	12.7	100
In helping to improve quality of life	160	74.1	21.9	14.4	43.1	9.4	11.3	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 72 Households' opinion on differences in NGO's support

	n	% of Responses	Agreement scale in percentage					
			SA	A	Nt.	D	SD	Total
After flood event	206	95.4	24.8	6.3	61.7	3.4	3.9	100
In relief and emergency services	148	68.5	6.8	8.1	75.0	4.7	5.4	100
In building flood defences	156	72.2	14.1	7.1	69.9	4.5	4.5	100
In helping to improve quality of life	146	67.6	6.2	10.3	69.2	5.5	8.9	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Table 73 Households' perception on community participation in risk management

	n	n as % of total households	Agreement scale in percentage					Total
			SA	A	Nt.	D	SD	
Feeling of being 'left out' in decision-making	213	98.6	31.9	16.4	17.8	14.1	19.7	100
Government allows community to participate in EDM	216	100	1.4	6.5	52.3	15.7	24.1	100
Government should allow community to participate in EDM	215	99.5	6.0	20.9	58.6	10.7	3.7	100

n= Number of respondents; SA=strongly agree; A=agree; Nt. =neutral; D=disagree; SD=strongly disagree

Appendix 13

Appendix 13 Outline of procedure for the use of chi-square test for independence to obtain possible relationships between dependent and independent variables

The procedure used to test the relationship between dependent variables (response to questions) and the explanatory variables, significant at $p < 0.05$ levels, is described below. In view of the large volume of data collected, analyses for relationship between the variables were carried out using chi-square tests on SPSS (Pallant, 2010; Bryman and Cramer, 2009) for all 5 independent and 220 dependent variables.

(a) *Types of variables obtained from questionnaire survey*

Several statistical tests are available to determine whether there is a significant difference between two or more groups of variables. In the questionnaire, the data collected were nearly all *categorical* or *nominal* and *ordinal*. Only one *dichotomous* (*yes or no*) variable related to their interest in participating in focus group interview was obtained.

From the definitions of Bryman and Cramer (2009, p.367), *nominal* variables are those that have two or more classes but which do not have an intrinsic order such as gender and marital status. *Dichotomous* variables are nominal variables which have only two groups or levels such as *yes* or *no*. *Ordinal* variables are those that have two or more types but these types can also be ordered or ranked as in the case of the number of members per household or as the five point Likert scale - *Strongly agree, agree, neutral, disagree and strongly disagree*. Of the 233 variables collected from each respondents, 107 were nominal, 1 dichotomous and 125 were Likert-type. Of the 125 ordinal variables, 13 were used either as independent variables or were not used at all in the chi-square analysis. Hence the number of dependent variables used in the analysis was 220 (107+1+112).

(b) *Non-parametric test*

Of the two test types, namely, *parametric* and *non-parametric*, the former test assumes normal distribution, homogeneous and ratio or interval data sets. In the study, no specific distribution was assumed and there were no restrictions on the homogeneity of the data and on data-set relationship. Moreover, the households surveyed were

considered *independent*. In view of the above considerations, the non-parametric *Pearson chi-square test of independence* seemed most suitable. It was also simpler and was less affected by extreme values. However, the data sets had to obey certain conditions for the applicability of the test.

(c) Assumptions for the use of chi-square test for independence

The following assumptions (Yates et al., 1999) are used in the chi-square test for independence:

- (i) For more than one degree of freedom, expected frequency is ≥ 1 or 20 per cent of the frequencies are < 5 .
- (ii) Simple random sampling has been used, that is all possible samples of a given number of objects are equally likely to occur. Each observation is independent of all others. It allows the use of statistical methods to analyse sample results.
- (iii) Data are categorical with no restriction on distribution, homogeneity and on data-set relationship.

In the case of the data set from the questionnaire, conditions (i) and (ii) were applied in each case. Yates et al. (1999) required condition (iii) to apply for chi-square test of independence. However, Walliman (2006; p 58) and Bryman and Cramer (2009; p. 226) recommended that cross tabulation and chi-square could be used for testing categorical and ordinal data sets. On the basis of the recommendations, as the independent variables and 107 of the dependent variables were categorical and 112 were ordinal, Pearson's chi-square test of independence had been applied to the whole set of data from the survey.

(d) An example of the Outcome of results using software

The case of '*Warning was delivered in time to act*' for small and large households Tables 1 and 2 were obtained from SPSS, a statistical software package which was used to calculate Pearson's χ^2 statistic and p-value < 0.05 level in order to examine possible association between the size of households (*independent variable*) and '*Warning was delivered in time to act*' (*dependent variable*). Mathematics are in the calculation of (a) χ^2 statistic, and (b) p-value < 0.05 level. In view of the large number of variables, the

package provided an efficient way of calculating the statistics which was otherwise quite elaborate.

The significant results from Tables 1 and 2 are summarised in Table 3. The dependent variable is given in first column while Pearson's χ^2 value, degrees of freedom (df) and p-value < 0.05 level drawn from Table 2 are given in the succeeding three columns. These are the Pearson chi-square value of 9.521 and df=3 and p-value = 0.023 (<0.05). From the footnote, it was observed that the χ^2 statistic was valid since only 12.5 % of the cells had expected count less than 5. The other statistics from Table 2 were not used in the analysis.

Table 1 Contingency table showing the Outcome of SPSS (Ver. 19) Programme for χ^2 statistic for possible relationship between 'Warning was delivered in time to act' as a function of household size at CLC; No response was obtained for 'Strongly disagree'.

Crosstab							
			Warning was delivered in time to act				Total
			strongly agree	agree	neutral	disagree	
No of members in household	household members less or equal to 4	Count	4	38	11	13	66
		Expected Count	2.0	31.3	11.3	21.4	66.0
		% within no of members in household	6.1%	57.6%	16.7%	19.7%	100.0%
		% within Warning was delivered in time to act	57.1%	34.2%	27.5%	17.1%	28.2%
	household members more than 4	Count	3	73	29	63	168
		Expected Count	5.0	79.7	28.7	54.6	168.0
		% within no of members in household	1.8%	43.5%	17.3%	37.5%	100.0%
		% within Warning was delivered in time to act	42.9%	65.8%	72.5%	82.9%	71.8%
Total		Count	7	111	40	76	234
		Expected Count	7.0	111.0	40.0	76.0	234.0
		% within no of members in household	3.0%	47.4%	17.1%	32.5%	100.0%
		% within Warning was delivered in time to act	100.0%	100.0%	100.0%	100.0%	100.0%

From Table 1, the actual count, the expected count, and the '*% within Warning was delivered in time to act*' were not reproduced in Table 3 .The primary information

extracted related to the percentage within each of the household sizes (small or large) that were grouped under each Likert-scale.

Table 2 Chi-square test values for the case given in Table 1, above

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.521	3	0.023
Likelihood Ratio	9.590	3	0.022
Linear-by-Linear Association	8.835	3	0.003
N of Valid Cases	234		

a 1 cells (12.5%) have expected count less than 5. The minimum expected count is 1.97

Percentage was preferred to actual figures so as to facilitate comparison among the large number of variables as the number of respondents varied from question to question and from one locality to another.

These figures enabled the comparison of how each group reacted to questions such as ‘*whether warnings were delivered in time to act*’. Furthermore, the “% within number of members” in small households for ‘strongly agree (6.1%)’ and ‘agree (57.6%)’ were combined to give ‘agree* (63.7%)’. This last figure was entered in Table 3. Similarly, the “% within number of members” in small households for ‘disagree (19.7%)’ and ‘strongly disagree (0%)’, in this case, were combined to give ‘disagree* (19.7%)’. Likewise, the corresponding figures in the case of “% within number of members” in large households were entered in Table 3.

Table 3 Summary of statistics that define the relationship between household groups and dependent variables

Dependent or Response variables	Chi-Square Test Results			Summary statistics in %			
	χ^2	df	p-value	Agree*	Dis-Agree*	Agree*	Dis-Agree*
Household size				Household \leq 4		Household $>$ 4	
CLC							
Warnings were delivered in time to act	9.521	3	0.023	63.7	19.7	45.3	37.5

This approach of grouping into ‘agree*’ and ‘disagree*’ was adopted to make the data for the large number of variables more manageable and make interpretation easier without losing the essential aspect of the responses for each variable. The Tables of all the variables obtained by using the package were not reproduced as they are too

voluminous. The unwieldy data should necessarily be condensed in a few manageable groups and tables for analysis (Kothari, 2006).

The percentage of neutral responses was excluded from the tables on the assumption that respondents were unclear about the question, uncertain what to respond or decided not to respond for various reasons. They could be taken to be '*Don't know responses*' or non-response '*that do not contribute or add to the measurement of the target attitude*' (Lam, et al., 2010). However, while the figures for the neutral cases were not entered explicitly, these could be deduced for each group by subtracting from 100% the sum of '*agree**' and '*disagree**'. These would be discussed briefly when the neutral cases appear significant.

Appendix 14

Appendix 14 – p-values from χ^2 -test for various household characteristics against dependent variables

	SPSS variable name	Indicators of Resilience	Coding instruction	Household size			Education level			Income level			Household with young children			Household with with 60+ age group		
				CLC	LH	GB	CLC	LH	GB	CLC	LH	GB	CLC	LH	GB	CLC	LH	GB
1	id		No. assigned to each household survey															
2	num		1=no. of household members				0.010	0.937	0.219	0.226	0.371	0.331						
3	agegrp1		Members age group 1=less than 3years			0.241			0.737			0.870						
4	agrgrp2		2=3yrs-14yrs			0.000			0.148			0.624						
5	agegrp3		3=15-22yrs			0.001			0.926			0.929						
6	agegrp4		4=23-40yrs			0.001			0.234			0.735						
7	agegrp5		5=41-60 yrs			0.003			0.097			0.129						
8	agegrp6		6=above 60yrs			0.549			0.684			0.731						
9	chldschool		1=no of children attending school	0.221	0.102		0.522	0.267	0.525	0.280	0.166	0.414						
10	educlevel		Education level of household:.	0.063	0.076	0.403		0.000	0.000	0.227	0.321	0.054						
87	damp1		Living scale in damp conditions for a short while	0.814	0.691	0.840	0.455	0.282	0.017	0.323	0.059	0.390	0.648	0.373	0.255	0.806	0.616	0.371
88	damp2		Living in damp conditions for aday:	0.700	0.172	0.935	0.424	-	0.325	0.510	0.303	0.935	0.497	0.862	0.289	0.559	0.341	0.394
89	damp3		Living in damp conditions for many days:	0.173	0.306	0.851	0.647	0.155	0.470	0.211	0.365	0.852	0.038	0.207	0.292	0.311	0.224	0.000
90	damp4		Not at all:	0.576	0.046	0.696	0.564	-	0.417	0.506	0.505	0.475	0.052	0.248	0.701	0.665	0.248	0.141
112	hserecov		Getting house to normal:	0.725	0.221	0.221	0.224	0.583	0.330	0.001	0.775	0.604	0.163	0.325	0.598	0.070	0.143	0.113
113	gardrev		Getting garden to normal:	0.719	0.725	0.279	0.048	0.549	0.539	0.000	0.354	0.953	0.665	0.356	0.008	0.072	0.118	0.648

155	rely1		Rely on myself:	0.599	0.843	0.854	0.276	0.560	0.242	0.847	0.971	0.318	0.410	0.933	0.478	0.406	0.217	0.097
156	rely2		Rely on my family:	0.291	0.770	0.211	0.106	0.575	0.281	0.794	0.954	0.466	0.440	0.909	0.451	0.465	0.233	0.005
157	rely3		Rely on my relatives:	0.482	0.571	0.026	0.424	0.495	0.039	0.806	0.858	0.591	0.172	-	0.181	0.731	0.257	0.004
158	rely4		Rely on my neighbours:	0.627	-	0.092	0.700	-	0.164	0.526	--	0.912	0.680	-	0.114	0.108	-	0.239
159	rely5		Rely on charity organizations:	0.226	-	0.346	0.566	-	0.693	1.000	-	0.171	0.426	-	0.735	0.789	-	0.064
160	rely6		Rely on local organizations:	0.784	-	0.351	0.143	-	0.677	0.636	-	0.827	0.831	-	0.659	0.556	-	0.333
161	rely7		Rely on government authorities:	0.584	-	0.391	0.019	-	0.055	0.278	-	0.044	0.745	0.025	0.836	0.460	0.361	0.569
166	reponslty1		Taking responsibility to avoid harm to family:	0.777	0.469	0.602	0.042	0.971	0.437	0.404	0.701	0.584	0.688	0.552	0.412	0.490	0.825	0.251
167	reponslty2		Taking responsibility to protect my house:	0.777	0.508	0.360	0.042	0.557	0.416	0.404	0.864	0.937	0.688	0.611	0.233	0.679	0.995	0.175
168	reponslty3		Taking responsibility to avoid damage to belongings:	0.793	0.649	0.688	0.046	0.557	0.603	0.389	1.000	0.854	0.680	0.867	0.178	-	0.746	0.195
169	cop1		Coping mechanism before each flood event: removing possessions from ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
170	cop2		2:evacuate to safe grounds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
171	cop3		3:placing flood guards at doorsteps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
172	cop4		4=making furrows to divert water	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
173	cop5		5= move to refugee centre	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
174	cop6		6=move to relative's	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
175	cop7		7=move to neighbour's	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
176	cop8		8=stockpile food	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
177	cop9		9=move animals to safer grounds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
178	cop10		10=none of above	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
192	awareliv		Awareness of living in a flood zone:	0.673	0.847	0.902	0.365	0.694	0.053	0.288	0.045	0.808	0.261	0.755	0.428	0.802	0.906	-
193	awincr fld		Awareness of increase in flood events	0.724	0.892	0.943	0.272	0.565	0.048	0.187	0.024	0.508	0.228	0.621	0.424	0.628	0.786	0.393
203	warnscs1		Flood warning sources:1=radio	0.559	-	-	-	-	-	0.351	-	-	0.565	-	-	0.547	-	-
204	warnscs2		2=TV	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
205	warnscs3		3=from neighbours	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

