LOCAL LEVEL FLOOD MANAGEMENT, RISK REDUCTION, AND COPING AND ADAPTATING IN THE RED RIVER VALLEY, MANITOBA, CANADA

BY

JOBAED RAGIB ZAMAN

A Thesis Submitted to the Faculty of Graduate Studies of

the University of Manitoba

in partial fulfilment of the requirement of

MASTER OF NATURAL RESOURCES MANAGEMENT

Clayton H. Riddell Faculty of Environment, Earth, and Resources
Natural Resources Institute
University of Manitoba
Winnipeg

Abstract

The purpose of this research was to study the pattern of flood preparedness, response and recovery, and the drivers of changes in flood management, i.e., coping and adapting, in the Red River Valley of Manitoba, Canada. I conducted my research following a case study approach with a qualitative research design. My study included the communities of St. Adolphe and Ste. Agathe in the Rural Municipality (RM) of Ritchot in Southern Manitoba. Techniques and instruments that were applied for data collection included Key Informant Interviews (8), Oral History Interviews (7), and Document Review.

The findings of the research revealed that local community-level flood preparedness, response, and recovery in the Province of Manitoba are primarily designed, governed, managed, and evaluated by Provincial government authorities using a top-down approach. Given that Canada has a long history of bailing out disaster victims, and as the approach has been generally non-participatory, community members show reluctance in taking precautionary measures, resulting in undesired losses and damages. The findings of my research also identified the major drivers of coping and adaptation measures for building flood resilience within the communities, which included: functioning partnerships among stakeholders, strong institutional structures that facilitate interactive learning, knowledge co-production, resource sharing, communication and information sharing, and infrastructure supports. However, there were only a few efforts to develop an institutional atmosphere conducive to spontaneous network development, yielding diverse coping and adaption strategies at the community level in the Province of Manitoba.

Acknowledgement

I would like to take this opportunity to acknowledge the copious support I had been privileged to receive from several individuals during my research. I am thankful to the Almighty as I have been surrounded by such kind-hearted and patient people, without who's gracious support this research would never be possible.

First and foremost, I would like to express my gratitude toward my thesis supervisor, Dr. C. Emdad Haque for his invaluable guidance and pivotal support that made my academic experience and journey as a graduate student fruitful. His continuous advice, encouragement, and cerebral conceptual ideas were indispensable to this research. I am also grateful to him for the financial arrangement and assistance from a SSHRC InSight Grant and the Graduate Enhancement of Tri-Council Stipends (GETS).

I deeply acknowledge the support and direction I received from my master's thesis advisory committee members – Dr. David Walker and Dr. Faisal Islam. Their astute observations and intellectual contributions have made this research meaningful. Their perspectives and theoretical explanations have broadened my understanding of the subject matter.

I am indebted to Jodi Goerzen for her advice and direction on communication with my then-prospective interviewees. Her help and support were unparalleled throughout the communication process. I would also like to extend my appreciation to Md. Abul Kalam Azad. His advice on preparing questionnaires and conducting interviews was constructive and valuable.

I am beholden to the faculty members of the Natural Resources Institute, University of Manitoba, as I learned innumerable theories, concepts and cases through the astonishing lectures and exercises during coursework. I am also grateful to the NRI staff for their seamless administrative support. I am also very grateful to the government and non-government officials and the community people of my study area for sharing their perspectives and assistance throughout the research.

Finally, I would like to recognize the enormous sacrifices made by my family – my parents, my wife, elder brother, and sister-in-law. Their inspiration and support during my study and research have always pushed me to do better. I would like to dedicate this thesis to them.

DEDICATION

This thesis is dedicated to my family.

Contents

List of Tables

List of Figures

Acronyms

RM	Rural Municipality
CAD	Canadian Dollars
NGO	Non-government Organization
REB	Research Ethics Board
IDNDR	International Decade for Natural Disaster Reduction
UN-ISDR	United Nations International Strategy for Disaster Risk Reduction
NRF	National Response Framework
EMO	Emergency Measures Organization
WMSD	Water Management and Structures Division
CSM	Communication Services Manitoba
FAM	Manitoba Families—Emergency Social Services
AGR	Manitoba Agriculture
EC	Manitoba Environment and Climate
INR	Manitoba Indigenous and Northern Relations
JUS	Manitoba Justice
MEECL	Manitoba Education and Early Childhood Learning
ODM	Office of Disaster Management
MTI	Manitoba Transportation and Infrastructure
CSC	Manitoba Civil Service Commission
OFC	Office of the Fire Commissioner
RCMP	Royal Canadian Mounted Police
DND	Department of National Defence

PS	Public Safety Canada
ISC	Indigenous Services Canada
CRC	Canadian Red Cross Society
SA	Salvation Army
MDS	Mennonite Disaster Services
ARES	Amateur Radio Emergency Service
LiDAR	Light Detection and Ranging
EMPS	Emergency Measures and Public Safety
EOC	Emergency Operations Center
MECC	Manitoba Emergency Coordination Centre
SoLE	State of local emergency
PSoE	Provincial state of emergency
MCIs	Mass casualty incidents
HFA	Hyogo Framework for Action
DRR	Disaster Risk Reduction
SFDRR	Sendai Framework for Disaster Risk Reduction
LCAD	Local Coping and Adaptation to Disasters
PMT	Protection Motivation Theory
INAC	Indigenous and Northern Affairs
DFA	Disaster Financial Assistance
RRBC	Red River Basin Commission
IISD	International Institute for Sustainable Development

Glossary

***Preparedness**:* Preparedness involves the actions that ensure the resources necessary to carry out an effective response, before the disaster takes place (Bradley and Bautista, 2010).

Response: Disaster response refers to the measures that are taken to protect people, the environment, and other resources from natural or anthropogenic hazards, including the provision of relief during disaster events (Tomaszewski et al, 2015).

***Recovery**:* Recovery from a disaster is a complex process starting immediately after a disaster event. It is considered as an act as well as a process of returning to a normal state after a period of difficulty passes.

***Coping strategies**:* Coping strategies are adopted by people or organizations where they use their resources, skills, and opportunities in order to defend themselves from the adverse effects of the consequences of a disaster (Parsons et al., 2016).

Adaptive capacity: Adaptive capacity is defined as the ability of a system to plan and prepare for and adjust to stress, affecting its vulnerability through the modulation of exposure and sensitivity (Engle, 2011).

Disaster management: The term refers to the aggregate of all activities, programs, and measures undertaken by various responders before, during, and after a disaster.

Disaster Management Cycle: The Disaster Management Cycle consists of three sequential components: (i) pre-disaster preparedness; (ii) response after a natural hazard strikes a community (such responses are carried out by individuals and local institutions); and (iii) post-disaster recovery and rehabilitation.

Chapter 1

Introduction

Local communities and local institutions are central elements of the present thesis research. A territory-based community or geographically localized settlement involves a group of people with a shared territory, common life, collective actions, and mutual identity [1]. In a local community, institutions represent the rules used by humans interacting within a range of variable, repetitive, and structured environments, where the rules are designated by government authorities or developed and enforced by community members themselves. Norms relevant to particular situations and ways of interaction among individuals are also regarded as institutions [2]. Three features inherent to any local community include: (i) a geographic dimension, (ii) human life dimensions, and (iii) relatively complete organizational structures (institutions and patterns of behaviour that cover the broad range of human interests). In such a local setting, community-level preparedness to deal with natural hazard risks, response to disasters, and recovery measures are commonly based on previous experience, institutional structure and supports, and human agency (i.e., proactive initiatives).

Individuals and local communities are usually engaged with the major components of the *disaster management cycle* that includes: (i) pre-disaster preparedness, (ii) response measures taken after the onset of a disaster, and (iii) post-disaster recovery and rehabilitation. *Preparedness* involves actions that ensure the resources necessary to carry out an effective response are available, before the disaster takes place [3]. The activities that constitute disaster preparedness include: planning processes to ensure that individuals, households, and organizations are ready; formulation of disaster plans; stockpiling resources for effective response; and the development of skills and competencies to ensure effective performance of disaster-related tasks [4]. *Recovery* is a complex process starting immediately after a disaster. It is considered as an act as well as a process of returning to a normal state after a period of difficulty passes. However, the definition of *normal* is a matter of debate. The pre-disaster state may even become undesirable after the disaster [5]. Naturally, the political, economic, social, and institutional characteristics of a region have direct influence on the recovery procedures [6].

Coping strategies are adopted by people or organizations where they use their resources, skills, and opportunities in order to defend themselves from the adverse effects of a disaster [7]. In disaster management, adaptation includes different kinds of activities to reduce impact of a disaster-shock, e.g., moderation of harm, and facilitating learning to increase the availability of beneficial opportunities. Such activities often are more effective responses natural hazards than efforts to control nature [8]. As a focus of the present research, it is very important to study the context-specific factors and processes that influence local coping and adaptation activities and strategies [9].

In the Province of Manitoba, Canada, overland floods plaguing rural municipalities carry destructive potential that can uproot the lives, businesses, and communities of people living in the Province's hazardous floodplain areas [10]. This thesis research focuses on critical aspects of flood management, including flood preparedness, response, recovery, and coping and adaptation strategies, along with their drivers, at the level of local communities and institutions. The study area is the Rural Municipality (RM) of Ritchot, Manitoba, Canada. There have been numerous severe floods in Manitoba, and with the growing threat of climate change worldwide, the frequency of floods, along with other environmental disasters, is also increasing in Manitoba [11].

Sensitivity to environmental hazards, such as floods, depends on the variability of geophysical events and the degree of socioeconomic tolerance [12]. Communities and individuals prepare themselves to cope with possible disasters; their preparation depends on the recorded magnitudes and frequencies of floods and their previous experience and resources. The consequence of extreme events can be catastrophic losses of both human lives and valuable resources. Such events are considered rare, but when they do take place, new issues and questions arise with respect to the human ability for coping, prevention, and mitigation of similar future events [13]. Several researchers have addressed the geophysical and societal causes of and issues with floods in Manitoba, focusing on the causes of floods and their management [14-17]. However, very little is known about the local dimensions of flood management, specifically local mechanisms and drivers, and the forces that underpin local community resilience to floods.

In consideration of the above backdrop, the present study aims to identify and evaluate the local level of risk-reduction efforts and patterns of flood preparedness, response and recovery, as well as the drivers of change, in the RM of Ritchot, Manitoba. In this chapter, the context and background of the study are introduced first, followed by the research problem statement, the purpose and objectives of the research, its significance, a brief description of the study area, and the organizational structure of the thesis.

1.1 Context and background

Historically, Manitoba has recorded major floods since the early 1800s. The floods of 1826, 1852, 1861, 1950 and 1979 caused substantial loss and damage along the Red and Assiniboine River Basins [18]. Notably, the frequency of extreme floods has increased in recent decades. Data in Table 1.1 illustrates the increased flood frequencies in recent decades relative to the historical past.

Spring flooding in the Red River Basin of Manitoba is a recurrent phenomenon. Several major floods have taken place in Manitoba in recent years, which have had a severe impact on people and infrastructure, and in turn, the Provincial economy. For example, the agro-based economy of the Province has been severely affected by spring floods that inundate agricultural lands following about six months of snow-covered winter (Rashid, Haider, & Hunt, 2000) [19].

Table 1.1 Extreme floods in Manitoba.

Flood Year	Return Period
1826	667
1852	150
1861	45
1950	28
1979	27

1997	110
2009	33
2011	30

Source: Data compiled by Mahmud (2015).

Following the flood of 1950, numerous structural measures were implemented in Manitoba to avoid flood damages, for example, the Red River Floodway, Portage Diversion, and Shellmouth Dam [20]. Despite such adaptation measures, economic losses due to floods, including losses in crop production, declarations of emergency, and damage to infrastructure have been increasing in recent years [21]. Moreover, climate variability and change have the potential to increase the annual discharge and to shift the starting time and peak levels of flooding in both the Assiniboine and the Red River Basins [22], which could render the structural measures less effective. Because flood damage can also be lessened through better understanding of public and experts' risk perception and knowledge and information sharing [23], it is necessary to improve emergency and disaster governance structures and establish an interactive decision-making process in flood management.

Recent studies have begun to address issues concerning stakeholder engagement, integration of local knowledge into flood management planning, the role of social networks and social learning in local-level coping and adaptation, and the role of institutions in flood management [24-28]. However, a focus on local-level flood preparedness and recovery measures, and patterns and drivers of coping and adaptations strategies for enhancing flood resilience has generally been absent in studies of Manitoba. This knowledge gap is addressed in the present research.

1.2 Flood management in Manitoba and the statement of the research problem

According to the 2016 census, the population of the Province of Manitoba was 1,278,365 [29]. Manitoba is called the Keystone province because of its central position in the Canadian confederation. Much of the surface of the eastern and northern part of the Province is taken up by

the Canadian Shield, while much of the south is flat prairie. Waterbodies including very large lakes constitute 15% of Manitoba [30].

In this geographic setting, the economy of Manitoba relies mainly on agriculture, energy, mining, and forestry, most of which are related to natural resources and dependent on the weather system and its dynamic variations. The climate of the Province is extreme, which can be explained in large measure by its central position on the North American continent. Therefore, Manitoba is subjected to natural hazards like tornados, thunderstorms, drought, flood, wildfire, winter storms, etc. These natural hazards cause deaths, injury, and socioeconomic losses in the region. For example, in the flood of 1997, 27,400 people had to be evacuated and damages and costs exceeded CAD $500 million [31]. Among natural hazards, flood-risk is the most prominent in Manitoba as floods frequently cause catastrophic losses to communities.

With the development of knowledge and experience, several structural measures have been undertaken to prevent flood damages in Manitoba. Along with dykes in vulnerable regions, major structural-engineering measures that have been implemented include the Red River Floodway, Portage Diversion, Shellmouth Dam, and Fairford River Water Control Structure [32].

However, the increasing trend of flood losses in the Province can be attributed to two kinds of factors – geophysical and societal. The geophysical causes include isostatic rebound, low-lying topography, creation of ice jams, unusual ice processes, and anomalous weather conditions. In addition to the geophysical factors, there are several societal factors that influence flood losses in Manitoba. These factors are related to the pattern of flood management, coping and adaptation strategies, and the learning processes at both the local community and institutional levels. Some of the societal causes are elaborated below.

An example of a structural-engineering intervention causing the flooding of some communities beyond the natural flood level is the flood of 2011, which was termed a “super flood”. The responsible Provincial department decided to divert flood water to Lake Manitoba and then to Lake St. Martin, in order to protect the City of Winnipeg from devastating flood levels. This artificial diversion brought about dire consequences for the inhabitants of Lake St. Martin, most of whom were First Nation people [33]. A court found the Manitoba government to be responsible

for the severe flood that took place beyond the natural level, as it destroyed homes and forced people to evacuate [34].

Anthropogenic activities certainly have an enormous influence on the advent of flood disasters. Ahmari, Blais and Greshuk (2016) [35] found that there was an association between the 2014 summer flood in Manitoba and changing land use and anthropogenically extended drainage networks, altering prairie hydrology.

Morris-Oswald [14] attributed the Red River Basin's vulnerability to floods to inadequate interactions between communities and institutions regarding flood risk management, where institutions dominate the response stage in flood management. Similarly, Wachira and Sinclair [71] found that despite the public being the first responders to a flood threat, their role in relevant Provincial decisions were minimal. In addition, within the City of Winnipeg, the Red River Floodway has reduced physical risk and provided the residents with a false sense of security. Consequently, a lowered risk perception has developed, leaving residents more vulnerable to unforeseen circumstances [36].

Flood preparedness, response, and recovery processes can be top-down, bottom-up, or balanced between the two in terms of governance. The top-down approach refers to a centralized control, whereas bottom-up governance is collaborative. Central authorities have more opportunities than community people to promote participation, resolve conflicts, and set common standards [37], because they govern public resources.

Coping and adaptation are two processes that are embedded within flood preparedness, response, and recovery activities, and relate to temporal changes. Definitions of coping and adaptation vary in accordance with various fields of study. In disaster management, *coping strategies* include short-term adjustments in response to climate change [38]. *Adaptations* are defined as various forms of the manifestation of adaptative capacity to reduce vulnerability, where *adaptive capacity* is the ability of an individual or a group to cope with, prepare for, and/or adapt to disturbances and uncertain conditions.

According to Armitage et al. (2011) [39], emerging networks, or horizontal and vertical linkages give rise to new social practices and stakeholder interactions. These practices enhance the ability of local communities to cope with variability and build longer-term adaptive responses,

minimizing risk and uncertainty. Institutions have the capacity and ability to promote knowledge development and social learning. Such learning can help increase adaptive capacity and reduce vulnerability [38]. Looking at disaster management through the lens of social learning, Haque et al. (2021) [40] observed that while disasters bring about loss, damage and human sufferings, but they can also offer unique scope for gathering experiences to learn. In this case, approaches and policies need to emphasize social learning that involves multiple parties, such as practitioners, policymakers, civil society representatives, and communities.

Social learning is currently considered a promising approach regarding collective decision-making in societal processes, especially processes that are characterized by complex, uncertain and involve multiple social perspectives. At the local level, social learning has significant policy implementation potential, as it is an overarching and normative concept creating a platform for individuals and organizations to learn from and about each other through information sharing, dialogue, or conflict.

Purpose and objectives of the research

The purpose of this research was to investigate patterns in flood preparedness, response, recovery, and coping and adaptation strategies, along with the drivers influencing their change, at the local community and institutional levels in Manitoba.

The two specific objectives of this thesis have been broken down into six research questions. Three research questions have been formulated for each objective, and the results related to each are presented in chapters two and three. The specific objectives and their respective research questions are presented in Table 1.2.

Table 1.2 The specific objectives and research questions in the thesis

Specific objectives of the thesis	Associated research questions
1. To examine the pattern of flood preparedness, response, and recovery	a) What is the pattern of local-level flood preparedness, response, and recovery in Manitoba? b) How can the structure of local-level flood management in Manitoba be characterised?

at the institutional level	c) How is the existing flood management structure in Manitoba compatible to its context?
2 (a). To identify institutional coping and adaptation measures at the community level; 2 (b). To examine the drivers of coping and adaptation measures	a) What are the dynamics of institutional coping and adaptation measures at the community level? b) What are the drivers of coping and adaptation strategies at the institutional level? c) What are the drivers of coping and adaptation measures at the local community level?

1.3 Methodological approach

Accomplishing the objectives of this research necessitated a thorough understanding of coping and adaptation strategies at the local community and institutional levels, factors of changes in principal elements of flood management, and the drivers of all of these. It also required identification of major actors in flood management at both local community and institutional levels, as well as the quasi-formal institutions in the communities that work diligently during a flood emergency and have profound influence over building flood resilience. Here, the answers were sought by examining the social settings of the selected local communities, their associated institutions, and the professionals and stakeholders who are embedded in these social settings and institutional systems. This required access to the flood history of Manitoba, policy documents and reports on regulations, news media documents, and experiential knowledge of local communities and relevant government and NGO professionals.

A qualitative research method was adopted to comprehend the pattern of flood preparedness, response and recovery, and the factors influencing their changes. As I explored and tried to understand the individual and collective human dimensions of the problems associated with flood disasters, a qualitative approach was found to be appropriate. This approach also helped me achieve my goal of data collection in the participants' setting, inductive data analysis to move from particulars to general themes, and to focus on individual and collective interpretations of

flood incidents and management activities [41]. Qualitative research helps researchers glean answers to questions about experience, meaning, and perspective from the standpoint of participants [42], and this aligned with the purpose of my study.

1.3.1 Strategy of inquiry and study area

In designing my research, I employed a case study strategy of inquiry [43] in order to explore local-level flood management mechanisms through the lens of coping and adaptation strategies. In qualitative research, the case study strategy involves asking questions that lead to developing a description of the case along with the themes that emerge from studying it. Case study-based research provides in-depth description of and insight into a process or a phenomenon within a bounded system or setting [44, 45]. It is a scientific investigation into real-life phenomena, where the investigation is in-depth within its environmental context (Ridder, 2017) [46].

The applicability of a case study approach has been recognized traditionally in community-based flood disaster management research. Its application is justified by its ability to involve the community people, which in turn offers a way to incorporate vulnerable populations and their resources into studies [47]. The case study strategy aligns well with community-based research because it involves creating a platform for approaching communities [48], and provides opportunity to explore contemporary social dimensions, real life problems, and social processes within a community [49].

The case study approach was the best fit for my study because I explored problems with the current patterns and processes of flood preparedness, response, and recovery in Manitoba, and identified the drivers of changes in them. The issues examined are specific to the local communities of St. Adolphe and Ste. Agathe in the RM of Ritchot. This research constitutes a case study representing this local context, and the sources of information were relevant organizational documents and the memory, experiences, and opinions shared by local community and institutional stakeholders.

These communities were selected primarily because of their high physical exposure and vulnerability to floods due to their geographic location, their experience of floods in recent decades, and the willingness of the RM of Richot to participate in the research. There were some

secondary reasons behind selecting these communities, which included their geographical accessibility and vicinity to four significant rivers, namely, the Red River, Rat River, LaSalle River and Seine River. The Red River is the largest of the four. It flows in from the United States northbound by the Villages of Ste. Agathe and St. Adolphe, through the City of Winnipeg, and eventually drains into Lake Winnipeg [50] (Shown in Figure 1.2).

It is notable that only a limited number of studies have yet been carried out on nature and drivers of the flood management strategies to build community flood resilience in this area. As well, the selected communities potentially exemplify a microcosm of flood management strategies, measures, and outcomes in the Canadian local context.

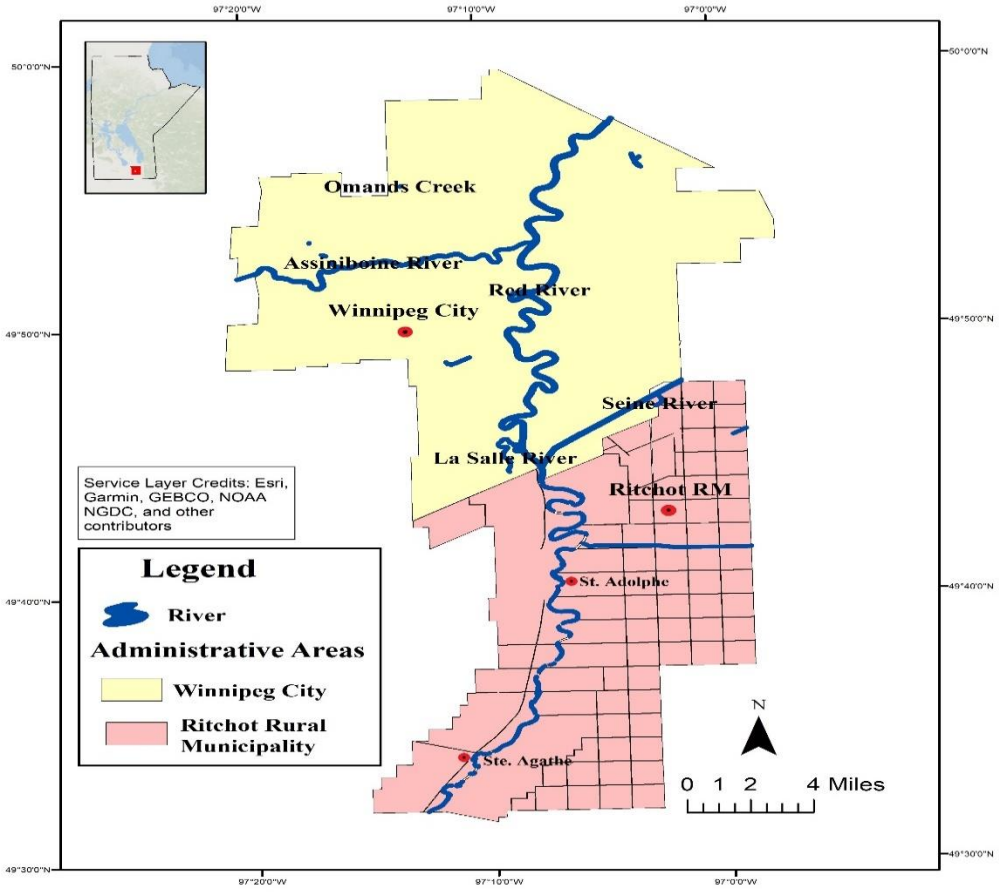

Figure 1.1: Location map of Ritchot RM, Manitoba (Source: Google Maps).

The geographic location of the RM of Ritchot along the Red River floodplain makes it a flood-prone area. In terms of location, climate, and ecological characteristics, a marked continentality is exhibited by the Province. One of the most important influences on Manitoba's climate is its latitudinal position. Not only is the climate of Manitoba extreme, but it is also variable.

The flood characteristics are unique in Manitoba and are strongly influenced by the landscape of the Red River Valley. Flows of the river are erratic and highly variable, ranging from periods of virtually no flow to extremely high flows that create flood conditions. Data presented in Tables 1.3 and 1.4 exhibit the profile of the RM of Ritchot and the respective population and industry of the two selected communities.

Table 1.3 Profile of Rural Municipality of Ritchot

Criteria	Ritchot RM
Population	6679 persons
Land area (square kilometers)	333.55 (128.78 square miles)
Population density per square kilometer	20 (12.43 miles)
Employed	3835
Unemployed	170
Main mode of commuting	Car, truck, van – as a driver. Other modes include car, truck, van as a passenger, public transit, walking, bicycle.

Source: Census Profile, 2016 Census, 2019.

Table 1.4 Demographic and economic characteristics of the study communities

Community	Population	Females	Population of ages <15 and >65	Industry
St. Agathe	640	325	225	Agriculture, forestry, fishing, hunting, construction, manufacturing, wholesale and retail trade, finance and insurance, educational services, health care and social assistance, accommodation and food services.
St. Adolphe	1,360	665	475	Agriculture, forestry, fishing, hunting, construction, manufacturing, wholesale and retail trade, transportation and warehousing, information and cultural industries, finance and insurance, real estate, professional, scientific, and technical support, educational services, health care and social assistance, accommodation and food services, public administration.

Source: Statistics Canada, 2019. Census Profile, 2016 Census.

1.3.2 Selection of participants

Prior to the selection of participants, ethical approval was procured from the Research Ethics Board (REB), University of Manitoba (see Appendix 3). Two sampling techniques were adopted to select participants for my research: purposive and snowball sampling. Purposive

sampling is pursued for better matching of the sample to the aims and objectives of the research [51], and therefore this sampling technique assisted me in selecting participants who were relevant to my research and have had long exposure to floods and experience of living in the floodplain.

I asked for assistance from the participants I found through purposive sampling to look for other potential participants who also had long exposure to floods in the two communities. I was thus able to find new participants in the local communities who were eligible and interested in participation. I pursued this process until data saturation took place (Naderifar et al., 2017) [52].

To request participation, I first emailed potential participants briefly describing the study and its purpose and objectives. After they agreed informally, I sent them a letter of consent so that they could be aware of the preconditions of participating in the study. I then arranged for interviews according to their preferences for a convenient time, place, and manner of communication (Zoom or in-person). I recorded the audio of the interviews with their consent, and also took notes during the interviews. There were specific participant selection criteria in my research based on the method of data collection. Two kinds of interviews were conducted in the study, namely key informant interviews (KII) and oral history interviews. The criteria for selecting interviewees are presented in Appendix 1.

All interviews were conducted in English, and then transcribed and coded to understand the pattern of flood preparedness, response, and recovery, drivers of changes to them, and social learning from the flood experiences.

1.3.3 Methods of data collection

To elucidate how flood management activities are governed and how social learning contributes to the dynamics of such management, I gathered and assembled both primary and secondary data. For primary data collection, I employed two qualitative data collection instruments, namely Key Informant Interviews (8) and Oral History Interviews (7). I also utilized Document Review to obtain a clear and precise idea of how the institutions relevant to flood management work in Manitoba at the local level.

Key informant interviews are held with individuals with knowledge of a particular issue. It is an effective method that allows deep investigation into an issue in which the respondent is well versed [42]. It helps in understanding and explaining experiences and reasons behind the changes in social and political processes [53, 54]. Although the method is place-based, it is also possible for the informants to identify attitudes and issues in the locale under study that have been recognized in other places, if necessary [55].

A semi-structured interview questionnaire was used for carrying out these interviews. Eight respondents were selected from: the community, officials engaged in flood management from the local and Provincial governments, non-profit organizations, and community-based groups. They were interviewed once. The key informant interviews were carried out on a one-to-one basis. The duration was usually half an hour.

Oral history interviews involve the collection of stories and reminiscences that are provided by a person or persons who have had firsthand knowledge and related stories [56]. It is a collaborative narrative building process between the researcher and interviewee, which involves spending a longer period of time together [57]. In this method, the experiences of individuals are emphasized [58]. Seven oral history interviews were carried out to analyze the interviewees' common experiences and variable perceptions; each interview was one and a half to two hours long. The participants of the oral history interviews were elderly members of the community who had experienced historical floods, and included one ex-politician who had in-depth knowledge and experience of the floods and their management in the Province.

Table 1.5 provides an overview of the methods of data collection, the objectives for which those methods were adopted, and the associated rationale.

Table 1.5 Summary of research objectives, methods of data collection, and rationale

Objectives	Research questions	Methods of data collection	Rationale
1) To examine the pattern of flood preparedness, emergency response, and recovery at the institutional level	a) What is the pattern of local-level flood preparedness, response, and recovery in Manitoba? b) How can the structure of local-level flood management in Manitoba be characterised? c) How is the existing flood management structure of Manitoba compatible to its context?	• Document review; • Key informant interviews; • Oral history interviews.	• Document review provided background of the current flood management activities in Manitoba, and how institutions work. • KII helped understand the reasons behind the flood management activities. • Oral history interviews explained the changes of flood management activities at the local level.
2) a) To identify institutional coping and adaptation measures at the community level; b) To examine the drivers of coping and adaptation measures	a) What are the dynamics of institutional coping and adaptation measures at the community level? b) What are the drivers of coping and adaptation strategies at the institutional level? c) What are the drivers of coping and adaptation measures at the local community level?	• Document review • Key informant interviews • Oral history interviews.	• Document review provided the chain of incidents and the government initiatives that drove the changes in flood management at the local level. • KII provided an understanding of the drivers that were determined by the actors at the government and the local community level. • Oral history interviews explained how the drivers of coping and adaptation influenced changes in flood management over time.

1.3.4 Method of data analysis

A data reduction approach was applied to edit the data, summarize them, and make them presentable [59]. I coded the collected data for data reduction, organization, and analysis. I coded them according to key themes, sub-themes, and dynamic interconnectedness among the themes. For this purpose, I created a file named *codebook*, which I followed to organize the data [60]. For coding the data, I used a paper-based system to determine the key themes and sub-themes that I collected from each interview. Afterwards, I presented the data in written form by integrating them following the objectives and associated research questions in my research.

1.4 Significance of the research

The research focuses primarily on the understanding of the patterns of local-level flood preparedness, response, and recovery, and the drivers of coping and adaptation strategies in the communities of St. Adophe and Ste. Agathe in the RM of Ritchot, Manitoba. The dynamics of the formal institutional structure at the local level and the informal social interactions and learning are not well known, despite the fact that these factors play vital roles in all stages of the flood management cycle.

