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A thesis submitted in fulfilment of the requirements for the degree of  
Doctor of Philosophy in Built Environment

**Thesis with Publication**

# Enhancing Community Resilience: Innovative Strategies for Flood Risk Management in New Zealand

By

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Massey University

2024

# Abstract

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The increasing frequency of flood events, amplified by the impact of climate change, has heightened the urgency for improved flood resilience in vulnerable communities, particularly in regions such as Northland, New Zealand. Despite widespread awareness, current flood risk management strategies in Northland predominantly focus on response and recovery, with limited emphasis on proactive, long-term risk reduction. This research addresses this critical gap by examining how community resilience can be strengthened through sustainable and participatory flood management approaches. The study aims to develop a balanced framework that integrates bottom-up governance, community-driven initiatives, and long-term preparedness to enhance flood resilience.

A mixed-methods approach was employed, combining qualitative and quantitative techniques. Data were collected through case studies, semi-structured interviews with key stakeholders, community surveys, and spatial flood mapping, providing insights from both local communities and institutional actors. The analysis focused on identifying factors influencing resilience, including intergenerational knowledge transfer, the integration of traditional and local knowledge, and the effectiveness of collaborative decision-making processes.

The findings reveal that while communities are aware of flood risks, preparedness actions remain fragmented and reactive, with limited implementation at the household and community levels. Existing policies and infrastructure largely prioritise emergency response, leaving long-term risk reduction underdeveloped. Additionally, gaps were identified in flood mapping accessibility, land-use planning, and the incorporation of indigenous knowledge into governance processes.

Based on these insights, the research proposes a practical framework for improving flood resilience, which includes recommendations for adaptive policies, community engagement strategies, and integration of local knowledge into planning and decision-making. This framework provides a pathway not only for Northland but also for other regions facing recurring floods, offering guidance for building resilient, sustainable communities in the face of increasing climate-related hazards.

**Keywords:** Flood Resilience, Community-Based Flood Management, Risk Reduction, Bottom-Up Governance, Preparedness, New Zealand

# Acknowledgment

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I would like to express my sincere gratitude to the individuals and organisations that have played a crucial role in the successful completion of this research. Their unwavering support and collaboration have been invaluable throughout this journey.

First and foremost, I extend my heartfelt appreciation to all the participants, key stakeholders, and librarians in the Northland Region, New Zealand. The cooperation and assistance provided by the Northland Regional Council, Whangarei District Council, Kaipara District Council, and Far North District Council have been instrumental in obtaining the necessary data and the time required to address my research queries.

To my Supervisors, Prof. Suzanne Wilkinson and Dr Mohamed Elkhaboutly, for their continuous support and reminding me when I am in doubt, Suzanne, the biggest inspiration not to separate a life and a PhD and to work with integrity and professionalism, but not to forget our value as a community researcher is to be humble. Our research was designed to fill the gap and help the system function at its maximum potential, not to dictate and force our way in. Mohammed, my biggest supporter, who tolerated my random thoughts and turned them into beautiful paper, my ramblings into a nice journal, and my weaknesses into opportunities. He will challenge me to be a better researcher who listens and not to forget that my goal is to give back to the people.

Massey University, especially the School of Built Environment, and the GRS team for supporting and granting me the Massey Doctoral Scholarship for the beginning of my journey. Colleagues and friends at PhD room, colleagues and friends at Beca, and friends and family I met here in New Zealand. Suri, Jony, Angky, Grace, Bez, Siyu – Best flatmates, thank you for the support, especially when I needed to travel for data collection. We made it a fun road trip up north. Sean Ching – one of the first friends I met at Massey - thanks for sharing your time to drive me around Northland for my pilot study. I received great journal publications from the journey! Family in Indonesia: Mom, Dad, Vilky, Nane, and Jabar, who never stop believing in me, even though I took more time to finish this thesis. And Tisab – my anchor, the reason I am still having my best life, despite many late nights of work, keeping me calm while facing a storm and under pressure with writing, deadlines, and challenges. And for myself to not give up and keep moving forward.

When I embarked on this research in 2020, flood research was not as prevalent as other natural hazards or major disasters. Particularly in Northland, where floods often occur on a smaller scale and in scattered locations, it was perceived as a secondary issue compared to the one-off damages

experienced in more urban areas. However, my research team and I recognise the significance of repetitive small-scale floods over the years, which present unique risks and require distinct solutions compared to major one-off floods.

Engaging in conversations with colleagues and academicians overseas revealed a lack of awareness about New Zealand's susceptibility to flooding, especially given its green landscape and seemingly abundant spaces. The prevailing perception associated major flood problems with overpopulation, limited green land for water absorption, and unsustainable development. The question of why New Zealand, with its vast spaces, faces flooding remained a persistent thought in my mind.

Our research uncovered a universal truth – the risk of major floods is omnipresent, but over time, people tend to forget about it. This is not the case for the resilient people of Northland, who engage in ongoing conversations and initiatives to improve community resilience against floods. The region's history of annual flooding, attributed to the low-lying and basin areas of the towns, necessitates ongoing efforts to enhance preparedness and resilience.

Despite the ongoing challenges faced by Northland, the community's proactive approach to flood resilience serves as a model for regions with less experience in handling such recurring events. Motivated by this, our research team is committed to exploring ways to empower the Northland community further and share valuable lessons learned with communities beyond its borders. This research not only contributes to the understanding of flood dynamics but also aims to make a meaningful impact on building resilient communities worldwide.

*I want to dedicate this thesis to my loving parents, sisters, brothers, friends, and colleagues who always give me support and encouragement. Supervisors who always believe in me.*

*And to Tisab, who is always by my side.*

# Declaration

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I hereby declare that the contents and organisation of this dissertation constitute my own original work and do not compromise in any way the rights of third parties, including those relating to the security of personal data.

Widi Auliagisni

2024

# Thesis with Publication

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This is a thesis with publications.

Attached is the Massey University Doctoral Thesis with Publication Guidelines

## DOCTORAL THESIS WITH PUBLICATIONS GUIDELINES

### THE DIFFERENCES BETWEEN A DOCTORATE WITH PUBLICATIONS AND A TRADITIONAL THESIS OR DOCTORATE BY MONOGRAPH

The “Doctorate with Publications” is an alternative to the traditional “Doctorate by Monograph” approach to writing the doctoral dissertation.

In a traditional Doctoral thesis by Monograph, the doctoral student writes up their research in a comprehensive thesis or book form, with typically discrete chapters that cover for example, an introduction, literature review, conceptual development or methods, results and analyses, discussion, and conclusions. The monograph approach demonstrates both depth and breadth of knowledge in the student’s discipline within a single tome. Often only once the doctoral thesis is completed is an attempt made to publish one or more research articles arising from the work, which are then submitted to academic journals or other appropriate peer-reviewed literature.

In a Doctoral thesis with Publications, the doctoral student authors or co-authors multiple articles on their research during their doctoral programme. These articles are then collated and linked together to constitute the doctoral thesis. Each article will be structured in a way that is appropriate for the field and specific publication, often typically comprising an abstract, introduction with literature context, conceptual development or methods, results, analyses, discussion, and conclusions. This may lead to some repetition in a thesis of this nature, which is not in this context seen as a flaw. It is important to recognise that a thesis with publications is not composed exclusively of publications (see structure below). A doctoral thesis with publications must still demonstrate sufficient breadth and depth of knowledge in the discipline but does so using an appropriate number of discrete published articles as chapters (see below).