206	warnscs4		4=passers-by	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
207	warnscs5		5=mobile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
208	warnscs6		6=internet	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
209	listwarng		Frequency of listening to flood warnings:	0.899	0.158	0.519	0.453	0.160	0.081	0.136	0.017	0.338	0.264	0.182	0.448	0.208	0.323	0.718
210	warndel		Warning was delivered in time to act.	0.023	0.690	0.217	0.032	0.552	0.689	0.002	0.583	0.960	0.214	0.942	0.463	0.291	0.030	0.987
211	warnunder		Warning is fully understood:	0.502	0.030	0.387	0.038	0.185	0.193	0.001	0.149	0.403	0.463	0.147	0.930	0.706	0.003	0.096
212	warnotund		Warning is not understood at all:	0.237	0.763	0.629	0.571	0.657	0.047	0.616	0.176	0.591	0.326	0.177	0.916	0.041	0.895	0.181
213	warnimprv		Opinion on improving flood warning:	0.307	0.645	0.942	0.108	0.235	0.926	0.00	0.543	0.568	0.691	0.412	0.980	0.395	0.286	0.726
11	hseown		House ownership	0.290	0.928	0.004	0.055	0.134	0.078	0.005	0.491	0.254						
12	ocception		Occupation of respondent:	0.090	0.426	0.673	0.446	0.820	-	0.00	0.00	0.00						
13	ethnicgp		Ethnic group of respondent:															
14	floodexp1		Respondent's agreement to experience flood hazards in the past 3 years	0.959	0.916	0.801	0.179	0.226	0.712	0.004	0.456	0.519	0.196	0.242	0.259	0.846	0.540	0.440
15	floodexp2		Flood hazard experienced after a cyclone	0.2	0.958	0.637	0.347	0.356	0.411	0.002	0.970	0.392	0.279	0.387	0.664	0.862	0.289	0.828
16	floodexp3		Flood hazard experienced after heavy rains:	0.916	0.751	0.528	0.282	0.590	0.772	0.003	0.662	0.295	0.316	0.929	0.284	0.825	0.285	0.530
17	floodexp4		Flood hazard experienced after a storm surge	0.822	0.892	0.816	0.372	0.076	0.481	0.001	0.468	0.287	0.297	0.629	0.898	0.748	0.236	0.930
18	floodexp5		Experience of more than one flood for the last 3 years	0.973	0.591	0.175	0.197	0.787	0.068	0.003	0.791	0.062	0.446	0.128	0.307	0.668	0.041	0.073
19	floodexp6		Flood hazards experienced every year in the last 3 years:	0.975	0.877	0.020	0.132	0.601	0.994	0.005	0.653	0.249	0.400	0.299	0.076	0.586	0.045	0.794
20	impact1		House was inundated:	0.558	0.011	0.016	0.797	0.960	0.551	0.041	1.000	0.388	0.937	0.092	0.266	0.707	0.678	0.354
21	Impact2		Personal effects were damaged:	0.297	0.003	0.128	0.485	0.933	0.383	0.262	-	0.575	0.669	0.199	0.180	0.398	0.397	0.798
22	Impact3		Garden was flooded:	0.643	0.856	0.059	0.531	0.370	0.475	0.006	0.804	0.164	0.858	0.124	0.136	0.355	0.513	0.634
23	Impact4		Neighbourhood was flooded:	6	0.045	0.178	0.513	0.204	0.606	0.195	0.435	0.491	0.798	0.124	0.020	0.452	0.812	0.941
24	hseinund		Flood water reached:	5	0.457	0.011	0.203	0.038	0.495	0.00	0.637	-	0.230	0.539	0.020	0.078	0.637	0.614

25	tngimp1		1 = Damage done to the house walls.	-	-	-	-	-	-	-	-	-	-	-	-	0.386	-	
26	tngimp2		2 = Damage done to roof	-	0.083	-	-	-	-	0.386	-	-	-	-	-	0.485	-	
27	tngimp3		3 = Damage done to floor	4	0.146	-	-	0.460	-	0.273	0.485	-	-	-	0.515	-	-	
28	dmgbelong1		Damage done to buildings: 1=Furniture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
29	dmgbelong2		2=mattress	5	-	-	0.390	-	-	0.194	-	-	0.049	-	-	0.773	-	
30	dmgbelong3		3=clothes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
31	dmgbelong4		4=utensils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
32	dmgbelong5		5=electrical appliances	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
38	gdenfld		Water came up:	0.768	0.872	0.200	0.069	-	0.424	-	-	0.845	0.931	0.350	0.013	0.332	0.799	0.027
39	dmggar1		Damage done to garden; 1=fruit trees	-	-	-	-	0.217	-	-	0.704	-	-	-	-	-	-	
40	dmggar2		2=hedge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
41	dmggar3		3=vegetable patch.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
42	dmggar4		4=flower and ornamentals	0.391	-	-	0.312	-	-	0.887	-	-	0.330	-	-	0.409	0.245	-
64	lastang1		House has not been able to get to normal since last flood :	0.892	0.117	0.662	0.245	0.413	0.279	0.00	0.313	0.199	0.990	0.297	0.879	0.044	0.464	0.626
65	lastang2		Personal effects were lost and could not be replaced:	0.647	0.061	0.203	0.300	0.411	0.653	-	0.201	0.385	0.847	0.375	0.573	0.043	0.703	0.372
66	getnorm1		1=lack of financial resources	0.391	-	0.495	0.251	-	0.090	0.640	-	0.398	0.295	-	0.504	0.668	-	0.914
67	getnorm2		2=lack of building materials	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
68	getnorm3		3=No insurance coverage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
69	getnorm4		4=accumulated debt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
70	getnorm5		5=chronic illness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
71	getnorm6		6=others	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
91	affect1		Living in crowded conditions: 1=strongly agree	0.460	0.219	0.775	0.145	0.720	0.304	0.020	0.555	0.832	0.023	0.372	0.158	0.901	0.656	0.828
92	affect2		Large number of unemployed	0.615	0.559	0.603	0.659	0.396	0.860	0.00	0.826	0.836	0.541	0.654	0.340	0.737	0.759	0.966
93	affect3		Drug addicted neighbourhood	0.559	0.186	0.772	0.627	0.759	0.102	0.235	0.223	0.464	0.782	0.240	0.170	0.376	0.273	0.092
94	affect4		Disrupted family structures:	0.658	0.991	-	0.643	0.491	-	0.182	0.677	-	0.593	-	-	0.534	0.658	-
95	affect5		Garbage strewn neighbourhood:	0.998	0.146	0.233	0.255	0.063	0.715	0.068	0.072	0.277	0.736	0.649	0.301	0.154	0.536	0.688

96	affect6		Mosquitoes infested area:	0.828	0.827	0.060	0.003	0.834	0.498	0.00	0.410	0.393	0.648	0.604	0.081	0.345	0.258	0.875
97	affect7		Lack of community cohesion:	0.309	0.654	0.778	0.041	0.544	0.004	0.00	0.658	0.273	0.295	0.025	0.312	0.559	0.100	0.404
98	affect8		Isolation from a community centre:	0.482	0.794	0.980	0.454	0.242	0.737	0.196	0.531	0.623	0.192	0.742	0.201	0.391	0.064	0.754
99	affect9		No health centre:	0.538	0.537	0.974	0.681	0.371	0.356	0.149	0.314	0.758	0.033	0.090	0.473	0.775	0.268	0.338
100	affect10		No youth centre:	0.709	0.896	0.801	0.476	0.689	0.796	0.001	0.511	0.939	0.796	0.384	0.100	0.101	0.437	0.949
101	affect11		No shopping amenities:	0.884	0.974	0.572	0.043	0.273	0.623	0.005	0.252	0.985	0.929	0.578	0.114	0.060	0.732	0.953
102	affect12		Lack of support from local authorities:	0.799	0.724	0.231	0.041	0.537	0.778	0.003	0.452	0.041	0.274	0.642	0.916	0.002	0.464	0.005
103	hsefabric		House is made of:	0.905	0.445	0.672	0.006	0.666	0.023	0.001	0.363	0.375	0.664	0.036	0.516	0.200	0.864	0.737
104	hsetype		Type of house:	0.313	0.274	0.109	0.375	0.203	0.412	0.487	0.435	0.933	0.922	0.426	0.527	0.763	0.142	0.265
105	hseowship		House ownership:	0.896	0.584	0.114	0.113	0.054	0.230	0.00	0.212	0.022	0.827	0.099	0.247	0.335	0.083	0.287
106	lndownship		Land occupation:	0.450	0.705	0.490	0.041	0.042	0.089	0.003	0.442	0.097	0.573	0.180	0.556	0.224	0.077	0.675
194	reasfldincr1		Reasons for flood increase in the region	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
195	reasfldincr2		2=insufficient drainage	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
196	reasfldincr3		3=clogged ditches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
197	reasfldincr4		4=clogged streams	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
198	reasfldincr5		5= clogged rivers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
199	reasfldincr6		6=too many buildings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
200	reasfldincr7		7=climate change	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
201	reasfldincr8		8= deforestation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
202	reasfldincr9		9=low priority given from local authorities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	anifect1		Animals affected: 1=cow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	anifect2		2=goats	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35	anifect3		3=poultry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	anifect4		4=dogs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37	anifect5		5=cats	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43	neighund		Neighbourhood inundated:	4	0.703	0.000	0.704	0.505	0.240	0.001	0.637	0.045	0.561	0.010	0.000	0.003	-	0.195
44	power1		Power supply not interrupted:	2	0.871	0.665	0.258	0.945	0.964	0.629	0.125	0.493	0.687	-	0.609	0.186	0.346	0.776

46	water1		Water supply not interrupted:	0.131	0.688	0.745	0.533	0.737	0.821	0.464	0.119	0.489	-	-	0.617	-	0.168	0.592
47	water2		Water supply interrupted temporarily:	0.894	0.273	0.009	0.684	-	0.055	0.028	0.190	0.101	0.929	0.307	0.094	0.209	0.640	0.108
48	water3		Water supply was muddy:	-	-	0.140	-	-	0.217	-	-	0.198	-	-	0.261	-	-	0.414
49	telecom1		Telecommunication was not interrupted:	0.076	0.732	0.423	0.068	0.705	0.100	0.432	0.024	0.867	0.806	0.354	0.830	0.455	0.117	0.120
50	telecom2		Telecommunication was interrupted temporarily:	-	-	0.976	-	-	0.494	-	-	0.889	-	-	0.167	-	-	0.082
51	roadprac1		Road was not affected:	0.768	0.764	0.907	0.360	0.868	0.466	0.153	0.036	0.789	0.028	0.797	0.895	0.344	0.137	0.807
52	roadprac2		Road was affected:	0.433	-	0.262	0.810	-	0.763	0.961	-	0.126	0.240	-	0.593	0.146	-	0.025
53	transpt1		Transport not interrupted:	0.509	0.434	0.573	0.070	0.759	0.134	0.637	0.058	0.549	0.263	0.614	0.597	0.018	0.331	0.247
54	transpt2		Transport interrupted temporarily:	0.104	-	0.692	-	-	0.805	0.255	-	0.509	0.145	-	0.670	0.436	0.072	0.228
55	school1		School interrupted temporarily;	-	0.492	0.001	-	0.554	0.635	-	0.121	0.427	-	0.458	0.006	-	0.558	0.067
56	school2		School interrupted for 1 day:	-	1.000	0.024	-	0.850	0.128	-	0.556	0.489	-	1.000	0.124	-	-	0.014
57	school3		School interrupted for 1 day	-	-	0.384	-	-	0.852	-	-	0.610	-	-	0.000	-	-	0.384
81	expo1		Living in a flood prone area:	0.540	-	-	-	-	-	0.271	-	-	0.565	-	-	0.545	-	-
82	expo2		2=coastal wetland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
83	expo3		3=on a river bank	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
84	expo4		4=down a mountain slope	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
85	expo5		5=close to a stream	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
86	hsesitu		House situation;	-	0.405	0.870	-	-	0.485	-	0.491	0.027	-	0.139	0.058	-	0.527	0.133
162	adapt1		Raising floor above watermark:	0.550	0.639	0.815	0.476	0.898	0.445	0.238	0.369	0.116	0.256	0.807	0.298	0.684	0.197	0.503
163	adapt2		I build higher flooring	0.604	0.134	0.708	0.933	0.829	0.747	0.097	0.371	0.333	0.712	0.562	0.565	0.951	0.521	0.341
164	adapt3		Accepting things as they are:	0.273	0.919	0.379	-	0.347	0.746	0.439	0.962	0.842	0.273	0.519	0.448	0.439	0.440	0.367
165	adapt4		Live through the event:	0.448	0.747	-	0.621	-	-	0.101	0.197	-	0.551	0.490	-	0.551	0.197	-
58	intan1		Respondent was upset about damage:	0.647	0.124	0.331	0.495	0.395	0.293	-	0.659	0.433	0.408	0.264	0.886	0.208	0.582	0.032
59	intan2		Family was disrupted:	0.949	0.669	0.290	0.077	0.427	0.045	0.002	0.793	0.984	0.427	0.113	0.163	0.063	0.403	0.906
60	intan3		Children missed school:	0.605	0.734	0.012	0.389	0.532	0.428	0.711	0.432	0.047	0.001	0.201	0.001	0.062	0.695	0.456
61	intan4		Loss of sentimental items :	0.709	0.296	0.168	0.069	0.308	0.399	0.003	0.105	0.422	0.484	0.182	0.386	0.402	0.752	0.740