In terms of flood management activities, most literature emphasizes understanding national and global level flood management patterns [61-65]. As well, there is a plethora of literature focusing on the strategies for coping and adaptation to floods [66-70]. But few research studies have yet looked into the local level of flood management patterns and the nature of and interplay among factors influencing local coping and adaptation measures, including in the Province of Manitoba.

Recognizing this gap in research and the significance of local-level flood management patterns (for context-based problem resolution) and importance of identifying the drivers of changes in flood coping and adaptation strategies, the goal of this study was to address this knowledge gap. The findings of this particular research will help understand local perspectives of flood management activities,

forces behind successful flood mitigation, and reasons for failed measures. Such understanding can spur and inform the undertaking of locally adaptive policy development and implementation.

1.5 Statement of contribution

I am the sole author for Chapters One and Four. I wrote the two chapters under the adept supervision of Dr. C. Emdad Haque. Chapters Two and Three have been developed for publication and were co-authored manuscripts. Both Chapter Two and Chapter Three were co-authored by me as lead author, Dr. C. Emdad Haque, and Dr. David Walker. Chapter Two was published in the *Geographies* journal and Chapter Three in the *Geosciences* journal. Biographic citations for the chapters are given below:

Chapter 2: Zaman, J. R., Haque, C. E., & Walker, D. (2022). Local-Level Flood Hazard Management in Canada: An Assessment of Institutional Structure and Community Engagement in the Red River Valley of Manitoba. *Geographies, 2(4)*, 743-768.

I carried out the fieldwork including the interviews for data collection. I and Dr. C. Emdad Haque developed the conceptual considerations. I wrote the manuscript with support from Dr. C. Emdad Haque and Dr. David Walker. Dr. C. Emdad Haque supervised the project. All authors contributed to the final manuscript.

Chapter 3: Haque, C. E., Zaman, J. R., & Walker, D. (2023). Risk-Reduction, Coping, and Adaptation to Flood Hazards in Manitoba, Canada: Evidence from Communities in the Red River Valley. *Geosciences, 13(3)*, 88.

I carried out the fieldwork including the interviews for data collection. I and Dr. C. Emdad Haque developed the conceptual considerations, conducted analysis and interpretation and wrote the manuscript with support from Dr. David Walker.

1.6 Organization of the thesis

This thesis is organized into four chapters. Chapter One introduces the study by laying out the context and background, the research problem, purpose and objectives of the research, methodological approaches to the research, significance of the research, and a description of the organization of the thesis. Building on the findings of my research, Chapter Two and Chapter Three offer a detailed presentation of the results of the study's two main areas of empirical investigation. Chapter Two focus on the pattern of local-level flood management in the Red River Valley by assessing institutional structure and the level of community engagement. Chapter Three analyses findings on risk reduction, and drivers of coping and adaptation to floods as evidenced from the local communities and institutions. Both chapters display the narratives, relevant literature, methodology, key takeaways, and analytical discussions. Finally, Chapter Four represents a synthesized and thematic discussion of the overall major findings, while concluding the thesis with an indication of the critical contributions of the study, significant policy implications, suggestions for future research, and key limitations of the study (Table 1.6).

For this present study, I have followed a manuscript-based format, as appropriate and compatible with my approach and findings. Based on research findings, I have prepared two peer-reviewed journal papers that have recently been published. The data collection and the methods of data analysis for these chapters were similar. As a result, there are some repetitions and overlaps in the method sections. However, each chapter offers unique insights into the significance of local-level flood management patterns, the contributing drivers of coping and adaptation strategies, and their policy implications.

Table 1.6 Chapters and content of the thesis

Chapter	Description
Chapter One	*Introduction* (Context and background, research problem, purpose and objectives, methodological approaches, organization of the thesis, and references).
Chapter Two	*Local-level Flood Hazard Management in Canada: An Assessment of Institutional Structure and Community Engagement in the Red River Valley of Manitoba* (Abstract, introduction, conceptual framework, methods and study area, findings and analysis, discussion, conclusion, and references).
Chapter Three	*Risk-Reduction, Coping and Adaptation to Flood Hazards in Manitoba, Canada: Evidence from the Red River Valley Communities* (Abstract, Introduction, conceptual considerations, flood vulnerability and risk-reduction measures in the Red River Valley, Manitoba, materials and methods, results, discussion, conclusion, and references).
Chapter Four	*Discussion and Conclusion* (Introduction, methodological approaches, key findings, major contributions of the research, policy implications and recommendations, future research, major limitations of my study, and references).

1.7 References

1. Theodori, G. L. Community and community development in resource-based areas:Operational definitions rooted in an interactional perspective. *Society and NaturalResources, 18(7).* **2005**, pp. 661-669.
2. Ostrom, E. Institutions and the Environment. *Economic affairs, 28(3).* **2008**, pp. 24-31.
3. Bradley, A. T., and Bautista, M. *Handbook to practical disaster preparedness for the family*. **2010**, Retrieved from https://books.google.ca/books?hl=en&lr=&id=eXdCK7QghcgC&oi=fnd&pg=PA3&dq=Handbook+to+Practical+Disaster+Preparedness+for+the+Family:+Arthur+Bradley%3B+2010.%09Available&ots=vaq_k8vFMJ&sig=tYHmYjE_OjMNyKnP1IbayOSkyY&redir_esc=y#v=onepage&q=Handbook%20to%20Practical%20Disaster%20Preparedness%20for%20the%20Family%3A%20Arthur%20Bradley%3B%202010.%09Ava ilable&f=false
4. Sutton, J. and Tierney, K. D*isaster Preparedness: Concepts, Guidance, and Research*. University of Colorado, Boulder, Colorado. **2006**, Retrieved from https://www.bencana - kesehatan.net/arsip/images/referensi/april/Disaster%20Preparedness%20Concepts_Jurnal .pdf
5. Platt, S. Factors affecting the speed and quality of post-disaster recovery and resilience. *Earthquake Engineering and Structural Dynamics in Memory of Ragnar Sigbjörnsson: Selected Topics*. **2018**, 369-403.
6. Haque, C.E. and Burton, I. Adaptation Options Strategies for Hazards and Vulnerability Mitigation: An International Perspective. *Mitigation and Adaptation Strategies for Global Change, 10*. **2005**, pp. 335-353.
7. Parsons, M., Glavac, S., Hastings, P., Marshall, G., McGregor, J., McNeill, J., Morley, P., Reeve, I. & Stayner, R. Top-down assessment of disaster resilience: A conceptual framework using coping and adaptive capacities. *International Journal of Disaster Risk Reduction, 19*. **2016**, pp. 1-11.
8. Lei, Y., Yue, Y., Zhou, H., & Yin, W. Rethinking the relationships of vulnerability, resilience, and adaptation from a disaster risk perspective. *Natural hazards, 70(1).* **2014**, pp. 609-627.
9. Berman, R. J., Quinn, C. H., & Paavola, J. Identifying drivers of household coping strategies to multiple climatic hazards in Western Uganda: implications for adapting to future climate change. *Climate and Development.* **2015**, *7(1),* 71-84.
10. Crumb, B. *Planning for Disaster: Assessing the Overland Flood Hazard in the Rural Municipality of De Salaberry* (Master's thesis, University of Manitoba, Winnipeg,Canada). **2006**, Retrieved from https://mspace.lib.umanitoba.ca/handle/1993/29674
11. Haque, C.E., Choudhury, M. and Sikder, M.S. Events and failures are our only means for making policy changes": learning in disaster and emergency management policies in Manitoba, Canada. *Natural Hazards, volume 98*. **2018**, pp. 137-162.
12. Smith, K. *Environmental hazards: assessing risk and reducing disaster.* 6th ed. Abingdon, Oxon ; New York, Routledge. **2013**.

13. Haque, C.E. Risk Assessment, Emergency Preparedness and Response to Hazards: The Case of the 1997 Red River Valley Flood, Canada. *Natural Hazards, volume 21*. **2000**, pp. 225 - 245.
14. Morris-Oswald, M. *The Social Construction of Vulnerability to Flooding: Perspectives and Values from the Red River Basin* (Doctoral dissertation, University of Manitoba, Winnipeg, Canada). **2007**, Retrieved from https://mspace.lib.umanitoba.ca/handle/1993/8017.
15. Sikder, M.S. *Disaster and Emergency Management (DEM) Policy Shifts, and Learning in Manitoba, Canada* (Master's thesis, University of Manitoba, Winnipeg, Canada). **2017**, Retrieved from https://mspace.lib.umanitoba.ca/bitstream/handle/1993/32862/Sikder_Md%20Sowayib.pdf?sequence=5&isAllowed=y
16. Haque, C. E., Mahmud, K. H., Walker, D., & Zaman, J. R. Geophysical and Societal Dimensions of Floods in Manitoba, Canada: A Social Vulnerability Assessment of the Rural Municipality of St. Andrews. *Geosciences.* **2022**, *12(2)*, 56.
17. Haque, C. E., and Etkin, D. People, community, and resilience: Societal dimensions of environmental hazards. *Natural hazards (Dordrecht), 41(2).* **2007**, pp. 271-282.
18. *Manitoba Flood Facts.* Government of Manitoba. **n.d.**, Retrieved from https://www.gov.mb.ca/flooding/history/index.html on December 13, 2020
19. Rashid, H., Haider, W., & Hunt, L. Post-flood assessment of emergency evacuation policies in the Red River basin, Southern Manitoba. *The Canadian Geographer, 44*. **2000**, 369-386.
20. Blais, E. L., Clark, S., Dow, K., Rannie, B., Stadnyk, T., & Wazney, L. Background to flood control measures in the Red and Assiniboine River Basins. *Canadian Water Resources Journal/Revue canadienne des ressources hydriques.* **2016**, *41(1-2)*, pp. 31-44.
21. Canadian Disaster Database. **2013, September 12**, Retrieved from https://cdd.publicsafety.gc.ca/rsltseng.aspx?cultureCode=enCa&boundingBox=&provinces=3&eventTypes=&eventStartDate=&injured=&evacuated=&totalCost=&dead=&normalizedCostYear=1&dynamic=false
22. Simonovic, S. P., & Li, L. Sensitivity of the Red River Basin flood protection system to climate variability and change. *Water resources management, 18(2).* **2004**, pp. 89-110.
23. Chowdhury, P. D., & Haque, C. E. Risk perception and knowledge gap between experts and the public: issues of flood hazards management in Canada. *Journal of Environmental Research And Development, 5(4).* **2011**, pp. 1017-1022.
24. . Hiwasaki, L., Luna, E., & Shaw, R. Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. *International journal of disaster risk reduction, 10*. **2014**, 15-27.
25. Kreibich, H. and Thieken, A.H. Coping with floods in the city of Dresden, Germany. *Natural Hazards, 51*. **2009**, pp. 423-436.
26. Dewi, A. Community-based analysis of coping with urban flooding: a case study in Semarang, Indonesia. ITC. **2007, March**.

27. Johannessen, Å., & Hahn, T. Social learning towards a more adaptive paradigm? Reducing flood risk in Kristianstad municipality, Sweden. *Global Environmental Change, 23(1).* **2013**, pp. 372-381.
28. Pahl-Wostl, C., Becker, G., Knieper, C., & Sendzimir, J. How multilevel societal learning processes facilitate transformative change: a comparative case study analysis on flood management. *Ecology and Society, 18(4),* **2013**.
29. Statistics Canada. Census Profile, 2016 Census. 2019, August 09. *Statistics Canada*. **2019**, retrieved from https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CSD&Code1=4602075&Geo2=PR&Code2=46&SearchText=Ritchot&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=4602075&TABID=1&type=0 on December 19, 2020.
30. Corkery, M. T. Geology and landforms of Manitoba. *J. Welsted, J. Everitt and C. Stadel (eds), The Geography of Manitoba*. The University of Manitoba Press, Winnipeg. **1996**, pp 19-21
31. Rannie, W. The 1997 flood event in the Red River basin: Causes, assessment and damages. *Canadian Water Resources Journal / Revue Canadienne Des Ressources Hydriques.41(1-2).* **2015**, 45-55.
32. Government of Manitoba. *Hydrologic Operations. Manitoba Transportation and Infrastructure*. **n.d.**, Retrieved from https://www.gov.mb.ca/mit/wms/ops/index.html
33. Geebu, R. *Analyzing the Geographical Impact of Water Control Structures and the 2011 "Super Flood" of Manitoba on Lake St. Martin First Nation using Historical Aerial Photos, Light Detection and Ranging Data, and Geographical Information System* (Master's thesis, University of Manitoba, Winnipeg, Canada). **2017**, Retrieved from https://mspace.lib.umanitoba.ca/xmlui/handle/1993/32509
34. Froese, I. Manitoba government deemed partially responsible for 2011 flooding of Lake Manitoba. *CBC News*. **2021, June 13**, Retrieved from https://www.cbc.ca/news/canada/manitoba/manitoba-loses-lawsuit-lake-manitoba-property-owners-flooding-1.6063752
35. . Ahmari, H., Blais, E. L., & Greshuk, J. The 2014 flood event in the Assiniboine River Basin: causes, assessment and damage. *Canadian Water Resources Journal/Revue canadienne des ressources hydriques.* **2016**, *41(1-2),* pp. 85-93.
36. Olczyk, M.E. *Flood Risk Perception in the Red River Basin, Manitoba: Implications for Hazard and Disaster Management* (Master's thesis, University of Manitoba, Winnipeg, Canada). **2005**, Retrieved from https://mspace.lib.umanitoba.ca/handle/1993/7909
37. Huntjens, P., Lebel, L., Pahl-Wostl, C., Camkin, J., Schulze, R., Kranz, N. Institutional = design propositions for the governance of adaptation to climate change in the water sector. *Glob. Environ. Chang.,* 22. **2012**, 67–81
38. Berkes, F., & Armitage, D. Co-management institutions, knowledge, and learning: Adapting to change in the Arctic. *Etudes/Inuit/Studies, 34(1).* **2010,** 109-131.
39. Armitage, D., Berkes, F., Dale, A., Kocho-Schellenberg, E., & Patton, E. Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Global environmental change.* **2011,** *21(3),* 995-1004.

40. Haque, C. E., Berkes, F., Fernández-Llamazares, Á., Ross, H., Chapin III, F. S., Doberstein, B., Reed, M.G., Agrawal, N., Nayak, P.K., Etkin, D., Doré, M. & Hutton, D. Social learning for enhancing social-ecological resilience to disaster-shocks: a policy Delphi approach. *Disaster Prevention and Management: An International Journal, 31(4).* **2021**, pp. 335 - 348
41. Creswell, J. W. *Qualitative inquiry and research design: Choosing among five approaches.* **2012**, London, UK: Sage Publications.
42. . Creswell, J. W. *Research design: Qualitative, quantitative, and mixed methods approaches.* **2013**, Sage publications.
43. Hammarberg, K., Kirkman, M., & de Lacey, S. Qualitative research methods: when to use them and how to judge them. *Human reproduction.* **2016**, *31(3),* 498-501.
44. Lincoln, S. Y. *Naturalistic inquiry* (Vol. 75). Egon G. Guba (Ed.). London, UK: Sage Publications. **1985**.
45. Creswell, J. W., & Creswell, J. D. *Research design: Qualitative, quantitative, and mixed methods approaches*. **2017**, Sage publications.
46. Ridder, H. G. The theory contribution of case study research designs. *Business Research, 10(2).* **2017**, 281-305.
47. Phillips, B. D. Qualitative methods and disaster research. *International Journal of Mass Emergencies and Disasters, 15(1).* **1997**, pp. 179-195.
48. Neuman, W. L. *Social research methods: Qualitative and quantitative approaches.* Edinburgh: Pearson Education Limited. **2014**.
49. Yin, R. K. *Case study research : Design and methods*. Los Angeles: Sage. **2014**.
50. Emergency Planning. (n.d.). *Ritchot Municipality*. Retrieved from https://www.ritchot.com/p/emergency-planning on December 19, 2020.
51. Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D. & Walker, K. Purposive sampling: complex or simple? Research case examples. *Journal of research in Nursing.* **2020**, *25(8),* 652-661.
52. Naderifar, M., Goli, H., & Ghaljaie, F. Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in development of medical education, 14(3).* **2017**.
53. Patton, M. *Qualitative Research and Evaluation Methods (3rd edition).* Sage publications Inc. **2002**.
54. Rubin, H. J., & Rubin, I. S. *Qualitative interviewing: The art of hearing data*. Sage. **2011**.
55. Elmendorf, W. F., & Luloff, A. E. Using key informant interviews to better understand open space conservation in a developing watershed. *Journal of Arboriculture, 32(2).* **2006**, pp. 54-61.
56. Janesick, V. J. *Oral history for the qualitative researcher: Choreographing the story*. **2010**,Guilford Press.
57. Liamputtong, P. *Qualitative research methods,* Australia and Newzealand Oxford,University Press. **2009**.
58. Marshall, C., & Rossman, G. B. *Designing qualitative research*. Sage. **2010**.
59. Mezmir, E. A. Qualitative data analysis: An overview of data reduction, data display, and interpretation. *Research on humanities and social sciences, 10(21).* **2020**, 15-27.

60. Cope, M. Coding qualitative data. *Qualitative research methods in human geography, 3*. **2010**, 281-94.
61. Krieger, K. The limits and variety of risk-based governance: The case of floodmanagement in Germany and England. *Regulation & Governance, 7(2).* **2013**, 236-257.
62. Othman, M., Ahmad, M. N., Suliman, A., Arshad, N. H., & Maidin, S. S. COBIT principles to govern flood management. *International journal of disaster risk reduction, 9.* **2014**, 212-223.
63. Butler, C., & Pidgeon, N. From 'flood defence'to 'flood risk management': exploring governance, responsibility, and blame. *Environment and Planning C: Government and Policy, 29(3).* **2011**, 533-547.
64. Heintz, M. D., Hagemeier-Klose, M., & Wagner, K. Towards a risk governance culture in flood policy—Findings from the implementation of the "floods directive" in Germany. *Water, 4(1).* **2012**, 135-156.
65. Latif, A. A., & Arshad, N. H. A review of flood management governance framework in malaysia and selected countries. In *Proceedings of the 6th International Conference on Information Technology and Multimedia* (pp. 178-183). **2014, November**, IEEE.
66. Maltais, D., Lachance, L., Brassard, A., & Dubois, M. Social support, coping and psychological health after a flood. *Sciences sociales et santé, 23(2).* **2005**, 5-38.
67. H., Kreibich, H., Müller, M., & Merz, B. Coping with floods: preparedness, response and recovery of flood-affected residents in Germany in 2002. *Hydrological Sciences Journal, 52(5).* **2007**, 1016-1037.
68. Stewart, R. M., & Rashid, H. Community strategies to improve flood risk communication in the Red River Basin, Manitoba, *Canada. Disasters.* **2011**, *35(3),* 554-576.
69. Thistlethwaite, J., Henstra, D., Brown, C., & Scott, D. How flood experience and risk perception influences protective actions and behaviours among Canadian homeowners. *Environmental management, 61(2).* **2018**, 197-208.
70. Hurlbert, M., & Gupta, J. Adaptive governance, uncertainty, and risk: policy framing and responses to climate change, drought, and flood. *Risk Analysis, 36(2).* **2016**, 339-356.
71. Wachira, J. and Sinclair, A. J. 2005. Public participation in the emergency response phase of flooding: A case study of the Red River Basin. *Canadian Water Resources Journal,* 30(2): 145-158.

Chapter 2

Local-Level Flood Hazard Management in Canada: An Assessment of Institutional Structure and Community Engagement in the Red River Valley of Manitoba *

Abstract: While there is a large body of literature focusing on global-level flood hazard management, including preparedness, response, and recovery, there is a lack of research examining the patterns and dynamics of community-level flood management with a focus on local engagement and institutional mechanism. The present research explores how local communities mobilize themselves, both individually and institutionally, to respond to emerging flood-related situations and recover from their impacts. A case study approach was applied to investigate two towns in the Red River Valley of Manitoba, Canada: St. Adolphe and Ste. Agathe. Data collection consisted of in-depth interviews and oral histories provided by local residents, in addition to analysis of secondary official records and documents. The findings revealed that local community-level flood preparedness, response, and recovery in the Province of Manitoba are primarily designed, governed, managed, and evaluated by the Provincial government authorities using a top-down approach. The non-participatory nature of this approach makes community members reluctant to engage with precautionary and response measures, which in turn results in undesired losses and damages. It is recommended that the Government of Manitoba develop and implement a collaborative and participatory community-level flood management approach that draws upon the accumulated experiential knowledge of local stakeholders and institutions.

Keywords: place-based community; flood hazard; disaster cycle; local-level; community engagement; community resilience; participatory decision-making; stakeholders; Red River valley;

2.1 Introduction

Geographers have long been interested in understanding the resource potential and "hazardousness of a place," the latter having been succinctly detailed more than half a century ago by Kenneth Hewitt and Ian Burton [1] in their seminal work in Ontario, Canada. The subsequent interest in the vulnerability of "place-based" communities to natural hazards sparked a discourse focusing on how people and local communities deal with multi-hazards, particularly their coping and adaptation

* Zaman, J. R., Haque, C. E., & Walker, D. (2022). Local-Level Flood Hazard Management in Canada: An Assessment of Institutional Structure and Community Engagement in the Red River Valley of Manitoba. *Geographies, 2(4)*, 743-768.

processes [2,3]. This notion has also been applied to larger scale risk research and management [4–7]. Such efforts in flood risk assessment of both urban and rural communities encompassed improving our understanding of the hazards, exposure, and vulnerability of places in the cities and countryside [8–10]. A local community can be defined as a group of people who live in a common or shared geographic location, have interactions with one another, are organized around common values, and have social cohesion generating social units larger than a household [11]. Among the various types of natural hazards, flooding is a leading cause of disaster loss at multiple levels, from the local community level to the sub-national level, across the globe. Settlements along river valleys are vulnerable to significant interruption in their daily lives due to abnormal flooding [12,13].

Early institutional efforts to reduce disaster losses failed due to their over-emphasis on structural-engineering measures and a lack of critical analysis of disaster risk. This failure led the United Nations to declare the period between 1990–1999 as the International Decade for Natural Disaster Reduction (IDNDR). Notably, this action led to the creation of the UN International Strategy for Disaster Risk Reduction (UN-ISDR), which facilitated the coordination of disaster-risk-reduction efforts at the national level. Although the UN-ISDR promoted risk awareness and institutional development, it did not yield any legally binding treaties with targets or consequences for noncompliance. In 2005, a total of 168 countries signed the Hyogo Framework for Action (HFA), which aimed to reduce disaster losses significantly by 2015; unfortunately, the HFA was not very effective as evidenced by increased vulnerability, exposure to, and losses from disasters occurring since 2005.

This failure made it apparent that our understanding of the local community situation is generally poor, and that efforts to engage with disaster management decision-making at this level have not been very effective. These realizations resulted in the creation of the 2015 Sendai Framework, which called for the empowerment of local communities and authorities by directly involving them in the formulation of disaster management policy [14]. Figure 2.1 illustrates how the approaches taken in the various UN initiatives have shifted since 1990, primarily through learning and taking measures to effectively empower and engage local communities and institutions [15,16].

The Sendai Framework for Disaster Risk Reduction (2015–2030) represented an important paradigm shift: instead of an approach that emphasizes a location's physical vulnerability to disaster, the Sendai Framework endorsed an integrated, participatory approach based on providing stakeholders with meaningful roles in the decision-making process [17]. Participatory approaches attempt to create a bridge between stakeholders and policy makers by enabling community members to share their concerns and interests in the decision-making process through platforms designed to facilitate engagement and dialogue [18,19]. Such efforts to integrate local or municipal level entities to flood risk decision making were made in several countries [20–22]. The need to transition to a more

participatory and bottom-up approach to flood management has generally been recognized in the scholarly literature as optimal and effective [23–25], and the Sendai Framework one of the first practical implementations to embody this consensus.

In Canada, the rural communities in the Red River Valley in the Province of Manitoba have historically been vulnerable to catastrophic flooding. The flood history of the Red River Valley can be traced back to 1793 AD. For instance, fur traders located near the present Canada-USA border wrote that the Red River had risen to a "prodigious height" [26,27]. Subsequent noteworthy floods include: the flood of 1826, which was estimated to have a return period of 500 years; a high-magnitude flood in 1852 and 1861; the flood of 1950 which inundated the City of Winnipeg and was seminal in the creation of top-down government management of future floods; the floods of 1974, 1979, 1996, and 1997 during late 20th century; and floods in 2006, 2009, and 2011 that suggest a decrease in the return frequency of devastating floods. The comparative peak discharges in the years of major floods in the Red River Valley are shown in Figure 2.2.

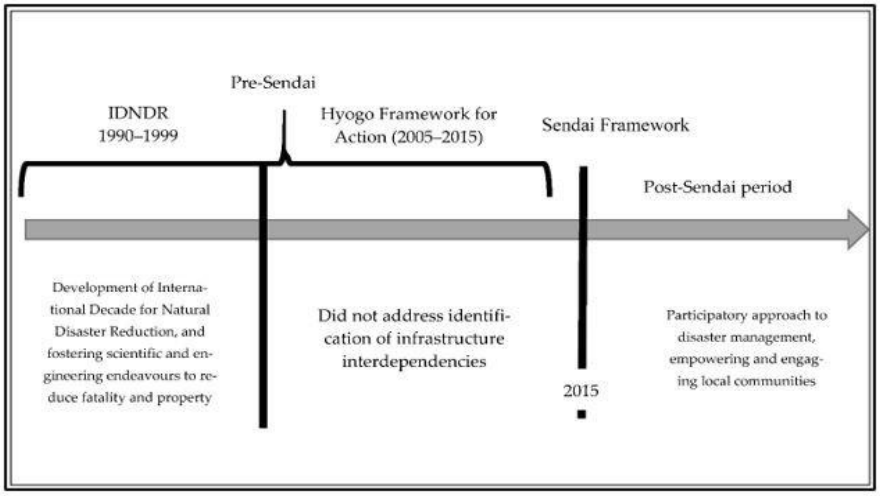

Figure 2.1. Chronological changes in the emphasis of UN disaster management strategies.

In the 21st Century, the floods of 2009 and 2011 have been notable in terms the water discharge volume and magnitude of loss. However, the most significant recent flood occurred in 1997. This flood, known as "The Flood of Century", was the most severe to occur in the Red River Valley since 1852. The water level of the Red River was approximately 7.5 m at the James Avenue, and would have been upwards of 10.5 m without flood control works [28,29]. The 1997 flood caused high running water levels in the Red River and numerous other rivers throughout Manitoba, which adversely impacted many communities (Figure 2.3).

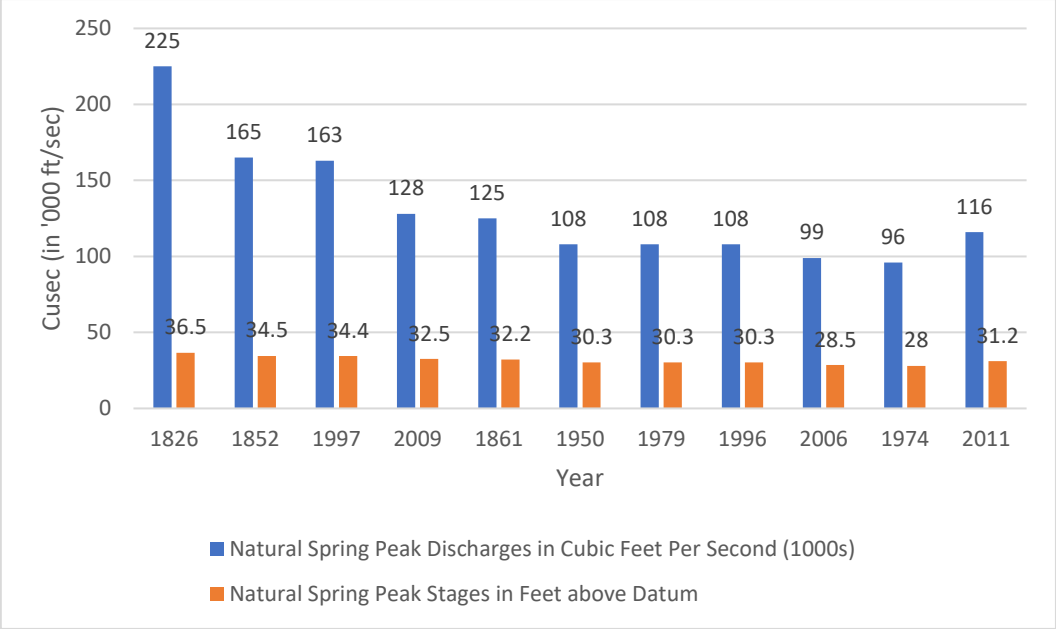

Figure 2.2 Red River at James Avenue in Winnipeg, Manitoba (Data source: Manitoba Flood Facts, n.d.) [28].

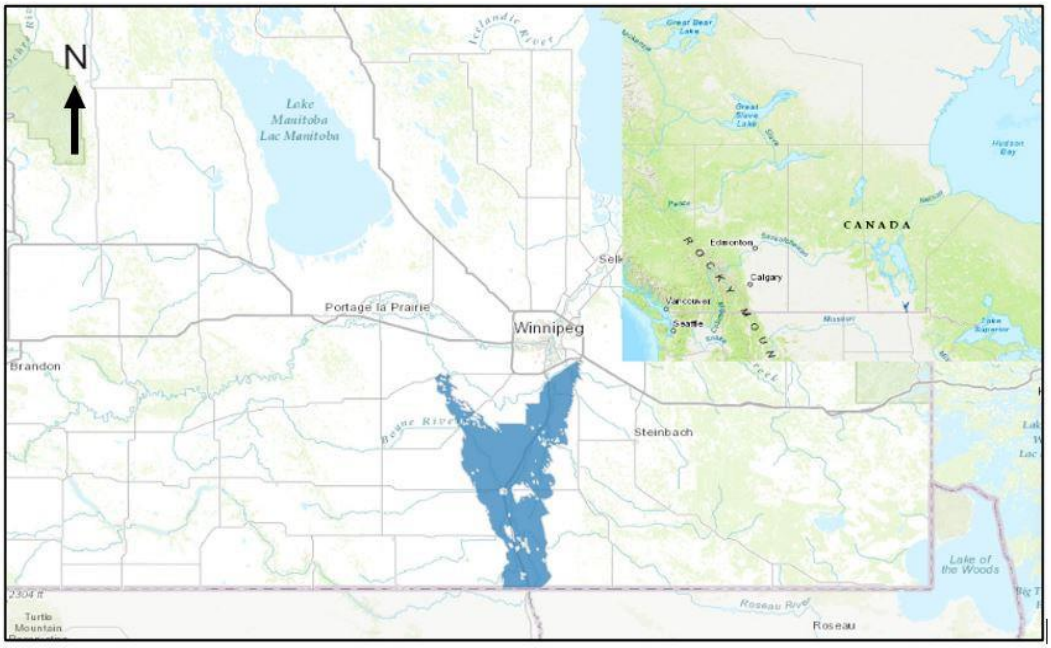

Figure 2.3. Geographical extent of the 1997 flood which was labelled as "the Flood of the Century" (Source: Government of Manitoba, Red River Flood—1997 [30], 2019 [31]).