### GUIDELINES FOR PREPARING A THESIS WITH PUBLICATIONS (TwP)

Candidates considering presenting their thesis with published work should consult with their supervisors early in their candidature to determine whether the thesis with publication format is appropriate. If a candidate is considering this format, it is expected that this be identified as part of the ‘confirmation of registration’ candidature milestone process.

A Doctorate with Publications requires a candidate to present a thesis comprising typically between two and six research papers/publications. The exact number of publications included in the thesis may vary by discipline. Students may write a monograph thesis and publish just one paper. The publications may be various stages of publication at the time of thesis submission for examination.

The expectation is that the doctoral candidate should target mainstream journals in their discipline for publication of their work. Wherever possible aim for international and highly ranked journals, or a journal with a robust peer review process.

Publications contributing to the doctoral thesis must have been written during the period of candidature enrolment and supervision in the doctorate, and candidates cannot present material which was published prior to their doctoral enrolment as part of the thesis.

Published material may be submitted for examination once only and by one doctoral candidate, so where team research is involved, it is important to clarify roles at an early stage. In special circumstances, different parts of the same publication may be submitted for examination by different candidates (e.g. where experiments and modelling have been done by different people). This will need to be clarified in a statement of contribution that is required to accompany each chapter comprising a publication (see below).

Where work has been published, the journal/publisher may need to give copyright permission for the material to be included in a thesis which will be placed in the Library’s electronic repository. Candidates should gain copyright clearance as early as possible if this is the case. It should however be noted that thesis chapters comprising discrete articles/publications must be formatted according to a consistent style within the body of the thesis and not according to publication formats. Usually journals permit reproduction of pre-print versions of articles that are not in final publication format.

Candidates can change their decision to present their thesis in the thesis with publication format and revert to a monograph format during their candidature (for example, if results do not go as expected and are not deemed publishable), as long as the decision does not impact on the time to completion and the thesis submission is within the doctoral guidelines.

## STRUCTURE OF THESIS WITH PUBLICATIONS

Thesis structure will vary depending on the number of research papers to be included. A thesis with publications may consist of a combination of published and non-published chapters. The thesis may therefore include papers that:

- Are in the (final) process of being prepared for publication in a peer-reviewed journal (in prep.)
- Have been submitted for publication in a peer-reviewed journal but not yet accepted (in review, including in revision after reviewers' comments)
- Have been accepted for publication in a peer-reviewed journal but not yet published (in press)
- That are published in a peer-review journal, edited book chapter, or equivalent.
- That are in exhibitions, site specific installations, film, video, scores (with exegesis)

Some chapters may include work that is not publishable, but which nevertheless contributes to the subject body of knowledge and is thus admissible for doctoral research. A doctoral thesis with publications may therefore partly or (nearly) entirely comprise research papers.

Notwithstanding the previous paragraph, the thesis must have an overall introductory chapter which outlines the topic, justifies the research, identifies research objectives and outlines the thesis structure, indicating those chapters that have been written as papers for peer-reviewed publication.

Before the start of each chapter which represents a research paper or publication, the candidate must complete and include a DRC 16 'Statement of Contribution – Doctorate with Publications/Manuscripts'. The DRC 16 outlines the student contribution, authorship, intended target journal and the status of the publication.

The research paper/manuscript should be presented in the same form as they were presented, or intend to be presented, for the target journal, with exception that the referencing and text formatting should be standardised throughout the thesis and must be in the body of the chapter.

The candidate should outline the links between the chapters/research papers. A chapter comprising an article will necessarily include an opening paragraph linking with the preceding chapter and/or a closing paragraph linking to the next chapter, in which the overall fit of the article is set clearly within the body of research that is the doctoral thesis.

The candidate must ensure that all methods used in the body of research for the thesis are clearly described in the thesis. These are usually contained within the method sections of the corresponding papers. However, appendices should also be used to outline or expand upon methods that may have been abbreviated for publication. Any data and discussion that was also abbreviated to conform to the strictures of the publication process, including information published as supplementary material should also be included in appendices to the thesis. If appropriate, it is also acceptable to have unpublished chapters that may focus on a methodology, or set of results, but also the methodology chapter (or parts thereof) may be published. Unpublished chapters are entirely admissible in a thesis with publications. The thesis introduction should clarify what chapters are published and they should be referenced accordingly.

The thesis should conclude with a final chapter providing a synthesis of the work as a whole presented in the body of the thesis. It is important that discrete published chapters are brought together in this coherent synthesis to demonstrate the overall contribution to knowledge provided by the body of research within the thesis. Final overall conclusions revisiting the research objectives draw the thesis to a close at the end of the synthesis, or as a short, discrete chapter according to preference and disciplinary practice.

Formatting of the final thesis may be a challenge as the thesis should be a whole, presented in the same font and format, so figures and tables have to be renumbered and references consistently formatted.

The thesis with publications must still work as an integrated whole, address a significant research question or questions, and present a clearly identified original contribution to knowledge of the subject with which it deals.

## AUTHORSHIP OF THE PUBLICATIONS

The authorship of publications is determined based on the APA authorship guidelines, which also highlight that the supervisors are NOT automatically the authors on all publications arising from the candidate's research for the doctorate. Only supervisors who have contributed sufficient intellectual knowledge to an academic paper that is part of a doctorate with publications should be included as co-authors of that academic paper. Authorship of publications is decided by discussion and agreement between the supervisors and candidate.

In some cases, the candidate may be the sole author of a publication(s). Where the candidate is a joint author with supervisor(s) and/or others, the contribution by the candidate is normally expected to be in the capacity of first/primary author. Multi-authored papers in a thesis must have a *substantial and significant* contribution by the candidate. The principal supervisor signs the 'Statement of Contribution: Doctorate with Publications/Manuscripts (DRC 16)' specifying the candidate's contribution. To protect the interest of candidates, it is important that authorship is discussed at an early stage of candidacy, ideally with the involvement of an independent party, such as the unit postgraduate coordinator, with an ideal context being the confirmation process.

Candidates are advised to fully reference previous publication of their own sole-authored work, including graphs, tables and images that they themselves have generated. Any other intellectual content must be fully and appropriately referenced to the person(s) that supplied them. They are then able to sign a statement that the thesis is their own work.

## EXAMINATION

The candidate is expected to have a working knowledge of all parts of the thesis, and to be able to answer questions about the thesis as a whole in the oral examination.

The University sets the standard by which theses are examined, and acceptance of any part by a publisher does not necessarily mean that it meets examination standards. Examiners will be instructed to examine all parts of the thesis with equal rigour and may request major or minor changes to any part of the thesis regardless of whether it has been published or not. Material included in a thesis with publications is clearly of publishable quality, but the candidate's understanding of their body of work in its constituent parts, as well as the whole, must be examined.

Whether a candidate submits their thesis in traditional monograph form or with publications, examiners will still be asked to examine the thesis following the same guidelines:

- That the candidate shows familiarity with, and understanding of the relevant literature
- The thesis provides a sufficiently comprehensive study of the topic
- The research questions have been identified
- The methods adopted are appropriate to the subject matter and properly applied
- The research findings are documented and explained coherently
- The thesis as a whole makes an original contribution to the knowledge of the subject with which it deals, and the candidate understands the relationship of the thesis to the wider context of the knowledge in which it belongs.

It is advisable for supervisors to select examiners who are familiar with the *Doctorate with Publications* format if at all possible.

## FREQUENTLY ASKED QUESTIONS

*Which is of more value? A TwP or a monograph?*

- For the examination process there is no difference. Some candidates may find it beneficial to have published papers in their thesis for subsequent job opportunities or for applications for a post-doctoral research position. An examiner will not see a monograph of lesser value if it meets all the criteria for doctoral studies.