62	intan5		Suffered from job pay:	0.800	0.545	0.818	0.075	-	0.334	0.00	0.306	0.748	0.030	0.036	0.825	0.029	0.479	0.368
63	intan6		Members of family suffered from job pay:	0.858	0.395	0.867	0.278	0.506	0.563	0.00	0.337	0.753	0.279	0.062	0.666	0.056	0.290	0.501
72	emotion1		Still suffer from recurrent flood event:	0.339	0.714	0.717	0.212	0.169	0.486	0.00	0.343	0.093	0.364	0.333	0.094	0.167	0.639	0.603
73	emotion2		Last effect and effort to come back to normal:	0.673	0.146	0.094	0.360	0.924	0.670	0.00	0.173	0.054	0.574	0.040	0.155	0.019	0.540	0.036
74	emotion3		Deteriorating mental health effect on the family:	0.368	0.234	0.207	0.510	-	0.415	0.084	0.036	0.363	0.334	0.033	0.971	0.338	0.358	0.023
75	emotion4		Deteriorating physical health effect on the family:	0.109	0.234	0.167	0.559	-	0.570	0.092	0.036	0.316	0.277	0.033	0.878	0.000	0.358	0.238
76	worry1		Worry about my livelihood:	0.808	0.766	0.556	0.575	0.124	0.766	0.057	0.544	0.033	0.464	0.204	0.319	0.266	0.499	0.895
77	worry2		Worry about my family quality of life:	0.398	0.800	0.481	0.659	0.180	0.491	0.087	0.809	0.047	0.234	0.093	0.405	0.050	0.136	0.855
78	worry3		Worry about the future of my children:	0.390	0.696	0.495	0.422	0.141	0.304	0.760	-	0.346	0.102	0.279	0.122	0.036	0.465	0.863
79	worry4		Worry about impact on my property:	0.700	0.681	0.678	0.347	0.060	0.688	0.087	-	0.559	0.287	0.543	0.464	0.134	0.534	0.947
80	worry5		Worry about increase of vector disease after flood event	0.148	0.258	0.618	0.324	0.603	0.531	0.660	-	0.211	0.020	0.410	0.951	0.489	0.345	0.708
114	healthrev1		Family lasting health problems	-	0.361	-	0.099	-	-	-	0.687	-	-	0.050	-	-	0.223	-
115	healthrev2		2= psychological trauma.	-	-	-	0.104	-	-	-	-	-	-	-	-	-	0.084	-
116	improve1		Has improved significantly:	0.279	0.208	0.791	0.542	-	0.651	0.389	0.261	0.724	0.094	0.697	0.400	0.178	0.515	0.044
117	improve2		Improved slightly:	0.059	0.867	0.540	0.164	0.078	0.729	0.465	0.389	0.509	0.854	0.264	0.058	0.297	-	0.073
118	improve3		Remained unchanged:	0.808	-	0.215	-	-	0.952	0.141	-	0.296	0.693	-	0.050	0.093	-	0.276
119	improve4		Somewhat deteriorated:	0.286	-	0.267	0.033	-	0.740	0.038	-	0.088	0.833	-	0.106	0.073	-	0.105
120	improve5		Deteriorated significantly:	0.439	-	-	0.624	-	0.620	0.299	-	-	0.047	-	0.046	0.773	-	0.292
121	qual1		Improved significantly:	0.897	0.514	0.413	-	-	0.780	0.277	0.071	0.949	0.292	0.167	0.827	0.053	0.875	0.062
122	qual2		Remained largely unchanged:	0.547	1.000	0.040	-	0.061	0.924	0.042	0.248	0.160	0.718	0.248	0.257	0.035	1.000	0.467
123	qual3		Deteriorated significantly:	0.411	-	0.051	-	-	0.818	0.261	-	0.352	0.015	--	0.380	0.764	-	0.342
107	reasonliv1		Respondent living facilities.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
108	reasonliv2		2=Access to amenities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
109	reasonliv3		3=close to relatives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
110	reasonliv4		4=same community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

111	reasonliv5		5=own choice	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
124	selfprotect1		Reliance on oneself for protection from floods: 1= myself.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
125	selfprotect2		2=my family	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
126	selfprotect3		3=relatives	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
127	selfprotect4		4=neighbours	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
128	selfprotect5		5= own community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
129	selfprotect6		6=charity org	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
130	selfprotect7		7=local authorities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
131	selfprotect8		8= Gov authorities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
132	shortsupt1		Respondent receives short-term support from:Relatives	-	0.935	-	-	-	-	-	-	-	-	-	-	-	-	-
133	shortsupt2		2=own community	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
179	helpneigh1		Providing help to neighbour in flood event:1=shelter	0.559	0.368	-	0.420	-	-	0.368	0.562	-	0.513	-	-	0.513	-	-
180	helpneigh2		2=food	-	-	-	-	-	0.259	-	-	0.245	-	-	-	-	-	-
181	Helpneigh3		3=short-term assistance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
182	helpneigh4		4=moral support	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
183	helpneigh5		5=none	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
184	prtaftfld1		Participation in helping others after flood event: 1=helping neighbours	-	-	0.623	-	-	0.508	-	-	-	-	0.315	-	-	0.505	-
185	prtaftfld2		2=clearing debris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
186	prtaftfld3		3=liaising with local authorities and NGO's	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
187	prtaftfld4		4= none of the above	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
188	collab1		Collaboration with others to mitigate flood impact:1=Collaborate with neighbours	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
189	collab2		2=collaborate with local authorities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
190	collab3		3=collaborate with NGOs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
191	collab4		4= none of the above	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
230	comfeel		Community feeling of abandon at every flood hazard	0.836	0.099	0.587	0.169	0.312	0.718	0.014	0.526	0.562	0.433	0.295	0.352	0.021	0.761	0.558

231	comenv		Participation in environmental decision making:	0.390	0.573	0.416	0.523	0.208	0.680	0.087	0.741	0.009	0.007	0.261	0.773	0.969	0.239	0.947
232	comnoenv		No participation in environmental decision making:	0.764	0.221	0.375	0.282	0.433	0.797	0.031	0.087	0.641	0.663	0.384	0.873	0.429	0.616	0.902
233	grpintvw		Interest in focussed group interview															
134	shortsupt3		3=local charities	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
135	Shortsupt4		4= social organisations and NGOs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
136	shortsupt5		4=government	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
137	assist1		Forms of assistance received: 1=Money	-	-	-	-	-	0.512	-	-	0.231	-	-	0.231	-	-	0.231
138	assist2		2=food	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
139	assist3		3=clothes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
140	assist4		4=utensils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
141	assist5		5=mattresses	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
142	assist6		6=furniture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
143	assist7		7=housing material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
144	assist8		8=children school material	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
145	assist9		9=none	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
146	relocate1		Relocation to a government centre:	0.268	-	0.366	0.641	-	0.494	0.758	-	0.062	0.418	-	0.521	0.362	-	0.457
147	relocate2		Relocation to a relative's :	0.122	-	0.226	0.346	-	0.431	0.560	-	0.106	0.079	-	0.054	0.320	-	0.569
148	relocate3		Relocation to other places:	0.604	0.459	0.416	0.072	-	0.385	0.807	0.118	0.004	0.392	-	0.463	0.049	0.459	0.930
149	measure1		Provision of building material:	0.644	-	0.924	0.815	-	0.369	0.518	-	-	0.644	-	0.560	0.130	-	0.526
150	measure2		Provision of financial grants:	0.511	0.221	0.592	0.045	-	0.176	0.073	0.659	0.005	0.589	0.212	0.429	0.807	0.047	0.411
151	measure3		Provision of soft loans:	0.182	0.073	0.617	0.027	-	0.550	0.110	0.343	0.043	0.678	-	0.273	0.639	0.635	0.429
152	measure4		Insurance from hazard risk:	0.479	0.188	0.692	0.489	0.537	0.605	0.880	0.217	0.835	0.344	0.588	0.626	0.195	0.347	0.311
153	measure5		Assistance from government was enough:	0.699	0.522	0.054	0.182	0.686	0.549	0.873	0.837	0.736	0.109	0.047	0.796	0.494	0.707	0.023
154	measure6		Assistance from government was not enough:	0.998	0.308	0.266	0.482	0.168	0.622	0.008	0.733	0.716	0.614	0.369	0.443	0.854	0.640	0.334
214	emergimp		Emergency warning services should be improved:	0.488	0.463	0.273	0.098	0.435	0.099	0.00	0.777	0.853	0.345	0.983	0.944	0.362	0.205	0.144
215	fldmitig		Other measures to be taken besides flood warning:	0.361	0.357	0.135	0.181	0.428	0.838	0.00	0.835	0.156	0.716	0.269	0.577	0.564	0.190	0.018

216	strucmeas		Structural measures should be improved:	0.344	0.493	0.213	0.107	0.409	0.646	0.00	0.778	0.079	0.634	0.234	0.574	0.663	0.207	0.014
217	strucoth		Other measures besides structural must be improved:	0.358	0.339	0.817	0.131	0.428	0.976	0.00	0.637	0.021	0.353	0.139	0.883	0.553	0.280	0.015
218	govedupro1		Invest in flood risk and mitigation programmes in schools	0.608	0.985	0.640	0.105	0.907	0.445	0.010	0.513	0.236	0.764	0.075	0.677	0.781	0.139	0.013
219	govedupro2		Invest in flood risk and mitigation programmes in community centres	0.633	0.949	0.358	0.078	0.592	0.728	0.009	0.551	0.944	0.771	0.030	0.062	0.749	0.291	0.179
220	govedupro3		Invest in flood risk and mitigation programmes in youth clubs	0.849	0.933	0.545	0.084	0.531	0.330	0.028	0.409	0.874	0.690	0.036	0.324	0.551	0.325	0.086
221	disp1		Differences in government support to different communities during flood	0.688	0.734	0.823	0.147	0.441	0.629	0.147	0.599	0.069	0.344	0.319	0.064	0.031	0.663	0.109
222	disp2		Diff. in govt. support to different communities after a flood hazard	0.806	0.956	0.919	0.171	0.500	0.961	0.160	0.786	0.105	0.193	0.530	0.670	0.082	0.721	0.488
223	disp3		Diff. in govt. support to diff. comm. in relief and emergency services	0.816	0.956	0.364	0.122	0.500	0.347	0.034	0.786	0.188	0.057	0.530	0.004	0.040	0.721	0.448
224	disp4		Diff. in govt. support to different communities building flood defences	0.782	0.772	0.591	0.298	0.428	0.401	0.035	0.891	0.343	0.046	0.500	0.066	0.024	0.677	0.728
225	disp5		Diff. in govt. support to diff. com. in helping to improve quality of life	0.830	0.792	0.710	0.184	0.428	0.109	0.017	0.891	0.156	0.065	0.500	0.249	0.039	0.677	0.813
226	ngosup1		Differences in NGOs support to the community after a flood hazard	0.017	0.647	0.631	0.039	0.504	0.771	0.008	0.641	0.093	0.913	0.390	0.389	0.085	0.568	0.182
227	ngosup2		Diff. in NGOs support to the comm. in relief and emergency services	0.022	0.618	0.428	0.013	0.431	0.506	0.017	0.649	0.482	0.578	0.395	0.361	0.026	0.433	0.200
228	ngosup3		Diff in NGOs support to the community in helping to improve our quality of life	0.022	0.618	0.293	0.023	0.431	0.178	0.017	0.649	0.430	0.691	0.398	0.089	0.026	0.433	0.413
229	ngosup4		Differences in NGOs support to the community building flood defences	0.022	0.618	0.192	0.024	0.431	0.821	0.019	0.649	0.651	0.722	0.398	0.290	0.010	0.433	0.131

Legend:

- | | | | |
|---------------|---------------|-------------|------------------------------|
| Orange | p < 0.05 | Red | Social |
| Green | Economic | Pink | Environmental/Infrastructure |
| Yellow | Psychological | Blue | Community competence |
| Grey | Institutional | | |

Appendix 15 Focus group interview Transcript data (CLC)