The 2009 spring flood, which was largely due to a heavy rainstorm in the first week of November 2008, had the fourth highest water levels recorded in the Red River Valley since 1826. Unfavorable ice conditions further exacerbated the flooding in the Red River watershed, causing the Red River to crest at 6.9 m in Winnipeg. In 2011, a steady rise in water levels was observed in several lakes and in rivers, including the Red, Assiniboine, Souris, Pembina, and Qu'Appelle, causing the Government of

Manitoba to declare high flood risk for communities along the affected bodies of water. When the Red River peaked in Winnipeg on April 7, the 2011 flood had become the third largest in the last 150 years, and had necessitated the declaration of a Province-wide state-of-emergency [30,31].

In addition to their physical vulnerabilities, social stressors also amplify the vulnerabilities of local communities in Manitoba. Although community residents and municipal managers are knowledgeable and experienced in local risk and hazard assessment and response, external factors such as provincial/regional floodplain policy and development have often discouraged local-level risk-management initiatives [32]. Overall, there is a lack of literature on the mechanisms and dynamics of local-level disaster management, and engagement of the locale in decision-making particularly concerning flood management, in Manitoba [33]. While community-level activities are intertwined with municipal and Provincial governmental authorities, the state of local-level institutions and their role in flood disaster management are not well-documented. As such, it is necessary to investigate the institutional arrangements and local-level patterns relating to flood preparedness, response, and recovery in the Province of Manitoba.

The purpose of this study is to identify attributes of the local-level flood-management structure in Manitoba, Canada, with respect to flood preparedness, response, and recovery. Specifically, this study has two key objectives: (1) to examine the salient features of local-level flood preparedness, response, and recovery in selected rural communities; and (2) to map and analyze stakeholders' views on the effectiveness of the existing structure and approaches to community-level flood management.

This paper is organized into six sections. In Section 2, we present the conceptual considerations and framework of this research, followed by a detailed description of the materials and methods in Section 3. In Section 4, we analyze the results and major findings of the study, and in Section 5, we discuss the implications of our results and compare how they align or diverge from those of previously published works. Finally, the conclusions of our study are presented in Section 6.

2.2. Conceptual Considerations: Disaster Management Cycle and Community Engagement

The term, "disaster management," refers to the aggregate of all activities, programs, and measures undertaken by various responders before, during, and after a disaster. Such actions can help to avoid disasters, and/or reduce their impacts, and/or help to recover from associated losses [34]. The Disaster Management Cycle (Figure 2.4) consists of three sequential components: (i) pre-disaster preparedness; (ii) response after a natural hazard strikes a community (such responses are carried out by individuals and local institutions); and (iii) post-disaster recovery and rehabilitation.

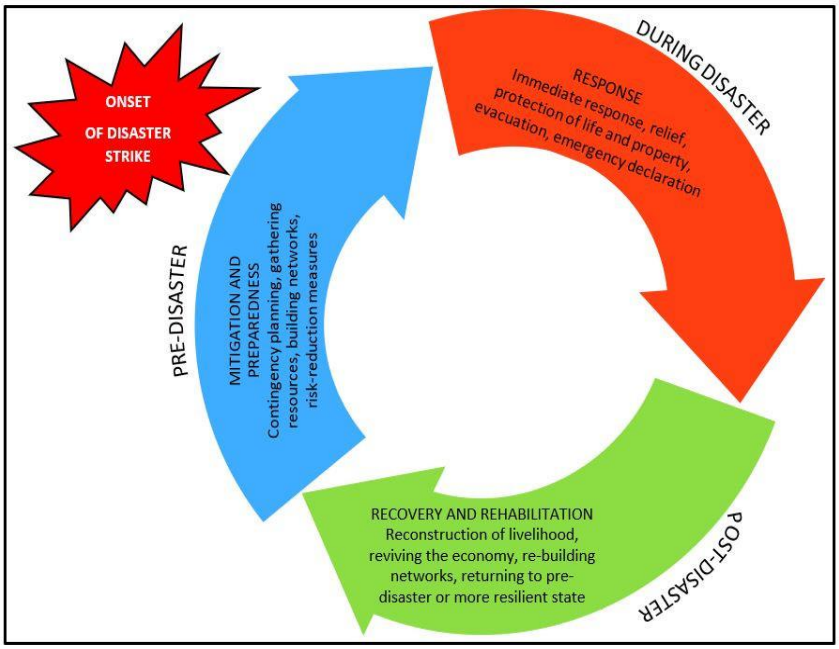

Figure 2.4 Disaster management cycle.

People in communities prepare themselves for floods in various ways. In the Red River Valley of Manitoba, Canada, community members tend to employ few interventions or actions to prepare for future floods. The principal flood-preparation measure taken in communities in the Red River Valley is floodproofing, which entails raising the elevation of houses and properties out of the reach of floodwaters; however, such action is typically only carried out in locations where it is recommended or made mandatory by the local/municipal government. During the pre-flood phase, community members also use their social network to collect sandbags to protect their lands and properties. However, a false sense of security, inspired chiefly by structural measures such as community dikes, is cited as the primary driver of the overall resistance to, or lack of, interest in preparedness [35].

Raising awareness among community members about risk-reduction potential and motivating them to take precautionary measures are integral elements of effective flood preparedness. In New South Wales, Australia, flood-management education and information sharing have been emphasized to help local communities reduce flood risks and respond effectively when disasters do occur [36]. Such education plans are developed, evaluated, and implemented by local committees consisting of community residents, business representatives, local council members, and government agency staff.

Flood memory is another source of knowledge that is often co-produced and shared at the community level for effective flood management and preparation measures. McEwen et al. [37] found that, in the United Kingdom, flood memory is utilized as a major instrument for flood preparedness. To develop flood memories in the preparedness phase, schools include “flood week” as part of their

curricular activities, and flood action groups are mobilized for the rehearsal and reinforcement of flood memory. Community people then build on these flood memories to develop and implement further proactive measures.

In Germany, communities tend to place their low-value assets in flood-prone areas. In addition, after the floods of 2002, households in the Elbe basin joined neighbourhood flood networks to prepare for the next flood. However, many households and businesses had not taken any precautionary measures, and instead relied completely on insurance and government bail outs [38]. Terpstra and Gutteling [39] observed that, in the Netherlands, people in local communities took steps such as installing flood-proof flooring and situating electrical outlets higher up on the walls. In addition, community members also kept a tentative evacuation plan and an emergency kit in their households. Overall, however, communities in developed countries tend to rely heavily on upper-level government interventions.

2.2.1. Response (Onset of Disaster) and Its Components

Disaster response refers to the measures that are taken to protect people, the environment, and other resources from natural or anthropogenic hazards, including the provision of relief during disaster events [40]. In the United States, the National Response Framework (NRF) defines disaster response as the capability to save lives, and to protect property and the environment. Furthermore, it is critical to note that disaster response should also meet basic human needs after an incident has occurred [41].

People in communities within the Red River Valley of Manitoba, Canada, tend to rely on their own capacity to respond to floods, as well as communication with those in their neighbourhoods via social media and/or phone calls. In addition, community members also communicate with emergency managers in the local government and seek advice on when to start pumping out floodwaters from breached areas of community dikes. Evacuation is not usually a preferred option among residents in communities. During the 1997 flood, more than 27,000 residents in the Red River Valley were evacuated from their communities [42]. However, such large-scale emergency responses can only take place when Provincial and federal institutions help to implement them.

In recent years, social media has emerged as a major platform where community members can share information and organize initiatives. These united efforts both complement and complicate professional emergency efforts, especially when response measures are undertaken without coordination. During the 2014 urban flash floods in Germany, the government utilized social media platforms such as Facebook and Twitter to engage communities in response and relief actions. This approach proved effective, as community actions initiated through these platforms helped to

substantially limit flood damages [43]. Similarly, several Facebook groups acted as the primary medium for citizens to gather and share information during the 2013 floods in Dresden, Germany. These networks functioned as "switch boards" that connected citizens in need of help with those who were able to offer it. This initiative was well-received by both the residents of Dresden and the local government [23,44].

2.2.2 Flood Recovery (Post-Disaster) and Its Indicators

Recovery is a complex process that begins immediately after a disaster and focuses on returning to a "normal state" or to a "new normal state" after the period of difficulty passes. However, the concept of "normal" is a matter of debate. Based on the context, "normal" can be interpreted as either the pre-disaster state, or the subsequent state that follows a new trajectory post-disaster. In fact, with loss and damage of infrastructure, local ecosystems and sometimes total elimination of existing landscape (e.g., large-scale landslides), recovering to the pre-disaster condition may become impossible. The pre-disaster state may even become undesirable after a disaster [45].

Recovering from a disaster follows variable courses depending on the magnitude, type and nature of the hazard and the scale of the disaster. Both pre- and post-disaster planning and a successful implementation such resources and strategies help quick recovery from disasters. Following Smith and Wenger's early work [46], we identify the components of successful local recovery plans (Table 2.1). During the recovery phase, emergency supplies, logistical and financial assistance, and psychological help play pivotal roles. For instance, Medd et al. [47] found that community members in Hull, England relied on both social and institutional supports for their mental, physical, and financial recovery following major flooding. For their physical recovery, many of these people relied on health service systems. Although some people who had lost their homes in the flood reported being uncomfortable with living in rented housing, many said that spending time with family members had been effective in facilitating their mental recovery.

Local communities often take initiatives to manage and recover from flood losses. For instance, Rowlands [48] observed that some communities in Australia had installed large roadside blackboards where community members could write messages to one another and where important information could be shared each morning during the early recovery stage. At the time of Rowlands' [48] study, these blackboards had been in place for more than a year. The blackboards served as a community source of information regarding where to find help, who could help, and who needed support. Moreover, the local hotel and pub became community rallying points where food, drink, and shelter were offered, and where people could gather, find one another, and self organize.

2.2.3 Local Community Engagement with Disaster Management

Many local governments engage stakeholders in determining criteria to follow during developing flood-emergency and disaster management strategies [34]. In other cases, traditional authority-led interactions and creative approaches to citizen engagement and citizen-initiated collaboration with authorities have all shaped the role of citizens in flood management [35,36]. For example, spontaneous local involvement and volunteerism in Australia have been cited as playing a key role in driving effective disaster management and recovery planning [49].

To investigate a given local-level flood-management governance structure, it is necessary to gain an understanding of flood preparedness, response, and recovery patterns by identifying their respective elements and indicators. Community members can undertake flood management initiatives, but, unlike formal institutions, they face resource constraints and lack the necessary technical expertise. Therefore, cooperation and coordination between local and Provincial governments is required to intervene and mobilize their resources. Although disaster management governance structures can take a variety of different forms, they can generally be categorized as either “top-down” or “bottom-up.”

Top-down structures are approaches wherein a central government agency acts as the sole authority by setting goals and guiding implementation. For over a century, emergency and disaster management approaches followed a “top-down” approach, relying heavily on structural-engineering interventions. The Province of Manitoba was no exception to this norm [50].

Table 2.1 Components of successful local recovery plans.

Components	Explanation or Meaning
Community involvement	Inputs provided by stakeholders; actions taken by policymakers; reduction of conflict via communication.
Information	Communication of hazard characteristics; potential areas; population size; composition and distribution of the population to be impacted; local economic factors; resources available for post-disaster condition; power dynamics; programs and responsibilities of local, state, and federal governments, as well as NGOs, businesses, and other relevant stakeholder organizations; current and projected land-use patterns; type and location of existing and projected development.
Learning	Taking lessons from previous disaster experience, observation, and other protective measures taken by community members for future implementation.
Organization	Identification of groups and organizations with the potential to provide specific or assigned assistance; recovery and reconstruction committee; involvement of government agencies and non-profits in such organizations.
Network	A social structure spontaneously developed or necessitated by an emergency including a set of social actors and involving social interactions facilitating information flow, knowledge co-production, and collective actions.
Procedures	Action-oriented plans and modification of policymaking procedures to enable rapid decision making.
Damage evaluation	Clarification of operational tasks regarding mobilization, deployment, and coordination of those assigned to conduct damage assessments; utilization of information to rapidly assimilate and assess local needs and implement pre- and post-disaster reconstruction strategies.
Finances	Linking identified needs gathered from damage assessment to existing funding sources, technical assistance, and appropriate policies; identification of alternatives when local needs do not match recovery program eligibility criteria; development of contingency budgets when localized disasters do not meet federal disaster declaration criteria.

Top-down approaches generally fail to engage community members, and are often ineffective at addressing the root causes of vulnerability and systemic issues. This results in the emergence of numerous local disputes, along with demands for transparency, engagement with civil society, and the inclusion of the community in the decision-making process. For example, during the 2010–2011 floods in Queensland and New South Wales, Australia, the number of assistance requests from community members received by local council and State Emergency Service representatives was so great that it outstripped their capacity to respond effectively [51]. In southern Alberta, Canada, government initiatives aimed at transformative change toward social capacity building were unsuccessful due to insufficient engagement from community members [52]. Conversely, experiential learning from the 2013 floods in Germany engendered numerous local disputes wherein community members became highly vocal about their desire to be included in the decision-making process [53]. These deliberations led to the formulation of a participatory, “bottom-up” structure wherein multiple governmental and non-governmental entities agree to collaboratively participate in the decision-making process and work to achieve a consensus on a common set of goals and implementation strategies [54].

2.3 Materials and Methods

In this study, we apply the "place-based" case study approach developed by Cutter et al. [2] and Yin [55], as this approach provides an in-depth description of, and insights into, a process or phenomenon within a bounded system or setting [56,57]. The study areas selected for this research were the communities of St. Adolphe and Ste. Agathe in the Rural Municipality (RM) of Ritchot in Manitoba, Canada. The case study approach has been traditionally recognized as being applicable for community-based flood disaster management research, as it effectively enables the involvement of community members, which in turn allows their concerns—as well as those of vulnerable populations—and their resources to be incorporated into the study [58].

After developing an in-depth understanding of the effectiveness of the existing flood-management system and determining its current state based on a review of the literature, the active participation of community members and officials from NGOs and local and Provincial governments was sought to document the local-level patterns and approaches to flood preparedness, response, and recovery measures. To meet these objectives, this study employs a community-based research methodology.

2.3.1 Study Area

The field study for this research was carried out in the communities of St. Adolphe and Ste. Agathe, which are located in the Rural Municipality (RM) of Ritchot, Manitoba (Figure 2.5). These communities were selected for three key reasons: (i) their high physical exposure and vulnerability to floods due to their geographic location; (ii) their experiences with flooding in recent decades; and iii) a willingness to participate in the research on the part of the Ritchot rural municipality authority and the residents of the area.

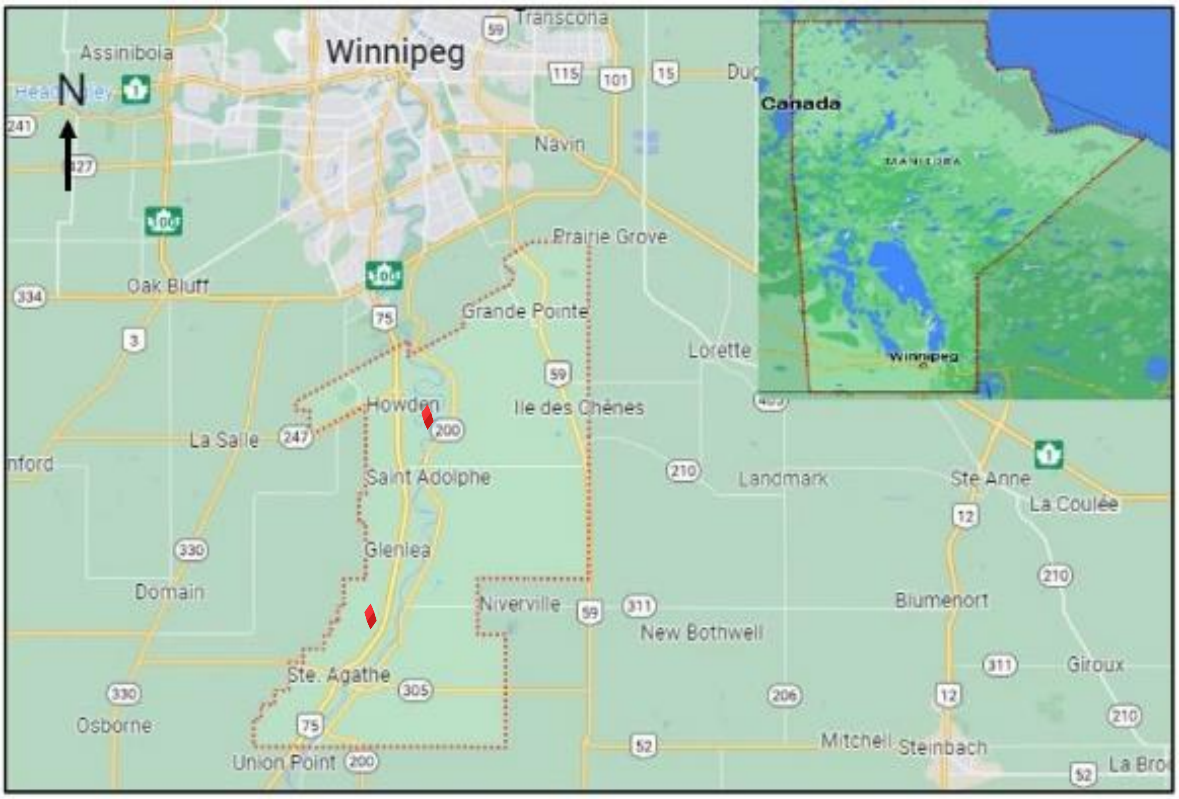

Figure 2.5 Location map of Ritchot RM, Manitoba (Source: Modified from Google Maps). = Study area.

The RM of Ritchot's geographic location within the Red River flood plain; a post-glacial, lacustrine area with little slope gradient and occupied by a north flowing river that receives meltwater from the south before becoming ice-free, makes it extremely susceptible to flooding. Notably, seasonal discharges from the Red River are highly variable, which results in the RM being flooded at irregular, but frequent intervals. In recent decades, the populations of St. Adolphe and Ste. Agathe have been growing, as have the number of businesses and industries that operate out of these communities. At present, the RM of Ritchot has a total population of 6679 [59], with most people living in St. Adolphe and Ste. Agathe mainly relying on farming- and service-based livelihoods.

According to data from the 2016 Census, females make up more than half of the populations of both St. Adolphe and Ste. Agathe. In addition, 48.9% of the population of St. Adolphe and 35.2% of the population of Ste. Agathe are either less than 15 years of age or more than 65 years old [59], demographic characteristics that make these two communities more vulnerable to flood impacts.

2.3.2 Data Collection Instruments

A 3-tier study design was formulated and implemented. Primary data were collected via three instruments: (i) key informant interviews (KIIs); (ii) oral history interviews (OHIs); and (iii) a review of relevant documents. Data collection took place in 2020 and 2021. KIIs were selected as a data-collection instrument because they facilitate deep investigation into an issue about which the respondent is highly knowledgeable [60]. As such, KIIs are helpful in gaining an understanding of, and explaining the experiences and reasons behind, changes in social and political processes [61,62]. For the present study, eight key informants were selected from the two studied communities, as well as from the Provincial government and NGOs. These individuals were interviewed in-person using a semi-structured questionnaire.

Oral history interviews (OHIs) were used as a data-collection instrument because oral history is comprised of the stories and memories of a person or a group of people. Thus, OHIs emphasize the experiences of individuals [63], as the participants possess firsthand experiential knowledge related to the stories [64]. Seven OHIs were conducted with members from the two communities using a semi-structured questionnaire, with the results being compared to identify common experiences and variable perceptions. Finally, a desk review of relevant documents was conducted by combining the steps developed by Sikder [65] and O'Leary [66]. These steps are detailed in Table 2.2.

Table 2.2 Steps followed in document review.

Step	Activities Performed
Selection of information sources for data collection	A list of documents was prepared to explore. Identified sources included: (i) University of Manitoba libraries; (ii) University of Manitoba's link to Google Scholar for research articles; (iii) annual reports and documents from NGOs involved in flood management in Manitoba; (iv) laws, by-laws, acts, and policy documents from the Government of Manitoba and EMO websites; (v) Public Safety Canada website; (vi) local and national newspapers; (vii) officials of governments and NGOs. Selected data types were qualitative in nature.
Accessibility check	The accessibility of the selected documents was checked. Documents that were internal to a particular organization were inaccessible, and therefore not available for review. Documents that were publicly available were utilized for data collection.
Maintaining neutrality	The authenticity and credibility of the documents were assessed by discussing them with associated participants. The agendas of the documents were also explored to remove biases. In addition, consideration was given to all available sources without prioritizing. The production of the documents and the reasons for their production were also explored.
Analysis	Witting evidence (what the document was meant to impart) and unwitting evidence (everything else can be gleaned from the document) were determined and available data were analyzed.

Precision of review	All documents were rigorously scrutinized, and meanings were interpreted.
Understanding the processes	Documents from the Provincial government were collected to examine the step-by-step processes of adaptation measures in order to determine their patterns and drivers.

2.4 Results

The results of the present study revealed that the flood-management remains a policy issue in Manitoba, and that efforts to this end are ongoing and have produced a number of multi-level institutional initiatives. In 2019, the Government of Manitoba unveiled the Manitoba Flood Coordination Plan [67], which was developed in an effort to coordinate the various Provincial and federal departments and agencies involved in flood management. Provincial and federal stakeholders formed the Flood Steering Committee, which was co-chaired by representatives from the Manitoba Emergency Measures Organization (EMO), Manitoba Transportation and Infrastructure's Water Management and Structures Division (WMSD), and Communication Services Manitoba (CSM). A Flood Annex Planning Committee was also established; this committee is responsible for developing, reviewing, and updating the Plan, and convenes at the request of the EMO. A list of agencies that have contributed to the planning process is presented in Table 2.3.

Table 2.3 Government and non-government members of the Flood Annex Planning Committee.

Provincial Agencies	Federal Agencies	Non-Government Agencies
Communications Services Manitoba (CSM)	Department of National Defence (DND)	Canadian Red Cross Society (CRC)
Manitoba Families—Emergency Social Services (FAM)	Public Safety Canada (PS)	Salvation Army (SA)
Manitoba Agriculture (AGR)	Indigenous Services Canada (ISC)	Mennonite Disaster Services (MDS)
Manitoba Environement and Climate (EC)		Amateur Radio Emergency Service (ARES)
Manitoba Indigenous and Northern Relations (INR)		
Manitoba Justice (JUS)		
Manitoba Education and Early Childhood Learning (MEECL)		
Manitoba Emergency Measures Organization (EMO)		
Manitoba Health, Seniors and Active Living - Office of Disaster Management (ODM)		

Manitoba Transportation and Infrastructure
(MTI)
Manitoba Civil Service Commission (CSC)
Office of the Fire Commissioner (OFC)
Royal Canadian Mounted Police (RCMP)
(pursuant to Provincial Policing Contract)

Source: Compiled from information available in Government of Manitoba, Manitoba Transportation and Infrastructure (n.d.) [29].

Presently, Emergency Measures Organization (EMO) under Manitoba Transportation and Infrastructure is the Department that is primarily responsible for flood-management activities in the Province. While the Water Management and Structures Division also plays a pivotal role, other divisions within MI, such as Engineering and Operations, provide engineering and construction expertise, infrastructure protection, operational and logistical support, survey information, and Provincial traffic and transportation systems management.

During the emergency response phase, the EMO engages relevant organizations and acts as the Provincial coordinating department. In addition, the EMO also coordinates federal response and assistance for the Province through the Public Safety Canada Regional Office. Several organizations fulfill their pre-established roles and responsibilities during an emergency and/or the flood-recovery phase. These organizations include but are not limited to: Manitoba Transportation and Infrastructure (MTI), Communications Services Manitoba (CSM), Environment and Climate, Manitoba Families, Manitoba Agriculture, Manitoba Education and Early Childhood Learning, Manitoba Indigenous and Northern Relations, the Office of Disaster Management (on behalf of Manitoba Health, Seniors and Active Living), the Office of the Fire Commissioner, Manitoba Justice, and the Royal Canadian Mounted Police (RCMP).

2.4.1 Pattern of Local-Level Flood Preparedness in Manitoba

2.4.1.1 Provincial Flood Preparedness Influencing Local Preparedness

Each year, MI's Hydrologic Forecast Center issues a spring flood outlook, which is typically forecast during the third week of February and updated during the third week of March. However, summer flood events resulting from severe rainfall may develop rapidly. Therefore, Manitoba Transportation and Infrastructure's communication regarding summer flooding is not included in the formal flood outlook report. The flood outlook (or alert) or forecast information is used in a meeting co-chaired by representatives from MI, the EMO, and CSM. The steering committee then establishes a flood planning benchmark for potential flood events. Given the area's high flood potential, the Inter-

Agency Emergency Preparedness Committee and senior government officials are briefed about the situation [67].

Our study identifies several major critical structural and non-structural measures of flood preparedness in Manitoba. The s*tructural measures* include: (i) the construction of the Red River Floodway; (ii) maintenance and modification of the Red River Floodway according to needs; (iii) the provision of operating guidelines for flood-protection structures; (iv) engagement in land-use planning based on flood experiences; (v) the development of community dikes and pump stations; and (vi) dike pump and drainage maintenance.

The *non-structural measures* include: (i) a review of the operating guidelines for flood-protection structures; (ii) the establishment of the Manitoba Floodway Expansion Authority and the development of the EMO; (iii) coordination between Provincial and municipal governments regarding flood forecasts and subsequent measures; (iv) the publication of reports detailing the Provincial government's research, findings, and recommendations; (v) communications by the Manitoba Floodway Authority to raise public awareness; (vi) the implementation of lessons learned from the 1997 Red River Flood under the "Canada-Manitoba Partnership Agreement on Red River Valley Flood Protection"; (vii) clarification of definitions for transparency purposes; (viii) the establishment of the Red River Floodway Operation Advisory Board to facilitate information dissemination and exchange among stakeholders in a timely manner; and (ix) hiring retired experienced civil servants to engage and communicate with First Nations communities.

2.4.1.2. Local-Level Flood-Preparedness Measures

Although local-level flood preparedness in Manitoba mainly depends on Provincial initiatives, the participants in the KIIs and OHIs noted that local institutions have also undertaken some critical local activities in the preparedness phase. These activities include: (i) municipal authorities becoming more vocal about their interests when negotiating with the Provincial government; (ii) municipal governments advising the community with respect to flood preparedness (e.g., the local RM government asked residents to floodproof their houses by raising the foundation); (iii) residents working collectively to build their local economies and add economic value to their communities; (iv) local municipal representatives and sub-watershed-committees working together on water-retention projects to mitigate flood losses; (v) the establishment of community-managed pump stations to remove floodwaters; and (vi) the use of social media by community members to facilitate dialogue and the exchange of information regarding flood preparedness.

Empirical evidence suggests that local-level flood preparedness in Manitoba is dependent on senior-level institutional initiatives. The former Department of Manitoba Transportation and Infrastructure (MTI) built and managed structural and non-structural infrastructure relevant to flood management. For risk communication, the Government of Manitoba keeps local communities updated on their research through published reports, which are available on the Provincial government's website. In addition, the MTI regularly held press conferences, and the EMO maintains contact with municipal governments and local representatives to communicate vulnerabilities and update them on context-specific measures. As one government representative shared:

> *"This will be debatable, but in my experience, we've gotten more comfortable with sharing information transparently with partners. We realized that there's a risk there. Information can be misinterpreted, maybe even abused, and exploited. But, by and large, sharing things accurately and in good faith leads to better outcomes. So, I think we've gotten better."*

With experiential learning, the local communities took proactive initiatives as well. For example, the people of St. Adolphe realized that flood-management strategies developed by the government prioritize the capital city of Winnipeg due to its vital economic role in the Province. To build their economic strength, local businesses have attempted to diversify their offerings in order to capitalize on their close proximity to the US-Canada border.

The development of networks and the utilization of new technologies in flood preparedness are also evident. For example, the Watershed Districts work as non-profit organizations that use government funding to identify flood-preparedness problems and seek solutions. The use of LiDAR to generate a three-dimensional visualization of an area has created newer opportunities for flood preparedness. An official from one of the watershed districts stated that:

> *"With LiDAR, we can take our modeling of the watershed. Previously, we could do maybe two or three projects a year. Now we have the potential to look at up to 20 projects and implement half of them in a year. It's quite phenomenal."*

As part of one community initiative, a group of community people, with the help of the local government, constructed the Red River Valley Floods Interpretive Center, which now houses detailed information on floods in Manitoba and along the Red River Valley. The management committee of the Interpretive Center also provides educational tours for students of various ages to help them to learn about floods, how to adapt to floods, and the history of floods in Manitoba and the lessons learned from them. One elderly participant from Ste. Agathe shared that:

"The community people put the Red River Valley Foods Interpretive Center in the Cartier Park. The interpretive center was used by Manitoba Conservation and Water Resources for meetings. It was used as a school program facility. The then-premier used it on four occasions for press conferences during flood events."

However, from the data collected, it is evident that aside from flood-proofing houses, which is mandated by the local government, there have been few flood-preparedness efforts at the household level in the studied communities.

2.4.2 Pattern of Local-Level Response to Floods in Manitoba

In this section, we focus on the pattern of response during the 1997 flood and, more recently, the floods of 2009 and 2014. According to the Manitoba Flood Coordination Plan [53], during a flood emergency, the Government of Manitoba operates under an incident command system that links all contributing departments and agencies. The Flood Steering Committee provides the operational leadership to respond to flood emergencies throughout the Province, as it is co-chaired by the Assistant Deputy Minister of Emergency Measures and Public Safety (EMPS), the Assistant Deputy Minister of MI-Water Management and Structures Division, and the Assistant Deputy Minister of Communication Services Manitoba. Based on the scale and scope of the measures taken, senior representatives of other primary, coordinating, and supporting departments and agencies may also serve on this steering committee.

During a flood response, the steering committee is responsible for communication across Provincial and federal agencies and for making operational decision. During the emergency response phase of flood management, activities conducted by MI include flood forecasting; predicting and monitoring elevations; operating the Red River Floodway, Portage Diversion, Fairford River Water Control Structure, and Shellmouth Reservoir; modeling/mapping of the flood plain; undertaking mitigation initiatives.

The Manitoba EMO coordinates the response phase and plays a key role in facilitating collaboration between Provincial departments, local authorities, non-government organizations, private-sector entities, and other relevant stakeholders. To support governmental departments, NGOs and private companies capable of contributing to the emergency response are contacted and mobilized according to their capacities. Each department is also advised to activate their own Emergency Operations Center (EOC) in accordance with their emergency response plans, and municipalities

affected by a flood emergency are advised to activate and follow their emergency plans as well. After the activation of the Manitoba Emergency Coordination Centre (MECC), municipalities may be asked to participate in daily community conference calls, submit situation reports, and upload all relevant information and updates relevant to the response in WebEOC.

In a flood emergency, a local authority has the power to declare a state of local emergency (SoLE) within their region, while the Provincial government has the power to declare a Provincial state of emergency (PSoE), which provides it with access to specific powers under the Emergency Measures Act. Our field investigation identified six major elements of response in St. Adolphe and Ste. Agathe (Tables 2.4 and 2.5). These elements include: (i) evacuation of the residents; (ii) psychosocial support in emergency conditions; (iii) coordination among levels of government; (iv) relief management; (v) communication among community people and authoritative institutions; and (vi) protective measures by governments.