*How do you structure a TwP?*

- It is similar to a monograph. Introduction chapter; followed by the literature review (which may or may not be published), then one can have a methodology chapter, but it is not required; and then the chapters which may or may not have been published already (in prep/review/press/published). The last chapter is the discussion or synthesis where the whole thesis and research must be discussed and the novel contribution covered.
- Chapters may require additional introductions and conclusions to ensure clarity of relationship with broader thesis.

*Each published article typically describes literature, methods etc. So how do you avoid repetitive writing across the thesis chapters?*

- This cannot be prevented, but the candidate should try to minimise where possible. Although a paper may have been published, it will still be 'examined' as part of the overall thesis, and repetition will be taken into account by the examiners.

*How does a New Zealand TwP measure up against a doctorate (usually by monograph) in the U.S.?*

- There is no difference. The same academic principles (e.g., original contribution to knowledge etc) apply to both versions. The required word limit still applies.
- Even if much of the content has been published in peer-review outlets the thesis must still pass as a doctorate (an original, coherent contribution as a body of knowledge to the discipline).

*Is different work involved in a TwP compared to a monograph?*

- Yes. One has to plan the chapters as papers, start writing earlier in the doctorate and while writing the thesis, submit and revise previous chapters/ papers as per the reviewer's comments. Once a paper is submitted, control is in the hands of the journal editors.

*Is there anything to prevent you from publishing while presenting your thesis in a monograph form?*

- No not at all.

*Is there a minimum or maximum number of publications per thesis?*

- No. It can vary, often only one chapter is actually published, others maybe under review, and some submitted. Generally, it is expected that there are between two and six chapters which are in published format (in prep/review/press/published).

*Is it more challenging to produce a TwP when conducting research from a mixed method or humanities approach?*

- Potentially. This option is most likely to be useful in cases where a student has already some experience in producing articles or reports and therefore seeks to pursue a TwP given familiarity with this genre. However, it may be more difficult to ensure a coherence of work around an overarching research question in these fields.

*What are the rules around authorship? Does the doctoral candidate always have to be the lead author? What if the journal doesn't use a first author system, and instead lists them alphabetically?*

- It is expected that the candidate is the lead author. In Humanities and Social Sciences, the usual practice is to rank authors alphabetically unless one author is a clear lead author, in which case the position of names can at times be determined by contribution. Massey expectation is that authorship is determined based on the APA authorship guidelines.

*Does qualitative research (that is done from a science discipline) sit well with publications?*

- There is no reason why not. It will be important to select journals carefully and choose the most appropriate publication outlet for the work.

*If your supervisor is new to TwPs, who else can a student go to for advice (for both the student and the supervisor)?*

- GRS, and they can refer the student to staff whose students regularly do TwP.
- Postgraduate Coordinators in the academic units.

*How are ethics managed and integrated into the TwP process?*

- There is no difference. If a researcher is working with people or animals, the ethics process needs to be addressed and discussed in the papers/ chapters.
- There are ethical considerations with regards to co-publishing that need to be considered (i.e. ensuring student work is appropriately recognised in publications).

*Monograph vs. TwP - Is this a personal decision or does it have to be justified in another way?*

- The student and supervisory panel should discuss the format of the thesis in the provisional year. Supervisors and students should both agree that TwP is the best avenue.

*When do you decide which journal to submit to? How do you make that decision? How do you make sure that you stay productive in that process?*

- The journal should be discussed with the supervisors. Once one paper is submitted the candidate should start the next one or work on the literature review.
- Ensure good quality publication outlets (well known, well ranked) to ensure strong reviews and to maximise student benefit.

*What are some of the challenges associated with TwP? And what tips/advice is there for overcoming those challenges?*

- Staying within a time frame and not extending the Doctorate while waiting for papers and reviews. Keep productive while waiting for an Editor's reply.
- Dealing with reviewer's comments can be challenging, but your supervisors should provide support, and this provides good preparation for examiners comments.
- Formatting of the final thesis may be a challenge as the thesis should be a whole, presented in the same font and format. So, figures and tables have to be renumbered and references consistently formatted because the thesis is a publication in its own right and as such should be a cohesive document.
- Ensuring the student retains a birds-eye view of the thesis as an overarching project that, with all parts working together, makes an original contribution to the field.

*When you decide to do a TwP, is there a formal process for that, or is it simply an agreement that you make with your supervisor(s)?*

- There is no formal process. Just an agreement between the student and supervisor(s). However, there are forms that need to be completed as part of the submission of the thesis which attributes the contribution of the candidate and other authors for those chapters in the thesis that are publications or in the process of publication (in prep/review/press).

*If in doubt, please contact your supervisor.*

# Thesis Structure and Authorship

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This PhD thesis is a combination of four individual papers written as manuscripts for publication in refereed journals, and two proceedings, in addition to the general introduction and synthesis. This has led to unavoidable repetition in some of the content between the 10 chapters, especially in the methods sections. Papers also co-authored to acknowledge contribution towards the paper, including input into the original thesis concept, designing the research, administration, and editing the manuscript. **Chapter 5** “Flood Risk Management in New Zealand: A Case Study of Northland Urban Community” was presented at CIB World Building Congress 2022, and the manuscript has been published in the open-access journal Earth and Environmental Science, Volume 1101, Future Proof City in 2022 and is co-authored by Prof Suzanne Wilkinson and Dr Mohamed ElkhARBOUTLY. **Chapter 6** “Using community-based flood maps to explain flood hazard in Northland, New Zealand” was presented at the APRU Multi Hazards Conference in 2021, and the manuscript was published in the open-access Progress in Disaster Science Journal in 2022, co-authored by Prof Suzanne Wilkinson and Dr Mohamed ElkhARBOUTLY. **Chapter 7**, “Overview of New Zealand Legislation for Flood Resilience”, was presented at Western Sydney University, Australia, for the 45th AUBEA Conference 2022 and published in the proceedings titled 45<sup>th</sup> AUBEA Conference 2022: Global Challenges in a Disrupted World: Smart, Sustainable and Resilient Approaches in the Built Environment, Australia. **Chapter 8** “Enhancing Flood Resilience through Effective Land-use Planning Policies in New Zealand” was presented at the 46th AUBEA Conference 2023. The full manuscript is in the process of being published and will be co-authored by Prof Suzanne Wilkinson and Dr Mohamed ElkhARBOUTLY. **Chapter 9** “Learning from floods – How a community develops future resilience” was published in the MDPI Open Access Water Journal 2022 and co-authored by Prof Suzanne Wilkinson and Dr Mohamed ElkhARBOUTLY. For all the chapters in this thesis, my input was the greatest. I planned the research, carried out the fieldwork, analysed all the data, and wrote all the content.