Original and Transcript text from Focus group interview at CLC

Original Conversation in creole (local language)	Transcript into English (CLC)
<i>Bonsoir, mo appelle Anoradha. Mo souhaite la bienvenue, merci Sybille pour accorde nous sa place là. Et Annick pour appelle zot</i>	<i>Good evening. My name is Anoradha. Welcome. I thank Sybille for allowing us to use this room and Annick for inviting you.</i>
<i>A nous commencer par presente zot.</i>	<i>For a start, please introduce yourselves.[Each one presents herself]</i>
<i>Maintenant raconte-moi un peu zot experience lor inundationet qui zot penser ?</i>	Now, tell me about your experience with flood and what are your thoughts about them?
<i>[Bruits de fond]</i>	<i>[Noise in the background]</i>
De leau rentrer dans la case quand la plie tombe	When it rains, water enters my house.
De l'eau coule la boue rentrer	The running water carries mud with it
<i>Qui fer la case la coulé - Zonne bizin coné qui fer la case la coulé– pas bien rangé?</i>	<i>Why does water enter your house – You should know why – Is it that the house is not well built, or what?</i>
De leau finne rentrer, So probleme doube - Tolle ek Sali pas encore mette (3persons) – tout de leau tentre, dale	Water enters the house for two reasons – The tin roof and the flooring has not been fixed.
<i>Quand ena inundation tout dimoune tracassé, non, zotte worry qui fer ?</i>	When flood occurs, everyone is worried, yes? why do you worry?
Pas cone qui pou arrive.	We do not know what will happen.
Tracasse, Probleme	Worries, problems
<i>Oui, La santé, vieux dimoune dans la case, ene banne zenfants, pas coner qui pou fer</i>	<i>Yes, health, elderly persons in the house, there are children, you do not know what to do.</i>
Pas ena contract, nous pas gagne droit	We do not have a contract, we have no

monte ene la same, construire	right to build a room, build
<i>Est ca probleme- la, tout les annes zotte gagne ca, alle ca empire</i>	<i>Do you face the problem every year, does get worse with time?</i>
12 ans li reste la.	She has stayed here for 12 years.
Li dans crown land. Gagne inondation bien. Gouvernement finne tire li Mette li plis en bas – tire photos – gagne plis inondation.	She is on Crown Land. The land gets heavily inundated. The Government has taken her away and moved her lower down - just where you were taking photographs - the new location is hit worse than the original place
Ene mon voisin ine gagne contrat, nous nous pas finne gagne. Comment ca se fait.	A neighbour has obtained title deeds. We have not yet received any. How is that so?
<i>Ine politises ca?</i>	<i>It is politically motivated?</i>
Ti finne guette Henri, ti alle lors radio public mais pas finne gagne contract.	We went to see Henri, even went on public radio but still no title deed.
<i>Banne zenfants malade, ca aussi ene problem? Pas ene dimoune vine guette zotte, lasistance</i>	<i>Children are sick, that's a problem too? No one visits you, any assistance?</i>
Zero assistance.	No assistance at all.
<i>Ca veut dire self- reliance?</i>	<i>Does that mean self-reliance?</i>
Ramasse tout mange, mette lahaut. Si le soir pas trouve narien, Pas cone qui pou arrive.	We collect all the cooked food and place them higher up. If at night we do not see anything (<i>i.e. Flood water</i>), we do not know what will happen next.
<i>Zotte ladan, ca zotte problem, zotte bisin dire</i>	<i>You are the one who face the problem, you have to say it.</i>
Lave lasiette dehors, lavelinge dehors. Tout travail fer dehors ici	We wash our dishes outside, our clothes outside. All the tasks are carried out outside the house.
<i>House chores (children speaking) Outside Chacune cause pour li</i>	<i>House chores outside (children speaking)? Everyone should speak for</i>

	<i>herself.</i>
Qui finne gagné – gagné maladie dehors	What we got? Caught disease.
<i>Maladie - moustique, de l'eau sale pourrie, stagnante</i>	<i>Illness – mosquitos – dirty and stagnant water?</i>
[Ene madame vini] – li plis affecte par inundation	[A lady joins in] - She is more affected by flood water
<i>Ti zenfants aussi vulnerable?</i>	<i>Young children are more vulnerable?</i>
Zotte gagne la boue ziska la [<i>indique genou</i>].	Mud flow up to here – [<i>Pointing to her knee</i>]
<i>Kotte ou reste madame?</i>	<i>Madam, where do you live?</i>
Maladie – moustique, Moi, mo reste dans hoteur, donc mo pas gagne problem sauf delo dans la cous. La gratelle, malade la peau, l'asthme, humidite, talons grate, malade li pieds De leau ramasse – la mare- de l'eau vine noir	Illness – mosquitos <i>I live higher u, so I do not have any problem, except that water come into the yard.</i> Itching, skin disease, asthma, humidity, itching of the heels, disease of the foot. Water remains stagnant – wetland – water turns dark
<i>L'odeur? High impact</i>	<i>The smell? High impact</i>
Maison petit Bonheur – Radio plus – li pas cone astere – leur la pluie tombe ki pou cone Ene zoli lacase – la haut – tire li depis zone inondable – pas cone ki pou arrive avec la pluie. Pour Jessica fine range a cote la Riviere. Jessica pas fine vini	'Maison Petit Bonheur' – was built by Radio Plus – we do not know what happens next – we will know only when the rains. come(<i>Note: A private radio station built the from public donations</i>) The house is beautiful – on higher grounds – move them away from area usually inundated. Do not know what will happen when the rains come. For Jessica, the new house has been built close to the river bank. Jessica is not here.
<i>Ki lotte problem apart lacaze inonde?</i> <i>Meuble</i>	<i>What other problem apart from inundated house? Furniture</i>

De l'eau tombe lors mange.	Water fall on food
<i>Qui de l'eau qui descene – montagne, la riviere?</i>	<i>Which water gets into house –from mountain or river?</i>
De la riviere - l'eau toilette qui monter – sewerage water overflow De l'eau toilette - manhole bouche	From the river – water from pits come up – sewerage water overflows Water from toilet pits – manholes get clogged
<i>Qui zotte fer pour combatte ca , zotte laisse li</i>	<i>What do you do to redress the situation, do you just leave it</i>
<i>Zotte attende jusqu'a dimoune vine debouche.</i> <i>Zotte pompe aussi –le re vine pareil</i> <i>Reste comme ca meme – debrouille zotte difil zotte meme</i> <i>So maman ena proble lestomac – reste ladans meme</i> <i>Charity organisations vinne aide</i>	They wait until someone unclogs the manholes. They pump off the water, but the situation reverts back to the original state We stay just like that – we have to take care of ourselves Her mother has stomach problem – remain in the situation Charity organisations come our aid
<i>Self reliance ki manire zotte fer ?</i>	<i>Self-reliance – how do you get organised?</i>
Pas ena Sali, linge mouille – laisse li sec comme ça même	We have no flooring, the clothing remain wet – let it dry on its own
<i>Combien le temps pour vine normale?</i>	<i>How long does it take for normalisation?</i>
Deux jours, trois, une semaine Humidite la reste – prend trois semaines Quand matelas mouille – mette li ene cote – dormi lors la meme Mette goni lors la Pas facile ca Ti bebe encore – misère	Two days, three, one week Humidity stays – may take three weeks When mattresses get wet – we turn it upside down – we then sleep on it We place gunny bags on it Life is not easy Babies the more – misery
<i>Impact? – [Another participant joined in]</i>	<i>Impact? – [Another participant join in]</i>

High la <i>[Pause]</i>	High <i>[Pause]</i>
<i>Qui zotte penser pour sorti dans problem.</i>	<i>What are your thoughts about getting out of the problem?</i>
Ca qui so lacase la haut – no problem Mais nous ici enbas, grand problem quand la pluie tomber. Nous bizin alle dans center refuge.	Those who live higher up – no problem But for us down here, we face major problem when rains fall We have to move to Refugee Centre
<i>Combien jours ?</i>	<i>For how many days?</i>
En 2005, nous ti reste pendant longtemps – ene mois	In 2005, we stayed in Refugee Centre for a long period – one month.
<i>Et government la? Li aider?</i>	<i>And the Government? It provided help?</i>
Si gouvernement aider, pas enan problem... Bouche pas bouche, meme zaffaire Longtemps pas beaucoup familles La façon qui fine arranger. Pour CLC seulement – Astere ena lacase lors crownland Deborder	If Government were to help, then no problem... Whether the drain gets blocked or not , it's the same story Formerly there were not many families It's the way the houses have been built In the case of CLC only - now a house has been built on crown land Overflow
<i>Vieux dimounes?</i>	<i>The elderly?</i>
Ene handicapé. Tellement inondation – pas ti capave sorti même SMF ti vine tire – le pas le aller – li mort la même. Kotte-li ene vieux dimoune – rhumatisme	There are the handicapped. So much flooding – cannot even come out SMF [Note: <i>Special Mobile Force is a para-military Unit for emergency situations</i>] come to help people out – they do not want to go out – they prefer to die. She has an elderly person – rheumatism
<i>Li affete par dileau?</i>	<i>It affects water?</i>
Li pas trouve clair, leve lipeds lors lili Tater, lipeds dans dilo, leve lipied lors lili	He is nearly blind, he puts his feet on bed Feels, finds his feet in water, lifts his feet

Nous chagrin – nous pe rier	on bed We feel sorry for him – we may be laughing
Mo dans hauteur – mais ena dileau deux cotes	I am on high grounds – but there is water on both sides
<i>Vive avec stress?</i>	<i>Live in stress?</i>
Mette matela enbas	We put our mattress on ground.
<i>Entre aider?</i> Maman ti alle travaille, trois enfants dans lacase, voisin casse la porte pou tire enfants, la boue La boue et de leau finne rentrer – maman dimande permission pour vine lacase – pas gagner	<i>Mutual help?</i> A mother had gone to work, three children were at home and the neighbour had to break in to pull out the children, mud all over. Mud and water had flowed in – the mother had asked for authorisation to return home – did not get.
<i>Qui ou finne fer?</i> <i>De l'eau reste combine de temps?</i>	<i>What did you do?</i> <i>How long did the water stay in house?</i>
Ca qui reste ladans capave raconte plis Depis l' autorite vine, zenfant fini gagne la galle	Those affected could give more details By the time the authorities came, the children had got scabs.
<i>Zotte penser -Decision – autorite – dimande zotte lopinion dans amelioration pou zotte vive dans bien?</i>	<i>Your thoughts – decision – authority – ask your opinion on improvement for a better quality of life?</i>
Temps en temps ene dedomagement de Rs300 - Qui ca pou faire Qui materiaux li pou aste pour ca largent la? Personnellement – Gouvernement donne li – les zotte pas gagne – zotte loin Ene pas ena electricite	Once in a while get a sum of Rs300 for repairs – how far will the amount go What materials would such an amount buy? Personally – Government gives – others do not get the sum – they live further away No electricity
<i>Depande lors zotte – pompier vini?</i>	<i>Rely on one self – fire services comes over?</i>

Deleau meme niveau qui la riviere – pompier pas capave faire narien	The water is at the same level as the river – fire services unable to act
<i>Longtemps reste la?</i>	<i>You have been staying here for a long time?</i>
12, 5, 6,7 ans	12, 5, 6, 7 years
<i>Merci</i> <i>Qui facon gagne compensation inundation?</i>	<i>Thanks</i> <i>What do you have to do to get compensation?</i>
La Police vini – faire laqueue, gagne la guerre Ca qui conserne pas vini Deja gagne visite Ministres logement, la terre Jamais mo ti gagne visite. Leta inundation – li pas ti vini, apres qui li ti vini	We have the visit of the Police – we queue up, we often have a fight Authorities concerned do not turn up We have had the visits of Ministers of Land and Housing I did not have any visit During flood – he did not visit us, he came well after
<i>Comment problem solve?</i>	<i>How to solve the problem?</i>
Pa ti besoin casse – bisn ameliore lacase Conditionne nous lacase – ameliore nous qualite de vie Quand govt donne ene ti lacase – mette ene ti latable, Lacase d’abord – debrouiller La case casse casse, pas capave faire narien Dimin mange - dileau tombe lors li – cotte nous pou aller?	Should not have broken – must improve the house Consolidate our houses – improve our quality of life When Government gives us a house – then we can bring in a table House first – then we will manage If the house is in a poor state, nothing can be done Food – water will drip on t it – where can we go?
<i>Pas ena zenfants?</i>	<i>No children?</i>
Mari amene li cotte voisine	Husband takes them to the neighbour

<p>Nouveau construction (Maison du bonheur?) – pas encore gagne inundation – pas cone qui pou arrive dans inundation – la riviere monte labas..... Noufine deplace reste eneplace – zotte dimoune faire boule avec zotte</p>	<p>New construction (<i>Maison du Bonheur</i>) – no flood yet – do not know what will happen in case of flood – the river over ther rise as well... We have remained at the same place – others are moved constantly</p>
<p><i>Tous les ans?</i></p>	<p><i>Every year?</i></p>
<p>Depis fine deplace – pas encore gagne la pluie torentielle Lers gagne warning – avant precaution – de l’eau pe vini. Pour Jessica – range la case ti Bonheur lors la berge. Li pas fine vini – Radio 1 Esperer qui pas pour gagne de leau</p>	<p>Since displaced – no torrential rain By the time we are aware that warning has been issued – before precaution – flood water is here. For Jessica- construct a small house ‘ti Bonheur’ on the river bank. They did not come – Radio 1 Hope flood water does not rise up to the new house.</p>
<p><i>Chikoungounya?</i></p>	<p><i>Chikoungounya?</i></p>
<p>OU...Oui... Tous ca marginal lands-ca La riviere dangeureux Li profound – capave charier La riviere la rissser , tourbillon vine avec ca</p>	<p>Ou...Ou... All over the marginal lands The river is dangerous It is deep – can carry away The river pulls, accompanied by eddies</p>
<p><i>Risquer ici?</i></p>	<p><i>Risky here?</i></p>
<p>Apres Mon Gout, ca meme lendroit plis risquant. Mon Gout pe encore range JCB vine tire laterre – revine pareille – laboue revini, piens repousse- revinne pareil L’herbe pousee – revine pareille – del’eau revinne cotte toi Dimoune zette salete – bouche canal enplis</p>	<p>After Mon Gout, ours is the most risky place. There is still construction at Mon Gout The tractor removes the soil – remain unchanged – mud is again brought back, Plants grows again – it is the same all over Grass grows – no change – water comes to the house again People throw wastes – clutter the canal again</p>