In terms of emergency response, an official from the local government shared that they hope there will not be another flood similar in magnitude to the 1997 flood. During the emergency response phase of the 1997 flood, the Canadian Red Cross, the Salvation Army, and the Hutterite Colonies played an active role in supporting the people in the community. The Canadian Red Cross used vans to deliver food and water to those impacted by the flood, and they also raised money from all over Canada to assist them financially. For their part, the Salvation Army provided financial assistance to the community members based on their needs, while the Hutterite colonies contributed human resources in the management of sandbagging machines. Our results further revealed that the response phase of flood management in the two studied communities has partly been influenced by flood preparedness. The more the communities are prepared, the less they are vulnerable to flooding and the better they can respond to such events. Activities to this end have been spontaneous, improvised, and needs-based. During the flood of 1997, both communities had to be evacuated, which is significant as records indicated that Ste. Agathe had never experienced flooding previously. Looking back, one elderly member of the Ste. Agathe community offered the following insights:

> *"I'd say complacency played a big role in us flooding in 1997, because we'd never flooded before. So, I'd say it was ignoring what the government was saying. If the government tells you the water level is going to be 776.5 feet, and you don't dike it, there's going to be a problem. So, it was that refusal to believe that there was going to be a problem."*

The community was overwhelmed by the impact of the 1997 flood, and people were evacuated immediately thanks to the rapid action taken by the local and the Provincial governments. Although, numerous personal and public properties were destroyed, such losses created a sense of unity and

cohesion within the community as people came forward to help each another and share their emotions. One community member burst into tears while sharing his experience during an oral history interview, explaining that he felt guilty when he was living in a hotel because he had been less impacted by the 1997 flood than others in his community. He shared that:

> *"I would get back to the International Inn about between 10 and 11 o'clock at night with my brother and I would walk into the door and that's where you would see the support group. Because people were coming back from their property, if they had been allowed to go, and they had lost their house, their property, and other people were there to support them. It was strong enough. And the disaster was so awful that, after a number of days, I would not go amongst that group. I would sneak in and go to my room because my place had not been overwhelmed. I felt terrible. Imagine! I felt terrible that I had saved my house! That's how bad that disaster was. And some people were seniors. So yes, there was massive support amongst […] people who knew each other. And if they didn't, they got to know each other. Personnel and the leadership at the hotel were also very, very supportive."*

To synthesize the patterns in emergency and flood disaster response, here, it is useful to apply a model developed by Wong-Parodi and Feygina (2018) that combines the elements of disaster emergency response and mass casualty incidents (MCIs) (also see O'Neill, 2005). We compared these elements with the aspects of emergency response that surfaced during the KIIs and OHIs in relation to the contexts of St. Adolphe and Ste. Agathe. It is apparent that during the 1997 flood and more recent floods, the Government of Manitoba has made efforts to respond to the situation based on the learning and experiences it has gained from previous floods. The efforts taken by the Provincial government are detailed in Table 2.4.

The key informant interviews and oral history interviews revealed that harmony and solidarity among community members are the principal elements that bolster flood response, especially under emergency conditions. Table 2.5 presents the patterns in local flood response in the communities of St. Adolphe and Ste. Agathe.

Table 2.4 Flood-response measures by the Provincial government influencing local community responses in Manitoba, Canada.

Emergency Response Components	Sub-Components	Activities Performed
Evacuation-relevant factors		
	Evacuation zone	• Provincial government has a team to forecast probability of flooding.
	Risk awareness	• To raise risk awareness and take the necessary steps to manage evacuation and information flow, the Emergency Measures Organization (EMO) replaced the reeves and managed the communities during the 1997
	Source of warning	• Government of Manitoba issued warnings and helped evacuate people from flood-affected communities. Most of the people from St. Adolphe were housed in the then-International Inn hotel.
Coordination among government levels		
		• Municipal and Provincial governments coordinate to effectively manage evacuation. • In an emergency, the Provincial government coordinates with the local government to determine the necessity of temporary dikes, road closures, and ring closures. • In 2006, the Government of Manitoba initiated the "Ice-Jam Mitigation Program.".
Relief management		
	l	• Provincial government covers costs of road closures, partial or complete ring dike closures, business interruptions, and changes to shipment routines. • Provincial government takes a risk-based approach towards relief management.
Communication		
	Between institutional officials and community members	• In collaboration with the municipal government, the EMO integrates information from Provincial stakeholders and provides it to Manitoba Transport and Infrastructure. • EMO serves as the hub for coordination between the municipal and the Provincial governments. They provide immediate and direct support to municipalities. • EMO engages the federal government when the situation exceeds the capacity of the Provincial government.
Protection measures by the governments		
		• Manitoba Transport and Infrastructure is the governmental department responsible for the Provincial road network and the Provincial water control network.

- Employees are switched within departments inside the Provincial government to enhance the efficiency with which emergencies are managed.

Table 2.5 Local-level response to floods in St. Adolphe and Ste. Agathe.

Emergency Response Components	Sub-Components	Activities Performed
Evacuation-relevant factors		
	Evacuation zone	• Municipal government sets up an office where evacuated community members can obtain information. • RM of Ritchot municipal government provides boats that can be used by evacuees to check in on their properties after certain intervals.
Psychosocial factors		
	Mental health	• During the 1997 flood, the community members convened each evening to share their experiences of the day. They also found that sharing their losses had a cathartic effect.
	Self-efficacy	• Community members made independent efforts (e.g., managing dozers from CAT). • Flood of 1997 evacuees used to return to their properties every day, without the permission of the government staff; as a result, the less damaged houses were saved. • During a flood, each household responds on its own. Sandbags or earthen dikes are most commonly used.
	Social support and social capital	• Committees within the communities are generated spontaneously based on necessity. • During the 1997 flood, Hutterite colonies took over the management of sandbagging machines. • During the 1997 flood, a kitchen was set up in the municipal hall in St. Adolphe, where women in community volunteered to make food for everyone.
Relief management		
		• Salvation Army provided each household with up to $1000 based on their needs during the 1997 flood.
Communication		
	Among community members	• When an emergency occurs, local people volunteer to help other community members and the government. • Students play a major role in volunteering. • After receiving a flood forecast, the people in Ste. Agathe communicate with one another and establish a group known as the “essential services.”
	Between officials and community members	• During an emergency, municipal government prefers to hire and/or solicit the help of local people who have cars, physical ability to work, and flood experience and knowledge. • Municipality sets up an office to manage volunteers. • During the 1997 flood, the Canadian Red Cross went to the affected communities with food vans and handed out food and water to the evacuated people.
Protection measures by government		

- Municipal government manages copious sandbags to be used by the community people to protect their homes and properties from floodwater.
- Municipality follows the Emergency Plan Manual in cases of emergencies, including floods.

2.4.3 Pattern of Local-Level Flood Recovery in Manitoba

Following the Manitoba Flood Coordination Plan, the Flood Annex Planning Committee allows residents to return to their respective municipalities after the recession of floodwaters, as outlined in the re-entry guidelines. The municipalities receive extensive Provincial assistance in their post-emergency operations, including re-entry operations, clean-up, restoration of utilities, flood damage estimation, claims for financial assistance, and the resolution of flood operations costs.

The respondents identified five dimensions relating to flood-recovery patterns and activities at the local level in Manitoba: (i) functioning partnerships among stakeholders; (ii) recovery governance; (iii) preparing for the next flood; (iv) physical and economic recovery; and (v) the social and physical fabric of homes and communities. Some of these activities are carried out as part of Provincial initiatives aimed at all vulnerable municipalities, while others are specific to the communities of St. Adolphe and Ste. Agathe.

2.4.3.1 Provincial Flood-Recovery Activities in Manitoba

Recovery Governance

In Manitoba, all decision-making approaches at the Provincial government level, including those relating to flood-recovery activities, must move through a public-policy process. Since bureaucrats and politicians serve a democratically elected government, decisions related to flood-recovery activities must be approved by the elected leadership. For their part, bureaucrats can draw upon lessons learned from experience and research on similar cases to develop recommendations and a plan for the government to implement. Once a plan has been developed, the elected leadership evaluates its feasibility, but this can be influenced by the government's political mandate. A member of the bureaucracy involved in flood management in Manitoba stated that:

> *"We're not like a non-profit or a research think tank, or even a private organization that can just decide, oh, we've learned these lessons, we're going to do it. What we do, government has to see value in it. And it's got to be a part of their platform."*

However, the area of flood management has an advantage because, unless there has been a recent flood with devastating impacts on peoples' lives, political campaigns typically do not give much attention to flood-management mandates. This lack of attention enables the

decision-making process to be more flexible and allows elected leaders to explore different options and alternatives to find those that work best. Thus, power dynamics, accountability, and hierarchy are the major factors in flood-recovery measures in Manitoba.

Physical and Economic Recovery

After the flood of 1997, the Government of Manitoba and the Canadian Red Cross evaluated damages to individual properties and compensated people independently based on these evaluations. The Provincial government and the municipal government collaborate to manage compensation programs through a needs-based approach. After the 1997 flood, the Provincial government sent adjusters to estimate the damages to each flood-affected house once the floodwaters had receded, and to assess whether a house was salvageable or a write-off. The adjusters also examined personal items, differentiating those that were deemed to be essential products from those that were considered luxury items. For example, beds were considered essential items, while televisions and lawn mowers were considered luxury products. Once this assessment had been completed, the government compensated individuals for the essential items that had been lost, but not for their luxury items. Each household was eligible to receive up to $100,000 based on their needs.

The municipal government and the Provincial government also collaborate with the federal government when flood-related damages and losses exceed the capacity of the Province. The federal government assists the Manitoba government financially through the Disaster Financial Assistance program. One member of the Government of Manitoba bureaucracy explained that,

> *"Once a flood is over, the municipal government works closely with Public Works and the EMO. They also work with the Disaster Financial Assistance unit of the federal government to coordinate the disaster sites and document pictures. Then, they finalize the repairments throughout the municipality together. They put all claims [and] evidence together, and submit those for reimbursements according to DFA guidelines. The federal government sends money to the municipalities through the Provincial government."*

In Southern Manitoba, farmers are especially impacted by major floods, as such events destroy their crops and harvests. Currently, farmers have access to private insurance to protect their crops and property. Examples of such insurance include, Farm and Agricultural Insurance in Ontario and Manitoba, Farm and Agricultural Insurance, and Farm Insurance—the Co-operators, Western Financial Group's Farm, and Ranch and Crop Hail Insurance.

After experiencing floods, some designated regions are considered unsuitable for living. To help homeowners in these areas, the Provincial government developed a buyout program through which it purchases condemned houses from their owners to assist with the financial burdens of resettlement. This program is generally active in areas that are deemed risky for both the occupants and the rescuers due to prevailing flood conditions.

2.4.3.2 Flood-Recovery Initiatives in St. Adolphe and Ste. Agathe

Functioning Partnership among Stakeholders

After the 1997 flood, the people of St. Adolphe and Ste. Agathe worked together to recover from the economic losses they had suffered. As part of this recovery, the people of these communities took advantage of their proximity to the US-Canada border when redeveloping their businesses. The community people also requested that the Provincial government increase the radius of the community dikes to allow more space for their businesses to flourish. This request was granted and carried out utilizing local knowledge. The people in the community developed community-based groups to present their demands to the local and Provincial government; following the flood of 1997, the people of these communities became very vocal about their interests, including their strong desire to rebuild and protect their communities. Collective efficacy and social cohesion played a major role in such activities. The people of Ste. Agathe also established an Economic Development Committee, which was chaired by a member from within the community. The purpose of this Committee was to work towards rebuilding the community.

Social and Physical Fabric of Homes and Communities

After losing a house, or parts of it, due to floods, along with everyday commodities, it becomes very difficult for individuals to cope with the sense of loss of the social connections and lives built within the community. With regard to his experience following the 1997 flood, one elderly member of the community remarked, “I just lost fifteen years of my life!”

The difficulty of psychosocial recovery was evident, as the community members still shed tears of sadness while sharing their experiences of the 1997 flood, even after 25 years. The intangible losses caused by a flood can hardly be compensated through monetary assistance. With sadness, suffering, and agony, comes attribution of blame. Consequently, the communities have become very concerned about their rights after the 1997 flood. In a conversation with the then-premier, the community reprimanded the Provincial government’s

past endeavours to protect the communities from floods. A member of the St. Adolphe community shared that, “We shamed the government into providing us with dikes, funding, and to put plans in place.” Such community actions ensured a quick recovery, with considerable assistance coming from the Provincial government.

2.5 Discussion

In this study, we investigated the salient features and characteristics of local-level flood management in the communities of St. Adolphe and Ste. Agathe, which are situated in the RM of Ritchot in Manitoba, Canada. To this end, we analyzed the patterns of flood preparedness, response, and recovery in these communities. In terms of preparedness for coping with flood hazards through structural mitigation measures, the communities were indifferent to the uncertainty and unpredictable nature of floods in Manitoba and even expressed their frustration regarding the necessity of their involvement in flood-management activities. Such lack of engagement and even unwillingness to being part of the process is a major obstacle in knowledge co-production and stakeholder partnership.

As Scolobig et al. [68] observed in their study of Tasmania, Australia, a lack of willingness among at-risk populations to share the responsibility for disaster management measures can encourage a top-down approach. According to the findings of this Australian study, although local participation may create conflict between public and private interests, it is necessary for government authorities to understand community perspectives and responsibility expectations. Kahl’s [69] study of Giles County, Virginia, USA, reaffirmed that the people of the community actively participated in flood modelling to help the local government enhance its flood preparedness. For example, the community members identified inaccuracies in the model and enlightened the researchers who were preparing the model about any community-specific necessities that needed to be considered.

In Italy, Germany, England, and the Netherlands, the professionalization of community members as risk-management stakeholders was noticeable at the local level [70,71]. Such efforts to increase community capacity and efficiency have generally been absent in the Red River Valley communities of Manitoba. Flood-preparedness activities in these communities are more centralized in Departments of the Manitoba Government, and the process through which community members can participate in such activities is not well-defined. Moon et al. [72] observed a similar state of public engagement in Belfast, Northern Ireland, which had a participatory process that was not transparent and did not encourage active participation from

the key stakeholders. Consequently, proactive flood-preparedness measures did not take place in these communities.

In the Red River Valley, the community respondents alleged that there is a one-way flow of information, with little-to-no reciprocity. For example, the EMO informs schools, hospitals, and senior homes about imminent risks and potential evacuation. After evacuation warnings have been communicated by the Provincial government, the emergency coordinator at the municipal level takes the initiative to evacuate the affected community members. In potentially high-risk situations, the EMO and forecast group from Manitoba Transportation and Infrastructure goes out to the communities to conduct briefings. The EMO has direct contact with the emergency management coordinators of local municipalities. However, little-to-no community input is considered in such briefings.

In 2022, Manitoba Transportation and Infrastructure held a "flood outlook" press conference to provide information about flood risks at the regional level, the resources and capacity of the Manitoba government, and Federal Disaster Financial Assistance arrangements. Such centralized management systems cause community members to become reliant on the local and Provincial government for flood response rather than empowering them to mobilize their own resources and local knowledge and skills. This is problematic, as such approaches eventually extinguish community members' interest in taking measures at the community level.

Manitoba's centralized system is comparable with that Southern Alberta, Canada, where social capacity could not be built due to lack of public engagement [52]. The failure of institutions to mitigate flood losses engenders public rage, as was evident after the 1997 flood. Not unlike Manitoba, experiential learning from the 2013 flood in Germany gave rise to local disputes as well [52,53].

Nonetheless, the panel responsible for reviewing the operating guidelines of flood-protection structures has established a website where it can communicate background information about its management practices and where the public can submit comments and opinions. Such interactive initiatives make flood preparedness in the Red River Valley top-down in character with very little community-level participation.

It is evident that, in Manitoba, the majority of flood-management policies and decisions are meant to be implemented at the community level, but are designed by the Provincial government with little-to-no input from the communities they affect. Such a top-down approach is unsustainable, as it is incapable of incorporating the community's expectations, in addition to creating misunderstandings between the government and community members. For example, our empirical investigation revealed growing dissatisfaction among community

people and non-profit organizations about numerous measures taken by the Provincial government, including those related to the financial aid systems, prioritizing the City of Winnipeg in flood management, lack of fund allocation to the RMs, and the absence of timely communication. These results align with those of Haer et al.' [73] study of Rotterdam-Rijnmond, the Netherlands, which found that risk-based top-down communication strategies are less effective than collaborative ones.

There is ongoing coordination and collaboration between the Provincial government and local governments in the Red River Valley, especially in response to floods. However, the decision-making process has been and largely remains centralized, with community engagement being limited to manning the pumping stations, sandbagging, communication of assistance, and volunteering services. In emergency situations, community members tried to collaborate with one another, and the advent of social media has made communication among community members more dynamic. For example, Facebook groups allow community members to exchange valuable information and share their experiential knowledge. A similar scenario was observed during the 2013 floods in Dresden, Germany, where people in the community primarily communicated with one another and shared information via Facebook [44].

Local-level flood recovery in the Red River Valley is primarily managed by the local and Provincial governments. The Provincial government and the municipal governments collaborate to manage compensation programs, whereas non-profit organizations such as the Canadian Red Cross assist in flood recovery at the field level. The community dikes surrounding St. Adolphe and Ste. Agathe were constructed with a larger radius than specified in the government plan, but this only occurred because the people of these communities took the initiative to make their wishes clearly known to the Provincial government. The benefits of local community input have been evident in many places. Unlike the flood-recovery process in the Red River Valley, the municipal government in Arnhem, Netherlands, took the initiative to engage citizens in knowledge co-production. Similarly, natural-hazard risk tolerance criteria for development activities were advocated by stakeholders in a government-driven engagement program aimed at shaping the recovery process following a flood in the District of North Vancouver, British Columbia [74,75].

In contrast to the informal community engagement observed in the flood-recovery measures implemented in the Red River Valley, community involvement has been formalized in Southern Alberta, Canada, where service providers have recognized the benefits of incorporating community members' insight and input into flood-recovery processes. Notably,

the people in these communities have also recognized their participation in the decision-making and implementation approaches as a way toward sustainable recovery. As a result, community engagement efforts engendered community-led services and initiatives [76].

In terms of flood recovery, the prevailing opinion among the majority of people in St. Adolphe and Ste. Agathe is that the Provincial government's flood-management strategy prioritizes the City of Winnipeg due to its economic contributions to the Province. They expressed their frustration at this perceived unfair treatment, and noted that it had driven them to focus on developing their economic value and clout as a community and to begin diversifying their community business offerings.

After careful analysis of local-level flood-management in the Red River Valley, it can be inferred that, while the relevant decision-making processes remain institutionally centralized, the overall flood preparedness, response, and recovery measures have begun to move away from conventional top-down approaches. However, local community participation and engagement in flood-management decision making is still limited. A false sense of safety due to structural mitigation measures and a lack of effective vertical collaboration between the formal institutions and the communities can be identified as two of the major factors responsible for this pattern. Consequently, the knowledge co-production process is thwarted, and a command-and-control structure remains the dominant flood-management paradigm in the Red River Valley.

2.6 Conclusions

Despite the UN Sendai Framework's strong call for local community engagement in disaster management and community resilience building, efforts to this end on the part of the Canadian federal and Provincial governments have been nominal. Consequently, there is a lack of knowledge and information on the local-level management of floods and other types of disasters, particularly in terms of engagement of the locale. The Province of Manitoba is no exception to this condition. The present case study makes a contribution to the understanding of the mechanisms and factors of local level flood risk assessment and management, especially in the context of a developed country like Canada. Given these knowledge gaps, the primary purpose of this study was to identify the attributes of local-level flood-management structures in Manitoba in terms of flood preparedness, response, and recovery. The specific objectives of the study were to examine the salient features of local-level flood preparedness, response, and

recovery, and to map and analyze stakeholders' views on the effectiveness of the existing structure and approaches to community-level flood management.

One of most conspicuous findings of our study is that the reluctance or often avoidance of flood risk-reduction and management responsibilities by the local communities, which is partly attributed to the previous experience of "bailing out" of flood-victims by the public funds, instigated a continuation of the top-down approach in the Province of Manitoba, Canada.

In agreement with the results of Homsy et al. [77] and McClymont et al. [78], the findings of our empirical investigation indicate that a multi-level governance approach, or a "fluid frontier" between top-down and bottom-up flood management, is necessary in the Province of Manitoba. Such an approach is likely to effectively minimize the limitations of a top-down technocratic approach, while maintaining vertical and horizontal communication and knowledge co-production and preserving order and a uniform guideline. The results of our study enable four key policy recommendations:

(1) Further research should be carried out to investigate the means and ways to encourage and motivate floodplain residents to undertake appropriate flood preparedness, risk-reduction and management responsibilities.

(2) Community-level flood management should be rigorous instead of depending entirely on institutional initiatives. Community members should be integrated into the decision-making process to utilize local-level knowledge, skills, and experience.

(3) Communication gaps between community members, local and Provincial governments, and non-government organizations should be addressed using interactive, two-ways means to improve trust, mutual respect, and knowledge co-production.

(4) To achieve sustainability, disaster- and flood-management approaches should adopt a pluralist governance structure that incorporates elements from both the top-down and bottom-up approaches.

(5) Further research is needed to investigate the dynamic combinations of top-down and bottom-up flood-management governance and to analyze the compatibility of multi-level governance in the context of the Red River Valley.

Finally, the present study has several limitations. First, the data used in the study are cross-sectional and therefore do not allow a time-series analysis for making longitudinal inferences. Second, only two selected towns on the Red River Valley of Manitoba were covered in the study and therefore, generalization about the entire Valley should be made with caution.

2.7 References

1. Hewitt, K.; Burton, I. *Hazardousness of a Place: A Regional Ecology of Damaging Events;* University of Toronto Press: Toronto, ON, Canada, 1971.
2. Cutter, S.L.; Barnes, L.; Berry, M.; Burton, C.; Evans, E.; Tate, E.; Webb, J. A place-based model for understanding community resilience to natural disasters. *Glob. Environ. Chang.* **2008**, *18*, 598–606.
3. Drakes, O.; Tate, E. Social vulnerability in a multi-hazard context: A systematic review. *Environ. Res. Lett.* **2022**, *17*, 033001.
4. Moulds, S.; Buytaert, W.; Templeton, M.R.; Kanu, I. Modeling the impacts of urban flood risk management on social inequality. *Water Resour. Res.* **2021**, 57, e2020WR029024. https://doi.org/10.1029/2020WR029024.
5. Pinos, J.; Quesada-Roman, A. Flood risk-realted research trends in Latin America and the Caribbean. *Water* **2022**, *14*, 10. https://doi.org/10.3390/w14010010.
6. Sadiq, A.-A.; Tyler, J.; Noonan, D.S. A review of community flood risk management studies in the United States. *Int. J. Disaster Risk Reduct.* **2019**, *41*, 101327. https://doi.org/10.1016/j.ijdrr.2019.101327.
7. Quesada-Roman, A.; Campos-Duran, D. Natural disaster risk inequalities in Central America. *Pap. Appl. Geogr.* **2022.,** May Issue, 1-13. https://doi.org/10.1080/23754931.2022.2081814.
8. Quesada-Roman, A.; Ballestero-Canovas, J.A.; Granados-Bolanos, S.; Birkel, C.; Stoffel, M. Improving regional flood risk assessment using flood frequency and dendrogeomorphic analyses in mountain catchments impacted by tropical cyclones. *Geomorphology* **2022**, *396*, 108000. https://doi.org10.1016/j.geomorph.2021.108000.
9. Lyu, H.-M.; Shen, S.-L.; Zhou, A.; Yang, J. Perspective for flood risk assessment and management for mega-city metro system. *Tunn. Undergr. Space Technol.* **2019**, *84*, 31–44.
10. Ikirri, M.; Faik, F.; Echogdali, F.Z.; Antunes, I.M.H.R.; Abioui, M.; Abdelrahman, K.; Fnais, M.S.; Wanaim, A.; Id-Belqas, M.; Boutaleb, S.; et al. Flood hazard index application in Arid catchments: Case of the Taguenit Wadi Watershed, Lakhssas, Morocco. *Land* **2022**, *11*, 1178. https:// doi.org/10.3390/land11081178.
11. Beck, U. *Risk Society: Towards a New Modernity;* Sage Publications: London, UK, 2004.
12. Haque, C.E. *Hazards in a Fickle Environment: Bangladesh*; Springer: Dordrecht, The Netherlands, 1997.
13. Mazzoleni, M.; Mard, J.; Rusca, M.; Odongo, V.; Lindersson, S.; Baldassarre, G.D. Floodplains in the Anthropocene: A global analysis of the interplay between human population, built environment, and flood severity. *Water Resour. Res.* **2021,** 57, e2020WR027744. https://doi.org/10.1029/2020WR027744.
14. Cutter, S.L.; Ismail-Zadeh, A.; Alcántara-Ayala, I.; Altan, O.; Baker, D.N.; Briceño, S.; Gupta, H.; Holloway, A.; Johnston, D.; McBean, G.A.; et al. Global risks: Pool knowledge to stem losses from disasters. *Nature* **2015**, *522*, 277–279.
15. McGee, S.; Frittman, J.; Ahn, S.J.; Murray, S. Implications of cascading effects for the Hyogo framework. *Int. J. Disaster Resil. Built Environ.* **2016**, *7*, 144–157.
16. Lechat, M.F. *The International Decade for Natural Disaster Reduction: Background and Objectives;* Blackwell: Hoboken, UK, 1990.
17. Busayo, E.T.; Kalumba, A.M.; Afuye, G.A.; Ekundayo, O.Y.; Orimoloye, I.R. Assessment of the Sendai framework for disaster risk reduction studies since 2015. *Int. J. Disaster Risk Reduct.* **2020**, *50*, 101906.

18. Thaler, T.; Seebauer, S. Bottom up citizen initiatives in natural hazard management: Why they appear and what they can do? *Environ. Sci. Policy* **2019**, *94*, 101–111.
19. Adger, W.N. Social capital, collective action, and adaptation to climate change. *Econ. Geogr.* **2003**, *79*, 387–404.
20. Quesada-Roman, A. Flood risk index development at the municipal level in Costa Rica: A methodological framework. *Environ. Sci. Policy* **2022**, *133*, 98–106. https://doi.org/10.1016/j.ensci.2022.03.012.
21. Santos, P.P.; Pereira, S.; Zezere, J.L.; Tavares, A.O.; Reis, E.; Garcia, R.A.C.; Oliveira, S.C. A comprehensive approach to understanding flood risk drivers at the municipal level. *J. Environ. Manag.* **2020**, *260*, 110127. https://doi.org/10.1016/j.jenvman.2020.110127.
22. Thistlethwaite, J.; Henstra, D. Municipal flood risk sharing in Canada: A policy instrument analysis. *Can. Water Resour. J.* **2017**, *42*, 349–363.
23. Edelenbos, J.; Van Buuren, A.; Roth, D.; Winnubst, M. Stakeholder initiatives in flood risk management: Exploring the role and impact of bottom-up initiatives in three 'Room for the River'projects in the Netherlands. *J. Environ. Plan. Manag.* **2017**, *60*, 47–66.
24. Serra-Llobet, A.; Conrad, E.; Schaefer, K. Governing for integrated water and flood risk management: Comparing top-down and bottom-up approaches in Spain and California. *Water* **2016**, *8*, 445.
25. Blázquez, L.; García, J.A.; Bodoque, J.M. Stakeholder analysis: Mapping the river networks for integrated flood risk management. *Environ. Sci. Policy* **2021**, *124*, 506–516.
26. Rashid, H. Interpreting flood disasters and flood hazard perceptions from newspaper discourse: Tale of two floods in the Red River valley, Manitoba, Canada. *Appl. Geogr.* **2011**, *31*, 35–45.
27. Brooks, G.; George, S. Flooding, structural flood control measures, and recent geomorphic research along the Red River, Manitoba, Canada. In *Geomorphic Approaches to Integrated Floodplain Management of Lowland Fluvial Systems in North America and Europe;* Hudson, P., Middelkoop, H., Eds.; Springer: New York, NY, USA, 2015, pp. 87–117. https://doi.org/10.1007/978-1-4939-2380-9_5.
28. Manitoba Flood Facts. (n.d.). History of Flooding in Manitoba. Government of Manitoba. Available online: https://www.gov.mb.ca/flooding/history/index.html (accessed on 2 July 2022).
29. Manitoba Transportation and Infrastructure. (n.d.). Historic Floods. Available online: https://www.gov.mb.ca/mit/wms/floodcontrol/redriverbasin/historic.html (accessed on 12 August, 2022).
30. Government of Manitoba. (n.d.). Flood Information – News and Bulletin. History of Flooding in Manitoba. Winnipeg, MB, Canada. Available online: https://www.gov.mb.ca/flooding/history/news_bulletin_2011.html (accessed on 12 August, 2022).
31. Manitoba Natural Resources. 1997 Flood Update. 1 May 1997 (accessed on 6 July 2022).
32. Stewart, R.M.; Rashid, H. Community strategies to improve flood risk communication in the Red River Basin, Manitoba, Canada. *Disasters* **2011**, *35*, 554–576.
33. Haque, C.E.; Kolba, M.; Morton, P.; Quinn, N.P. Public involvement in the Red River Basin management decisions and preparedness for the next flood. *Environ. Hazards* **2002**, *4*, 87–104.
34. Khan, H.; Vasilescu, L.G.; Khan, A. Disaster management cycle-a theoretical approach. *J. Manag. Mark.* **2008**, *6*, 43–50.