Signed by all involved co-authors:

**Prof Suzanne Wilkinson**

**Dr Mohamed ElkhARBOUTLY**

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# Lists of Publications

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**Chapter 5** “Using community-based flood maps to explain flood hazard in Northland, New Zealand” was presented at the APRU Multi Hazards Conference in 2021 and the manuscript was published in the open-access Progress in Disaster Science Journal in 2022

**Chapter 6** “Flood Risk Management in New Zealand: A Case Study of Northland Urban Community” was presented at CIB World Building Congress 2022, and the manuscript has been published in the open-access journal Earth and Environmental Science, Volume 1101, Future Proof City in 2022

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# Lists of Abbreviations

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<b>Abbreviation</b>	<b>Full Meaning</b>
<b>4Rs</b>	<b>Reduction, Readiness, Response, Recovery</b> – Framework under the CDEM Act for emergency management
<b>BCE</b>	<b>Building Code of 1992</b> – Part of New Zealand’s Building Act framework
<b>CDEM</b>	<b>Civil Defence Emergency Management</b> – National framework for disaster response and management
<b>CDEM Act</b>	<b>Civil Defence Emergency Management Act 2002</b>
<b>EQC</b>	<b>Earthquake Commission</b> – New Zealand organisation managing natural disaster insurance
<b>FRM</b>	<b>Flood Risk Management</b>
<b>GIS</b>	<b>Geographic Information System</b> – A Mapping tool used for flood susceptibility and spatial data analysis
<b>IFM</b>	<b>Integrated Flood Management</b> – Holistic approach linking land use, water, and disaster risk management
<b>IPCC</b>	<b>Intergovernmental Panel on Climate Change</b>
<b>LGA</b>	<b>Local Government Act 2002</b>
<b>LTP</b>	<b>Long-Term Plan</b> – Planning document used by regional and district councils
<b>MCDEM</b>	<b>Ministry of Civil Defence and Emergency Management</b> (now part of NEMA)
<b>NDRS</b>	<b>National Disaster Resilience Strategy</b> – New Zealand’s national resilience framework
<b>NEMA</b>	<b>National Emergency Management Agency</b> – Current central agency overseeing disaster management

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<b>NIWA</b>	<b>National Institute of Water and Atmospheric Research</b> – Key scientific body for flood and climate research
<b>NRC</b>	<b>Northland Regional Council</b>
<b>NZCPS</b>	<b>New Zealand Coastal Policy Statement</b>
<b>NZCCRI</b>	<b>New Zealand Climate Change Research Institute</b>
<b>RMA</b>	<b>Resource Management Act 1991</b>
<b>RMA Amendment Act</b>	<b>Resource Management (Energy and Climate Change) Amendment Act 2004</b>
<b>RPs</b>	<b>Regional Plans</b> – Regional government policies for land, water, and flood management
<b>UN</b>	<b>United Nations</b>
<b>UNECE</b>	<b>United Nations Economic Commission for Europe</b> – Related to international flood and water conventions
<b>UNESCO</b>	<b>United Nations Educational, Scientific and Cultural Organization</b>
<b>WRM</b>	<b>Water Resource Management</b>

# Chapter 1

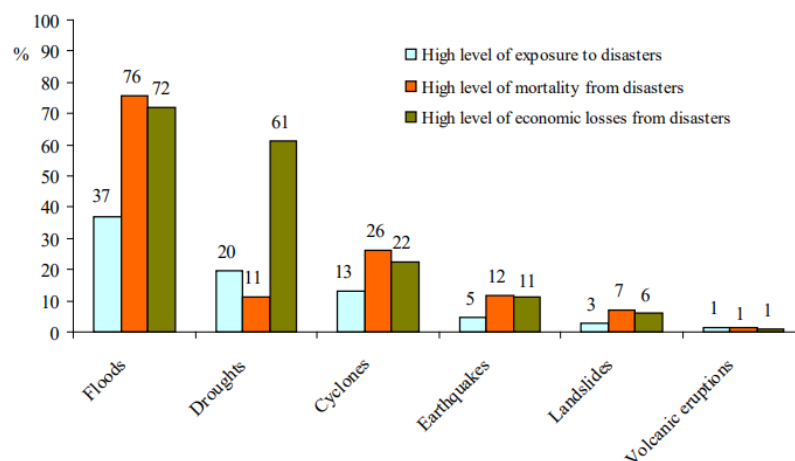
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## Introduction

## 1.1 Study Background

Flood hazards are among the most significant natural hazards faced globally, causing long-term social, economic, and environmental consequences for affected communities (Jongman et al., 2012; Kundzewicz et al., 2014; Merz et al., 2014). Historically, floods have displaced millions of people, caused extensive loss of possessions, and resulted in countless fatalities (Kundzewicz et al., 2010; Smith & Ward, 1998; UNDRR, 2022). Between 1998 and 2017, 90% of the 7,255 major global disasters were climate-related, with the majority being floods and storms (IPCC, 2022; UNDRR, 2019). Similarly, the UN World Water Development Report (2020) highlighted that 74% of natural hazards occurring between 2001 and 2018 were water-related, causing over 166,000 deaths and economic losses of nearly USD 700 billion (UNESCO, 2020; Winsemius et al., 2013). Alarming, most of these losses were uninsured (Surminski & Oramas-Dorta, 2014; Winsemius et al., 2013). The frequency and severity of floods continue to rise, with 176 flood hazards recorded globally in 2022, while the average annual global property damage now exceeds USD 90 billion (Hallegatte et al., 2013; Song et al., 2023). Over the past decade alone, total economic losses from floods reached USD 453 billion, almost ten times higher than in the 1970s (Kron et al., 2019; Statista, 2023).

Urbanisation has intensified both exposure and vulnerability to flooding. A study of 1,860 global cities revealed that flooding is the most common natural hazard affecting urban areas (Figure 1). In 2018, 683 cities—home to more than one billion people—were located in high-exposure flood zones (Gu, 2019; Jongman et al., 2012). Many of these cities face high levels of flood-related mortality and economic loss, even when hazard exposure is categorised as low or medium. This growing challenge has led the United Nations Office for Disaster Risk Reduction (UNDRR) to call for governance transformation, issuing global strategies such as the Sendai Framework for Disaster Risk Reduction and resilience action plans aligned with the Sustainable Development Goals (SDGs) (Kelman, 2015; UNDRR, 2023). Recent reports emphasise the importance of integrating cultural wisdom, local practices, and forensic analysis of past events to improve future disaster preparedness and risk reduction (UNDRR, 2024).



Note: Cities only included those with 300,000 inhabitants or more on 1 July 2018. See table 1 for definition of indicators.

**Figure 1 Percentage of cities worldwide with high levels of exposure and vulnerability to six types of natural hazards.**  
Source: Gu (2019) Figure 4.

However, global trends indicate that exposure to flooding is continuing to increase. By 2020, 75% of the world's land surface had been significantly altered, while 85% of natural wetlands had been lost (Davidson et al., 2018; UNESCO, 2020). Climate change is compounding this challenge, as shifting rainfall patterns and soil moisture regimes increase the likelihood of more frequent and severe floods (Hirabayashi et al., 2013; IPCC, 2021; Winsemius et al., 2013). Vulnerable populations, especially those with limited resources or adaptive capacity, are disproportionately affected (Cutter et al., 2016; Wisner, 2004).

The urgency of addressing water-related disasters was further underscored at the UN 2023 Water Conference, the first major UN meeting on water since 1977. This conference reviewed progress towards SDG 6 (clean water and sanitation), highlighting the need for partnerships and community-level resilience initiatives to reduce water-related disaster risks (United Nations, 2023). Watershed protection and rehabilitation, which integrate climate adaptation and resilience-building, were recognised as essential strategies for achieving sustainable development (Bennett et al., 2009; Pahl-Wostl, 2007) .

In New Zealand, flooding is the most frequent and costliest natural hazard, exacerbated by the country's low-lying coastal areas, small land mass, and exposure to extreme weather events (NEMA, 2021). Climate change has heightened the risks posed by recurring floods and tropical cyclones, threatening communities, ecosystems, and cultural heritage (IPCC, 2021; Kelman et al., 2015). Consequently, flood risk management (FRM) must prioritise risk reduction, minimise unavoidable disaster impacts, and promote resilience strategies at national and community levels (Schipper & Pelling, 2006; UNDRR, 2019).