<p>Servi de l'eau la riviere parcequi - 5hr de leau commence coule</p> <p>De l'eau propre – servi pour servi</p> <p>New inhabitants – fini gane l'eau, eclairage – tube dans bois</p> <p>La vie martyr-ca</p> <p>Vive la dans 6 ans - 13 ans – Mari martyr – (Rire)</p> <p>De leau rentrer – la moitie lili – zenfant tome de pis lili dans dilo</p> <p>Au ras lili – tourbillon – pas facile – decende – lors lili – gagne frais – de leau genou</p> <p>Reste dans wetland - Quand dire la Police – la Police pas tende – Police pas le alle la haut</p> <p>Personne pas vine gette nous – nous bizin alle donne nom</p>	<p>We use water from the river – tap water flows only after 5 pm</p> <p>Clean water – use for essentials</p> <p>New inhabitants – have got running water, lighting – tube light in the bush</p> <p>A martyr's life it is</p> <p>Have lived in this condition for 6 – 13 years – Tough martyr's life – (Laughs)</p> <p>Water enters – half way up the bed – children fall off the bed into water</p> <p>Level with the bed – eddies – not easy – descend from bed – feel cold – water up to the knee</p> <p>Live in wetland – when we tell the Police – Police turns a deaf ear – Police does not go further up</p> <p>Nobody come to visit us – we have to go and give our name</p>
<p>Additional information:</p> <p>Travaille macon; From Rodrigues;</p> <p>Zenfants lecole</p>	<p>Community living; Live near School, transport, infrastructure</p>

(September 2010)

Appendix 16 Focus group interview Transcript data (LH)

Original and Transcript text from focus group interview at LH

(LH, 02.02.2012)

Transcript in Creole – local language in Mauritius	Translation into English
<p><i>Bonsoir, mo apelle Anoradha . Merci pour zotte presence.</i></p> <p><i>Merci pour Shanta pour avoir accorder nous Le Center Communotaire.</i></p> <p><i>Zotte rapelle moi. Mo tuvine faire ene survey dans zotte lacaze ene fois</i></p> <p><i>Azordi mot i envie conner qui zotte ti envi dire moi sur zotte experience inundation , comment zotte vivre ca , so limpacte ak qui zotte faire pou diminuer so impact.</i></p> <p><i>Raconte moi, ene ene ti peu , ou lexperience lors inundation.</i></p> <p><i>Depuis quand ou reste la?</i></p>	<p><i>Good afternoon. My name is Anoradha. Thank you for your presence.</i></p> <p><i>Thanks to Shanta concerned for having allowed us to gather here.</i></p> <p><i>You remember, some ago I came to collect data for survey on flood hazard.</i></p> <p><i>Today, I just want you to give more information on your experience of living with flood, how you cope with it and your views on resilience building and on any assistance from authorities.</i></p> <p><i>Relate to me your experience with flood</i></p> <p><i>Since when do you live here?</i></p>
<p>Mo reste la depi zenfant. Mo papa ine achete sa terrain et li cone qui sa ene wetland.</p> <p>Nous fine reste ladans bien longtemp</p> <p>Nous gagne inonation a chaque gros lapluie.</p>	<p>I live here since childhood. My father had bought the land and he knew that it was a wetland.</p> <p>We have stayed here for a very long time.</p> <p>We are flooded every time we have heavy rains</p>
<p><i>Zis quand enan lapli, dans cyclone?</i></p>	<p><i>When do get floods, only during cyclones?</i></p>
<p>Oui, divent, gros lapluie, partout dilo ramasse.</p> <p>Moi mo lacaze couler coument ene passoire.</p>	<p>Yes, with strong winds and heavy rains, water collects everywhere.</p> <p>My house leaks like a sieve.</p>

<i>Combien d'eau rentre-t-elle ?</i>	<i>How much water enters your house?</i>
Chaque saison la pluie, l'eau rentre dans ma maison jusqu'à mon cheville. Tous mes meubles, mes lits, mes meubles sont gâchés. Chaque saison la pluie, moi et mes trois enfants nous évacuons chez ma mère.	Every rainy season, water in my house reaches up to my ankle. All my furniture, my bed, get spoiled. Every rainy season, I and my three children leave my house for my mother's.
<i>Mais quand reviens-t-elle ?</i>	<i>Then, when do you return?</i>
Une fois l'eau est partie, après deux ou trois jours. Toutes nos affaires sont gâchées. Moi je n'ai pas de mari. Donc moi je n'ai pas de soutien.	Once the water withdraws, after two to three days. All our belongings are spoiled. I do not have a husband. So I do not have anyone to assist me.
<i>Que faites-vous ?</i>	<i>What do you do then?</i>
Il y a beaucoup de bâtiments. Les voisins ne respectent pas, ils ont construit sur le canal de décharge.	There are many buildings. The neighbours have no respect; they have built right on the canal.
<i>Après l'inondation, avez-vous d'autres problèmes ?</i>	<i>After the flooding, do you have any other problem?</i>
Nous gagnons des moustiques et des maladies.	Mosquitos and illnesses.
<i>Et vous, madame ?</i>	<i>And what about you, madam?</i>
Moi je n'ai pas réussi à avoir une vie normale.	I am unable to have a normal life.
<i>Vous, madame, comment faites-vous ?</i>	<i>What about you madam, how do you manage?</i>
Moi au contraire, l'eau ne rentre pas dans ma maison mais mes affaires sont inondées chaque saison la pluie. Mes plantes sont gâchées.	On the contrary, I do not get water into my house. But my belongings get flooded every rainy season. My plants get spoiled.
<i>Vous avez des enfants ?</i>	<i>Do you have children?</i>
Mes enfants marchent dans l'eau pour aller à l'école. Nous acceptons de vivre dans ces conditions – c'est une partie de notre vie.	Children walk about in muddy waters to attend school. We have come to accept to live in such conditions – it forms part of our life.

<p>Moi mo reste directement lor canal qui ti sec par le passé.</p> <p>Mo pas ena assez lespace, alors mo fine construire lors canal. Quand la plié tombe, mo la chamber enbas rempli are de l'eau jusqu'a ene metre.</p> <p>Ou capave trouve encore mark dilo lors miraille. Tous mo terrain noye avec de leau.</p>	<p>I live right on top of the canal which was dry in the past</p> <p>I do not have enough space, so I have constructed on the canal too. When it rains, the room in the lower floor is flooded up to one metre.</p> <p>You can still see the water mark on the wall. The entire land is flooded.</p>
<p><i>Qui ou faire ? ou prend precaution?</i></p>	<p><i>What do you do then? Do you take precaution?</i></p>
<p>Mo bizin monte tous mo zaffaire la haut lors letage. Mo aussi alle reste lahaut quand inonder.</p> <p>Mo appelle pompier pou pompe delo depuis mo lacaze.</p> <p>Mo garcon ine alle quette autorites mais zotte pas ecouter.</p> <p>Moi mo lacaze pas inonde. Mais mo jardin li noye parcequi nous finne construire lors canal.</p>	<p>I have to carry all my belongings to the upper floor. I also stay upstairs when the ground floor is inundated.</p> <p>I call the Fire Services to pump out the water.</p> <p>My son has been to see the authorities but they do not listen.</p> <p>My house does not get inundated. But my garden is flooded as we have built right on the canal.</p>
<p><i>Qui ou penser bizin faire pour diminuer impact?</i></p>	<p><i>What do you think you should do to reduce the impact?</i></p>
<p>Nous pas capave faire narien et nous apprene vive avec debordement. Mo contine faire mo activite si pe ena trop lilo. Ou sinon mo attende dilo la baisser avant mo continuer.</p> <p>Mo pense bisin eduque dimoune pas zette saleter dans canal dilo.</p> <p>Mo vive avek mo maman qui malade.</p>	<p>We can't do anything and we have to learn to live with flood. I continue my activities if the water level is not too high. Otherwise I wait for the water level to go down before I continue.</p> <p>I think people should be taught not to throw waste in the canal.</p> <p>I live with my mother who is sick. Flood</p>

<p>Debordement vine jisqu'a genou. Nous alle refuge cotte nou voisin et retourne quant inundation diminue.</p>	<p>water rises up to the knee. We rush to take refuge at the neighbour's and we return when the water subsides.</p>
<p><i>Gouvernement pas reloge zotte?</i></p>	<p><i>Doesn't the Government relocate you?</i></p>
<p>Mo pas travaille. Mo gagne ene ti allocation are Gouvernement.</p> <p>Mo reste ici depis qui mot ti zenfant. Si zotte dire moi quitte sa place la, mo pas ena aucaine place pou aller.</p> <p>Moi aussi, mo vive ici depis longtemps.</p> <p>Jamain mo fine ena problem avec inundation meme si mo vive pres are sa canal la.</p> <p>Mo fine prend banne mesire contre inundation et mo fine mette muraille autour mon jardin. Mais, la route inonder et dilo retire li vite parcequi mo lacase lors la pente.</p> <p>Nou ena gros probleme chaque saison gros laplie. Mo lacase et tout mo terrain li noye.</p> <p>Mo lacase fine faire avec tole et li coule partout lers gagne gros laplie et en plis laplie ramasse lors parterre.</p> <p>Tout mo propriété endommage. Mo mari li malade et mo trop vieux pou alle travaille.</p> <p>Nous vive coster are cimetiére. Zotte fine barre li et ca finne aggrave la situation parcequi dilo qui vine dans</p>	<p>I do not work. I receive a modest Government allocation.</p> <p>I live here since childhood. If they ask me to leave this place, I have nowhere to go.</p> <p>I too live here since a long time.</p> <p>I have never had any problem with flooding even if I live close to this canal.</p> <p>I have taken the necessary measures against flood and I have built walls around my garden. But the road gets flooded and water withdraws quickly since my house is on a slope.</p> <p>I have big problem ever season with heavy rains. My house and my whole property get flooded.</p> <p>My house is made of tin roof and it leaks everywhere during heavy rains and moreover water collects on the floor.</p> <p>My whole property gets damaged. My husband is sick and I am too old to take up a job.</p> <p>We live near a cemetery. They have placed an enclosure making the situation worse as the water entering the yard</p>

<p>nous la cour pas capave sorti.</p> <p>Moi. mo vive tou seul avec mo deux enfants.</p> <p>Ena quelques annees mo mari finne quitte moi.</p>	<p>cannot flow out.</p> <p>I live alone with my two children.</p> <p>A few years back my husband abandoned me.</p>
<i>Ou reste tout seul?</i>	<i>You live alone then?</i>
<p>Non, mo rest ek mo 2 enfants. Mo lacaze ar tôle, li couler. Dilo vine depi lahaut. Couver mo Sali. Partout...</p>	<p>No, I live with my two children. My house has tin roof and it leaks. Water runs in from above. It spreads over the floor. Everywhere...</p>
<i>Comment ou debrouiller?</i>	<i>How do you manage?</i>
<p>◆ Mais nou reste ladans jusqua delo la aller. Mo travaille masson astere mo reste lacase pour guette mo garson.</p> <p>Mo vraiment frustrer avec sa la vie la. Moi, mo fine range mo lacage directement lors canal. Swa pas ti lors plan.</p> <p>Ti enan ene ti depression mais mo pas ti rend comte.</p>	<p>◆ We stay inside until the water flows away. I work as a mason now. I stay at home to look after my son.</p> <p>I am really frustrated with this life.</p> <p>I have built my house right on the canal. This was not in the land plan.</p> <p>There was a slight depression in the land but I did not pay heed.</p>
<i>Qui faire ou la case inonder?</i>	<i>Why is your house flooded?</i>
<p>Saison lapluie, li inonders mais maintenant plus souvent. Dimoune servi canal comment ene drain, enan moustic et pollution.</p> <p>Nous reste parmi nous proper famille. Nous gagne delo dans grand lapluie. Nous reste la depi longtemps.</p>	<p>During rainy season, it got flooded but it is more frequent now. People use the canal for waste disposal, mosquitos and pollution.</p> <p>We live among own family members. We have flood during heavy rains. We live here since a long time.</p>
<i>Qui zotte faire?</i>	<i>What do you do?</i>
<p>Nous alle cotte voisins.</p>	<p>We move to the neighbours'.</p>

Nous lacaze are tole. Pas gagne loans parcequi nous salaire pas depasse 4000 rupies.	Our house is built of tin. We do not get loans as our salary does not exceed Rs4000.
<i>Banne zefants correct?</i>	<i>Are the children fine?</i>
Non, zotte gagne malade lapo ek dilo sale dans canal.Pa enan choix. Mo missie enan employ temporaire. Government fine blie nous dans sa pays la.	No, they get skin disease with dirty water from the canal. We have no choice. My husband has a temporary employment. The Government of this country has forgotten us.
<i>Bon, mo remercier zotte. Enan un peu snack ek boissons pour zotte. Servi zotte.</i>	<i>Well, I am thankful to you. Please help yourselves to some snacks and refreshments.</i>

Appendix 17 Focus group interview Transcript data (GB)

Original and Transcript text from focus group interview at GB
(April 2012) Focus interview GB (April 2012)