35. Etkin, D.; Haque, E.; Bellisario, L.; Burton, I. *An Assessment of Natural Hazards and Disasters in Canada: A Report for Decision-Makers and Practitioners*; The Canadian Natural Hazards Assessment Project; Environment Canada: Toronto, ON, Canada, 2004.
36. Webber, D.; Dufty, N. Being Prepared–Community Flood Education Planning in NSW. In Proceedings of the 48th Annual Floodplain Management Authorities (FMA) Conference, pp. 1-7, Wollongong, NSW, Australia, 26–29 February 2008.
37. McEwen, L.J.; Krause, F.; Jones, O.; Hansen, J.G. Sustainable flood memories, informal knowledge and the development of community resilience to future flood risk. *WIT Trans. Ecol. Environ.* **2012**, *159*, 253–264.
38. Kreibich, H.; Seifert, I.; Thieken, A.H.; Lindquist, E.; Wagner, K.; Merz, B. Recent changes in flood preparedness of private households and businesses in Germany. *Reg. Environ. Chang.* **2011**, *11*, 59–71.
39. Terpstra, T.; Gutteling, J.M. Households' perceived responsibilities in flood risk management in the Netherlands. International *J. Water Resour. Dev.* **2008**, *24*, 555–565.
40. Tomaszewski, B.; Judex, M.; Szarzynski, J.; Radestock, C.; Wirkus, L. Geographic information systems for disaster response: A review. *J. Homel. Secur. Emerg. Manag.* **2015**, *12*, 571–602.
41. United States Department of Homeland Security. *National Response Framework*, 2nd ed.; 2013. Available online: natresp.pdhttps://training.fema.gov/hiedu/highref/national%20response%20framework-second%20ed-may%202013-natresp.pdf (accessed on 15 August, 2022).
42. Haque, C.E. 2000. Risk assessment, emergency preparedness and response to hazards: The case of the 1997 Red River flood, Canada. *Nat. Hazards* **2000**, 21, 225–245.
43. Fritze, H.; Kray, C. Community and governmental responses to an urban flash flood. In Proceedings of the ISCRAM 2015 Conference, Kristiansand,24–27 May 2015;
44. Albris, K. The switchboard mechanism: How social media connected citizens during the 2013 floods in Dresden. *J. Contingencies Crisis Manag.* **2018**, *26*, 350–357.
45. Platt, S. Factors affecting the speed and quality of post-disaster recovery and resilience. In Proceedings of the International Conference on Earthquake Engineering and Structural Dynamics, Reykjavík, Iceland. 12–14 June 2017; Springer, Cham, Switzerland, 2018; pp. 369–403.
46. Smith, G.P.; Wenger, D. Sustainable disaster recovery: Operationalizing an existing agenda. In *Handbook of Disaster Research;* Rodriguez, H., Quarentelli, E.L., Dynes, R.R., Eds.; Springer: New York, NY, USA, 2007; pp. 234–257.
47. Medd, W.; Deeming, H.; Walker, G.; Whittle, R.; Mort, M.; Twigger-Ross, C.; Walker, M.; Watson, N.; Kashefi, E. The flood recovery gap: A real-time study of local recovery following the floods of June 2007 in Hull, North East England. *J. Flood Risk Manag.* **2015**, *8*, 315–328.
48. Rowlands, A. Disaster recovery management in Australia and the contribution of social work. *J. Soc. Work Disabil. Rehabil.* **2013**, *12*, 19–38.
49. Henderson, F.; Steiner, A.; Farmer, J.; Whittam, G. Challenges of community engagement in a rural area: The impact of flood protection and policy. *J. Rural Stud.* **2020**, *73*, 225–233.
50. Haque, C.E.; Choudhury, M.U.I.; Sikder, M.S. "Events and failures are our only means for making policy changes": Learning in disaster and emergency management policies in Manitoba, Canada. *Nat. Hazards* **2018**, *98*, 137–162.
51. Box, P., Thomalla, F.; Van den Honert, R. Flood risk in Australia: Whose responsibility is it, anyway? *Water* **2013**, *5*, 1580–1597.

52. Bogdan, E.; Bennett, A.; Yumagulova, L. Public engagements in forward-looking recovery efforts following the 2013 floods in High River and Calgary, Canada. In *Community Engagement in Post-disaster Recovery*; Marsh, G., Ahmed, K.I., Mulligan, M., Donovan, J. and Barton, S., Eds.; Routledge: New York, NY, USA, 2017; pp. 37–54.
53. Otto, A.; Hornberg, A.; Thieken, A. Local controversies of flood risk reduction measures in Germany. An explorative overview and recent insights. *J. Flood Risk Manag.* **2018**, *11*, S382–S394.
54. Serrao-Neumann, S.; Harman, B.; Leitch, A.; Low Choy, D. Public engagement and climate adaptation: Insights from three local governments in Australia. *J. Environ. Plan. Manag.* **2015**, *58*, 1196–1216.
55. Yin, R.K. *Case Study Research: Design and Methods;* Sage: Los Angeles, CA, USA, 2014.
56. Lincoln, S.Y.; Guba, E.G. *Naturalistic Inquiry;* Sage Publications: London, UK, 1985.
57. Creswell, J.W. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*; Sage Publications: London, UK, 2012.
58. Phillips, B.D. Qualitative methods and disaster research. *Int. J. Mass Emergencies Disasters* **1997**, *15*, 179–195.
59. Statistics Canada. *Census Profile, 2016*; Statistics Canada: Ottawa, ON, Canada, 2019. Census. Online: https://www150.statcan.gc.ca/n1/en/type/data?MM=1 (accessed on 20 October 2022).
60. Creswell, J.W. *Research Design: Qualitative, Quantitative, and Mixed Methods Approach*; Sage publications: London, UK, 2013.
61. Patton, M. *Qualitative Research and Evaluation Methods* (3rd edition); Sage Publications: Thousand Oakes, CA, USA, 2002.
62. Rubin, H.J.; Rubin, I.S. *Qualitative Interviewing: The Art of Hearing Data*; Sage: Thousand Oakes, CA, USA, 2011.
63. Marshall, C.; Rossman, G.B. *Designing Qualitative Research*; Sage: Thousand Oaks, CA, USA, 2010.
64. Janesick, V.J. *Oral History for the Qualitative Researcher: Choreographing the Story*; Guilford Press: New York, NY, USA, 2010.
65. Sikder, M.S. Disaster and Emergency Management (DEM) Policy Shifts, and Learning in Manitoba. Master's Thesis, University of Manitoba, Winnipeg, MB, Canada, 2017.
66. O'Leary, Z. *The Essential Guide to Doing Your Research Project*, 2nd ed.; Sage Publications: Thousand Oaks, CA, USA, 2014.
67. Manitoba EMO. *Manitoba Flood Coordination Plan 2019*; Government of Manitoba: Winnipeg, MB, Canada, 2022. Available online: https://www.manitoba.ca/emo/pdfs/flood_annex.pdf (accessed on 20 August, 2022).
68. Scolobig, A.; Prior, T.; Schröter, D.; Jörin, J.; Patt, A. Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. *Int. J. Disaster Risk Reduct.* **2015**, *12*, 202–212.
69. Kahl, A.C. Flood Modeling and Community Engagement in Giles County, Virginia. Unpublished Doctoral dissertation, Virginia Tech: Blacksburg, VA, USA, 2020.
70. Puzyreva, K.; de Vries, D.H. 'A low and watery place': A case study of flood history and sustainable community engagement in flood risk management in the County of Berkshire, England. *Int. J. Disaster Risk Reduct.* **2021**, *52*, 101980.
71. Puzyreva, K.; Henning, Z.; Schelwald, R.; Rassman, H.; Borgnino, E.; de Beus, P.; Casartelli, S.; Leon, D. Professionalization of community engagement in flood risk management: Insights from four European countries. *Int. J. Disaster Risk Reduct.* **2022**, *71*, 102811.

72. Moon, J.; Flannery, W.; Revez, A. Discourse and practice of participatory flood risk management in Belfast, UK. *Land Use Policy* **2017**, *63*, 408–417.
73. Haer, T.; Botzen, W.W.; Aerts, J.C. The effectiveness of flood risk communication strategies and the influence of social networks—Insights from an agent-based model. *Environ. Sci. Policy* **2016**, *60*, 44–52.
74. Forrest, S.A.; Trell, E.M.; Woltjer, J. Emerging citizen contributions, roles and interactions with public authorities in Dutch pluvial flood risk management. *Int. J. Water Resour. Dev.* **2021**, *37*, 1–23.
75. District of North Vancouver. Risk Tolerance; British Columbia, Canada. 2017. Available online: https://www.dnv.org/programs-and-services/risk-tolerance (accessed on 18 August, 2022).
76. Fulton, A.E.; Drolet, J.; Lalani, N.; Smith, E. Prioritizing psychosocial services for children, youth and families post disaster. *Disaster Prev. Manag. Int. J.* **2020**, *29*, 591–607.
77. Homsy, G.C.; Liu, Z.; Warner, M.E. Multilevel governance: Framing the integration of top-down and bottom-up policymaking. *Int. J. Public Adm.* **2019**, *2*, 572–582.
78. McClymont, K.; Morrison, D.; Beevers, L.; Carmen, E. Flood resilience: A systematic review. *J. Environ. Plan. Manag.* **2020**, *63*, 1151–1176.

Chapter 3

Risk-Reduction, Coping, and Adaptation to Flood Hazards in Manitoba, Canada: Evidence from Communities in the Red River Valley *

Abstract: In general, much is known about patterns relating to flood risk reduction, coping, and adaptation in various types of communities; however, knowledge of their drivers—which are critical for building community resilience to natural hazards—is limited. The present study investigates the drivers of coping and adaptation measures vis-a-vis flood hazards at the community level and examines their interrelationships. This work employs a "case study" approach and analyzes two towns—St. Adolphe and Ste. Agathe—in the Red River Valley in the Province of Manitoba, Canada. Data collection consisted of in-depth interviews with key informants and obtaining oral histories from the locals, along with an examination of secondary official records and documents. The results revealed that the major drivers of local-level coping and adaptation include functioning partnerships among stakeholders, strong institutional structures that facilitate interactive learning, knowledge co-production, resources sharing, communication and information sharing, and infrastructure supports. It was observed that an institutional atmosphere conducive to spontaneous network development yields diverse coping and adaptation strategies. To improve the outcomes of coping and adaptation measures, close collaboration between community-based groups and formal and quasi-formal institutions, and transparency in decision-making processes are vital.

Keywords: flood hazard; water level; disaster; emergency; risk reduction; coping; adaptation; partnerships; institutions

---

3.1 Introduction

3.1.1 Background

Flood hazards occur when dry land becomes at risk of being geo-physically covered by water that has escaped or been released from the normal confines of an adjacent waterbody [1].

---

*Haque, C. E., Zaman, J. R., & Walker, D. (2023). Risk-Reduction, Coping, and Adaptation to Flood Hazards in Manitoba, Canada: Evidence from Communities in the Red River Valley. *Geosciences, 13(3)*, 88.

While the physical destruction wrought by floods is well-known, such events also have numerous negative social impacts, including coping capacity, access to health facilities, land tenure, transportation, housing, and socioeconomic status [2]. Globally, 44% of disasters are associated with floods. Indeed, from 1970 to 2019, flooding events accounted for 31% of the total global economic losses incurred by disasters [3]. Given the immense proportion of global disaster-induced losses caused by floods, flood risk reduction is a critical area of research and analysis in disaster management.

Over the years, there have been several shifts in international approaches to disaster management. Upon recognizing that institutional efforts to reduce disaster losses had largely failed, because they lacked a critical assessment of risk, the United Nations (UN) declared the period between 1990 and 1999 to be the International Decade for Natural Disaster Reduction (IDNDR). Key components of the IDNDR included the initiation of coordination among national-level disaster management efforts, as well as the promotion of risk awareness and the facilitation of institutional development. Furthermore, the IDNDR advocated for the development and implementation of scientific and engineering initiatives aimed at reducing fatalities and property losses from natural disasters. These actions subsequently led to the creation of the United Nations International Strategy for Risk Reduction (UNISDR).

Although the UNISDR did not produce any legally binding treaties with targets or potential repercussions for non-compliance, it did introduce the concept of *disaster risk reduction* (DRR) on the international stage [4]. The UN defines Disaster Risk Reduction (DRR) as,

> *"the systematic development and application of policies, strategies and practices to minimise vulnerabilities, hazards and the unfolding of disaster impacts throughout a society, in the broad context of sustainable development"* [5].

In 2005, 168 countries joined the Hyogo Framework for Action (HFA), which served as a global blueprint that member countries could use to guide their DRR efforts and reduce disaster-related losses by 2015 [4]. The HFA provided member nations with guiding principles, priorities for action, and practical means by which vulnerable communities could build disaster resilience [6]. However, at a summit in Sendai, Japan, in 2015, the 187 attending nations concluded that the HFA did not adequately address the increased vulnerability and exposure of communities to disasters, ultimately leading them to adopt the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030. The signatory nations agreed that DRR must address existing challenges and prepare for future disasters. As such, DRR focuses on three key areas: monitoring, assessing, and understanding disaster risk and sharing information; strengthening

disaster risk governance and coordination across relevant institutions and sectors; and cultivating meaningful participation by relevant stakeholders [7].

In disaster management, the terms, "coping" and "adaptation", are used interchangeably, but also convey separate meanings. Jabeen et al. [8] note that, in disaster studies, "coping strategies" and "adaptation strategies" are roughly synonymous within the context of climate change. However, while "coping" refers to a set of immediate and short-term measures or ex-post actions [9,10], "adaptation" measures typically involve more deliberate actions (ex-ante) [11]. According to Parsons et al. [12], coping with natural hazards is the process by which individuals or organizations utilize available resources, skills, and opportunities to address adverse effects that may result from a disaster. Furthermore, Lei et al. [13] note that adapting to disaster shocks involves mitigating harm and taking advantage of beneficial opportunities through learning, with the goal of harmonizing human actions with natural hazards, rather than attempting to control nature. Coping and adaptation measures consist of formal (e.g., market and public interventions) and informal instruments (e.g., individual, household, or community-based actions) [14], and are shaped by antecedent conditions [15]. In the context of the Red River Valley, we argue that coping and adaptation mainly involve adjusting to internal and external shocks and stresses. In this study, coping and adaptation processes are predominantly considered as separate processes (also see Azad et al. [16]); however, since there is conceptual overlap between coping and adaptation measures, we analyze these terms together as well as interchangeably in some sections.

We argue that certain drivers prompt the implementation of coping and adaptation measures in response to natural disasters such as floods. Identifying and analyzing the drivers of local-level coping and adaptation measures can potentially lead to the formulation of flood management policies that will enable successful and ongoing flood risk reduction. There is a large and robust body of literature on flood risk reduction and specific coping and adaptation strategies, including context-based approaches. For example, Parsons et al. [12] introduced a hierarchical Australian Natural Disaster Resilience Index based on coping and adaptive capacities that highlights the potential for disaster resilience. Investigating communities in France and Germany, Bubeck et al. [17] found that socioeconomic characteristics alone are inadequate for flood-coping appraisal; rather, the quality of such appraisals is also positively correlated with observational learning from the social environment. Elsewhere, Bloemen et al.'s [18] study of communities the United Kingdom and the Netherlands revealed that, in long-term flood management planning, an adaptation pathways approach is effective in advancing decision-making processes and increasing awareness. However, it is notable that limited effort

has been devoted to understanding the multifaceted and interrelated drivers of coping and adaptation measures at the local level. In this study, we consider the drivers of coping and adaptation strategies as the primary drivers that influence or motivate changes to, and the development of, new flood management measures when conventional [or maybe 'previous'] measures become obsolete.

This study investigates the patterns and the drivers of coping and adaptation in local-level flood management strategies in the Province of Manitoba, Canada. Specifically, this work has three key objectives: i) to identify institutional coping and adaptation measures at the community level; ii) to examine the drivers of coping and adaptation measures; and iii) to identify coping and adaptation challenges for future floods.

3.1.2 Conceptual Considerations

The development of coping and adaptation strategies is often spontaneous and largely reactive. Additionally, the drivers that drive such changes are contextual; that is, all drivers may not influence coping and adaptation simultaneously. Furthermore, the drivers of coping and adaptation measures are generally interrelated and influence one another in a complex, dynamic manner when motivating changes in flood management activities. To understand what drives coping and adaptation to floods, it is necessary to examine the psychological underpinnings of the related behavioural patterns, including the decision-making processes [19]. Erdlenbruch and Bonté [20] note that unanswered questions relating to local-level cases include how long communities maintain adaptation measures, and how rapidly the measures are disseminated within the community. In the context of flood management, identifying the drivers that drive coping and adaptation is essential in understanding how coping and adaptation measures are introduced and accepted or rejected by the community and institutional representatives. Additionally, determining how these drivers drive changes in flood management is also important.

The unpredictability of nature-induced disaster shocks such as floods, necessitates management strategies to enhance adaptative capacity and the ability to live with floods. Here, adaptive capacity is defined as the ability of a system to plan and prepare for stress and adjust to it as it affects vulnerability through the modulation of exposure and sensitivity [21]. Choudhury and Haque [22] argue that the concept of adaptive capacity is central to disaster vulnerability and resilience, and that it has profound implications for disaster risk reduction. In terms of resilience, adaptive capacity is associated with coping and adaptation strategies,

wherein it is a human attribute and a precondition for resilience [23]. To understand the drivers that influence how vulnerable communities cope with and adapt to floods, it is necessary to draw on insights from local community-level flood management, institutional contributions, and governance strategies.

In this study, we draw upon Erdlenbruch and Bonté's [20] Empirical Decision Model to formulate a framework that explains the interconnectedness between drivers of coping and adaptation to disasters at the local level. We refer to this framework as the Local Coping and Adaptation to Disasters (LCAD) framework (Figure 3.1). The LCAD framework (see Appendix 6 for an elaborated illustration) illustrates the pathways through which different drivers influence coping and adaptation measures in local-level flood management, and how their interconnectedness and interdependence results in a DRR outcome.

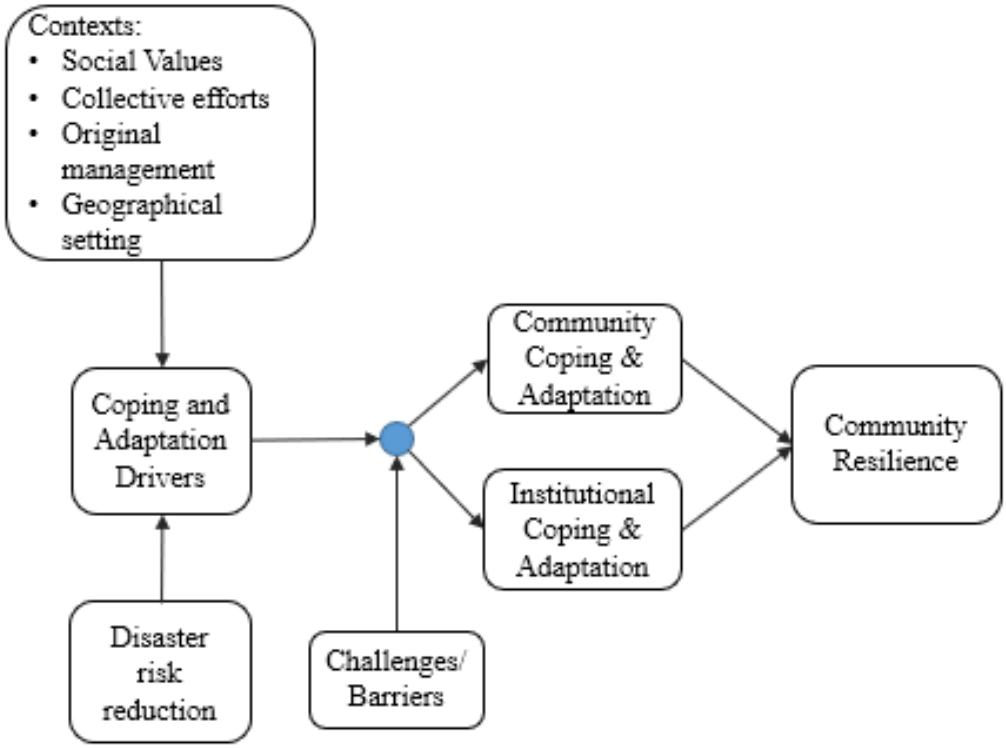

Figure 3.1 A conceptual framework explaining the interconnectedness between drivers of coping and adaptation to disasters and community resilience.

Erdlenbruch and Bonté [20] drew upon the Protection Motivation Theory (PMT) to formulate an agent-based model that simulates the adoption of individual adaptation measures and enables an evaluation of the efficiency of communication policies. Their model focuses on two complementary elements of risk perception: threat appraisal and coping appraisal. According to the PMT, perceived benefits can temper threat appraisal. For example, the Dutch

government took action to invest in flood-protection infrastructure, as it recognized the clear benefits of implementing flood risk-reduction measures. Notably, the Dutch government adopted a participatory approach by collaborating with the *Consortium Grensmaas* to implement these measures, and resulting in a network of knowledgeable governmental authorities and citizens [24]. Similarly, in Germany, threat appraisal led to proactive flood risk reduction, which included steps to implement the Floods Directives set forth by the European Union (EU). The Flood Directives require EU member states to identify, map, and manage flood risk and adopt adaptive legislation [25].

In our LCAD framework, social values, collective efforts, and original management strategy are conceptualized as sources of drivers. The short-term flood disaster coping drivers are primarily influenced by the level of knowledge and information, capacity to mitigate impact, conformity, sociocultural value, beliefs, and the locus of control. At the household and community level, drivers of coping and adaptation are unique in nature. For example, residents in the United Kingdom routinely adopt actions that are small, low-cost, low-tech, intuitive, and quick. Such coping and adaptation measures include making different dietary and/or clothing choices, and opening or closing windows. Conversely, long-term actions include relocating tangible goods to locations above flood level. To do their part to be prepared, many households also subscribe to the environment agency's flood warning service. Additionally, most households also purchase insurance to safeguard themselves from catastrophic financial impact from flooding [26].

Belliveau et al. [27] revealed that crop producers in the Okanagan Valley of British Columbia, Canada, cope and adapt to flooding based on the availability of resources and technology, as well as access to government programs. In Victoria, Australia, Wilby and Keenan [28] identified several drivers influencing adaptation measures at the community level, including routine monitoring, flood forecasting, data exchange, bridging organizations, contingency planning for disasters, insurance, and legal incentives to reduce vulnerability. In another study, Noll et al. [29] discovered that, in the United States, measures taken in the past significantly influence present and future coping and adaptation measures. In addition to threat appraisal and positive results from experience, coping and adaptation measures also depend on a household's existing adaptative capacity. In Ingham, a rural town in Queensland, Australia, community coping and adaptation actions are predominantly driven by the desire to rely on government initiatives as little as possible [30].

Social motivation can also play a major role in coping and adaption processes. As an example, in towns in England and Wales, Lo and Chan [31] discovered that when community

members observed others adopting coping and adaptation measures they were motivated to do likewise. The community's social network provided the necessary platform for learning. In addition, coping and adaptation is also driven by the perceived severity of flood damage, which is created through communicating information about risk. Information that creates fear and a sense of uncertainty is less likely than previously thought to be effective in driving such actions.

During and after a 2006 storm surge in Tsawwassen, British Columbia, Canada, coping and adaptation practices by members of the community were heavily influenced by the actions and opinions of family, friends, and neighbours, as well as the perceived benefits of different strategies, financial support, perception of other hazards, and government interventions [32]. Similarly, in a case study in Wagga Wagga and Kempsey, New South Wales, Australia, Khalili et al. [33] concluded that the indicators of a resilient community—the end results of coping and adaptive measures—were community, education, community participation, social support, learning, trust, exchange information, and shared information.

A variety of activities are integral to coping and adapting to floods, which may involve institutional measures and arrangements to help local communities. For example, in their study of towns in Alberta, Canada, Hayes et al. [34] suggested that, depending on the town's capacity, the Provincial government will award contracts to outside response organizations to help cope with floods. Furthermore, actions arising from people's belief systems and faith play an important role in coping and adaptation, especially in uniting community members in times of crises. Gianisa and Le De [35] observed that, after the 2009 earthquake in Padang, Indonesia, religious beliefs and practices played a key role in helping community members bond with one another and helped them successfully cope with the effects of the disaster.

Reaction to an incident can also be a major driver of coping and adaptation measures at the institutional level. For example, in the Netherlands, extreme discharges from the Rhine River in 1995 forced the evacuation of 200,000 floodplain inhabitants. The Dutch government realized that past practice of increasing height of the dikes was no longer adaptive in the face of future climate change. In 2006 they launched the "Room for the River" program, which initiated the development of multiple flood mitigation measures along the rivers to prevent flooding [36]. With multiple measures, this program indirectly reduces water levels. Such measures include deepening some channels, water storage where possible, dike relocations back from the existing channel to widen the river, secondary channels, removing flood plain deposits, lowering locks during flooding and reinforcing dikes. Garrelts and Lange [37] found that, in Germany, the public's perception of risk was not commensurate with the uncertainties caused by climate change, especially with respect to floods. This incongruence motivated the

regional and federal governments to embark on public-awareness campaigns stressing that the flood risk would persist, and that flood-protection measures guaranteed only limited safety.

In this paper, we argue that coping and adaptation are mobilized by learning-by-doing and initiatives at the community and institutional levels. A thorough understanding of local disaster risks and the underlying causes of the adverse impacts of flood disasters is indispensable in learning to live with floods, enhancing adaptive capacity, and building social, economic, and ecological resilience.

3.2 Flood Vulnerability and Risk-Reduction Measures in the Red River Valley, Manitoba

3.2.1 Geophysical Vulnerability

The geophysical vulnerability of a place is directly related to its physical exposure to natural hazards, particularly their magnitude, duration, and frequency [38]. As the flood-forming conditions and geophysical vulnerability of the Red River Valley in Manitoba, Canada, have been discussed in detail in an earlier publication [39], only a brief overview is provided herein. Three broad categories of flood-forming conditions prevail in the Red River Valley: (i) geological and physiographic conditions; (ii) hydrometeorological conditions; and (iii) human/societal drivers.

The southern part of the Province of Manitoba was formerly the floor of glacial Lake Agassiz, which resulted in its current status as a basin with a low-lying topography. Due to the flatness of the region, water can remain present for very long periods, which frequently results in significant surface flooding. The physiographic orientation of the Red River—it flows south-to-north (from North Dakota, USA, to Hudson Bay) with a gradual gradient decline in topography—further contributes to flooding as ice often remains on the northern stretch of the river as spring meltwater flows northwards. Additionally, isostatic rebound is causing elevation to rise faster in northern Manitoba, increasing flood risk in the south. Additional hydrometeorological conditions include large spring snowstorms caused by low pressure systems arising in the southwestern USA.

Apart from physical landscape and hydrometeorological causes, vulnerability to flooding can also be created by human-induced economic development. For example, in the Red River Basin, 98% of wetlands have been converted into farmland since European agricultural activities began in Manitoba [40]. In addition to the region’s flat topography and loss of wetlands, tilling practices and strategies for rapid surface drainage have also increased the

magnitude of flooding, as these practices increase surface runoff during heavy precipitation and during spring melt [29].

Population growth also contributes to an increase in the magnitude and frequency of flooding, as it requires the conversion of open spaces into paved areas, which in turn creates more runoff. This is a significant factor, as estimates suggest that the population of the Red River Valley has increased from about 265,000 in 1931 to over 750,000 in 2016 [41]. Furthermore, mitigation measures to protect infrastructure divert water into rivers and streams, which can lead to rapid increases in water levels and currents after spring melts and during summer storms [29]. Overall, the growing population living in the Red River Valley is exposed to more frequent and extreme flooding, rendering them very vulnerable to loss and damages with respect to property, livestock, and infrastructure.

3.2.2 Flood History in the Red River Valley

The notable floods of the 19th and 20th centuries in the Red River Valley include the flood of 1826, which had a return period of 500 years, and high-magnitude floods in 1852, 1904, 1916, 1948, 1950, 1979, 1997, 2009, and 2011. As flood memory plays a critical role in risk reduction and adaptation measures, it is important to analyse the historical patterns and experience of floods using archival data sources [42,43]. Indeed, the communities in Manitoba's Red River Valley have over a century of experience dealing with catastrophic floods, with the earliest instances being recorded by fur traders in 1793 and 1798 [44,45]. Comparisons of major flood years since the 1826 flood in relation to natural spring discharges and natural peak stages measured at James Avenue, Winnipeg, can be made from data presented in Table 3.1. The 1950 flood occurred between April-June and had a devastating impact on the capital city of Winnipeg, as more than 100,000 residents were forced to evacuate from their homes.

Table 3.1 Comparison of flood years in relation to natural spring peak discharges and natural spring peak stages measured at James Avenue, Winnipeg (the zero point of the gauge is 727.57 ft. above mean sea level) (Source of data: Manitoba Conservation and Water Stewardship, 2014). Note: 1974, 1979, 1996, 1997, 2006, 2009, and 2011 were computed without the use of Red River Floodway, Portage Diversion, and Shellmouth Dam.

Year	Natural Spring Peak Discharges in Cubic Feet per Second (Cusec) in '000	Natural Spring Peak Stages in Feet above Datum
1826	225	36.5
1852	165	34.5
1861	125	32.2
1950	108	30.3
1974	96	28.0
1979	108	30.3
1996	108	30.3
1997	163	34.4
206	99	28.5
2009	128	32.5
2011	116	31.2

The 1997 flood, dubbed "The Flood of the Century," was so severe that it caused other rivers to swell, which affected numerous communities along the Red River Valley. During this flood, the water level in the Red River rose by as much as 7.5 m, which reached its peak in early May–the highest peak since 1950 flood (see Figure 3.2)–with estimates suggesting that it may have reached up to 10.5 m without flood-control infrastructure. The Flood of the Century occurred between April-May of 1997, and was the most severe flooding event since 1852. This flood was caused by a combination of several meteorological conditions, particularly heavy rains in the autumn of 1996, which saturated the soil with moisture, and four blizzards throughout the winter and spring of 1997. In the spring, the heavy snowfall of the winter began to melt gradually, but a "Colorado Low" from the United States brought a massive snowfall at the beginning of April. By mid-April, the snow started melting again, but the runoff was too much for the water table to handle, thus yielding a once-in-a-century flooding event. The federal government responded by sending over 7000 military personnel to help with the flood effort over a 36-day period, while 25,450 people were forced to evacuate from the valley and relocate [29].

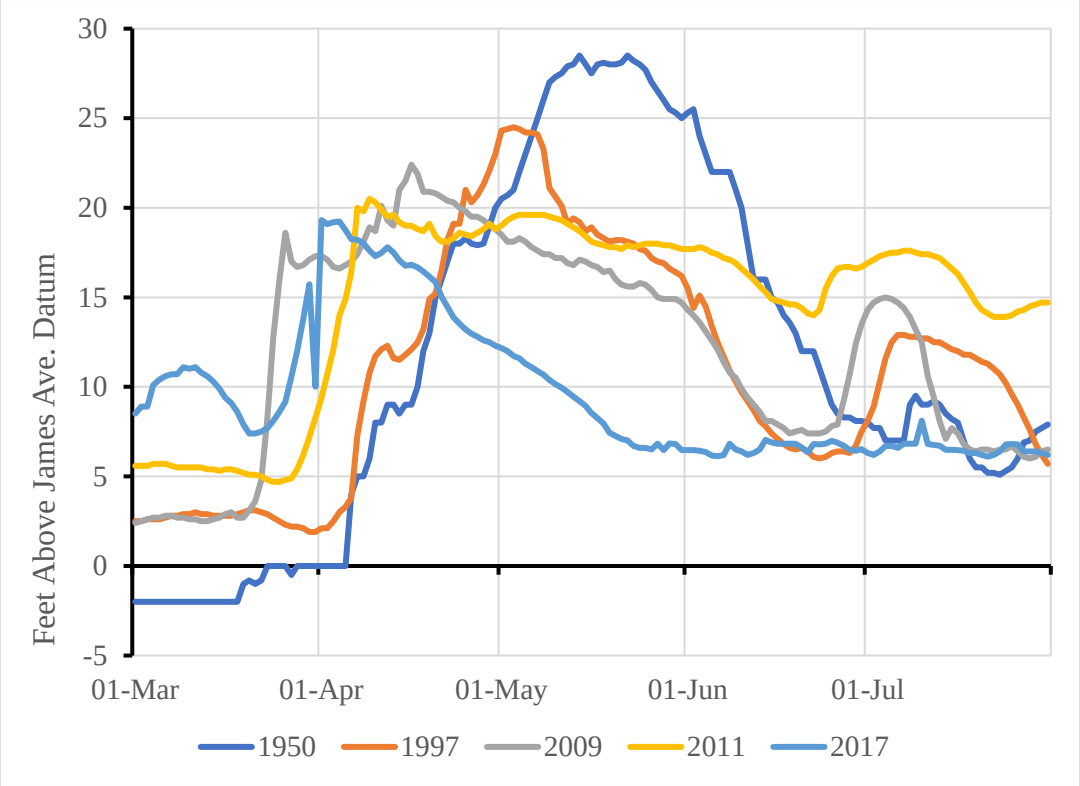

Figure 3.2 Historic Red River water levels at James Avenue, Winnipeg, 1950–2017. The zero point of the gauge at James Avenue is 727.57 ft. above mean sea level. (Sources of data: City of Winnipeg, and Water Survey of Canada, 2023).