Resilience, in this context, is both a capacity and a process—the ability of a system or community to adapt, recover, and thrive following disruptive events (Adger, 2003; Cutter et al., 2016). Flood resilience specifically focuses on reducing risks to people and infrastructure while creating space for natural river systems to adjust (Jongman et al., 2012; UNDRR, 2019). The overarching motivation is to make recovery faster, less costly, and more sustainable, reducing future vulnerabilities (Winsemius et al., 2015; Wisner, 2004).

Despite technological advances and policy interventions, historical evidence demonstrates that flood risk can never be entirely eliminated (Kundzewicz et al., 2014; Smith & Ward, 1998). Instead, sustainable solutions require a shift towards integrated governance systems, proactive land-use planning, and community-driven strategies. This thesis positions itself within this paradigm shift.

This research aims to develop community-based strategies for sustainable flood risk management in Northland, New Zealand, with a particular focus on recurring flood events. By examining historical flood impacts, governance transformations, and resilience action plans aligned with the SDGs, this study seeks to bridge the gap between national policy and local implementation. It emphasises the integration of indigenous knowledge systems, particularly mātauranga Māori, alongside modern science and technology to create holistic and locally appropriate solutions.

This research addresses four core dimensions:

1. Analysing risks and vulnerabilities related to recurring floods and their cumulative impacts.

2. Evaluating governance and legal frameworks for flood management at national and local levels.
3. Exploring the role of indigenous and community knowledge in strengthening flood resilience.
4. Proposing practical, action-oriented strategies for community-led flood risk reduction.

By addressing these dimensions, the study contributes to both academic understanding and practical policy development, offering pathways for Northland and other flood-prone regions to transition from reactive flood management to proactive, resilience-based approaches.

### **1.2 Addressing Recurring Flood Challenges in Multi-Level in New Zealand**

The frequency and intensity of flooding events have been on the rise due to various factors, including climate change, deforestation, and urbanisation. This introduction aims to explore the complex nature of flood hazards, starting from a global perspective and gradually zooming in to examine the specific case of New Zealand at the national, regional, and community levels. By analysing flood hazards through the lens of disaster management theory, we can gain insights into practical strategies for mitigating the impacts of floods and enhancing community resilience. Initial understanding to address the flood topic at different levels depicted in Figure 2. Globally, Water-related disasters pose significant global challenges, with climate change intensifying their frequency and severity. Floods, triggered by heavy rainfall, snowmelt, tropical cyclones, or tsunamis, result in loss of life and substantial damage to personal property and critical public health infrastructure. Alarming, between 1998 and 2017, floods impacted over 2 billion people worldwide. (WHO, 2020). WHO identifies the most vulnerable communities to floods as those residing in floodplains or non-resistant buildings, often lacking warning systems and having limited awareness of flood hazards. This vulnerability highlights a grave global concern with far-reaching consequences. Particularly troubling is the disproportionate impact on impoverished communities, which exacerbates inequalities and undermines sustainable development efforts.

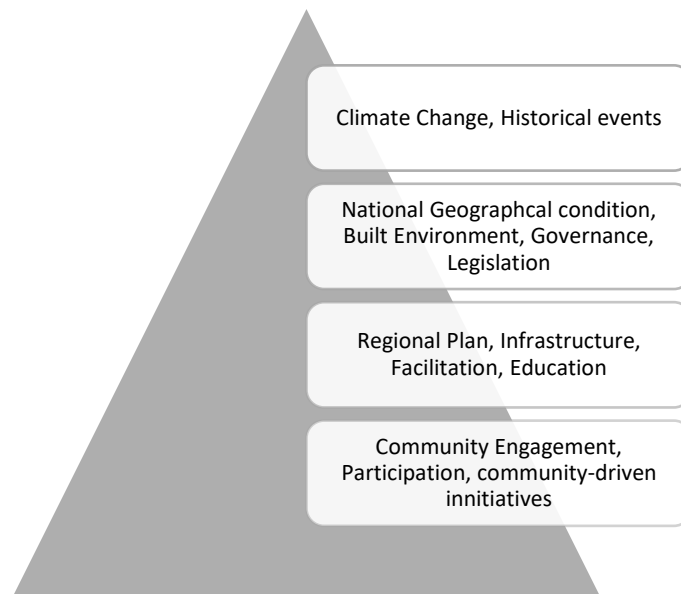


Figure 2 Initial understanding of flood topics at multi-level

The United Nations (UN) has recognised the gravity of this issue and has actively tackled flood management through initiatives like the Sendai Framework for Disaster Risk Reduction. This framework emphasises proactive measures, including risk assessment, early warning systems, and disaster response planning, as essential components to reduce the impacts of floods on vulnerable populations. (UN, 2015). The global perspective underscores the imperative for collaborative efforts among nations, involving the sharing of knowledge, resources, and best practices in flood risk management.

As New Zealand is located in the southwestern Pacific Ocean, it faces unique challenges related to flood disasters. The country experiences various flooding events, ranging from flash floods triggered by heavy rainfall to riverine floods resulting from prolonged periods of precipitation. Recent years have seen New Zealand affected by several devastating flood incidents, resulting in significant damage to infrastructure, displacement of communities, and disruption of economic activities. Acknowledging the gravity of this issue, the New Zealand government has implemented various policies and frameworks, such as the NZS 9401:2008 Managing Flood Risk – A Process Standard (Standards New Zealand, 2008), managing flood risk at the local level: a guidebook (Ministry for the Environment, 2010), and the risk-based approach to management for natural hazards (Ministry for the Environment, 2016). These initiatives focus on flood risk mapping, land-use planning, and developing robust emergency response systems.

Research by NIWA in 2010 indicates more than 50% of one or more 150-year ARI flood (0.67% AEP flood) events in populated New Zealand catchments in any given year. (Smart & McKerchar, 2010) The floodwater follows a downslope direction and pools where the outflow is restricted. The floodwaters carried sediment and built floodplains, and many New Zealand towns and settlements are built on these floodplains. (Richardson et al., 2014). The area prone to flooding can be predicted and identified by mapping the historic flood zones using hydraulic model studies. (NIWA, 2016a). As shown in Figure 3 Many communities situated on active floodplains are exposed to flood hazards (NIWA, 2016a; The Royal Society of New Zealand, 2016).



**Figure 3 Hydraulic model studies**  
**Model for flood zone prediction - Heathcote River flooding prediction, southeast Christchurch**  
**(based on pre-earthquake topography) (NIWA, 2016c)**

Entering the regional setting, the Northland region of New Zealand serves as a compelling case study regarding flood vulnerability and management strategies. In the northernmost part of the country, Northland features diverse landscapes, including rivers, estuaries, and coastal areas (Caludia Orange, 2015). However, these natural features also render the region highly susceptible to flooding. Northland has witnessed numerous severe flooding events in recent years, resulting in extensive damage to infrastructure, property, and the environment. Factors such as high rainfall intensity, steep terrain, and coastal dynamics contribute to the region's heightened vulnerability (NIWA, 2016a). Recognising the need for effective flood management, the Northland Regional Council has implemented various measures, including flood hazard mapping, land use regulations, and improvements to flood protection infrastructure. The council collaborates closely with local emergency management agencies and community groups to enhance preparedness, response, and recovery efforts.

While Northland's flood intensity seems minor, the frequency is enormous. Having fewer major destructive floods does not mean the community faces fewer risks than the areas often struck by the more extraordinary floods. Recurring floods can damage the land, structures, and property and contaminate water and soil. The local council has prepared an action plan to reduce flood risks. However, many factors can contribute to its performance. A framework is necessary to develop an effective solution that enhances the effectiveness of a flood risk reduction plan.