Creole	English
<i>Q : Ou reste dans wetland ?</i>	<i>Q: Do you live in wetland?</i>
A: Oui.	A: Yes
<i>Depuis combien l'année ?</i>	<i>For how long?</i>
19 ans	19 years
<i>Wetland-la, qui manière li ti été avant ?</i>	<i>How was the wetland before you moved in?</i>
Ti comble, Au commencement quand nous ti vinne reste, dimoune ti faire fouille. Li ti la mare. Comme ça même, de l'eau ti pe rentre dans lacaze. Pas ti ena ca manhole-la. Ti faire plainte. Lerre-la zotte vinne fouille. Ti mette tuyau enbas.	Initially, it was marshy when people had started digging. Even then, water used to overflow into our houses. There were no manholes. Following complaints, the authorities placed underground pipes for waste water discharge.
<i>Qui fere zotte fine faire manhole ?</i>	<i>Why did they place the manholes?</i>
De l'eau ti pe ramasse dans chemin. Dans lacaze aussi.	To drain the flood water collecting in the streets and in the houses as well.
<i>Pas dans lacaze ? Quand de l'eau monte l'ère ena la pluie ou comme ça même ?</i>	<i>Not in the house? When does the water overflow – when it rains or even in the absence of rain</i>
Quand ena grand li pluie. De l'eau-la monte. Zotte finne range pour manhole. Hier lere mo finne alle guette ca monsieur la li dire moi zotte ti finne ferme 'la gare'. Zotte ferme li. Lers manhole-la remplie et li suinte. Zotte fine alle discute are monsieur-la. Téléphoné combien coups pour ouvert ca manhole là. Monsieur la dire zotte pou ouver	During heavy rains, the water level rises. The man hole is supposed to drain away the flood water. Yesterday I called the officer and he explained that he had closed the floodgate. Often they close it. Thus during rainfall, the manhole is filled up and the excess flood water seep through area. The inhabitants have to call the officer several

li pou de l'eau la passe par manhole là. Lers zotte ouvert de l'eau allé. Manhole-la remplie. Pas ena l'espace pour de l'eau-la allé. Lers la de l'eau la remonte et li rentre dans la caze.	times and discuss the situation with him, asking him to open the floodgate. Once the floodgate is open, the water collecting at the surface drains through the manholes. It is only when the manholes are full, that floodwater overflows into houses.
<i>Combien hauteur de l'eau ?</i>	<i>How high does the water rise?</i>
Gros la plie. De l'eau la monte jusqu'à li pied dans la varangue. De l'eau rentre dans la lacaze. Mo bizin laisse de l'eau-la alle. De l'eau li sale. Senti malpropre	In the event of heavy rainfall, the water rises up to the ankle in the veranda. Water flows into the house. I have to wait until the water level goes down. The water is dirty and the odour is obnoxious.
<i>Combien temps zotte reste la-dans ?</i>	<i>How long do you stay in this situation?</i>
Si la pluie-la tombe grand matin jusqu'à a soir, bizin reste comme-ca même. Ramasse banne zaffaire vite. Vite. Mange tout la-dans même	If rains fall in the morning, we have to live in such a situation until afternoon. We have to collect our things hurriedly. We have food in here.
<i>Combien lacaze ena ?</i>	<i>How many houses are in this situation?</i>
Environ 200 lacaze. Zotte tous gagne ca problème-la. Ene ene madame pres là-bas, l'ère ena la pluie, li pas capave ouvert so la porte.	Some 200. They all undergo the same problem. One of neighbours cannot even open her door when the rain is heavy.
<i>Qui dégâts la pluie-la faire ? Abime zotte linge, lili?</i>	<i>What are the damages caused by flood? Spoil clothes, damage bed?</i>
Li dire moi, li pas capave garde narien en bas. Li bisin garde la haut. Mette frigidaire lors bloques.	She tells me that she cannot keep anything on or near the floor. She must keep them higher up. She has to place the refrigerator on blocks.
<i>Combien temps li comme ça ? Depuis qui zotte vine reste la ?</i>	<i>Since when you are in this condition? Is it since you moved here?</i>
Lers la plui tombe, de l'eau dans la varangue, pas capave ouvert la porte, narien.	When the rain falls, water collects in the veranda, we are unable to open even the

	door.
<i>Ki lotte dégâts?</i>	<i>What other damages?</i>
Mo meubles finne abime. Avec la pluie pendant longtemps, meubles finne pourri. Mo fine bizin zette li. Li aussi senti mauvais.	Our furniture is spoilt. When the rains fall over a long period, the furniture starts to rot. We have to throw them away. They have a bad smell.
<i>Li affecte banne zenfants ?</i>	<i>Do they affect children?</i>
Zenfants gagne la fièvre, gagne malade, gagne gratté, gagne bouton.	Children have fever, are sick, get itching and pimples.
<i>Qui zotte faire alors ?</i>	<i>What do you do then?</i>
Moralement nous fatigue surtout avec lodere sorti depi manhole, ca drain la sorti depi lotel qui passe devant mo laporte alle dans ene regard kot camion vine pompe devant laporte dimoune. Grand traca quand la pluie tombe. Zenfant pas kapav alle lecole. Parfois zot mette botte. Jour ou ti vini tellement la pluie ti tombe, partout deborde, mo dire zenfant pas alle lecol.	Morally, we are exhausted, especially with the bad odour from the manholes. The waste water pipes start from the hotel and cross near our houses and end in large manhole where lorries carrying waste water dump the wastes in front of people's houses. People are worried when rain falls. Children are unable to go to school. Often they wear boots. The other day, when you came there was so much rain and flood water everywhere that I told my children not to go to school.
Nou faire complainte mais personne pas vinne guetter. Nous reste la dans pendant ene semaine, deux semaines. Toujours personne pas vini.	We complain but no officer visits us. We continue to live in such conditions for a week, two weeks. Still we have no visit.
<i>Zotte ne pas penser pour faire ene group all guette lotorite ?</i>	<i>Why do you not get a group to see the authority concerned?</i>
Nous faire, mais sans resultat	We do, but still no result.
Chachi : La terre la mare ça. Government pas le rentre la dans, li dire zotte finne persiste range la caze la dans.	(Chachi): The area is wetland. Government is not concerned. It claims that we insisted in building in spite of its advice.

<p>Mo fine reste ici sa fer plis 40 ans zamais nous gagne sa problem la... dimoune fine range la caze , zette camions roche ek la terre , comble la mare. Moi mo gagne delo jusqua genou, mo fine bisi monte mo soubassement mais quand meme delo rentre dans la caze dans gros lapluie.</p>	<p>I have stayed in this location for 40 years but we never had such problem. People built their house on the wetland. They filled the marshy area with boulders and soil changing the natural drainage system. Now flood water reaches up to the knee. I have raised the foundation but still flood water flows into the house during heavy rains.</p>
<p>Avant nous pas ti pe noyer, astere drain bousser, dimoune fine range lacaze lors la, qui pou dire.</p>	<p>Previously we were not flooded, now the drains get blocked, people have built houses on the natural waterways, we dare not speak to them.</p>
<p>Dans cyclone, mo tole fine envoler, mo dimanne. L'aide Government, li dire nous pas pou gagne narien parcequi nou pas suppose reste ici, crown land sa, mais nous paye ene ti fees gouvernement chaque lanee.</p>	<p>During cyclones, my tin roof was carried away by the wind. I had requested assistance from Government. It refused since we were not supposed to build over the wetland. It is crown land, but we pay a fee to the Government every year.</p>
<p>Nou pe gagne sa problem depi 10 ans. Nous bizin mette rocksand divan laporte pour sorti dehors. Nous pas capa valle reste lote place, a causee nou travaille.</p>	<p>We are having problems for the last 10 years. We have to place sand bags in front of the door to withhold water from getting inside so that we can go out to work. We cannot move to another location since we work here.</p>
<p>Li pas facile pour nou, mo finn attrape chikungunya, depi mo pas capave leve mo lebras., mo tombe malade souvent, l'ambulance rentre dans delo vinne chereche moi.</p>	<p>Life is not easy for us. I got chikungunya fever. Since then, I am unable to raise my arm, I often fall sick; the ambulance has to cross the flood water to take me to hospital.</p>
<p><i>Zotte pas faire petition ?</i></p>	<p><i>You do not make petition?</i></p>
<p>Ou conne , chaque dimoune ena so qualite problem, L'auter cote, pas enan probleme,</p>	<p>You know, everyone has a different problem. Those on the other side do not</p>

zotte reste dans hauteur, zotte pas oule
cooperer

have the problem. They live on higher
grounds and do not want to cooperate.

Appendix 18

Appendix 18 Frequency of the types of resilience and references coded at each node for the three locations (Focus group interviews)

Type of resilience	Node/Theme/Variable	CLC	LH	GB	Total
Social	Household characteristics	5	5	5	15
	Social network	3	2	2	7
	Awareness of flood	5	3	3	11
	<i>Sub-Total</i>	<i>13</i>	<i>10</i>	<i>10</i>	<i>33</i>
Economic	Property ownership	2	6	5	13
	Lack of economic resources	11	6	0	17
	Extent of tangible impact	7	9	3	19
	<i>Sub-Total</i>	<i>20</i>	<i>21</i>	<i>8</i>	<i>49</i>
Institutional	Assistance to help recovery	9	3	8	20
	Relocation	5	1	0	6
	Flood experience	11	3	8	22
	Flood characteristics	5	8	4	17
	<i>Sub-Total</i>	<i>30</i>	<i>15</i>	<i>20</i>	<i>65</i>
Infrastructure	Type of house	6	6	2	14
	Land use	5	6	6	17
	Access to amenities and services	2	2	2	6
	Coping strategies	5	4	9	18
	<i>Sub-Total</i>	<i>18</i>	<i>18</i>	<i>19</i>	<i>55</i>
Psychological	Living with stress	14	8	11	33
	Uncertainties	12	9	2	23
	Worry about health	8	4	4	16
	<i>Sub-Total</i>	<i>34</i>	<i>21</i>	<i>17</i>	<i>72</i>
Community competence	Living with flood risk	6	4	3	13
	Local knowledge	5	3	3	11
	Community ties	3	2	1	6
	Values and beliefs	3	2	3	8
	<i>Sub-Total</i>	<i>17</i>	<i>11</i>	<i>10</i>	<i>38</i>
TOTAL		132	96	84	312

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 19 Director of Meteorological Services and Vice-Chairman of National Disaster Preparedness Unit (NPU)

Question: Suresh, you are the Director of the Meteorological Services as well as the Vice-Chairman of the National Disaster Unit (NDU), Can you tell me about role of Meteorological Service and the NDU in disaster management?

Answer: Well, the NDU is a well-structured coordinating unit and is composed of representatives from 25 Departments and Ministries under the aegis of the Prime Minister. NDU's prime responsibility is to ensure the safety and protection of the population of Mauritius in the advent of a disaster, especially of natural origin. It serves as a central system to supervise, monitor and co-ordinate the activities of other authorities, to arrange for the compilation and maintenance of relevant data which also serves as a database and to take critical decisions and to take stock of the entire preventive, remedial, rescue and relief measures.

Q: How are warning systems structured?

A: The most well-known system is *The Tropical Cyclone Emergency Scheme* which comprises four components, namely, General Preparedness, The Approach of a Cyclone, During the Cyclone and The Aftermath. Specific responsibilities are assigned to the various national authorities.

Q: Does the NDU have any similar schemes for other natural disasters?

A: It also has a *Torrential Rain Emergency Scheme* and similar schemes in the event of landslides and tsunamis.

Q: How would you assess the overall effectiveness of the schemes?

A: The system is very well groomed for cyclones and is very well understood by the population. It has come to trust the system of warnings and act accordingly. The public and private sectors receive the warnings promptly through all channels of communications and heed the warnings and advice almost to the letter. It is understood

that each institution or individual apply them in accordance with their own specific situation or condition. The system has been in operation since the sixties and has proved its effectiveness since the number of casualties due to cyclones directly has been nil for a few decades now.

Q: How does the system operate especially in the case of torrential rains?

A: The way the system operates is as follows: The Meteorological Department issues warnings of cyclones and torrential rains and makes them available to all concerned authorities and the media.

In the specific case of torrential rains, for the preparedness phase, flood prone areas are surveyed and a list is made available to all concerned. A special strategy and robust sensitization campaign is developed and implemented with authorities concerned. The local community participates actively. Parents are made aware of the risk to their children during flood conditions and encourage them to follow warnings and any advice given. Training for pro-active involvement in the preventive, remedial, rescue and relief operations are put in place by the authorities. The authorities review urban and rural development building plans and the state of the drainage system and arrange for appropriate remedial action to be taken.

Q: Which authorities are directly involved and during which phase?

A: The Police Department and Fire Services are present during and after response phase. The Social Security Department job is to provide shelter and food to those who are affected during a cyclone or torrential rains. The Ministry of Environment, the Health Department and the Fire Services are on alert during and after the hazard. The Ministry of Local Government and the Municipalities and District Councils are there to clean the debris and unblock drains. Cleaning of and maintenance of drains, desilting of streams and rivers are under the responsibility of the Ministry of Environment and the Ministry of Local Government and it is an on-going process. Any injured or sick person is taken care by the Department of Health.

Q: When do you have flood?

A: We have floods when there is torrential rain, also flash flood which happens unexpectedly. However, normally our topography is such that, often it drains off very quickly.

Q: What is a torrential rain?

A: When we record more than 100mm of continuous rain over a 24-hour period.

Q: Is the frequency of flood increasing in Mauritius?

A: I think so. In 2008, there were no cyclones but there was intense rain within a short period. All our reservoirs were filled.

Q: What are the causes of flood?

A: There is of course, intense rainfall over an area, badly designed drains with poor maintenance. If you remember Katrina in New Orleans, flood occurred mainly because of poorly maintained flood proof structures.

Q: What about the social dimension of a flood hazard?

A: We do our best to protect the lives of people. People have to be also responsible for their own safety during floods. For example, they should refrain from building walls and infrastructures across water course, which lead to greater adverse impact and more serious and widespread damage.

Q: Is there any special attention to certain sectors of the population in the context of torrential rains?

A: Whenever torrential rain conditions have produced 100 mm of rains and heavy rains are likely to continue at the beginning of a school day, schools will not be opened for school children. The Ministry of Education, Culture and Human Resources decides whether to open or to close educational Institutions in cases of localized flooding.

Q: What about the transport of population and marine services?