After the Flood of the Century, the most notable floods in the Valley were the floods of 2009 and 2011 [46]. One major cause of the 2009 flood was a heavy rainstorm that occurred in the first week of November 2008. In addition, an exceptionally cold winter restricted the percolation of spring runoff, while above-average snowpack thwarted runoff in the USA portion of the watershed. Thus, blocked drainage due to unusual ice conditions and disrupted surface runoff resulted in high river water levels. Similarly, in late 2010, precipitation reached a 15-year high when a super-charged "weather bomb" brought 50 to 100 mm of snow and rain. These high levels of precipitation were exacerbated by unusually cold spring temperatures, which disrupted snowmelt and made it difficult to predict flooding. The final factor leading to the 2011 flood occurred in April, when ice jamming along the Red River caused water levels to rise and flood the Red River Valley.

Since the 1950 flood, most Provincial adaptation measures in Manitoba, including boulevard diking, diversions, the Red River Floodway, the Portage Diversion, and the Shellmouth Dam, have been event-driven [47]. However, climate variability may increase annual discharges and shift the start of flood season and peak occurrence in the river basins

[48], which will potentially render current coping and adaptation measures less efficient. Wang et al. [49] argue that Manitoba should implement adaptation plans designed to cope with the adverse impacts and associated extremes of climate change, and to adapt to the unpredictable nature of floods in this Province.

3.3.3 Flood Risk-Reduction Measures

Flood risk reduction became a priority for the Manitoba government following the 1950 flood's devastating impact on the capital city of Winnipeg. As an adaptive measure after the 1950 flood, the federal and the Provincial governments jointly established a Royal Commission tasked with conducting a cost-benefit analysis assessing the potential damage of future floods compared to potential flood prevention and mitigation alternatives. The Royal Commission submitted its recommendations in 1958, which initiated a major project entailing the construction of floodway around Winnipeg. The floodway project had four components: (a) the inlet channel, (b) the floodway channel, (c) the outlet structure, and (d) the east and west dikes. The then-$63 million dollar project was cost-shared, with the federal government contributing $37 million.

In subsequent years, the Government of Manitoba drew upon the lessons learned from the floods of 1950 and 1966 and negotiated with the federal government to embark on a cost-shared project involving the development of permanent dikes along the Red River Valley. This permanent diking scheme included both the diking of towns and the protection of farmsteads by either ring dikes or elevating farm buildings by raising the foundations. These flood risk-reduction measures were upgraded to a 100-year flood level based on the lessons learned from the flood of 1979. The flood of 1997, the largest flood in the Red River Valley since 1852, was a reminder that flood risk-reduction through coping and adaptation processes is an interminable endeavour [50].

The catastrophic 1997 flood revealed that flood-control structures and institutional interventions were not sufficient for protecting the valley's inhabitants and their property due to lack of communication and understanding between institutions. Additionally, a reluctance to implement up-to-date regulations and limited public participation in the decision-making process during the flood were other key elements that rendered organizational preparedness and mobilization to cope with the flood emergency futile [50].

Concurring with Haque [50], Stewart and Rashid [51] suggest that, even a decade after the 1997 flood, a lack of risk communication, information sharing, bottom-up activities, and partnership development persists in the Red River Valley. Although structural mitigation

measures such as the Red River Floodway and community dikes can reduce floodwater flow, thus limiting flood risk to some extent, flood risk and vulnerability persist due to the occupancy of flood-prone zones, as well as external pressures created by regional floodplain policies and procedures affecting social vulnerability.

3.4 Materials and Methods

3.4.1 Study Area

The field study portion of this research was conducted in the communities of St. Adolphe and Ste. Agathe, which are located in the Rural Municipality (RM) of Ritchot, Manitoba. These communities were primarily selected due to their high vulnerability to floods as a result of their geographic location (Figure 3.3), their experiences with flooding in recent decades, and the RM of Ritchot's willingness to participate in the research. Additionally, these communities were also selected for their geographical accessibility, and their proximity to four rivers: the Red River, the Rat River, the LaSalle River, and the Seine River. The Red River is the largest of the four, flowing north from the United States, past Ste. Agathe and St. Adolphe, through the City of Winnipeg, and ultimately draining into Lake Winnipeg. All communications, interviews and analysis involving individuals in this study was conducted following Research Ethics Approval # HE2021-0126.

Limited research has been conducted on the patterns of flood preparedness, emergency response and recovery, and drivers of coping and adaptation in this geographical area. Thus, the understudied nature of this region presents an opportunity, as the selected communities have the potential to serve as exemplars of micro-level flood management in rural Canada.

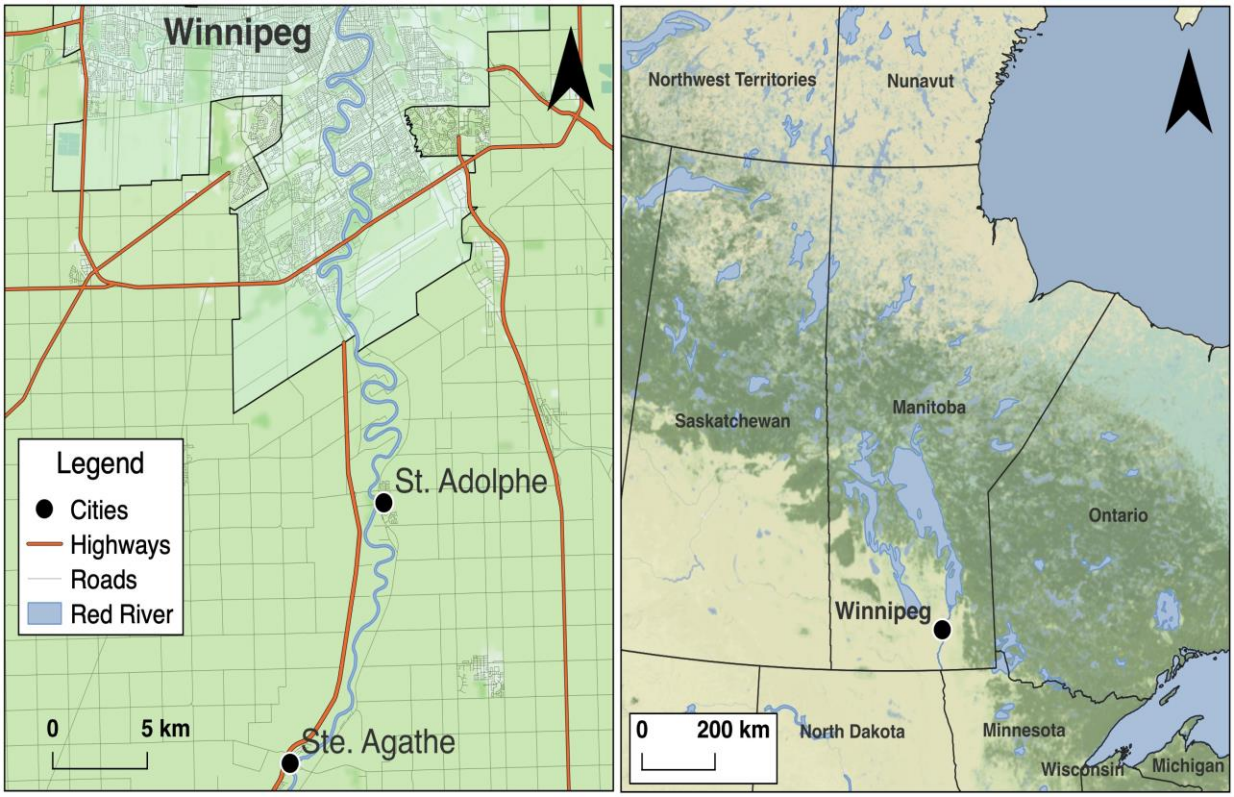

Figure 3.3 Map of Manitoba showing the locations of St. Adolphe and Ste. Agathe and location in Canada (Map tile background by Stamen Design, under Creative Commons BY 3.0. Data by OpenStreetMap, under ODbL.).

The flood characteristics in Manitoba are unique and profoundly influenced by the geography of the Red River Valley. The flow of the Red River is erratic and highly variable, ranging from periods of virtually no flow to extremely high flows that create flood conditions. Moreover, the populations of St. Adolphe and Ste. Agathe are steadily growing, along with the number of businesses and industries, which means that the number of vulnerable people, properties, and businesses in this area is also growing.

The residents of St. Adolphe and Ste. Agathe primarily depend on farming and tertiary services for their livelihood, which are often affected in times of flooding. Data from the 2016 Census indicates that 48.9% of the population in St. Adolphe and 35.2% of the population in Ste. Agathe are either younger than 15 years of age or older than 65 years of age (i.e., the dependent population). In addition, women account for approximately half of the population in both communities [52].

3.4.2 Field Methods and Data Collection Procedures

For this study we applied the case study approach developed by Yin [53], as it provides in-depth descriptions of, and insights into, a process or phenomenon within a bounded system

or setting [54,55]. In this research, the communities of St. Adolphe and Ste. Agathe were selected as the study area. The suitability of a "case study" approach has long been recognized in community-based flood disaster management research, as its inclusion of community members as a data source allows the study to capture the experiences of vulnerable populations and their resources [56].

After developing an in-depth understanding of the effectiveness of the existing flood management system and interpreting its current state, consultations with community members and officials from NGOs and local and Provincial governments were conducted. Such discussions aimed to examine their understanding of patterns of flood preparedness, emergency and recovery measures, and the drivers of coping and adaptation strategies at the local level. To meet these objectives, a community-based research method was employed.

A 3-tier study design was formulated and implemented. Primary data were collected via three methods: (i) key informant interviews (KIIs), (ii) oral history interviews (OHIs); and (iii) document review. KIIs were selected as a data collection method because they focus on individuals with knowledge relating to a particular issue, thus enabling an in-depth investigation into that issue [57]. The insights gained from KIIs help to understand and explain the experiences and reasons behind various changes in social and political processes [58,59]. Although KIIs are place-based, it is possible for the informants to identify attitudes and issues that have also been recognized in other places [60]. The KIIs used questionnaires consisting of semi-structured questions and were conducted with a total of eight respondents from the two selected communities, including government officials engaged in flood management in the RM of Ritchot, Provincial government personnel, and representatives from local NGOs. They interviews were conducted in person.

Data collection via oral histories was selected for use in this study because oral histories are comprised of local stories and reminiscences provided by community residents who have first-hand knowledge of the experiences contained therein [61]. OHIs are a collaborative, narrative-building process between the researcher and interviewee that involves spending a long period of time together [62]. OHIs emphasize the experiences of the individuals being interviewed [63]. To analyze the interviewees' common experiences and variable perceptions, a total of seven selected oral history interviews were carried out in the two communities using questionnaires consisting of semi-structured questions.

Purposive and *snowball* sampling procedures were employed for the selection of participants [64]. Purposive sampling was used to identify participants who could provide specific information about a given topic, while snowball sampling was helpful in identifying

key stakeholders who had experienced several floods and could therefore provide comprehensive insights [64].

In addition, document review was carried out by combining the steps developed by Sikder [65], and O'Leary [66], which are illustrated in Figure 3.4. A list of documents was prepared for analysis purposes using the following sources: (i) the University of Manitoba libraries; (ii) Google Scholar for research articles; (iii) annual reports and documents of NGOs involved in flood management in Manitoba; (iv) laws, by-laws, acts, and policy documents from the Government of Manitoba and EMO websites; (v) Public Safety Canada website; (vi) local and national newspapers; and (vii) government and NGO officials.

Project researchers checked the accessibility of the chosen documents and used publicly available ones for data collection. The authenticity and credibility of the documents were also assessed and verified by jointly analyzing them with the relevant participants. Furthermore, each document was analyzed for potential bias, and consideration was given to all available sources to avoid prioritization. The method and reasons behind the production of the documents were explored to aid in their interpretation. Witting evidence (what the document was meant to impart) and unwitting evidence (everything else that can be gleaned from the document) were identified. All documents were rigorously reviewed, and meanings were interpreted to draw conclusions. The data in these documents, which embodied the step-by-step processes of adaptation and risk reduction measures, were analyzed to determine their drivers.

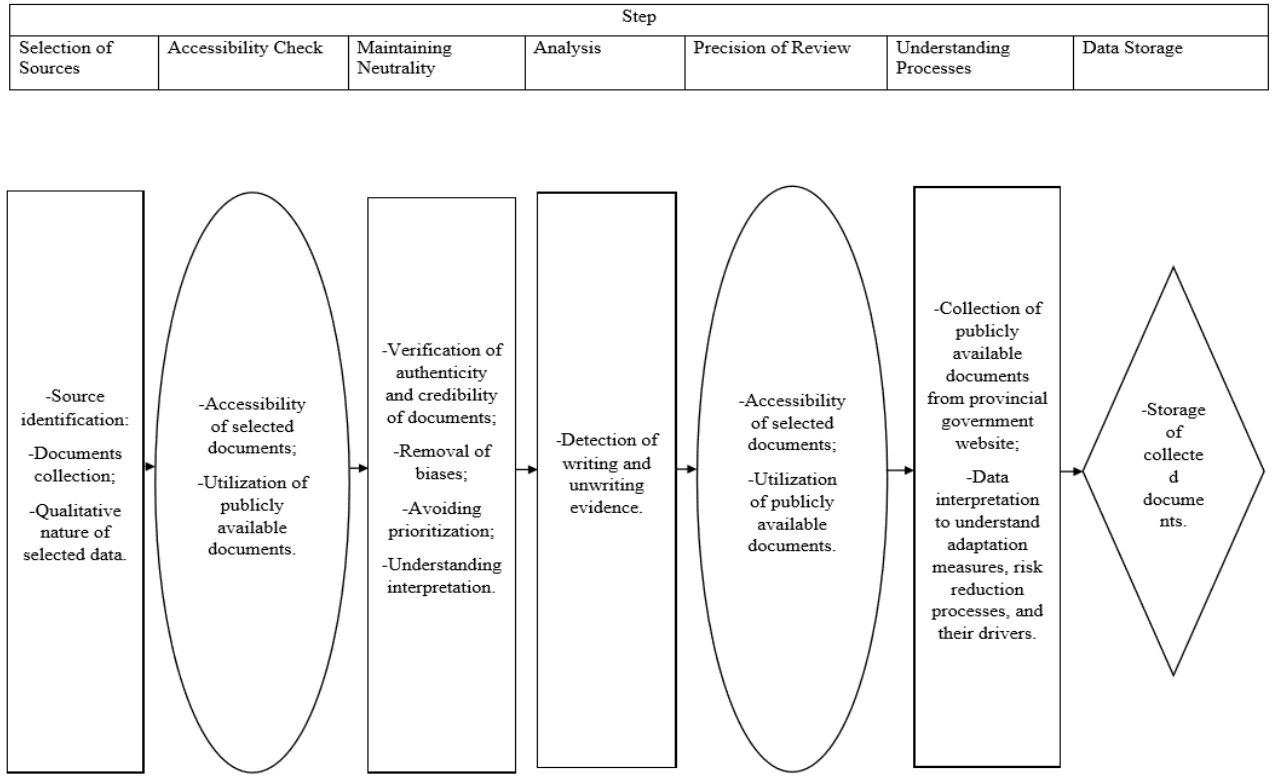

Figure 3.4 Document review process.

Project researchers checked the accessibility of the chosen documents and used publicly available ones for data collection. The authenticity and credibility of the documents were also assessed and verified by jointly analyzing them with the relevant participants. Furthermore, each document was analyzed for potential bias, and consideration was given to all available sources to avoid prioritization. The method and reasons behind the production of the documents were explored to aid in their interpretation. Witting evidence (what the document was meant to impart) and unwitting evidence (everything else that can be gleaned from the document) were identified. All documents were rigorously reviewed, and meanings were interpreted to draw conclusions. The data in these documents, which embodied the step-by-step processes of adaptation and risk reduction measures, were analyzed to determine their drivers.

3.5 Results

Empirical data suggest that local-level risk reduction, coping, and adaptation strategies to withstand flood losses in Manitoba, Canada, are not independent at the community and institutional levels. Rather, community- and institutional-level flood management measures are interdependent and integrated with each other. Overall, community members' rely heavily on

formal (different levels of governments and NGOs) and quasi-formal (community-based groups and organizations) institutions.

The coping and adaptation strategies discussed in this section have evolved over time, mostly based on previous flood experiences and shared learning. From our collected data, we identified three major areas where specific drivers influenced changes in flood management and instigated both spontaneous and intentional coping and adaptation measures. These areas are: (i) local community-level initiatives; (ii) interaction between governments, non-governmental organizations, and community members; and (iii) initiatives by non-profit organizations.

3.5.1 Community-Initiated Risk Reduction, Coping, and Adaptation Measures

We observed that community level initiatives were predominantly needs-based, especially when formal institutions failed to take flood-protection measures that aligned with the expectations of the community. These initiatives were undertaken at the individual level, collective level, and in communication with formal institutions. The identified local community-level coping and adaptation initiatives and their drivers are summarized in Table 3.2.

At the individual level, community members place sandbags around their properties after the release of the flood forecast to protect them from flood water. The community members' initiatives involve a wide range of activities. For example, in Ste. Agathe, river erosion remained a persistent concern, despite protective measures to save adjacent land and properties. As such, the residents reached out to the municipality authority and the Provincial government with the expectation of finding a solution. The Provincial government commissioned a study and concluded that the riverbank could be stabilized at an expense of $8 million. However, such an expense was difficult to justify, as Ste. Agathe had only 500 inhabitants at the time. Subsequently, the community ordered trees from Indian Head, a forestation center in Saskatchewan, and planted them along the riverbank to fortify it against floodwater. In addition, during an emergency, community members, including student volunteers who are bussed in, work together to help affected residents sandbag their properties. Pumps were installed to remove water from the diked areas of the communities, which needed to be purchased and maintained by community members. As a risk-reduction measure, the residents established a list of people able to run the pumps and help with evacuation, if necessary. This group, known as the Essential Services, consists of people with expertise in running gas

stations, working on machines, and making food. The rest of the community members were evacuated as conditions required.

If deemed insufficient, community people also became very vocal about the Provincial government's flood management strategies and held formal institutions accountable. For example, after the flood of 1997, a meeting was organized between residents of St. Adolphe and Ste. Agathe and the Premier of the Province at St. Boniface University. In this meeting, the community members in attendance demanded an explanation from the government for its actions during the preparedness and response phases.

Table 3.2 Local community-level drivers of coping and adaptation strategies.

Risk Reduction, Coping, and Adaptation Strategies	Driver	Learning
Individual action		
• Installing sandbags to save properties. • Building houses on elevated surfaces.	• Individual endeavors, as the 1997 flood was overwhelming for the federal, Provincial, and municipal governments. • Municipal government mandate on elevation.	• Installing sandbags around houses to protect them. • Houses built on elevated earth (manmade hills) are less prone to inundation. • 2 feet of water in 2009 being 'manageable' compared to 8.5 feet in 1997.
Working with volunteers		
• Volunteers (including students from local schools) help with sandbagging.	• Some communities were affected by the 1997 flood (St. Adolphe and Ste. Agathe) more than others	• Knowledge of coordinating with volunteers.
Community initiatives		
• After the 1997 flood, people in St. Adolphe presented their demands to thenpremier Gary Doer. • After the 1997 flood, the community people chastised the Provincial government for its lack of preparedness and communication at an event held at St. Boniface University. • Establishment of a list of people known as the Essential Services.	• Conveyance of community demands. • Raising local awareness. • Recency of flood. • Cohesion within communities developed by disaster shock. • Severity of a flood.	• Communication with government to inform it of community necessities. • Learning the potential of a flood disaster. • Pressuring the Provincial government to listen to demands. • Potential of collective action to respond to floods.
Social support		

• Community members planting trees to cope with floods. • Community people spontaneously helping one another. • Every evening, the evacuees convened to share their losses and sufferings and find catharsis among one another.	• Riverbank erosion in Ste. Agathe; stabilizing the riverbank required $8 million in funding from the Province. • In 1997, the potential for somebody to drown. • Need for catharsis.	• The Province could not justify such a cost for a community of around 500 people. • In an emergency, social capital must be built and help must come from within the community. • Mental support from community members provides strength.

3.5.2 Government-Institution-Led Strategies

Depending on the situation, the Provincial government adopts coping and adaptation measures in collaboration with local governments, non-government organizations (NGOs), and local communities. The Department of Manitoba Transportation and Infrastructure is responsible for the Provincial road network, Provincial water control network and also for the operation of the Red River Floodway (through the Red River Floodway Authority) and the maintenance of all 18 dikes in the Red River Valley. Risk-reduction decisions follow a hierarchal bureaucratic structure and their associated processes which involves stakeholders at various stages of these processes. The Emergency Measures Organization (EMO) is the primary coordinating body for flood emergency response, collaborating with relevant departments.

Table 3.3 shows the coping and adaptation measures taken by the Provincial government, their interaction with NGOs, and the drivers of such measures. In Manitoba, flood risk-reduction measures combine flood mitigation, preparedness, and response, with an emphasis on communication, proactive initiatives, reactive survival, and decision making. The Provincial government recognized that meaningful communication among stakeholders is critical for effective disaster and emergency management. Despite the potential that information may be misinterpreted, the government is willing to take that risk because of the benefits such knowledge provides. According to one government official, spending time on communication and explanation minimized the risk of misinterpretation:

> *"Communicating why mitigation activities are beneficial when you cannot see the result tomorrow is always difficult. Again, the information we provide to people is usually never sufficient because, by definition, it is a disaster where everybody is asking questions and saying they do not have enough information. But we always confirm the accuracy of the information we provide to people".*

The Emergency Management Division of Manitoba Transportation and Infrastructure works through their Emergency Operations Center and ensures strong links to key partners across the Emergency Management System. Every municipality has a Municipal Emergency Coordinator, who is involved with the planning processes of the Emergency Operations Center. The Center provides flood management information in response to queries from the Emergency Coordinators. When expenditures exceed the resources of the Province, a "request for assistance" will be made to the Federal government.

For the Province, the EMO serves as the information hub where the Provincial government can integrate information from stakeholders in schools, hospitals, and senior care homes for use in the event evacuation becomes necessary. The EMO relays information about the demand for and delivery of sandbags and any other service or resources provided by the government. The Provincial government has a liaison officer with expertise in flood management who maintains communications with chiefs of nearby First Nations communities. This allows the chiefs to contact the liaison officer directly in the event of an emergency, or they can reach out to Indigenous and Northern Affairs Canada (INAC).

Table 3.3 Interaction between governments, NGOs, and communities for coping with and adapting to floods.

Risk Reduction, Coping, and Adaptation Strategies	**Driver**	**Learning**
Communication and information sharing • Community people maintaining social relationships and being well informed. • Utilizing the ubiquity of cellphones. • Using websites to update people in the community. • Designating an emergency measures coordinator in every municipality. • EMO as the information center.	• Scarcity of sandbags. • Technological advancement. • Need for institutional help.	• Advance knowledge of sandbag availability. • Rapid information sharing. • The municipality councillor cannot manage floods on their own. • A designated information hub helps information flow.
NGO support • Canadian Red Cross providing food and water with food vans. • The nearby Hutterite Colony managing sandbags.	• Government support not being sufficient.	• NGOs raise funds from other Provinces. • NGOs provide manpower for recovery.
Government support • Materials, personnel, and offices with information. • Disaster Financial Assistance (DFA). • Employment of an adjuster.	• Need for information • Insufficient resources. • Banks not providing mortgages for lost worth.	• Flow of information helps coordination. • Separation of essential and luxury products.
Changes in municipal council		

• With time, part of municipal council changes.	• Age and experience	• New council members bring new ideas.
Shift of authority		
• The EMO replaced the reeves of St. Adolphe and Ste. Agathe in 1997	• Lack of expertise and experience.	• In emergencies, authority goes to emergency management experts.
Evacuation		
• Community members were evacuated to the then International Inn Hotel. • The evacuated community members were forced to violate evacuation rules in order to continue to care for their houses.	• Devastation of houses and property. • Urge among community members to save their houses.	• Knowledge of a temporary safer place. • The houses required constant care, such as pumping the water out and sandbagging.
Impact of waves		
• Application of the core trench strategy to install a temporary dike.	• River erosion destroying properties.	• Core trench strategy stops erosion.
Integrative measures		
• EMO directly contacts a community representative in the event of an emergency.	• Community institution relationship.	• Community's capacity to mitigate should be utilized.
Education		
• Project Cartier Park to establish the Red River Floods Interpretive Center. • The Provincial government's education initiatives.	• Perceived probability, consequences, benefits, and costs.	• Passing flood management knowledge to the future. • Lessons learned spread through education to the people of the community.
Physical intervention		
• The Ice Jam Mitigation program in 2006 and its expansion in 2011. • Road network management, operation of the Red River Floodway, and maintenance of all 18 dikes.	• Ice jams. • Sandbags are inexpensive.	• Ice jamming can unpredictably and quickly raise water levels. • Diked houses and areas functioning like a bowl.
Land use planning to reduce flood exposure		
• Initiation of the buyout program in 2009.	• Frequently flooded zones. • Uncertainty of floods	• Unpredictable floods are minacious for both the residents in the zone and the rescuers.
Risk communication		

• Government verifying information before dissemination.	• Possibility of confusion and distrust.	• There is an untrue assumption that information is withheld by the government.

During the 1997 flood, the Provincial government collaborated with the Canadian Red Cross to get food vans out to flood-affected communities to provide residents with food and water. The Provincial government also provided temporary offices within the communities where community members could go for information and guidance. Furthermore, the Province also arranged for boats to evacuate people living in remote areas or where road access was lost because of flooding.

When necessary, the Government of Manitoba contacts the federal government to activate the Disaster Financial Assistance (DFA) program, which is designed to provide disaster-affected community members with financial aid based on their needs. The Provincial government also sends an adjuster to flood-damaged houses to determine if they are salvageable or need to be "written-off." Based on the need assessment, a household could receive up to $100,000 in 1997.

The Provincial government takes initiatives to educate community members with respect to developing compatible emergency plans, communicating during emergencies, setting up evacuation routes, establishing an Emergency Operation Center in the municipality, and the need to store adequate food, water, and power to last for 72 h.

In 2006, the Government of Manitoba partnered with the municipalities to initiate the Ice Jam Mitigation Program, wherein they brought in Amphibexes (ice cutting machines) to break up the ice on the river. The program expanded in 2011, when two more Amphibexes were added to the existing two. Recently, the government's ice-cutting program was dissolved, and contractors are now hired to perform this work.

In 2009, the Government of Manitoba initiated the home buyout program, which allows the government to purchase homes that are vulnerable to floods and cannot be protected. Qualifying homes are those deemed to present harmful conditions for both the occupants and rescuers during a flood. The Province has also implemented a two-step application process for buying and building new houses outside of community ring dikes and in the Red River flood designated areas. For instance, new builds must adhere to flood-protection levels dictated by the Province. The two-step application requires builders to provide the municipality with a plan showing the proposed elevation of the house and to obtain a building permit.

In the past (~20 years ago), risk communication from the Provincial government to local communities placed considerable emphasis on appropriate emergency response. However, in recent years, the focus has shifted more towards flood mitigation and preparedness. Indeed, with climate change and the unpredictable nature of floods, "building resilient communities" and "climate change adaptation" have been gaining more attention in risk communication and disaster management approaches by the federal and Provincial governments.

3.5.3 Non-Governmental-Organization (NGO)-Led Strategies

In recent decades, changes in the wet and dry cycles due to climate change have become an additional concern with respect to flood and water management for non-profit and non-governmental organizations such as the Red River Basin Commission (RRBC) and the Watershed Districts. In 2022, after three consecutive dry years, snowfall, snowstorms, and rainfall broke decades-old records, which posed a serious flood threat in the event of a rapid (rather than gradual) spring thaw. However, even in dry cycles, farmers have become interested in water harvesting and water-retention projects, especially when water can be used with forages to feed cattle.

Non-profit organizations' contributions to local-level coping and adaptation measures, along with their drivers, are shown in Table 3.4. The Watershed District working in the RM of Ritchot and the RRBC are the two major non-profit organizations involved in flood management in St. Adolphe and Ste. Agathe. Water-retention projects are the most prominent of the projects run by the Watershed District. For water-retention projects, water is stored on lands rented from landowners or farmers that cannot be used for cultivation, but are suitable as pastures. The stored water can absorb flood water-shocks and it buffers the floodwater waves to mitigate further damages. Without water-retention projects, farmlands might become inundated due to "bottleneck effects" in the drainage system, which can in turn put nearby houses and roads at risk. One professional with the Watershed District referred to this phenomenon as the "bathtub effect." Since the cultivation of crops is more profitable than renting out lands for water-retention projects, farmers and landowners are generally reluctant to allocate their lands for such initiatives. However, the Watershed Districts authority has gradually been able to explain the long-term benefits of these projects to farmers and landowners. As a result, more farmers are now inclined to rent out their lands for a season to help minimize flood losses. As a coping and adaptation measure, the Watershed Districts tries to prioritize pastures for use as water-retention projects so that the grasses do not dry out and cattle can graze when the pastures are dry. For water-retention projects and

flood management planning, a three-dimensional mapping system is necessary. The Watershed Districts advocated for the utilization of LiDAR (Light Detection and Ranging)—which is a method for the determination of ranges—data in flood management as an adaptation measure, as LiDAR can produce a digital 3-D representation of the topography of the Earth's surface.

Table 3.4 Coping and adaptation initiatives by nonprofit organizations.

Risk Reduction, Coping, and Adaptation Strategies	Driver	Learning
Collaboration		
• Representatives from the municipality provide information to the Watershed Districts. • Collaboration between the Watershed Districts, IISD, and Service Water Management Planning for engineering work.	• Active initiatives taken by the municipalities. • Large projects requiring collaboration.	• Problems within the communities are best explained by the local representatives. • Grant approvals require collective decision making.
Newer methods		
• Advocating for LiDAR. • Acceptance of water-retention projects.	• Lack of proper mapping for projects. • Funding provided by the municipal and Provincial governments.	• Three-dimensional visuals from LiDAR. • Natural methods of mitigation.
Change in perception		
• Prioritizing pastures in spring.	• Lands used for water-retention projects cannot be used for cultivation in spring. • Devastating impact of floods and nutrient abundance after water recession.	• Pastures are perennial. • Floods may destroy crops. On the other hand, soil becomes very fertile after flood waters recede.
Inexpensive alternative		
• Utilization of berms as passive flow structures.	• Insufficient money to build drainage and automatically operated gates.	• Passive flow structures are inexpensive.
Provincial funding		
• Establishment of the Grow Trust Fund by the Provincial government.	• Realizing the potential of water-retention projects.	• Water-retention projects are natural initiatives to alleviate flood impact.
A common platform		
• The Red River Basin Commission works as a glue to hold stakeholders together.	• Differences in opinions among	• Putting "political hat" aside is important.

	decisionmakers, technical experts, and diplomats.