At the core of flood disaster management lies the involvement and resilience of local communities. Recognising the unique needs and vulnerabilities of each community is crucial for effective flood preparedness and response (O'Brien & O'keefe, 2013). There are popular studies discussing the community-based disaster management approach, also known as the CBDM approach, which is being utilised in many parts of the world when dealing with vulnerable communities in the face of disasters. The CBDM approach is a fundamental form of community empowerment and a compelling mechanism for disseminating ideas and claims from the bottom up. CBDM aims to reduce disaster impacts and risks through community participation that places people at the centre of development (Azad et al., 2019). These community-driven initiatives, such as the development of localised flood response plans, the establishment of community early warning systems, and the promotion of adaptive practices, play a vital role in reducing the impacts of floods on individuals and

their livelihoods (Blaikie et al., 2014). By understanding the community perspective, we can identify the factors that influence community engagement, participation, and resilience-building efforts, thereby contributing to the overall effectiveness of flood disaster management strategies.

In conclusion, addressing recurring flood problems and their multifaceted impacts necessitates a comprehensive approach that encompasses global initiatives, national strategies, regional case studies, and community actions. The international perspective provides valuable frameworks and guidelines, while the community perspective offers insights into effective practices and the profound influence of local actions on global flood resilience. By fostering collaboration and knowledge-sharing between global initiatives and local communities, we can collectively work towards building a more resilient future. This future will mitigate the impacts of flood disasters, empower communities, and protect lives and livelihoods on a global scale.

### 1.3 New Zealand Disaster Management Cycle

The concepts of the disaster management cycle for flood risk reduction are globally recognised, and for New Zealand, it is often referred to as the 4Rs: Reduction, Readiness, Response, and Recovery (NEMA, 2021). The UN plays a central role in shaping the global disaster management agenda, with the Sendai Framework for Disaster Risk Reduction 2015-2030 being a key framework. This framework emphasises proactive measures to reduce disaster risk and enhance resilience. It outlines four priorities: understanding disaster risk, strengthening disaster risk governance, investing in disaster reduction, and improving disaster preparedness.

These principles serve as the foundation for New Zealand's emergency management and disaster risk reduction plans. Other countries and organisations use similar concepts, albeit with different terminologies. For example, the United States employs Mitigation, Preparedness, Response, and Recovery (Lindsay, 2012), while the European Union, Canada, and Australia use Prevention, Preparedness, Response, and Recovery (Alexander, 2015; McArthur & Holley, 2022; Public Safety Canada, 2017). The differences lie in their emphasis and specific strategies. The choice of terminology reflects each country's context and priorities. However, despite the varied terminology, the core goals and principles remain consistent. Tailoring these concepts to each country's unique characteristics ensures the effectiveness and relevance of disaster management strategies.

Understanding the concept of the framework means understanding the emergency management process as the foundation. Emergency management encompasses a wide range of functions. It is commonly conceptualised as a cyclic process, structured around distinct phases that encompass both proactive and reactive measures in response to a hazardous situation. In simpler terms, emergency management can be categorised into three main stages:

1. **Emergency Preparedness / Readiness:** This phase involves the day-to-day activities conducted by emergency professionals before an event occurs, constituting a proactive approach. These activities encompass risk assessments, emergency planning, training exercises, and community engagement efforts.
2. **Emergency Responses:** In this phase, actions are taken in response to a specific hazard event. This reactive phase involves activities like risk mitigation (e.g., implementing temporary

defences), conducting rescue operations, managing continuity, and coordinating responses across multiple agencies.

3. Recovery activities in emergency management typically focus on the immediate aftermath of a hazard event. Examples include rehousing displaced individuals, addressing welfare needs, and restoring critical services.
4. Reduction: In addition to the traditional phases, there is a reduction phase aimed at minimising the impact of potential hazards. This phase involves proactive measures to decrease the likelihood and severity of hazards, such as implementing policies, infrastructure improvements, and community-based initiatives.

Emergency management differs from discussions on crisis and disaster management, as the latter often involves events or stressors that exceed the capabilities of standard operational systems to handle effectively. Such situations often necessitate external assistance extending beyond domestic systems. So, Disasters are characterised as events marking the breakdown of the expected and organised world. In contrast, emergency management deals with "ordinary" rather than extraordinary events, which can be managed using existing resources and established procedures. Nevertheless, there are evident synergies and dependencies between the disaster and the emergency management. Adopting the emergency framework for disaster management offers a structured and proactive approach. It optimises resource allocation, encourages collaboration, and ensures flexibility to address various types of disasters. The cyclic nature promotes continuous improvement, and public awareness initiatives empower communities. Overall, the framework enhances effectiveness in preparing for, responding to, and recovering from disasters.

As New Zealand strongly endorses the Sendai Framework, it has been a key influence in the development of the National Disaster Resilience Strategy. The strategy noted that good flood risk management requires actions across the 4 Rs (reduction, readiness, response and recovery) to be integrated to achieve the desired goal. New Zealand is vulnerable to various emergencies, including earthquakes, floods, and volcanic eruptions. The 4Rs align with the country's risk management approach, emphasising proactive planning, early warning systems, community engagement, and the integration of indigenous knowledge.

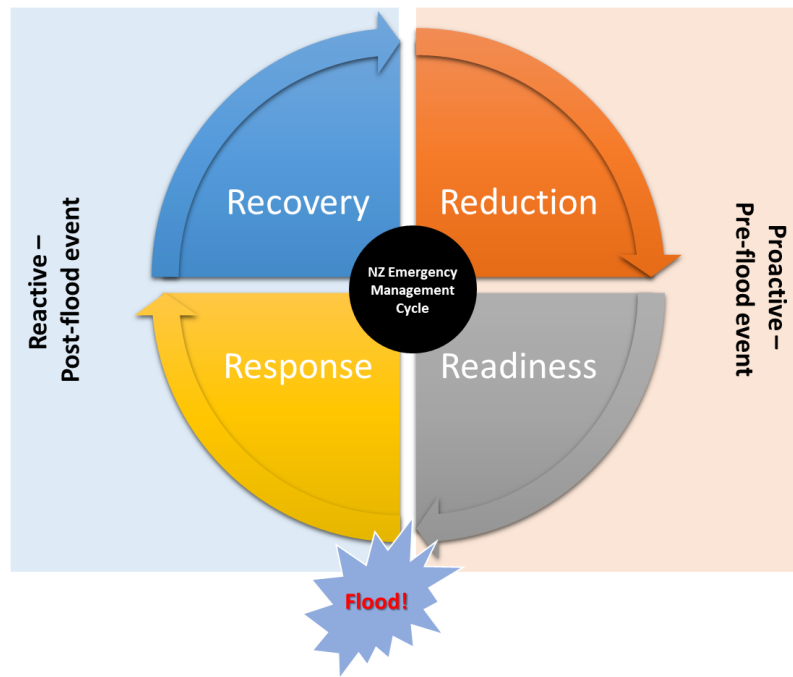


Figure 4 New Zealand emergency management cycle

The concept of Reduction encompasses strategies for eliminating or mitigating hazards where feasible and desirable, but it also recognises that this may not always be possible. Instead, the focus often centres on reducing the likelihood of risk and minimising its potential impact to an acceptable level. Readiness and Response, although often linked together, represent distinct phases in the disaster management cycle. As presented in the Figure 4 Readiness involves proactive measures taken before disasters strike, while Response pertains to the reactive measures implemented during and after disaster events.