A: In conditions of flood, the Police have to put in place an orderly system for the purpose of commuting the population from their work-place to the safety of their residence. The Ports Authority arrange for the transmission to the rainfall and other relevant data from Harbour Radio to the port services.

Q: What is the role of science and technology in your Department?

A: Science and technology is central to any warning system which relies of several factors from observation to data dissemination and research. A good warning draws on reliable data from an appropriately dense network of monitoring stations especially in the flood-prone areas. The data should be available in a timely manner through a robust telecommunication system. The precise analysis of the data requires proper assimilation and modelling that requires adequate computing facilities and well-trained personnel that can operate the system on a 24-hour basis. The product should be available to the authorities and the public immediately and regularly. The system should have adequate redundancy and has to be maintained by qualified personnel. A database and research facilities with suitable personnel is essential if the warning system is live up to the fast evolving requirements of modern nation.

Q: How does the system for flood warning compare with the tropical cyclone warning scheme?

A: Our contingency planning that is applicable to flood hazards is not so developed. For cyclones, we have good means of communication by radio, TV and internet. Tracking of cyclones are through well-developed satellite systems which are in orbit over the Indian Ocean. We exchange our scientific data and knowledge with Services of nearby countries to better warn our population during cyclones and ensure a coordinated approach.

Q: Do NGOs participate in the decision-making process of the NDU?

A: They are not directly represented at that level as they operate at the local or regional level. The choice of a representative NGO is not easy to make. However, they are encouraged and even invited to be involved at the local level. Their points of view are channelled upwards to the NDU and are taken into consideration in the decision-making process.

Thank you.

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 20 Representative of Fire Services

<i>Presentation</i>	<i>Presentation</i>
Moi, mo ene sub-officer, fire service	I am a sub-officer in the Fire Service
<i>Ou ti capave décrier moi qui ou rôle apart teigne dife ?</i>	<i>Could you tell me what your role apart from extinguishing fire is?</i>
Normalement, n'importe qui l'endroit enan inondation, nous gagne appel avant qui nous bouger. Nous enan 3ou 4 l'équipe. Nous bizin sorti a première appel. Avec nous lapompe et équipement, nous sorti vite.	Usually, we act in case of flooding. However, we move only when there is a specific call. We have 3 to 4 teams. We have to leave immediately following the first call. We leave as quickly as possible, taking with us the pumps and other equipment.
<i>Qui qualite inundation, suite ene cyclone ou grand la pluie ?</i>	<i>What is the nature of the flooding, following a cyclone or heavy rains?</i>
Cyclone ou lapluie. Pas enan distinction, meme quand enen cyclone Class 4. Ou dans débordement, nous bisin aller dans ene minute parcequi nou premier objectif, c'est save life avant.	Cyclone or rains - there is no distinction even in the case Class IV cyclone warning. Even in case of flooding, we have to leave the barracks within a minute since our primary objective is to save lives.
<i>Comment ou organise ou?</i>	<i>How do you get organised?</i>
Si enan inundation, nous alle minimum de 4 personnes.	In the event of flooding, at least four officers have is required.
<i>Quand ou alle, quand enan deja inundation ou gagne appel, ou gagne directive?</i>	<i>When you go out upon receiving a call about flooding, do you have to receive specific instructions as well?</i>
Nous gagne lapel depuis control room pour dire enan ene place finne inonder, delo monter dans lacaze.	We only have to receive a call from the control room informing us that there is flooding in a particular place and that water level is rising in house

<i>Qui equipment zotte ammener?</i>	<i>Which equipment you take along with you?</i>
Nous ena nou lapompe et raccord pour capve pompe dilo et jette li loin dehors.	We take along the pump and pipe to enable us to pump water out of the flooded area.
<i>Comment zotte intervenir?</i>	<i>How do you intervene?</i>
Aussitot qui nou arrive, nou rente dans lacase. Si enan delo dans lacase, nous commence pompe delo dehors, bizin enan ene minimum de 6 pouce avant nous pomper, delo dans la cour nou pas pomper. Fine deja gagne 5ft delo dans lacase, dans Terre Rouge.	Immediately after our arrival we contact the household concerned and we enter the affected house. In the event that there is a least 6 in of water in the house we start pumping. We do not pump water in the yard. I have witnessed 5 feet of water in a house at Terre Rouge.
<i>Donc ou premier priorité, c'est 'Save Life'?</i>	<i>So your first priority is to save life?</i>
Oui, sauve lavie dimoune, puis pompe delo. Nous qui faire premier intervention, nous dane si enan dimoune qui fine trappe endans, lerla, nous invien, parfois defence la porte pour tire dimoune. Dimoune malade ou handicapé, nous mette zotte lors stretcher, si enan zenfants nous tire zotte dehors et ammene zotte cotte zotte parents.	Yes, first save human life, then pump water. We are generally the first to intervene; we ascertain whether there are people trapped inside. If so we intervene immediately, at times we have to break in doors to remove people. Sick and handicapped persons are removed on stretcher. Children are taken out and brought to their parents.
<i>Esqui ou collaborer ek les zotte dimoune?</i>	<i>Do you collaborate with others?</i>
Oui des fois, mais ene fois fini pompe delo dans ene place, delo niveau fini baisser.	Yes, at times, but only when we have rescued people and pumped out the water and its level has gone down.
<i>Qui arrive delo dans lacour?</i>	<i>What happens to the water in the yard?</i>
Nous pas pense qui vraiment ene danger, mais nou intervenir, cotte enan danger, dimoune la so manger, so meubles pe	We intervene if we feel that it poses a threat to security, their food may be spoilt and their furniture may be damaged. We

<p>abimer.</p> <p>Nous intervention li 24hrs sur 24hrs.</p>	<p>intervene on a 24 hour basis.</p>
<p><i>Le soir li difficile?</i></p>	<p><i>Is it particularly difficult at night time?</i></p>
<p>Nous enan nou foglight, et nous bien equipper.</p>	<p>We have fog light and we are well equipped.</p>
<p><i>Qui lacaze ou intervenir?</i></p>	<p><i>For which type of houses do you intervene?</i></p>
<p>Tout lacaze, des fois banne zoli lacaze a etage delo juaqu'a 5ou 6 pieds, banne dimoune soit bizin quitter ou monte a l'etage.</p>	<p>All types of houses. Sometimes beautiful storeyed ones - water rises 5 to 6 feet. The occupants have to leave or move on the upper floor.</p>
<p><i>Prend par exemple, CLC, dimoune pe plainner qui dilo decende enne coup, comme ene torrent, esqui ou gagne letemps pour intervenir?</i></p>	<p><i>Take the case of Cité La Cure, people complain that water comes down all of a sudden, in the form of a torrent. In such cases do you time to intervene in the usual way?</i></p>
<p>Ca dimoune la meme qui en tord, zotte zette debris dans drains, dans grand lapluie, canal bloque, delo pas capave decend vers la mer, donc, li ramasser et renter dans la case dimoune.</p> <p>Des fois, quand enan inundation, nous gagne presque 50 appels a la fois, depuis Control Room (115) normalement nou alle cotte premier appel , si nous par trouve danger, nous alle cotte second ansi de suite.</p> <p>Nous dire occupant de la maison, si so cas pas grave. ecoute ou ti capave faire enne ti canal pour evacuer delo , nous enan les autre dimoune qui bizin nou l'aide.</p>	<p>Often people have themselves to blame. They throw waste in the drains and with heavy rains the waterway gets clogged and the excess water cannot flow to the sea but rise and move into the houses.</p> <p>Often with flood, we may receive up to 50 calls at one time from Control Room (115). Normally, we go to the first caller. Once there is no danger, we move to the second, and so on.</p> <p>When there are many callers, we assess the situation, request the occupants to take minor measures such as digging a small canal to evacuate the little water. Then we</p>

	move to the next needy caller.
<i>Si enan delo lors chemin et empache zenfant alle l'ecole ou empeche circulation?</i>	<i>In case there is water on the road preventing children from going to school or impeding circulation?</i>
Sa ausi nou faire partout cote enan danger.	We also attend to these whenever there is a threat.
<i>Conflict après lapel?</i>	<i>What of conflict after the call?</i>
Nou toujours fair Control Room connais, puis nous alle lors l'autre appel, nous travaille en equipe , et divise nous quand ena emergency un peu partout. Aussi. Nous liaise avec fire services entiere tout ile pendant emergency dans gros lapluie.	We always inform the Control Room and then move to the next caller. We work as a team and divide ourselves appropriately when there is emergency in more than one place. Also, we liaise with other Fire Service units during emergency in case of widespread heavy rains.
<i>Qui zotte relation avec banne dimoune qui ou alle sauver?</i>	<i>What is your relationship with the people you go to rescue?</i>
Des fois, zotte reproche nous, nous pas ien vine dans l'heure, alors ou essaye explique zotte, nou ti ailleurs, mais beaucoup des fois, nou gagne banne bon compliments et remerciements surtout quand zotte famille ine delaisse zotte.	Sometimes, they complain that we do not turn up on time. We try to explain that we were elsewhere. But more often we receive compliments and thanks especially when their families abandon them.
<i>Et comment ou confronte banne zenfants, bébé et dimoune blesse qui enan pied dans l'eau?</i>	<i>How do you handle children in distress, babies and injured persons who have their feet in flood water?</i>
Banne jeune enfants nous tire zotte et ammene zotte cote parents. Dimoune blesse, nou appelle la police et SAMU, qui transporte zotte l'hôpital tout proche	Young children are taken away and brought to their parents. As for injured persons we call upon the police and SAMU (ambulance) who take them to the nearest hospital.
<i>Après qui zotte fini tire delo depi zotte lacaze, zotte fini avec zotte travail</i>	<i>After removing water from their houses, you consider your work done?</i>

Oui, nous appelle occupant la, demande zotte si zotte satisfait lerela nou aller parqui nous pou toujours enan lote intervention ene lote l’endroit surtout pendant periode inundation la.	We call upon the occupant and ask them if they are satisfied and the immediate danger is over, we have to move on because we have to be available for the next intervention in another location especially durng periods of flood.
<i>Apres sa?</i>	<i>What then?</i>
Banne dimoune qui victim inondations alle station la police pour donne zotte noms, et bilans dommage qui delo finne faire qui ensuite enregistrer zotte comme flood victims aupres Securite Social.	The affected persons have to contact the Police to make a report on the extent and nature of flood-related damage and then formally register themselves as flood victims with the Social Security.
<i>Dire moi in peu lors zotte equipment?</i>	<i>Give me some more information about your equipment?</i>
Tout dernièrement, nous fine gagne banne lapompe tres sophistike, tres perfomant, et aussi les autres outils qui pou permettre nou faire nous travaille plus efficacemnt.	Recently we have received more sophisticated and efficient pumps as well as other tools which will enable us to intervene more effectively in case of disaster and emergencies.
Et aussi role de telephone qui presque tou dimoune enan, portable, joue ene grand role dans prevention et sauve la vie beacoup dimoune dans banne catastrophe naturelle tel que innondation qui pe vine plus frequent.	And the telephone is playing an important role as most people have a mobile. This is getting to be key in prevention measures and save lives especially in the event of natural disasters such as flood which is more frequent these days.
<i>Merci Sanjay, et bon courage dans ou noble travaille de Fireman.</i>	<i>Thanks you Sanjay and my best wishes in your noble profession as a Fireman.</i>

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 21 Interview with a Police Officer

Question: Good morning. Thanks for accepting to give an interview for a study on flood-related issues.

Answer: Good morning.

Q: As a policeman, could you tell on your role when there is a flood in your area.

A: Normally we are all called upon even those who are on leave and we have to inspect that area when flood is happening. We have to cooperate on Firemen, Mobile Force Unit and CGS lifesavers who are already there before us, facilitate their task in assisting flood victims For those who have already left for shelter elsewhere, our first task is to safeguard their belongings from looting . We also help to prevent life loss of the inhabitants, keep people away from dangerous waterways, and facilitate circulation of ambulances and other vehicles to evacuating sick or injured persons to nearby hospitals.

Q: How do you know when to take action, do you follow certain directives?

A: In the event of a flood, we get phone calls from the public or directives from the Information Room of Police Headquarters in Caserne Centrale, Port Louis. We are all on alert, go the flood site, assess the situation and depending on the gravity of the flood, call fireman, ambulance for further assistance.

Q: This is the emergency stage, what about your role in the recovery phase of a flood event?

A: After a flood event, those who are affected by flood come to the Police station to declare themselves as flood victims .We make a record of the things lost or damaged , then submit them with a reference which is to be shown at the Ministry of Social Security for further assistance.

Q: What do they normally declare?

A: Usually, it is food items, spoilt or washed away by water coming into the house.

Q: What are your other roles?

A: Our other role is to maintain order when flood victims go to receive assistance from the Ministry of Social Security. There is often chaos and fights among those waiting their turn.

Thank you for your time.

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 22 Representative of the Ministry of Social Security

Question: *What is the role of the Ministry in the event of a natural disaster?*

Answer: The role of the Ministry follows the guidelines in the event of cyclones. Once a warning of an impending cyclone is issued, the Ministry arranges for the opening and manning of established Refugee Centres in all localities. Shelter, food and certain basic amenities are assured for the expected duration of the cyclone.

Q: *Do you feel the guidelines meet the requirements in the event of flood?*

A: Our recent experience shows that the situation is quite different in the case of flood. While those with fragile construction are afraid that the cyclonic winds will blow over their houses built of corrugated iron sheet, the people affected by flood are primarily concerned with keeping the family in dry conditions and ensuring that the food, animals and their furniture are not spoilt. They also felt the urgency of clearing, cleaning and protecting from further damage rather than seeking safety in refugee centres.