After successfully implementing the retention projects, the lands became more fertile and easier to cultivate after the water receded. However, according to an official with the Seine Rat Roseau Watershed District, flooding has become unpredictable due to climate change, and such uncertainty is affecting the benefits of water-retention projects. This official further shared that:

> *"The Province currently only requires the Intensity-Duration-Frequency Runoff curve. But for water-retention projects implementation, we need an IDF curve that accommodates climate change. We are finding that seriously problematic".*

To cope with flood water, the Watershed Districts use a berm (a flat strip of land, raised riverbank, or a terrace that borders a river or a canal) across low-lying lands with a culvert underneath. Culverts enable a consistent flow of water, which is known as a passive flow structure. The Watershed Districts also collaborate with the International Institute for Sustainable Development (IISD) in constructing hydrodynamic models, which are prepared by reading the surface and sub-surface waterflow with the high-water tables in place. The Watershed Districts also collaborate with Service Water Management Planning, where they are able to work with the engineering team. In March 2019, the Provincial government initiated the Grow Trust to support watershed-based conservation initiatives. The Grow Trust is a $52 million trust, and the first of its kind in Canada.

The Red River Basin Commission (RRBC) plays a paramount role as a common platform for discussions relating to flood management and the preservation of stakeholders' interests, irrespective of political inclination. The RRBC also works as a reliable entity that holds stakeholders together and provides a platform where stakeholders from Canada and the United States can participate in open discussion.

3.5.4 Challenges to Coping and Adaptation Strategies in Flood Management

The challenges to coping and adaptation strategies at the local level vary based on the context. The results of this study identified patterns in coping and adaptation measures regarding local-level flood management in St. Adolphe and Ste. Agathe, as well as several challenges for implementation, including: (i) inadequate support from government; (ii) recovery timespan during the restoration period; (iii) loss of flood memory and collective amnesia; (iv) lack of community-

level preparedness; (v) disregard of emotional values; (vi) lack of transparency at the senior government levels; (vii) communication gaps; and (viii) private flood insurance coverage. These challenges are summarized in Table 3.5.

From Table 3.5, it is evident that a lack of communication is one of the major challenges in local-level flood management. For example, a growing dissatisfaction was observed among the RM respondents who felt the City of Winnipeg—Manitoba's capital city—is prioritized in the Province's flood management strategies. As one community member observed:

"At the end of the day, all residents in the Red River Valley deserve an equal amount of protection for flood events, regardless of where they live in".

There is also concern about the misinterpretation of disseminated information. One government official commented that, *in a risky environment, the more information the local community people receive, the more they think that they do not have enough information*. Such perceptions can be very detrimental to the ability to work collaboratively.

One Watershed District official claimed that, although the watershed and protected areas are under the Department of Agriculture and Resources Development, the officials in that department responsible for funding Watershed District projects do not have relevant technical knowledge. As a result, these decision makers do not properly understand the local needs of the community and cannot appropriately allocate a yearly budget.

Table 3.5 Multilevel challenges of coping and adaptation to floods in local level flood management in Manitoba.

Challenging Issues	Associated Actors/Stakeholders
Support from the government	
• Slower than required support from the Provincial and federal governments in 1997. • Unsatisfactory access to information and materials in 1997. • Initiatives are reactive rather than proactive. • Current political element in the decision-making process—community members' indifference towards flood management results in the prioritization of issues such as healthcare, policing, and education.	• Provincial government. • Community members.
Flood memory and collective amnesia	
• Faded flood memory. • "Collective amnesia" thwarting social learning processes.	• Community members.

	• Formal institutions.
Lack of community-level preparedness	
• Community depends on RM council for flood management. • No informal or quasi-formal groups are active currently. • Complacency within the communities.	• Local governments (municipalities). • Community-based groups.
Disregard for emotional value	
• Emotional value of homes and places is being ignored.	• Individual households. • Provincial government. • Federal government.
Community involvement in flood management	
• Conspicuous lack of community involvement. • Local knowledge is hardly utilized in planning.	• Community members. • Formal institutions (Provincial government).
Local-level administration	
• The municipalities compete with each other for revenue from property taxes.	• Competing local governments (municipalities).
Transparency at the Provincial government level	
• The Red River Floods Interpretive Center in Cartier Park was shut down due to lack of management.	• Community members. • Provincial government.
Communication gap	
• Growing conception among the community people of St. Adolphe and Ste. Agathe that the Provincial government prioritizes the City of Winnipeg in flood management measures. • No communication between the Provincial government and the community regarding the above concern.	• Residents of St. Adolphe and Ste. Agathe. • Provincial government. • Communities in vicinity.
Private flood insurance coverage	
• Private flood insurance companies select lower-risk areas for coverage. • The insurance companies have yet to be regulated properly.	• Vulnerable community members.

	• Private companies providing flood insurance.
Challenges faced by non-profit and nongovernmental organizations • Communication gap between the Watershed Districts and the Provincial government. • The councilors from town have little idea of the local issues. • Insufficient funding for projects and wages of non-profit employees. • Civil engineer decisionmakers have a limited idea of agricultural issues.	• Non-profit organizations. • Provincial government. • Local governments.

Local-level flood preparedness is influenced by the interplay between funding concerns, revenue generation, and the safety of the community. Many home buyers wish to purchase houses that are located near bodies of water. If a house needs to be elevated, such upgrades can cost upwards of $15,000 to $20,000, depending on the size of the house. This may discourage homebuyers from purchasing a house in municipalities with such regulations. Moreover, the costs of a large-magnitude flood fall under the DFA, which may potentially encourage people to purchase houses situated on low-lying land and lacking appropriate protective measures. Speaking about the rural municipalities, one Provincial government official stated that:

> *"They're kind of put in a bit of the unfortunate spot of trying to balance those competing interests that they have. Some municipalities do a good job of saying, "this is your protection level, if you want to build here, you better protect to this level." Others will say, "that's not really our job. We don't want to scare these guys off," and they're a little more permissive, and they will let things go. So that's an interesting piece of the puzzle".*

Faded memories of past floods contributes to a lack of preparedness. Communities tend not to prioritize or consider issues that they do not frequently encounter, leading to a sense of overwhelming shock when a major flood event occurs. A member of the St. Adolphe community stated that:

> *"Once the flood is gone and you're back into your house, and after four or five years you're back in naturally, almost where you were before. People just move on with their lives. I certainly did. And then you feel very comforted with some of the post-flood mitigation work".*

In terms of coping strategies during the emergency response phase of the 1997 flood, authority in the RM of Ritchot was concentrated in the hands of a councillor who was originally from Ontario and who possessed very little local knowledge. A community member from Ste. Agathe mentioned that:

> *"The Province had no information system, everything was manual. So, recovery was tedious at best. From a modeling perspective, in Ste. Agathe, we were told that the water level was going to be 776.5 feet above sea level. And that level was given to us probably 10 days prior to the water arriving. So, the modeling was okay. The direction to mitigate against the incoming water was where we failed as a Province and as a local community. The water came over the highway by six inches, it wouldn't have been that complicated to dike the highway, but they did nothing with the highway".*

3.6 Discussion

The findings of this study revealed multiple drivers of coping and adaptation strategies. To identify the drivers, we analyzed the patterns of coping and adaptation measures in the communities St. Adolphe and Ste. Agathe, Manitoba, Canada. The identified drivers of coping and adaptation strategies in these two communities were limited to local community initiatives, interaction among different levels of government, non-governmental organizations, and initiatives by non-profit organizations. Significantly, the findings showed that these drivers are not independent; rather, they are interdependent and intertwined.

As Olausson and Nyhlen [67] have suggested, networks formed spontaneously by stakeholders, rather than by the government, can engender diversified solutions in terms of focus, organization, and decision-making. After the 1997 "Flood of the Century," spontaneous networks were built in local communities in the Red River Valley. However, as memories of the flood faded, these networks began to dissolve, consequently increasing the region's vulnerability. This finding is consistent with Lopez et al.'s [68] observation that as a component of adaptation measures, social preparedness is strongly affected by human behavioral traits such as risk awareness, recency of flood experience, trust in the authorities, and interactions among social groups.

Our findings further revealed that the community members of St. Adolphe and Ste. Agathe have trust in the structural measures taken by the Provincial government and, as such, do not perceive a risk of devastating flooding. Therefore, the residents of these communities were generally reluctant to take any coping and adaptation measures, especially after the construction

of the community dikes. However, vulnerable residents did take steps to elevate their houses and other properties as mandated by the local municipal authority. In contrast, Porter et al. [26] found that households in the United Kingdom routinely adopted low-cost, low-tech, intuitive, and quick actions that included changing their diets and clothing and purchasing insurance. Similarly, in the rural town of Ingham in Queensland, Australia, the major driver of community-level coping and adaptation measures was the desire to rely on governmental measures as little as possible [30]. Even in the presence of reliable government initiatives (e.g., structural measures), such proactive measures would encourage coping and adaptation at the community level and decrease pressure on the capacity of local and Provincial governments.

Our research also revealed that, although the residents of these two communities were concerned about climate change, they did not take any adaptive measures to counter climate-induced uncertainties. This contrasts with the community members of the Okanagan Valley, British Columbia, Canada, whose coping and adaptation measures to withstand flood losses were driven by the changing climatic conditions and a motivation to be proactive [27].

Flood adaptation measures worldwide involve a wide range of specific activities that are driven by multiple drivers. For example, in Victoria, Australia, Wilby and Keenan [28] found that the enabling drivers of adaptation measures included routine monitoring, flood forecasting, data exchange, institutional reform, bridging organizations, contingency planning for disasters, insurance, and legal incentives. In Wagga Wagga and Kempsey, New South Wales, Australia, coping and adaptation were also driven by learning, the exchange of information, and shared information [33]. In St. Adolphe and Ste. Agathe, coping and adaptation measures at the community level were dependent on similar drivers, where the community members' experience indicated that sometimes flood forecasts were incorrect. Although the Provincial government took some measures to interact with the residents of these communities, the community members felt these measures were insufficient.

Coping and adaptation to flood disasters are also profoundly influenced by functioning partnerships among stakeholders. Haque and Etkin [69] observed that, along with experience of natural hazards and structural approaches, successful recovery and coping with disasters requires functioning partnerships among stakeholders within the formal organizational structure and involving them with interactive learning, the co-production of knowledge, resource sharing, and a

collective decision-making culture. Here, stakeholders include the residents of the community, municipal and Provincial governments, the federal government (depending on the magnitude of a flood), NGOs, and non-profit organizations. Our findings indicate that there is a functional partnership among the stakeholders in St. Adolphe and Ste. Agathe, and that they are connected to one another for collective initiatives. For example, the Provincial government communicates with the local government through the emergency managers. In the event of an emergency, the local government then communicates with representatives from the community.

In our study area, a neighboring Hutterite colony was very active in uniting and supporting the community members in Ste. Agathe and St. Adolphe during the 1997 flood. Similarly, in Alberta, Canada, faith-based quasi-formal institutions drove coping and adaptation measures substantively at the community level [34]. It is evident that quasi-formal institutions play a major role in supporting local communities with coping measures, especially during flood disasters. In addition, institutional measures involving the government are highly significant in withstanding floodwaters. For example, the Government of the Netherlands created reservoirs along the rivers designed to reduce high water levels [36]. The Government of Manitoba has supported the initiative undertaken by the Selkirk city and two RMs (St. Andrews and Clements) for deploying ice breakers on the Red River to thwart the formation of ice jams, which can potentially contribute to spring flooding.

Community members' perception of risk is another important driver of community-level coping and adaptation to flooding. Our findings indicate that risk perception is very low among the residents of St. Adolphe and Ste. Agathe. The community members felt that, while they may still need to deal with floods of inconvenience, the structural measures that had been instituted precluded the possibility of a large-scale devastating flood.

The community members also believed that, should major flooding occur, the Provincial government, local government, and non-profit organizations would take charge. The community members generally rely overwhelmingly on these institutions, which caused them to tend to be passive with respect to taking coping and adaptation measures. Insufficient communication among stakeholders was responsible for creating this misunderstanding. In their study of flood preparedness measures in the UK, Tompkins et al. [70] found that the adoption of a top-down-oriented targeted adaptation approach had been successful in generating anticipatory actions in

several regions in the country. However, to take advantage of the innovative opportunities from niche activities, community members must actively participate and collaborate.

At the Provincial level, the Government of Manitoba has invested extensively in flood-protection measures and their management for flood risk reduction. To this end, the government held public hearings and launched interactive websites to engage community people and solicit their opinions. The Dutch government took a similar approach by investing in flood infrastructure and by adopting a participatory approach in its implementation [24]. Interjurisdictional collaboration has been another successful flood risk-reduction measure for adapting to the changing flood frequencies and intensities in Europe. In Germany, flood risk-reduction measures included the implementation of the European Union Flood Directive, which allowed member states to identify, map, and manage flood risk [25]. In our study, we did not find such collaboration at the interprovincial level. However, climate change concerns have recently been added to the flood risk-reduction discussion in Manitoba. To assist with the development of strategies that account for climate change, stakeholders in Manitoba might look to the actions taken by the local governments in other countries. For example, the town of Singleton, Newcastle, and Lake Macquarie in the Hunter region of New South Wales, Australia, have proactively integrated climate change adaptation into their strategies, policies, and plans for disaster risk reduction focusing on land use and development [71].

3.7 Conclusions

In-depth studies on local level flood hazard-risk reduction, coping and adaptation strategies are scant, and the present study makes a contribution to this area by offering a case study of two communities of Manitoba, Canada. The findings of the study improving flood hazard-risk reduction and formulating effective adaptation strategies. In turn, this research can help achieving UN Sustainable Development Goals 2 and 11 (SDG-2 and SDG 11) that encompass achieving food security, and making the human settlements safe, resilient and sustainable.

The Red River valley communities in Manitoba, Canada, rely heavily on the numerous major structural-engineering interventions that have been implemented since the flood of 1950. However, 1997′s Flood of the Century exposed these interventions as inadequate, which resulted in significant interest in non-structural risk-reduction interventions such as preparedness, evacuation plans, and floodplain zoning. In recent years, coping and adaptation measures taken in the

communities of St. Adolphe and Ste. Agathe, Manitoba, Canada have been influenced by the interplay of several drivers. In particular, our findings showed that effective communication and the transparent sharing of information were the prime drivers in flood preparedness and emergency response, especially in sandbagging, and the evacuation process. We also found that technological advancement has played a major role in improving communication, as social media and government websites have become common platforms for communication between the government and members of these communities.

In Manitoba, the Emergency Measures Organization (EMO) serves as a hub for integrating information from stakeholders. The Provincial government and an NGO—the Red River Basin Commission (RRBC)—implement initiatives aimed at building awareness among community members with regards to flood preparedness and coping methods in emergencies. At the local community level, the Watershed Districts, supported by funding from the Provincial government, have also been implementing water-retention projects to manage floods.

At the local level, flood risk reduction strategies and measures by and large depend on historical conditions, including knowledge of past flood disasters, and other local conditions. Therefore, generalizations at the river basin level or broader organizational level for the purpose of undertaking reduction measures often are not effective. Understanding local conditions for effective measures is crucial.

Consistent with the exiting literature, our results revealed that effective and meaningful communication with stakeholders is crucial to the adoption of integrative and participatory coping and adaptation strategies, as such efforts can transform the flood management system into an interactive platform. Therefore, future policy formulation should emphasize the removal of bureaucratic constraints, the remediation of communication shortcomings, and the adoption of a more integrative decision-making process.

The findings of the empirical research presented herein give rise to the following recommendations:

(1) Community members must be made aware of the fact that flood frequency is becoming uncertain due to climate change. As such, the practice of "living with floods" should be a component of daily life activities. Community-based organizations should be proactive and maintain coping and adaptation strategies for flood management in their agendas.

(2) Formal and quasi-formal institutional organizations should collaborate with community-based groups.
(3) Private flood insurance should be regulated by the Provincial government.
(4) Trust among stakeholders should be built via communication and transparency. Technological advancement can be used to advance this objective.
(5) It is imperative that all officials of government and non-governmental organizations are appropriately trained to perform the duties required by their positions. The proper management of natural and financial resources is one of the preconditions of apposite coping and adaptation strategies.

This study had two key limitations. First, there is a scarcity of chronological data regarding local-level coping and adaptation to floods in Manitoba. And second, the focus of this study was limited to one municipality and, therefore, the results cannot be generalized to the whole Province. Future research should investigate the dynamics of community involvement, the development of effective communication methods and tools, and the potential scope of private insurance that would balance profits and helping community members manage flood risk.

3.8 References

1. Carter, R.A. Flood risk, insurance, and emergency management in Australia. *Aust. J. Emerg. Manag.* **2012**, *27*, 20–25.
2. Rufat, S.; Tate, E.; Burton, C.G.; Maroof, A.S. Social vulnerability to floods: Review of case studies and implications for measurement. *Int. J. Disaster Risk Reduct.* **2015**, *14*, 470–486.9.
3. WMO (World Meteorological Organization). Weather-Related Disasters Increase Over Past 50 Years, Causing More Damage But Fewer Deaths, 2021 August 31. Available online: https://public.wmo.int/en/media/press-release/weather-related-disasters-increase-over-past-50-years-causing-more-damage-fewer (accessed on 4 December 2021).
4. Cutter, S.L.; Ismail-Zadeh, A.; Alcántara-Ayala, I.; Altan, O.; Baker, D.N.; Briceño, S.; Gupta, H.; Holloway, A.; Johnston, D.; McBean, G.A.; et al. Global risks: Poor knowledge to stem losses from disasters. *Nature* **2015**, *522*, 277–279.
5. DFID (Department for International Development). Reducing the Risk of Disasters—Helping to Achieve Sustainable Poverty Reduction in a Vulnerable World: A Policy Paper. DFID, London, UK, 2006. Available online: https://www.preventionweb.net/files/2067_VL108502.pdf(accessed on 16 September 2022).
6. UNISDR. (n.d.). What is the Hyogo Framework for Action? Hyogo Framework for Action. Available online: https://www.eird.org/regional/hyogo-framework.html (accessed on 26 September 2022).
7. Weichselgartner, J.; Pigeon, P. The role of knowledge in disaster risk reduction. *Int. J. Disaster Risk Sci.* **2015**, *6*, 107–116.
8. Jabeen, H.; Johnson, C.; Allen, A. Built-in resilience: Learning from grassroots coping strategies for climate variability. *Environ. Urban.* **2010**, *22*, 415–431.
9. Berkes, F.; Jolly, D. Adapting to climate change: Social-ecological resilience in a Canadian western arctic community. *Conserv. Ecol.* **2001**, *5*, 18–32.
10. Wisner, B.; Blaikie, P.; Cannon, T.; Davis, I. *At Risk: Natural Hazards, People's Vulnerability and Disasters*; Routledge: London, UK, 2004.
11. Birkmann, J.; Tetzlaff, G.; Zentel, K.O. Addressing the challenge: Recommendations and quality criteria for linking disaster risk reduction and adaptation to climate change. *DKKV Publ. Ser.* **2001,** *38*, 59.
12. Parsons, M.; Glavac, S.; Hastings, P.; Marshall, G.; McGregor, J.; McNeill, J.; Morley, P.; Reeve, I.; Stayner, R. Top-down assessment of disaster resilience: A conceptual framework using coping and adaptive capacities. *Int. J. Disaster Risk Reduct.* **2016**, *19*, 1–11.
13. Lei, Y.; Yue, Y.; Zhou, H.; Yin, W. Rethinking the relationships of vulnerability, resilience, and adaptation from a disaster risk perspective. *Nat. Hazards* **2014**, *70*, 609–627.
14. Balgah, R.A.; Bang, H.N.; Fondo, S.A. Drivers for coping with flood hazards: Beyond the analysis of single cases. *Jàmbá. J. Disaster Risk Stud.* **2019,** *11*, 678.
15. Cutter, S.L.; Barnes, L.; Berry, M.; Burton, C.; Evans, E.; Tate, E.; Webb, J. A place-based model for understanding community resilience to natural disasters. *Glob. Environ. Change* **2008**, *18*, 598–606.
16. Azad, M.A.K. The Role of Social Learning in Enhancing Community Resilience and Recovery from Flash Floods in Sunamganj, Bangladesh. Master's Thesis, Natural Resources Institute, University of Manitoba, Winnipeg, MB, Canada, 2021.

17. Bubeck, P.; Wouter Botzen, W.J.; Laudan, J.; Aerts, J.C.; Thieken, A.H. Insights into flood coping appraisals of protection motivation theory: Empirical evidence from Germany and France. *Risk Anal.* **2018**, *38*, 1239–1257.
18. Bloemen, P.; Reeder, T.; Zevenbergen, C.; Rijke, J.; Kingsborough, A. Lessons learned from applying adaptation pathways in flood risk management and challenges for the further development of this approach. *Mitig. Adapt. Strateg. Glob. Change* **2018,** *23*, 1083–1108.
19. Rose, C.B.; Manktelow, K.; Booth, C.A.; Proverbs, D.G. Psychological drivers affecting flood coping strategies. *WIT Trans. State-Art Sci. Eng.* **2011**, *52*, 105–114.
20. Erdlenbruch, K.; Bonté, B. Simulating the dynamics of individual adaptation to floods. *Environ. Sci. Policy* **2018**, *84*, 134–148.
21. Engle, N.L. Adaptive capacity and its assessment. *Glob. Environ. Change* **2011**, *21*, 647–656.
22. Choudhury, M.; Haque, C.E. "We are more scared of the power elites than the floods": Adaptive capacity and resilience of wetland community to flash flood disasters in Bangladesh. *Int. J. Disaster Risk Reduct.* **2016**, *19*, 145–158.
23. Walker, B.; Holling, C.S.; Carpenter, S.R.; Kinzig, A. Resilience, adaptability and transformability in social–ecological systems. *Ecol. Soc.* **2004**, *9*, 5.
24. de Voogt, D.L.; Bisschops, S.; Munaretto, S. Participatory social capacity building: Conceptualisation and experiences from pilots for flood risk mitigation in the Netherlands. *Environ. Sci. Policy* **2019**, *99*, 89–96.
25. Surminski, S.; Thieken, A.H. Promoting flood risk reduction: The role of insurance in Germany and England. *Earth's Future* **2017**, *5*, 979–1001.
26. Porter, J.J.; Dessai, S.; Tompkins, E.L. What do we know about UK household adaptation to climate change? A systematic review. *Clim. Change* **2014**, *127*, 371–379.
27. Belliveau, S.; Smit, B.; Bradshaw, B. Multiple exposures and dynamic vulnerability: Evidence from the grape industry in the Okanagan Valley, Canada. *Glob. Environ. Change* **2006**, *16*, 364–378.
28. Wilby, R.L.; Keenan, R. Adapting to flood risk under climate change. *Prog. Phys. Geogr.* **2012**, *36*, 348–378.
29. Noll, B.; Filatova, T.; Need, A. One and done? Exploring linkages between households' intended adaptations to climate-induced floods. *Risk Anal.* **2022**, *42*, 2781–2799.
30. Boon, H.J. Disaster resilience in a flood-impacted rural Australian town. *Nat. Hazards* **2014,** *71*, 683–701.
31. Lo, A.Y.; Chan, F. Preparing for flooding in England and Wales: The role of risk perception and the social context in driving individual action. *Nat. Hazards* **2017**, *88*, 367–387.
32. Romanowski, S.A. Storm Surge Flooding: Risk Perception and Coping Strategies of Residents in Tsawwassen, British Columbia. Master's Thesis, University of Alberta, Edmonton, AB, Canada, 2010.
33. Khalili, S.; Harre, M.; Morley, P. A temporal framework of social resilience indicators of communities to flood, case studies: Wagga wagga and Kempsey, NSW, Australia. *Int. J. Disaster Risk Reduct.* **2015**, *13*, 248–254.
34. Hayes, K.; Poland, B.; Cole, D.C.; Agic, B. Psychosocial adaptation to climate change in High River, Alberta: Implications for policy and practice. *Can. J. Public Health* **2020**, *111*, 880–889.
35. Gianisa, A.; Le De, L. The role of religious beliefs and practices in disaster: The case study of 2009 earthquake in Padang city, Indonesia. *Disaster Prev. Manag.* **2018**, *27*, 74–86.

36. Ritzema, H.P.; Van Loon-Steensma, J.M. Coping with climate change in a densely populated delta: A paradigm shift in flood and water management in the Netherlands. *Irrig. Drain.* **2018**, *67*, 52–65.
37. Garrelts, H.; Lange, H. Path dependencies and path change in complex fields of action: Climate adaptation policies in Germany in the realm of flood risk management. *Ambio* **2011**, *40*, 200–209.
38. Hewitt, K.; Burton, I. *Hazardousness of a Place: A Regional Ecology of Damaging Events*; Department of Geography, University of Toronto: Toronto, ON, Canada, 1971.
39. Haque, C.E., Mahmud, K.H., Walker, D., and Zaman, J.R. Geophysical and Societal Dimensions of Floods in Manitoba, Canada: A Social Vulnerability Assessment of the Rural Municipality of St. Andrews. *Geosciences* **2022**, *12*, 56.
40. Sierra Club. Red River Valley: Future Flooding or Sensible Solutions? How Basin Wide Coordination and Wetlands Protection Can Reduce the Risk of Flooding in the Red River Valley. A Rep. Agassiz Basin Group Sierra Club. 1998. Available online: http://citeseerx.ist.psu.edu/viewdoc/download?rep=rep1&type=pdf&doi=10.1.1.37.9662 (accessed on 23 December 2021).
41. Painter, K.J.; Brua, R.B.; Chambers, P.A.; Culp, J.M.; Chesworth, C.T.; Cormier, S.N.; Tyrrell, C.D.; Yates, A.G. An ecological causal assessment of tributaries draining the Red River Valley, Manitoba. *J. Great Lakes Res.* **2021**, *47*, 773–787.
42. Porfido, S.; Esposito, E.; Alaia, F.; Molisso, F.; Sacchi, M. The Use of Documentary Sources for Reconstructing Flood Chronologies on the Amalfi Rocky Coast (Southern Italy). In *Geohazard in Rocky Coastal Areas*; Violante, C., Ed.; The Geological Society of London: London, UK, 2009; pp. 173–187.
43. Violante, C.; Biscarini, C.; Esposito, E.; Molisso, F.; Porfido, S.; Sacchi, M. The Consequences of Hydrological Events on Steep Coastal Watersheds: The Costa d'Amalfi, Eastern Tyrrhenian Sea. In *The Role of Hydrology in Water Resources Management*; Proceedings of a symposium held on the island of Capri, Italy, October, 2008, IAHS Press, Wallingford, UK..
44. Rashid, H. Interpreting flood disasters and flood hazard perceptions from newspaper discourse: Tale of two floods in the Red River valley, Manitoba, Canada. *Appl. Geogr.* **2011**, *31*, 35–45.
45. Brooks, G.R.; George, S.S. Flooding, Structural Flood Control Measures, and Recent Geomorphic Research along the Red River, Manitoba, Canada. In *Geomorphic Approaches to Integrated Floodplain Management of Lowland Fluvial Systems in North America and Europe*; Springer: New York, NY, USA, 2015; pp. 87–117
46. Manitoba Transportation and Infrastructure. (n.d.). Historic Floods. Available online*:* https://www.gov.mb.ca/mit/wms/floodcontrol/redriverbasin/historic.html (accessed on 22 March 2022).
47. Simonovic, S.P. Canada: Flood Management in the Red River Basin, Manitoba. In *WMO/GWP Associated Programme on Flood Management*; 2004, World Meteorological Organization, Geneva. Switzerland.
48. Simonovic, S.P.; Li, L. Sensitivity of the Red River Basin flood protection system to climate variability and change. *Water Resour. Manag.* **2004**, *18*, 89–110.
49. Wang, T.; Samsom, S.; Ng, A.K.; Earl, P. Climate change and the adaptation planning of inland port and rail infrastructures in the province of Manitoba in Canada. *Clim. Change Adapt. Plan. Ports* **2015**, *59*, 91–105.

50. Haque, C.E. Risk assessment, emergency preparedness and response to hazards: The case of the 1997 Red River Valley flood, Canada. *Nat. Hazard* **2000**, *21*, 225–245.
51. Stewart, R.M.; Rashid, H. Community strategies to improve flood risk communication in the Red River Basin, Manitoba, Canada. *Disasters* **2011**, *35*, 554–576.
52. StatCan. Census Profile, 2016 Census. Statistics Canada. 2019**.** Available online: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/index-eng.cfm on (accessed on 29 November 2019).
53. Yin, R.K. *Case Study Research: Design and Methods*; SAGE: Los Angeles, CA, USA, 2014.
54. Lincoln, S.Y. *Naturalistic Inquiry*; Guba, E.G., Ed.; Sage Publications: London, UK, 1985; Volume 75.
55. Creswell, J.W. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*; Sage Publications: London, UK, 2012.
56. Phillips, B.D. Qualitative methods and disaster research. *Int. J. Mass Emergencies Disasters* **1997**, *15*, 179–195.
57. Creswell, J.W. R*esearch Design: Qualitative, Quantitative, and Mixed Methods Approach*; Sage publications: London, UK, **2013.**
58. Patton, M. *Qualitative Research and Evaluation Methods*, 3rd ed.; Sage publications Inc.: 2002, Thousand Oaks, CA, USA.
59. Rubin, H.J.; Rubin, I.S. *Qualitative Interviewing: The Art of Hearing Data*; Sage: Thousand Oak, CA, USA, **2011**.
60. Elmendorf, W.F.; Luloff, A.E. Using key informant interviews to better understand open space conservation in a developing watershed. *J. Arboric.* **2006**, *32*, 54–61.
61. Janesick, V.J. *Oral History for the Qualitative Researcher: Choreographing the Story*; Guilford Press: 2010, New York, USA.
62. Liamputtong, P. *Qualitative Research Methods—Australia and New Zealand*; University Press: Oxford, UK, **2009**.
63. Marshall, C.; Rossman, G.B. *Des. Qual. Res.* **2010**. Sage: Thousand Okas, CA, USA.
64. Creswell, J.W.; Creswell, J.D. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*; Sage Publications Incorporation: Thousand Oaks, CA, USA, 2018.
65. Sikder, M.S. Disaster and Emergency Management (DEM) Policy Shifts, and Learning in Manitoba. Master's Thesis, University of Manitoba, Winnipeg, MB, Canada, 2017.
66. O'Leary, Z. *The Essential Guide to Doing Your Research Project*, 2nd ed.; SAGE Publications, Inc.: Thousand Oaks, CA, USA, 2014.
67. Olausson, P.M.; Nyhlén, J. Organization and decision-making in enforced networks: The river groups in Northern Sweden. *J. Contingencies Crisis Manag.* **2017**, *25*, 313–325.
68. Lopez, M.G.; Di Baldassarre, G.; Seibert, J. Impact of social preparedness on floodEarly warning systems. *Water Resour. Res.* **2017**, *53*, 522–534.
69. Haque, C.E.; Etkin, D. People, community and resilience: Societal dimensions of environmental hazards. *Nat. Hazards* **2007**, *41*, 271–282.
70. Tompkins, E.L.; Adger, W.N.; Boyd, E.; Nicholson-Cole, S.; Weatherhead, K.; Arnell, N. Observed adaptation to climate change: UK evidence of transition to a well adapting society. *Glob. Environ. Change* **2010**, *20*, 627–635.
71. Forino, G.; von Meding, J.; Brewer, G.; Van Niekerk, D. Climate change adaptation and disaster risk reduction integration: Strategies, policies, and plans in three Australian local governments. *Int. J. Disaster Risk Reduct.* **2017**, *24*, 100–108.