The final R, Recovery, encompasses coordinated efforts and processes aimed at facilitating immediate, medium-term, and long-term regeneration within affected communities following a civil defence emergency. Crucially, Recovery extends beyond post-disaster activities; it encompasses actions taken before disasters occur. Communities and organisations can enhance their capacity to recover swiftly and effectively by reducing their exposure to hazards (reduction) and preparing specific plans, arrangements, and resources for recovery. In this manner, the disaster management cycle continues as a dynamic and ongoing process, adaptable to the specific characteristics and needs of each country, such as New Zealand, to ensure the efficacy and relevance of disaster management strategies.

## 1.4 Community Resilience to Recurring Flood

In the Northland region, recurrent floods have become a persistent and widely acknowledged concern, recognised throughout the community. However, a question emerged despite this pervasive awareness: Why is it difficult for the local community to strengthen its ability to withstand frequent floods?

This research thoroughly examines how the Northland community addresses recurring floods to enhance its resilience. It follows a structured three-step approach:

1. Analysing historical flood data to understand patterns and contextual details.
2. Investigating the community's viewpoints to uncover the various factors influencing their responses and preparedness.
3. Evaluating the government's role, assessing the effectiveness of current flood risk management strategies, and identifying barriers to community resilience.

From the community's perspective, the impacts of floods are influenced by several key factors. These include geographical location, such as proximity to flood-prone areas, as well as the area's topographical features and access to water bodies. New Zealand's climate, characterised by its unpredictable rainfall patterns and the growing threat of climate change, further complicates the situation. The community's knowledge about floods plays a critical role in shaping their decisions and readiness to face such challenges. Financial resources are also crucial, as they significantly impact their ability to handle home repairs, invest in flood protection measures, evacuate when necessary, and obtain flood insurance. Additionally, active community engagement in government initiatives, flood protection efforts, and staying informed about relevant policies and developments are essential. These actions collectively contribute to enhancing community resilience against the recurring threat of floods.

From the government's perspective, efforts to address recurring floods have led to the implementation of a robust Flood Risk Management (FRM) plan, supported by relevant laws and regulations. However, the effectiveness of these measures requires careful evaluation. In New Zealand's Emergency Management Plan, FRM strategies are categorised into reactive and proactive approaches. Reactive measures involve immediate responses, such as flood response and recovery, while proactive measures focus on long-term planning, including preparedness and prevention strategies. Traditionally, FRM plans have leaned towards reactive measures due to their direct response to flood events, while proactive measures are often seen as less critical.

The influence of various factors on these decisions is evident, particularly with active involvement from community leaders, including traditional groups such as Iwi in Northland, who play a crucial role in shaping decisions. Urban communities, on the other hand, take a pragmatic approach due to their greater exposure to flood-related knowledge. Post-flood recovery is influenced by factors such as insurance coverage and availability, which affect decisions about home repairs, preparedness, relocation, and resuming daily life.

In terms of readiness, the Northland Council has developed flood maps to guide construction and preparedness efforts in safe areas. Land use planning also plays a crucial role in mitigating flood vulnerabilities caused by changes such as deforestation and housing development in flood-prone areas. Education and knowledge-sharing initiatives are essential, as they ensure communities understand the risks they face and how to mitigate them effectively. Bridging the gap between modern technology and traditional knowledge can enhance collaboration and integration efforts.

Reduction efforts include developing Early Warning Systems (EWS), identifying flood paths, and improving flood protection infrastructure and river management. However, some infrastructure developments inadvertently increase risks by failing to consider downstream effects or altering

natural water flows without assessing their broader impacts. While complete risk elimination is challenging, effective mitigation strategies are feasible.

In conclusion, achieving a balanced FRM plan involves improving both readiness and reduction measures. The Sendai Framework for Disaster Risk Reduction advocates for a gradual shift towards proactive measures and a community-centred approach. Maintaining this balance, rather than abruptly shifting focus between reactive and proactive strategies, is crucial for effective disaster management. This approach integrates community perspectives into legislation and FRM plans, drawing from past experiences to enhance resilience against recurring floods in Northland and similar regions.

### 1.5 Flood as a Research Topic

Research on floods, spanning from ancient civilisations to modern times, has evolved significantly, particularly in understanding their causes and impacts (Angelakis et al., 2023). Early observations and documentation by ancient societies laid the groundwork for flood research. However, systematic scientific inquiry began in earnest during the 19th and 20th centuries with pioneers like John Wesley Powell (Wilkinson, 2020) and Sir John Frederic La Trobe Bateman advancing our knowledge of river systems and flood behaviour (Ewen, 2014).

The establishment of meteorological and hydrological agencies, alongside technological advancements in data collection and analysis, propelled flood research further in the 20th century (Barry & Chorley, 2009). Today, flood research is a multidisciplinary endeavour involving hydrology, meteorology, climatology, geology, engineering, and more. This interdisciplinary approach continues to evolve as researchers strive to understand better and predict flood events, improve flood management strategies, and address challenges posed by climate change (Tabari, 2020) and urbanisation (Auliagisni et al., 2022a).

Several key developments have shaped flood risk management, including advancements in Remote Sensing and GIS Technology (Syifa et al., 2019), Flood Forecasting and Early Warning Systems (Acharya & Prakash, 2019; Smith et al., 2017), Climate Change and Flood Risk Assessment (Ballesteros et al., 2018; Waghwalwa & Agnihotri, 2019), Nature-based Flood Management (Hartmann, 2011), Infrastructure Resilience and Retrofitting (Huck et al., 2020). Notably, the integration of Social Science and Community Engagement marks a significant shift, highlighting the importance of understanding human behaviour and societal responses in flood management (Henderson et al., 2020; McCabe et al., 2006).

Social science research in flood studies faces unique challenges, such as subjectivity, the complexity of human behaviour, and navigating intricate social systems (Rodriguez et al., 2004). Overcoming these challenges requires collaboration across disciplines like sociology, psychology, anthropology, and economics. This interdisciplinary approach helps bridge gaps in understanding and enhances the effectiveness of flood risk management policies and strategies (Lane et al., 2011). Despite these complexities, studying floods through a social science lens is crucial for gaining insights into how communities perceive and respond to flood risks. This understanding informs more effective communication, preparedness, and recovery efforts, ultimately fostering community resilience.

In recent years, research on community resilience to flood risk has gained significant attention (Bulti et al., 2019), although it is not entirely new. While flood management has long been a focus, the specific study of community resilience has grown in response to ongoing challenges such as climate change and urbanisation, seeking a framework for action. There is now a greater recognition of communities' essential role in disaster preparedness and recovery efforts. This shift towards a holistic, community-centred approach reflects the changing dynamics of flood risk and emphasises the importance of empowering and supporting communities in effectively managing and recovering from floods. Chapter 3 provides an in-depth discussion of the research methods employed to explore this approach.

### 1.6 Problem Statement

Frequent floods in Northland pose a persistent challenge to the community, despite widespread awareness. There is a significant gap in understanding why the community remains vulnerable to these recurring flood events. Current flood management strategies emphasise response and recovery rather than proactive measures for flood reduction and preparedness. Strengthening the implementation of bottom-up governance and a people-centred perspective is critical to enhancing resilience against these challenges.

### 1.7 The Purpose of the Study

This study aims to enhance the resilience of the Northland community in response to recurring flood events while optimising disaster management processes. It highlights a bottom-up approach while creating a new strategy and emphasises a balanced approach, recognising the equal importance of measures addressing both response and recovery, as well as those focused on risk reduction and preparedness. Additionally, the research identifies essential components crucial for enhancing community resilience within the Northland region.