Q: *What do you think should be done in the event of flood?*

A: Contrary to the case of cyclone a new approach should be considered in the case flood. As conditions vary widely from one flooded area to the next, some variations in approaches should be applied to meet the specific needs of the local inhabitants. Some measure of decentralisation of the Ministry's role with the involvement of local communities and local NGOs should be envisaged.

Q: *How do cope with flood victims?*

A: On the 27th of March 2008, our officers worked on a list of flood victims. According with the Regulation¹⁵ made under the Social Act 1984, each household members affected by the flood was given a sum of Rs109 (£3) as an immediate assistance at the local Social Security Offices throughout the island but the number of flood victims were known, a sum of Rs5000 (£100) was given to each household .In addition to these, very affected households received some basic necessities like foodstuffs, clothing's, mattresses , kitchen utensils and school materials . Referring to the Report

on Payment to Flood Victims on the 1st of April: In CLC, there were 41 beneficiaries, LH some 15 and in GB some 15 as well.

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 23 Representative of the Ministry of Health

Question: Please describe the actions that the Ministry takes in the event of a natural disaster?

Answer: The Ministry of Health and Quality of Life has an Emergency Scheme that comes into operation in cases of Cyclones, Torrential rains and Landslides. According to Ministry Guidelines, the SAMU attends to such emergencies. In time when warnings are in force, it may be assisted with armoured vehicles. During the flood of 26 March 2008, the SAMU attended to 17 severe and 2 less severe cases.

Q: Your role appears to be more conventional in nature along the line of traditional medical interventions.

A: Indeed we respond to specific situations based on information made available to us from various sources. At the hospital, these cases are treated with urgency as are all other cases. No special arrangements are made either before, during or after an extreme event. Of course, the hospital staff is on alert as we expect an increase in people hurt during and immediately after such an event. We also prepare for cases of diarrhoea and other related diseases after the event.

Q: What do you see as the Ministry's role in preventive measures as extreme events such as flood appears to be on the increase and more widespread?

A: Recently, the Ministry has initiated the process of informing the public via the media of the need to boil water before drinking during and sometime after flood events. The incidents of skin irritation and itching are generally on the increase. The public will be henceforth informed systematically.

Q: In 2006/2007, the rainy season was followed by followed by the chikungunya epidemic when several thousands of people were affected. The frequent flood may give rise to such events in the future. What contingency measures exist to address such situations?

A: The *chikungunya* episode was unexpected and we were all caught unprepared. Now the medical staff have gained experience in dealing with such events. The Ministry is building contingency measures on such experience to address future occurrences. Such measures will have to be continually updated without unduly scaring the population and the tourists that visit our country.

Q: What other areas where the Ministry could take preventive and protective measures?

A: Apart from water, the Ministry could advise on food, clothing and home and yard sanitation.

Q: What other areas of preventive measures that the Ministry envisages to in the event of an extreme event?

A: A number of other measures are already announced by the media in the case of an impending extreme event. These could be coordinated and amplified to include health concerns and facilities available - hospitals, health centres, SAMU - to victims or people susceptible to be adversely affected. It may also be necessary to reinforce preventive measures and more systematic information dissemination ahead of a natural disaster.

Q: It is generally known that flood events in some cases may cause severe distress and even violent emotions comparable to group psychosis. What arrangements are made in such cases for the affected population?

A: Apart from the conventional medicine no group psychological therapy measures are taken on a routine basis. The Ministry may put in place therapeutic measures to address such needs in the event of natural disasters with the help of its psychologists, psychiatrists and community physicians and rehabilitative programmes to assist people in distress.

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 24 Interview with President of a local NGO at LH

Question: As an NGO worker, please explain what your NGO did to bring assistance to people who were affected by last flood event (2008)?

Answer: Our NGO, known as Action Civique de LH/Riche Terre, made significant contributions to alleviating the immediate suffering of the inhabitants stuck by the floods. It provided canned foods, cereals, rice, macaroni, clothing, copy books and writing materials for school children and various other useful items. As the NGO does not have its own resources it had launch an appeal to the inhabitants, business community, etc. We had to write to some of the firms. Overall, we found the inhabitants more generous. We also got cash contributions which we converted to goods. We got heaps of clothing. We were able to assist with food for a few days. A couple of women's NGO assisted us with the operation of identification and orderly distribution in accordance with the need of the individual family. A local business man provided us with storing facilities for a week or so.

However, we had to obtain permission from the Police authorities for the overall operation from collection to distribution. They were very helpful and expedient and also assisted with security. We kept a strict record. We provided receipts and forwarded a copy of the detailed account to the Police.

Q: *To how many people did you bring immediate assistance?*

A: Our record shows that we assisted some 40 families in need. Nearly all were women.

Q: *How were they contacted?*

A: The families affected live in the lower reaches of the Rivière Terre Rouge. Some of the members of the Association live in the area. They called upon the NGO to assist.

Q: *In what ways did you help?*

A: As mentioned earlier, the NGO collected foodstuff, clothing, school materials and other useful items urgently required. The funds collected were used to buy further items to ensure that there was enough for about a week's worth of food and that all families with school children had some writing materials.

Q: *Were they all of low income group background?*

A: As far as we could assess they were all of low income families. We worked closely with a couple of women's NGOs which operate in the area and are familiar with the situation of the families concerned. Our members also know many of the families assisted.

Q: *Would you call your assistance a short-term assistance?*

A: Yes, our assistance is primarily of a short-term nature. We did not offer any construction or other materials.

Q: *If not, in what other way do you offer long-term assistance?*

A: In view of the nature of the NGO with limited resources and the difficulty of accessing important sources for long-term assistance and managing them, our NGO focuses on short-term assistance whenever the need arises. However, on request, we assist the persons concerned with contacts where long-term assistance may be acquired.

Q: *Do you invest in structural, such as building and maintenance of flood proof structure?*

A: No. Primarily, we lack financial resources and human resources for management. It is also difficult for local NGOs to obtain resources for long-term assistance.

Q: *How do you obtain funds for such venture?*

A: For short-term assistance, we contact the local business community, other NGOs and the local inhabitants themselves. We provide receipt and keep a strict accounting and reporting procedure.

Q: *In what ways you think you contribute to resiliency and sustainability to such community?*

A: We could more by sensitisation. We could bring in the authorities concerned to give advice on ways of monitoring the possible onset of flood events, the pre-flood precautions to be taken, the possible action in the event of flood and the post-disaster actions. Subsequently, Our NGO could meet individually with the families concerned and reiterate the advice. It could monitor the situation more closely and keep contact with the families during the whole flood cycle. The NGO could do more on the long-term assistance to enhance resiliency. For example, the local NGOs could collaborate, draw up a Plan and develop a watch system in the event of flood and other disasters. They could act as a platform for interacting with the local and national authorities as well as with national firms and NGOs.

***Q:** How do you liaise with other NGOs and authorities to assist the flood-affected families?*

A: We have ad-hoc meetings with the NGOs most concerned and which are working with the inhabitants in the flood sensitive areas of the Village. We also have informal contacts with local authorities.

***Q:** How do you contribute to reliance and sustainability?*

A: We have been acting when the flood events seriously affect the inhabitants. We have no organised contributions towards reliance or sustainability. We have limited human and financial resources.

***Q:** Do you involve the local community and the flood-affected people in making decisions about how to help them?*

A: The local community is involved through the members of the NGOs familiar with the flood-affected inhabitants. No specific mechanism to involve the affected inhabitants in the decision-making process on the spur of the moments. We assess their immediate needs and take the necessary measures to assist.

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 25 Representative of local authorities

Question: What constitutes the local authority and what are statutory duties and responsibilities regarding natural disasters?

A: The local authority is generally represented by the Municipalities for towns and urban regions and District Councils for rural areas. Their responsibility includes “*the control, care, management, maintenance, improvement and cleansing of all pavements, drains, bridges, beds and banks of lakes, rivulets and streams.*”

Q: What is the state of water courses generally? Para 99,100

A: On the whole the situation is appalling. Actual photographs show that most of the water courses were blocked by unimaginable types of wastes – plastic bottles and bags, mattresses, refrigerators, tyres, construction materials, concrete blocks, iron sheets and branches. Grass and shrubs that grow on the river banks as well stones and branches carried during flood events often hinder the smooth flow of water. Some members of the public believe that the frequent flooding is the result of poor maintenance of the drains by the local authorities. This may be partly true but when considering the nature of most of the debris recovered from water courses point to the civic responsibility of the public as well.

Q: Don't you think the reasons for such uncivil actions and what is the responsibility of central government in all this?

A: The local authorities arrange for the collection of kitchen waste but no arrangements exist for the collection of the heavier waste such as refrigerators. This may partly explain the practice of throwing away such cumbersome object in the water ways. Where resources are inadequate and action is requires across an area covered by two or more local authorities, the government takes over. Another aspect is the strengthening of infrastructure and national policy on such matters.

Q: What are your constraints in maintaining the drains clean?

A: Lack of resources is the main concern. However, the constant call for change of priorities and the stretching of the available resources does not always allow for systematic cleaning of the drains. According to existing guidelines, all the drains must be cleared ahead of the rainy season. The available resources allows only for a partial adherence to the stated requirement.

Q: What do you think is the responsibility of the local inhabitants?

A: I think that the role of the local inhabitants is fundamental to addressing the crucial problem. They have to ensure that the natural water ways and storm drains in their land are kept clear and are not blocked in any way by walls, buildings or waste of any kind. These should be disposed of appropriately. They should collaborate with their neighbours and fellow residents in ensuring that drains and water courses are kept clear. As a community they should keep watch that the local authorities are duly informed of any flooding and monitor actions taken. Grouped in an NGO, they may have a stronger voice vis-à-vis their obstreperous fellow inhabitants and the authorities. They could also contribute to sensitisation by themselves and by inviting the authorities concerned on flood and on suitable measures to mitigate the impacts.

Q: What do you think are the responsibility of developers?

A: Developers as well as individuals have been allowed to build on low lying areas and even on wetland such as GB. The land is accessible to low income families and the developer backfills the land and level the ground. He obtains the permit, adds the amenities – road, water and electricity – and sells the plots often during the dry periods. The buyers are subjugated by the proximity to the sea or the hillside view or the proximity to an attractive riverside with a soothing water flow. On the first heavy downpour, the fury of the flood gives a jolt. When the new land lords realise the situation first hand, they often wall themselves in or even build walls on the natural water ways which had been conveniently left out of the title deeds by the developer. Water from one house is transferred to another living room or kitchen. People become desperate and much ill will is generated among neighbours. The problem becomes complex and intractable. The land owners find it difficult to collaborate and take a few steps back and work together to address the core problem. Complaints are constantly

filed. They reach a state of desperation. The authorities find it difficult to provide ready solution.

Q: What do you think, in summary, are the root causes of increasing flood in most areas?

A: A number of factors contribute to increase of flooding in most areas. There is the non-respect of the guidelines laid down for obtaining a permit for the construction. There are constructions on existing natural drains and the encroachment on water ways. The households throw away their waste in the drains. Promoters do not build adequate drainage in new construction sites.

Q: What additional long-term measure should the Government take to address the situation?

A: So far, in view of the expediency of providing housing to the needy families, housing complex are built first and the accompanying drainage well after often disastrous flood events have struck. This is the case with LH as well as CLC. This approach should be reversed through strengthened policy measures, addressed primarily to developers. The rivers and other water ways as well natural drains need to be protected by a reinforcement of existing legislation. The local authorities should be empowered through appropriate legislation to intervene where needed. The strict enforcement of the law should be accompanied by sensitising inhabitants, especially those directly affected by flood, as to the causes of the flooding and of measures that they may take to mitigate their effects. The sensitisation should be given priority at school and community levels. The culture of protecting the environment should be inculcated at school level.

AGENCY STAKEHOLDERS' INTERVIEWS

Appendix 26 Representative of the Ministry of Environment

Q: What do you see as the role of the Ministry in flood mitigation?

A: The Ministry's role is preventive and less during flooding. The detailed report on flood prone areas over the Island led to the formulation of a programme of land drainage. Institutional framework has been established extreme events such as torrential rains.

Q: What in your opinion could be done to address the growing floods and their inexorable impact?

A: The available database on flood prone areas should be updated as a matter of urgency. An integrated flood management strategy should be put in place. The formulation and implementation of the strategy should involve the affected communities, the local NGOs and the local authorities.

Appendix 27

Appendix 27 Number of nodes per theme for each of the types of resilience as expressed by the representatives of agency stakeholders

Type of resilience	Themes	NPU & Met	Police	Local authority	Health	Fire Services	NGO	Total
Social	Vulnerable persons	2	3		2	4	4	15
Economic	Flood impact		1	1	1	4	2	9
	House ownership			2				2
	Lack of resources			1			4	5
Infrastructure	Blocked waterways			2				2
	Drainage system			4				4
	Environmental problems			3				3
	Equipment					1		1
	Flood characteristics	4		3	1	2		10
	Built environment	4		4				8
	Land use			5				5
Institutional	Assistance	3	3				4	10
	Communication	1	1		2	4		8
	Institution responsibility	2						2
	Legislation			4				4
	Relief and Emergency		1		2	4	2	9
	Relocation		1					1
	Science and Technology	3						3
	Warning and Response	2						2
Psychological	Health risk				3			3
Community competence	Awareness	2		3	2		1	8
	Community responsibility	1						1
	Coping strategies			1				1
	Decision making	4						4
	Network	3	3	1	2		2	11
	Public complaints			2				2
	Public responsibility			3				3
Total		31	13	39	15	19	19	136