Chapter 4

Discussion and Conclusion

4.1 Introduction

The goal of my thesis research was to examine the local-level flood management mechanisms, processes, and drivers of coping and adaptation to floods in the Red River Valley of Manitoba, Canada. The specific objectives of this research were:

1. To examine the pattern of flood preparedness, response, and recovery at the institutional level;
2. (a) To identify institutional coping and adaptation measures at the community level;
   (b) To examine the drivers of coping and adaptation measures

I used a case study approach, where the level and processes of collaboration, hierarchy, and drivers of flood management measures surfaced as key insights in building community resilience.

While most literature emphasizes global-level flood hazard management and coping and adaptation measures to build flood resilience (Ward et al., 2015 1; Zevenbergen et al., 2013 2; Gunnell et al., 2019 3; Mugume and Butler, 2017 4), research on local-level flood management patterns, and drivers of coping and adaptation to floods in local communities and institutions is still scarce. In Canada, research on flood management has generally been limited to the national and Provincial levels. The focus at the national level has been on the history of national strategies (Shrubsole, 2013) [5], national flood insurance implications (Oulahen, 2015) [6], and a national assessment of social vulnerability (Chakraborty et al., 2022) [7], whereas at the Provincial level, power and policy dynamics (Self and Penning-Rowsell, 2018) [8], policy opportunities (Lyle and McIean, 2008) [9], and longitudinal analysis of disaster management (Haque et al., 2019) [10] have been investigated.

Similarly, the focus of global flood management research has historically included risk modelling (Ward et al., 2015) [1], natural infrastructure for flood management (Gunnell et al., 2019) [3], and functional resilience in urban drainage (Mugume and Butler, 2017) [4]. This thesis has focused on addressing the above noted gaps in local community-level studies by examining

the pattern of flood preparedness, response, and recovery, and the drivers of their changes over time (i.e., coping and adaptation) at the local level in Manitoba, Canada.

In Manitoba, a few investigations have been conducted to examine different facets of local and Provincial-level flood management. The different thematic areas covered include: knowledge and information sharing among federal and Provincial authorities, local authorities, and local community people (Crumb, 2006) [11]; flood risk management and dominance of the institutional response (Morris-Oswald, 2007) [12]; flood risk perception (Ogston, 2005) [13]; policy learning (Haque et al., 2018) [10]; floodplain policy restriction of local action and empowerment (Stewart, 2007) [14]; and geophysical and societal dimensions of floods (Haque et al., 2022) [15]. Inadequate attention has hitherto been paid to the local-level flood management patterns and drivers of coping and adaptation strategies in Manitoba. Hence, this particular research has been conducted to understand the local dynamics of flood management patterns, and the interdependent drivers of coping and adaptation, which individually and/or together influence the overall local coping and adaptation strategies.

The following section presents an overview of the context of the two case study communities and critical aspects of local flood management.

4.2 Methodological approaches

The research was carried out with a pragmatic lens or worldview that focuses on actions, situations, and consequences rather than antecedent conditions (Creswell and Creswell, 2018, p. 379) [16]. As a qualitative research approach helps a researcher glean answers to questions about experience, meaning and perspectives from the standpoint of participants (Hammarberg et al., 2015) [17], I adopted this approach for my study. Case studies are well suited to examining real-life phenomena within an environmental context (Ridder, 2017) [18], and hence I used that strategy to conduct research in my study area.

The communities of St. Adolphe and Ste. Agathe were selected due to their high physical exposure and vulnerability to floods because of their geographic location. In addition, the community people have experienced floods in recent decades. The key informants for interviews were carefully selected from the local community people and government and non-government officials who are directly involved in local level flood management. Oral history interviewees were

purposefully selected from within the community, and included individuals with a long history of flood experiences.

4.3 Key findings

An elaborate explanation of my thesis research findings associated with the two main objectives has been laid out and synthesized in this section. Key findings pertinent to the objectives are presented in Table 4.1. Following the table, brief elucidations of the thematic areas are provided.

Table 4.1: Thematic representation of the key findings in accordance with the objectives of the study

Key findings	**Objective 1**: To examine the pattern of flood preparedness, response, and recovery at the institutional level.	**Objective 2 (a)**: To identify institutional coping and adaptation measures at the community level.	**Objective 2 (b)**: To examine the drivers of coping and adaptation measures.
Risk perception of community people influencing preparedness, coping, and adaptation.	√		√
Arrangement of spontaneous participation in lieu of a formal setting.		√	
Lack of willingness among at-risk populations to share disaster management responsibilities, encouraging a top-down approach.	√		√
Need for professionalization/formalization of community members as risk management stakeholders.	√		√
Exchange of information, stakeholder partnerships, learning, and institutional reform conducive to learning.		√	

Centralization of flood management system – decision-making and information flow.	√	√

❖ **Lack of engagement of at-risk populations with disaster management responsibilities is sustaining the status quo**

Sharing responsibilities between community and institutional levels assist building risk perception on one hand, and alleviates the burden and pressure from both on the other. My study revealed that the community people had very nominal involvement and responsibilities in flood management in the study area. With the structural measures in place, especially to address flooding problems, they had developed a false sense of safety that left them unprepared at the household and community level, and completely dependent on government initiatives. Consequently, in an emergency, they rely on government-level response and assistance from quasi-formal institutions, i.e., NGOs. Such a system induces a top-down management setting, where community people's involvement decreases substantially. Scolobig et al. (2015) [19] and Bogdan et al. (2017) [20] shared similar findings from their study of Tasmania, Australia, and Southern Alberta, Canada, respectively, where the lack of interest of the at-risk population caused a top-down flood management pattern, influencing local-level coping and adaptation measures. On the other hand, in Giles County, Virginia, USA, the community people actively participating in flood modelling to help local government in the enhancement of flood preparedness, and assisted in the development of a balanced management system between central authorities and local authorities and people, i.e., interactive disaster governance.

❖ **Need for professionalization and formalization of community members as risk management stakeholders**

As Lalancette and Charles (2022) [21] suggested from their survey of Canada's coastal municipalities, access to resources and governance in terms of institutional setting and political capacity are two of the key factors influencing local hazard management. In Italy, Germany, England, and the Netherlands, community people at the local level were found

to be regarded as risk-management stakeholders in flood management, which encouraged an interactive and collaborative management system (Puzyreva and de Vries, 2021 22; Puzyreva et al., 2022 23). Similarly, community involvement has been formalized in flood management activities in Southern Alberta, Canada, as formal institutional experts have recognized multiple benefits in incorporating community members' local knowledge and contributions (Fulton et al., 2020) [24]. In the Red River Valley of Manitoba, provisions have recently been made for community people to participate in the decision-making process by sharing their opinions through government websites. However, the participation process through the government website follows a centralized arrangement. A similar condition was seen in Belfast, Northern Ireland by Moon et al. (2017) [25], where the participatory process did not encourage active participation from the key stakeholders, and proactive flood preparedness measures were absent in the communities.

- **Centralization of flood management system – decision-making and information flow**

In the Red River Valley, the platforms for the flow of information were not satisfactory to community people. They alleged that the information flow system was a one way process with minimal reciprocity. As a result, there is a growing concern in the communities and local government of my study area that the Provincial government did not make much effort to include their local experience in the decision-making process. In Germany, a similar setting caused a situation where failure of institutions to mitigate flood losses instigated public rage. Experiential learning from the 2013 flood gave rise to local disputes, exacerbating post-flood actions (Otto et al., 2018) [26]. Such systems display symptoms of a top-down flood management system, where coping and adaptation measures are driven mostly by reactive forces. This kind of management system becomes unsustainable with changes in the character of floods, as it is incapable of incorporating public expectations and creates misinterpretations and misunderstandings between community people and institutional actors. Haer et al. (2016) [27] also found in their study in Rotterdam-Rijnmond, the Netherlands, that top-down communication strategies are less effective than collaborative ones.

❖ **Arrangement of spontaneous participation in lieu of a formal setting**

Findings of my thesis research unveiled that the Government of Manitoba tried to engage community people and receive feedback on their extensive investment in flood protection measures and management for risk reduction through formalized, structured programs. However, there was very little interest from the community people of my study area in participating in such feedback mechanisms. This initiative was similar to the Netherlands, where the Dutch government invested in flood infrastructure through a participatory approach in implementation (de Voogt et al., 2019) [28]. However, the formal setting of participation did not seem to be effective in St. Adolphe and Ste. Agathe. In this regard, Olausson and Nyhlen (2017) [29] suggested that networks that are formed spontaneously rather than formally by the government, are more effective at introducing diversified solutions to flood-related problems. In Manitoba, after the 1997 flood, networks evolved spontaneously at the local level, but were dissolved afterwards due to faded flood memory and a false sense of safety. In contrast, in their study in Ingham, Queensland, Australia, Boon (2014) [30] found that the major driver of community and household coping and adaptation strategies was a lack of trust and confidence in the government.

❖ **Exchange of information, stakeholder partnerships, learning, and institutional reform conducive to learning**

In the Red River Valley, Manitoba, the reciprocal flow of information was missing. The local government complained that the Provincial government would sometimes repair dikes in the area without informing them. Such activities caused anxiety and uncertainty within the local government and communities as they felt that the Provincial government was hiding information. However, the Provincial government would only share information that was verified, as unverified pieces of information could create dissention. Altogether, a lack of a trusting environment influenced coping and adaptation strategies immensely. In both Wagga Wagga and Kempsey, New South Wales, Australia, and Victoria, Australia, it was found that coping and adaptation were driven by the exchange of lessons learned (Khalili, 2015) [31] and information shared (Wilby and Keenan, 2012) [32].

- **Risk perception of community people influencing preparedness, coping and adaptation**

  According to Erdlenbruch and Bonté's (2018) [33] dynamic agent-based model simulating the adoption of individual adaptation measures, perceived benefits can temper threat appraisal. Risk perception is a significant driver of appropriate coping and adaptation strategies in flood management. In both St. Adolphe and Ste. Agathe, the community perceived that with the structural mitigation measures in place, and with the different layers of governments being prepared for emergency response and recovery, there might be a "flood of inconvenience", but not a flood that would cause devastation. Such a mindset thwarted them from preparing for future floods, as they failed to understand the limitations of existing institutional capacities. Tompkins et al. (2010) [34] also found in the UK that top-down adaptation approaches generated anticipatory actions, but hindered utilization of room for innovation.

  Collaboration and communication between different layers of governments, and between the community people and local institutions are preconditions of effective coping and adaptation to floods. Therefore, a top-down flood management pattern is not compatible with local-level flood management interventions, except for emergency response to large scale events where resources need to be mobilized quickly. My findings suggest that, overall, the measures undertaken by the Provincial government were only partially successful, because local community people were generally passive in such activities. Therefore, collaborative and spontaneous discussion with a multi-dimensional exchange of information should be facilitated, as this will encourage community people to participate in flood management.

4.4 Major contributions of the research

- My research examined the major elements of flood preparedness, response, and recovery in the Red River Valley, and found ample evidence that local-level flood management follows a top-down pattern. Earlier studies primarily investigated the Provincial or national levels, focusing on risk perception, vulnerability mitigation, transition and transformation in disaster management policies, and social support. My study examined the micro-level

context both at the community and institutional levels, and unveiled limitations in planning and execution.

- By examining the roles of collaboration, coordination, and information exchange while maintaining transparency, my study postulates that a balance between top-down and bottom-up patterns of flood management needs to be developed. An interactive flood management system, or multi-level governance approach not only alleviates pressure on institutional capacities, but also enables community people to participate in the development of coping and adaptation strategies while ensuring the optimal utilization of public resources. While earlier studies have focused on holistic flood management approaches, my thesis research analyzed the local community and local and Provincial institutional components to identify and describe the gaps and remedies recommended by diverse stakeholders. In this regard, my research provides policy recommendations for opening new doors towards multi-level institutional collaboration.
- By investigating the local/micro-level coping and adaptation measures in the two communities along the Red River Valley, my study revealed the major interdependent elements that drive coping and adaption measures in the communities, and the formal, quasi-formal, and informal institutions that are responsible for local flood management in the communities. In flood disaster studies, substantial gaps remain in regard to examining the drivers of coping and adaptation measures, since most studies focus instead on tools and intervention strategies. In chapter three, I describe how the drivers of coping and adaption measures are interrelated and can influence flood management individually or in combination. My research showed that at the local level, while technological advancements have improved the dynamics of communication through websites, social media, and news media, a communication gap still exists between the different levels of institutions and between the community people and their governments. My findings also identified the key challenges and the associated actors/stakeholders that will help policymakers address gaps in developing effective coping and adaptation strategies and measures.
- Recent public policies and emergency management strategies have exhibited a focus approach to adopt a participatory approach to Manitoba's disaster and emergency management issues and problems. However, several local-level challenges persist in the Red River Valley that require further scrutiny and attention. These challenges include:

- Proper and appropriate level of engagement of the the community people in public policy formulation are required. Although the Manitoba government has endeavoured to create a platform through EngageMB, an online opinion-sharing platform, the community participation in them is still very low. Therefore, benefits and effectiveness of such platforms need to be communicated to the community people for effectively for their mobilization and enthusiastic participation.
- A trust from the local community people to believe that the Provincial and the federal government will treat their flood losses and damages fairly, as opposed to only prioritizing major urban centres such as, Winnipeg -- the capital city of Manitoba.
- There is still a lack of closer and effective communication and collaboration between the different levels and layers of governments and non-government organizations.
- The community people are yet to be aware and recognize that the structural flood mitigation measures, while efficiently protecting the communities, have limitations. Hence, local community level preparedness and coordination are pivotal to reducing flood damages.

4.5 Policy implications and recommendations

In my research, collaboration among stakeholders has been identified as the principal component for flood management and building community-level flood resilience. The study has several policy implications, which are:

1) Community-level flood management should be self-instigated, instead of relying entirely on institutional initiatives. There should be platforms to encourage the spontaneous participation of both community and institutional people in decision-making processes. Such a platform would enable the utilization of local knowledge and experiences.
2) To sustain a resilience, flood management approaches should adopt a pluralist governance structure, incorporating elements of both top-down and bottom-up approaches. Relevant

formal and quasi-formal institutional organizations should also collaborate with community-based groups to successfully address local-level concerns and needs.

3) Local-level community awareness is an essential part of coping and adaptation measures, as it develops contextual risk perception. The government should take necessary steps to make community people aware of the uncertainty of flood frequencies and consequences. A practice of "living with floods" will introduce necessary changes in the drivers of coping and adaptation measures.
4) The community members were not contended with the present scheme of flood insurance (privatized), and more research at the academic and government level is necessary to identify an appropriate approach toward flood insurance.
5) Enhancing awareness and training formal and quasi-formal institutional officials about local necessities is a prerequisite for the proper management of public resources. For this, the engagement of appropriate subject matter experts in challenges requiring immediate resolution is important.
6) Analysis and results engendered from this study on flood management can be applied to other types of natural hazards in Canada (including but not limited to wildfire). It is crucial to engage and mobilize multi-level (local, provincial, federal, and international) institutions in disaster management. Specifically, for disaster preparedness, recovery, and overall coping and adaptation, an integration of community engagement and learning, and institutional technical knowledge can be beneficial. Both short-term and long-term adaptive measures can be formulated based on lessons learned at the community level, and technical knowledge, skills, and experiences of the formal and informal institutions.

4.6 Future research

- ❖ I found that components of building flood resilience, and the challenges of flood preparedness, response, and recovery vary significantly among communities. For a holistic Provincial approach towards addressing these challenges and flood management, additional micro-level studies such as this are needed in the Province, and across Canada.
- ❖ My research identified and analyzed the local-level drivers of coping and adaption measures in the communities along the Red River Valley. Further research should investigate the dynamic interdependence between such drivers.

- My investigation has indicated some of the key challenges in coping and adaptation in St. Adolphe and Ste. Agathe. Future research should study contextual solutions to these challenges, and how they can be incorporated in policy considerations.

4.7 Major limitations of my study

- The data used in my study are cross-sectional, and as such longitudinal inferences could not be drawn and the analysis lacks the investigation of historical changes in local-level flood management.
- The study area included only two of the communities along the Red River Valley. Hence, the data and the findings do not represent the Provincial or national entities as a whole. To enable generalization, it would be necessary to carry out similar studies in other communities and local jurisdictions.
- I conducted the study during the COVID-19 pandemic, and therefore, my interviews took place via online platforms. As a result, my data collection procedures may have some weaknesses regarding a deeper connection with the research participants; due to lock-out of communities and lack of in-person interactions, direct participatory observation in the field was not possible.

  These limitations might have affected the reliability and validity of the results of the present study.

4.8 References

1. Ward, P. J., Jongman, B., Salamon, P., Simpson, A., Bates, P., De Groeve, T., Muis, S., de Perez, E.C., Rudari, R., Trigg, M.A. & Winsemius, H. C. Usefulness and limitations of global flood risk models. *Nature Climate Change*. **2015**, *5(8)*, 712-715.
2. Zevenbergen, C., van Herk, S., Rijke, J., Kabat, P., Bloemen, P., Ashley, R., Speers, A., Gersonius, B. & Veerbeek, W. Taming global flood disasters. Lessons learned from Dutch experience. *Natural Hazards.* **2013**, *65(3)*, 1217-1225.
3. Gunnell, K., Mulligan, M., Francis, R. A., & Hole, D. G. Evaluating natural infrastructure for flood management within the watersheds of selected global cities. *Science of the Total Environment.* **2019**, *670*, 411-424.
4. Mugume, S. N., & Butler, D. Evaluation of functional resilience in urban drainage and flood management systems using a global analysis approach. *Urban Water Journal*. **2017**, *14(7)*, 727-736.
5. Shrubsole, D. A history of flood management strategies in Canada revisited. In *Climate Change and Flood Risk Management* (pp. 95-120). **2013**, Edward Elgar Publishing.
6. Oulahen, G. Flood insurance in Canada: Implications for flood management and residential vulnerability to flood hazards. *Environmental Management.* **2015**, *55*, 603-615.
7. Chakraborty, L., Thistlethwaite, J., Scott, D., Henstra, D., Minano, A., & Rus, H. Assessing social vulnerability and identifying spatial hotspots of flood risk to inform socially just flood management policy. *Risk Analysis*. **2022**, Pp. 1-21.
8. Self, J., & Penning-Rowsell, E. Power and policy in floodplain management, drawing on research in Alberta, Canada. *Water Policy*. **2018**, *20(1)*, 21-36.
9. Lyle, T., & Mclean, D. British Columbia's Flood Management Policy Window–Can We Take Advantage?. In *Presentation, 4th International Symposium on Flood Defence: Managing Flood Risk, Reliability and Vulnerability, Toronto, ON*. **2008, May**.
10. Haque, C. E., Choudhury, M. U. I., & Sikder, M. "Events and failures are our only means for making policy changes": learning in disaster and emergency management policies in Manitoba, Canada. *Natural Hazards.* **2019**, *98(1)*, 137-162.
11. Crumb, B. *Planning for Disaster: Assessing the Overland Flood Hazard in the Rural Municipality of De Salaberry* (Master's thesis, University of Manitoba, Winnipeg, Canada). **2006**, Retrieved from https://mspace.lib.umanitoba.ca/handle/1993/29674
12. Morris-Oswald, M. *The Social Construction of Vulnerability to Flooding: Perspectives and Values from the Red River Basin* (Doctoral dissertation, University of Manitoba, Winnipeg, Canada). **2007**, Retrieved from https://mspace.lib.umanitoba.ca/handle/1993/8017.
13. Ogston, D. J. *Perception of natural hazard risk and preparedness: a case study of St. Jean Baptiste, Manitoba* (Master's thesis). **2006**.
14. Stewart, R.M. *Community Perspectives of Flood Risk and Social Vulnerability Reduciton: The Red River Basin Case* (Doctoral dissertation, University of Manitoba, Winnipeg, Canada). **2007**, Retrieved from https://mspace.lib.umanitoba.ca/handle/1993/8023
15. Haque, C. E., Mahmud, K. H., Walker, D., & Zaman, J. R. Geophysical and Societal Dimensions of Floods in Manitoba, Canada: A Social Vulnerability Assessment of the Rural Municipality of St. Andrews. *Geosciences.* **2022**, *12(2)*, 56.
16. Creswell, J.W. and Creswell, J.D. Research Design Qualitative, Quantitative, and Mixed Methods Approaches. (Fifth Edition). **2018**, SAGE Publications, Inc.

17. Hammarberg, K., Kirkman, M., & de Lacey, S. Qualitative research methods: when to use them and how to judge them. *Human reproduction.* **2016**, *31(3)*, 498-501.
18. Ridder, H. G. The theory contribution of case study research designs. *Business Research.* **2017**, *10(2)*, 281-305.
19. Scolobig, A., Prior, T., Schröter, D., Jörin, J., & Patt, A. Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. *International journal of disaster risk reduction.* **2015**, *12*, 202-212.
20. Bogdan, E.; Bennett, A.; Yumagulova, L. Public engagements in forward-looking recovery efforts following the 2013 floods in High River and Calgary, Canada. In *Community Engagement in Post-disaster Recovery*. Marsh, G., Ahmed, K.I., Mulligan, M., Donovan, J., Barton, S., Eds.; Routledge: New York, NY, USA. **2017**, pp. 37–54.
21. Lalancette, A., & Charles, A. Factors influencing hazard management by municipalities: The case of coastal communities. *Global Environmental Change.* **2022**, *73*, 102451.
22. Puzyreva, K., & de Vries, D. H. 'A low and watery place': A case study of flood history and sustainable community engagement in flood risk management in the County of Berkshire, England. *International Journal of Disaster Risk Reduction.* **2021**, *52*, 101980.
23. Puzyreva, K., Henning, Z., Schelwald, R., Rassman, H., Borgnino, E., de Beus, P., Casartelli, S. & Leon, D. Professionalization of community engagement in flood risk management: Insights from four European countries. *International Journal of Disaster Risk Reduction.* **2022**, *71*, 102811.
24. Fulton, A. E., Drolet, J., Lalani, N., & Smith, E. Prioritizing psychosocial services for children, youth and families postdisaster. *Disaster Prevention and Management: An International Journal.* **2020**, *29(4)*, 591-607.
25. Moon, J., Flannery, W., & Revez, A. Discourse and practice of participatory flood risk management in Belfast, UK. *Land Use Policy.* **2017**, *63*, 408-417.
26. Otto, A., Hornberg, A., & Thieken, A. Local controversies of flood risk reduction measures in Germany. An explorative overview and recent insights. *Journal of Flood Risk Management.* **2018**, *11*, S382-S394.
27. Haer, T., Botzen, W. W., & Aerts, J. C. The effectiveness of flood risk communication strategies and the influence of social networks—Insights from an agent-based model. *Environmental Science & Policy.* **2016**, *60*, 44-52.
28. de Voogt, D. L., Bisschops, S., & Munaretto, S. Participatory social capacity building: Conceptualisation and experiences from pilots for flood risk mitigation in the Netherlands. *Environmental Science & Policy.* **2019**, *99*, 89-96.
29. Olausson, P.M. and Nyhlén, J. Organization and Decision-Making in Enforced Networks: The River Groups in Northern Sweden. *Journal of Contingencies and Crisis Management.* **2017**, *25(4)*, pp. 313-325.
30. Boon, H. J. Disaster resilience in a flood-impacted rural Australian town. *Natural hazards.* **2014**, *71(1)*, 683-701.
31. Khalili, S., Harre, M., & Morley, P. A temporal framework of social resilience indicators of communities to flood, case studies: Wagga wagga and Kempsey, NSW, Australia. *International journal of disaster risk reduction.* **2015**, *13*, 248-254.
32. Wilby, R. L., & Keenan, R. Adapting to flood risk under climate change. *Progress in physical geography.* **2012**, *36(3)*, 348-378.
33. Erdlenbruch, K. and Bonté, B. Simulating the dynamics of individual adaptation to floods. *Environmental Science & Policy.* **2018**, *84*, 134-148

34. Tompkins, E. L., Adger, W. N., Boyd, E., Nicholson-Cole, S., Weatherhead, K., & Arnell, N. Observed adaptation to climate change: UK evidence of transition to a well adapting society. *Global environmental change.* **2010**, *20(4),* 627-635.

Appendix 1: Criteria for interviewee selection
The criteria are as follows:

Inclusion criteria for KII:

1) The participants will be from local community people, government officials involved in flood management, and NGO professionals. Government officials and NGO professionals may or may not be from the local community. However, they must have experience and/or role in the flood management of either of the two communities.

2) The participants should have experience and/or firsthand knowledge of recent floods and flood management, especially after the 1997 floods in their community.

Inclusion criteria for oral history interview:

1) The participants will be from local community people.

2) The participants should have extensive flood experiences. The selected participants in the oral history interviews will have longer exposure and personal experience of floods and management activities, preferably before and after the flood of 1997 in their community. Their personal experiences will be recorded to analyze the changes in flood management scenario over time, and how social learning from those floods led to collective actions.

Appendix 2: Certificate of completion of TCPS 2: CORE

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Jobaed Zaman

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Certificate # 0000724019

Date of Issue: **26 June, 2021**

Appendix 3: Ethics approval form the University of Manitoba

University of Manitoba | Research Ethics and Compliance

Human Ethics - Fort Garry
208-194 Dafoe Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

PROTOCOL APPROVAL

Effective: December 10, 2021 Expiry: December 9, 2022

Principal Investigator:	Jobaed Zaman
Advisor:	C. Emdad Haque
Protocol Number:	HE2021-0126
Protocol Title:	*Local Level Flood Management in Manitoba: A Case of Adaptation and Social Learning in the Rural Municipality of Ritchot*

Andrea L Szwajcer, Chair, REB2

Research Ethics Board 2 has reviewed and approved the above research. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2018).

This approval is subject to the following conditions:

i. Approval is granted for the research and purposes described in the protocol only.

ii. Any changes to the protocol or research materials must be approved by the HEO before implementation.

iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.

iv. This approval is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.

v. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.

vi. The University of Manitoba may request to audit your research documentation to confirm compliance with this approved protocol, and with the UM *Ethics of Research Involving Humans*Ethics of Research Involving Humans policies and procedures.

Appendix 4: Interview guide for Key Informant Interviews

4.1 Interview guide for local and Provincial government representatives and NGO officials

Code:

Location of interview:

Date:

1) How many floods have you experienced over the last two decades?
2) What lessons did you/your organization learn from these floods?
3) What kinds of flood control/management (preparedness, emergency response, and recovery) measures did your organization take during the floods of 2009, 2011 and 2014?
4) What were the factors that influenced these measures?
5) How did you/your organization organize these activities? What did you learn from them?
6) How did you share your learning with other professionals in your and other organizations?
7) What were the platforms in your organization for sharing knowledge and experiences (learnings)?
8) Who were the major actors that attended these platforms?
9) What did you/your organization learn from such sharing?
10) What are the factors that influenced you/your organization to learn?
11) How did your organization use these learnings for adaptating to future floods?
12) In terms of personal and shared learning over the last two decades of flood experience, what changes have occurred?
13) What changes did you observe in structural (physical/engineering) and non-structural (policy, compensation etc.) measures regarding flood management?
14) What are the factors that drove the changes in flood preparedness, emergency response, and recovery in your organization?
15) How has your learning enhanced your organization's capacity to withstand flood losses?
16) How has your learning helped your organization to take collective actions?
17) How did you collectively implement what you learned?
18) What kind of collective actions were taken by your organization/local community?
19) In terms of shared learning and collective action, what kind of challenges did your organization face?

20) How did the flood events influence policy initiatives?
21) How does your organization address and resolve the problems/challenges?
22) Please provide your recommendations for improving flood management.

4.2 Interview guide for the community people

Code:

Location of interview:

Date:

1) What are the organizations that worked with you before, during and after the floods of 2009, 2011 and 2014?
2) What kind of actions did these organizations take?
3) Did you participate in these actions or did you have an opportunity to participate in these activities?
4) What did you learn from these activities?
5) Did you participate in any institutional meetings, public hearings, or any other platform for sharing knowledge and experience that were organized by the municipality or Provincial government, NGOs or community-based organization? If yes, what did you learn?
6) Who participated in these platforms? (Stakeholders and actors).
7) How did the organizations use the learnings from these platforms in flood management afterwards?
8) How did such learnings and flood management actions enhance the community's capacity to adapt to floods and flood losses?
9) What flood management measures do you take before, during and after a flood has occurred in your community?
10) What are the changes that you have brought into your flood management activities after experiencing the recent floods?
11) What are the factors that influenced the changes?
12) What did you learn from your recent flood experiences, and from the changes that you have made in your flood management activities?
13) Have you shared the learnings with your community members?
14) How did you share them?

15) Is there any platform in your community for discussing your learnings with one another?
16) Have you found any changes in coping (short term) and adaptation (long term) strategies in your community? If yes, what were these changes?
17) What are the factors that influenced your learning?
18) What were the major learning from the sharing-platforms?
19) Have these learnings helped your community to act collectively for flood management? If yes, how?
20) What kind of collective actions were taken by the community members?
21) What are the factors that influenced such collective actions? (both positively and negatively)
22) Did such actions enhance the community's capacity to adjust to floods? If yes, how?
23) Did the community members face any challenges in the learning process / collective action / coping and adaptation? If yes, what kind of challenges did they face?
24) Please suggest on how the community members and the organizations (local and Provincial governments, NGOs, and community-based organizations) can improve their activities and resolve these challenges.

Appendix 5: Interview guide for Oral History Interviews
Code:

Location of interview:

Date:

1) Please tell me about the major changes you noticed in flood management activities after the 1997 flood.
2) What are the changes you observed in flood management activities of the municipality and the Provincial government?
3) Why do you think the changes have occurred in flood management activities? Could you please tell me stories revealing some specific situations that you experienced?
4) How were coping (short term) and adaptation (long term) strategies adopted before the 1997 flood in your community?
5) How were personal learnings shared in your community during the 1990s? Could you give me one or more examples?
6) What were the steps the municipality and Provincial government had taken to integrate community people in flood management? How has that process changed in recent years?
7) Do you recall any activities that your community performed collectively before, during and after the 1997 flood? Please tell me the stories. What did you and your community learn from those activities?
8) How are the platforms for sharing knowledge and experience different from the ones before the 1997 flood? Why do you think it changed?
9) How did your parents and grandparents try to cope and adapt to floods and flood losses? How are the present-day your community activities different from the previous ones?
10) Who were the people that attended learnings-sharing platforms before and during the 1997 floods? Do you think the attendees are different now? If yes, why do you think it changed?
11) Compared to the 1997 flood, how has knowledge sharing improved or worsened now? What is the difference between the outcomes of those shared learnings?
12) What are the factors that influenced flood management strategies before the 1997 flood? What drivers have changed during the recent floods?

13) Would you *agree or disagree* that the "current flood management measures have enhanced your community's capacity to adapt to floods and flood losses compared to pre-1997 flood management scenario"?
14) What are the challenges you still face in your community to withstand flood losses? Please provide your recommendation based on your learnings over the years to improve flood management policies and practices.

Appendix 6: A conceptual framework explaining the interconnectedness between drivers of coping and adaptation to disasters at the local level.