### 1.8 Research Aim, Questions and Objectives

#### 1.8.1 Research Aim

**This thesis aims to enhance the resilience of the Northland community in response to recurrent flood events and to optimise disaster management processes. The overarching goal is to improve preparedness, response, and recovery capabilities in dealing with floods, thereby minimising their adverse impacts.**

#### 1.8.2 Research Questions

This research project centered on two overarching research questions.

**Q1: How can Northland improve its flood management strategies to effectively prepare for, respond to, and recover from recurrent flood events?**

**Q2: What are the key factors influencing community resilience to floods in Northland, and how can these factors be optimised to minimise flood impacts and enhance disaster management processes?**

To make them analytically manageable and to best discuss in the conclusion chapter (Chapters 10 and 11), the research has been distilled into seven sub-questions, each driving a dedicated findings chapter Figure 5.

These questions guide the research objectives, which include enhancing community resilience, optimising disaster management processes through risk reduction strategies, emphasising a balanced approach in flood risk management, and identifying fundamental components crucial for enhancing community resilience within the Northland region. The following table summarises how each objective aligns with specific chapters of the thesis, providing a structured framework for addressing these research questions and achieving the research aim. To achieve this aim, the study addresses the research questions listed in Table 1.

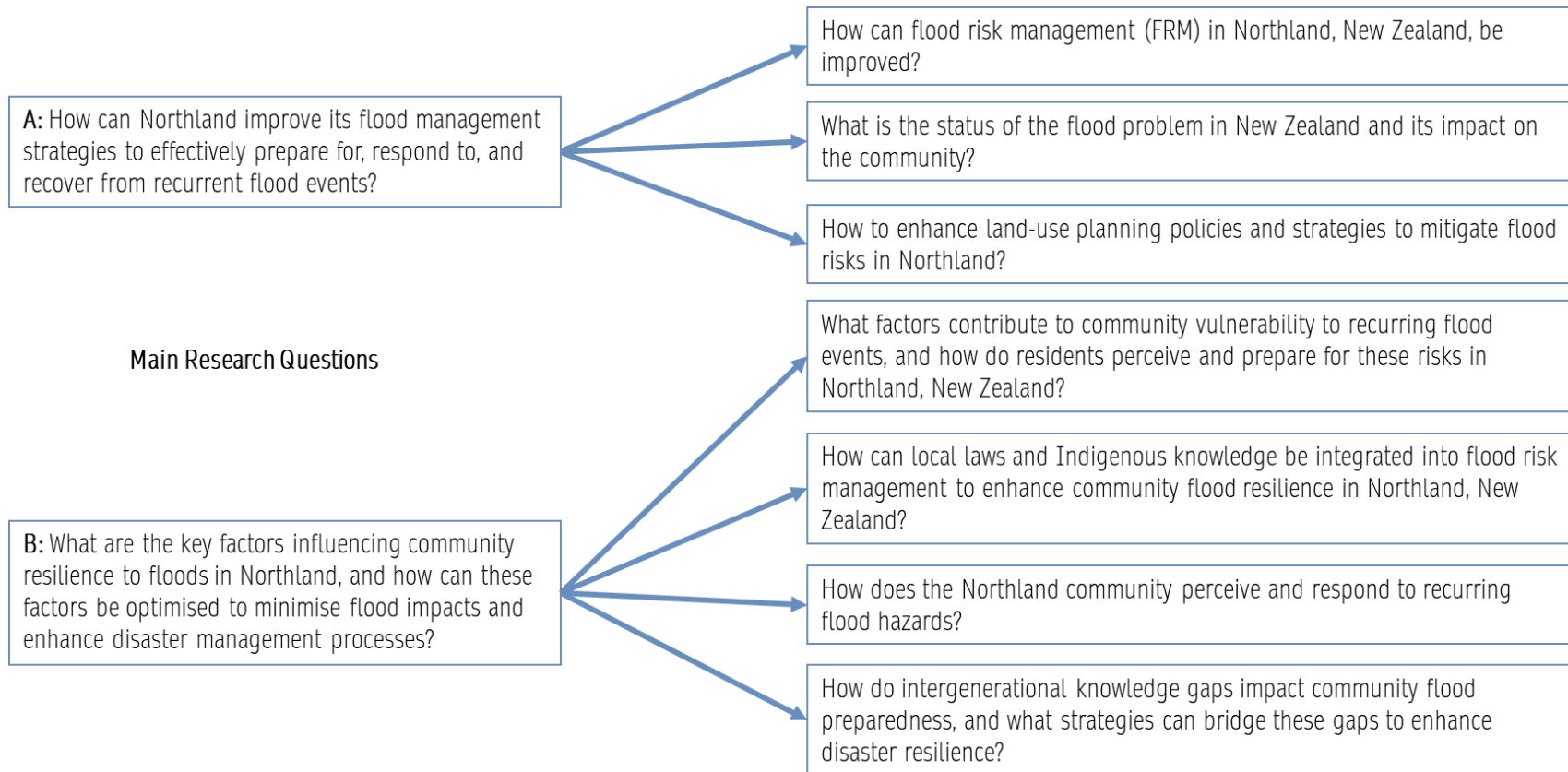


Figure 5 Distilled sub questions

Table 1 Research Questions and Objectives

Main Research Questions	Research Objectives	Research Sub questions	Relevant Chapters
1. What is the status of the flood problem in New Zealand and its impact on the community?	<p>A. To identify factors that contributed to the community vulnerability</p> <p>B. To assess community perceptions of flood risks and their preparedness behaviours.</p>	<p>i. What characteristics make the Northland community more vulnerable to flood risk impacts?</p> <p>ii. How will impacts be experienced differently by the more vulnerable?</p> <p>iii. What strengths do they also have that will assist in responding to impacts and adapting to recurring floods?</p>	Chapter 4: Community Vulnerability to Floods
2. How can flood risk management (FRM) in Northland, New Zealand, be improved?	<p>A. To identify current gaps in Northland’s flood management strategies, focusing on preparedness, response, and recovery.</p> <p>B. To explore how flood risk management (FRM) in Northland can be enhanced through the integration of structural and non-structural measures.</p>	<p>i. How effective are the current structural flood risk management measures in Northland (e.g., dams, stop banks, floodways) in mitigating flood risks, particularly during extreme events?</p> <p>ii. In what ways can community-based flood risk management (CBFRM) improve flood resilience in Northland, and what is the role of local flood working groups in this process?</p> <p>iii. What are the strengths and limitations of the legislative frameworks governing flood risk management in Northland, and how do they influence flood preparedness and response strategies?</p> <p>iv. How does urban expansion in floodplain zones affect flood risk in Northland, and what strategies can be implemented to address these risks through integrated planning and flood management practices?</p>	Chapter 5: Flood Risk Management in New Zealand: A Case Study of Northland Urban Community.

<p>3. What is the status of the flood problem in New Zealand and its impact on the community?</p>	<p>A. To evaluate the usability and accessibility of current flood hazard maps for non-expert users in Northland.</p> <p>B. To propose improvements to flood map design and dissemination, incorporating community-based knowledge and preferences to serve flood-prone communities better.</p>	<p>i. How effective are the current flood hazard maps in communicating flood risks to communities in Northland, New Zealand?</p> <p>ii. What are the barriers to the accessibility, comprehension, and usability of existing flood maps for the public?</p> <p>iii. How can community-based approaches be integrated into flood map development to enhance flood risk communication?</p>	<p>Chapter 6: Using Community-Based Flood Maps to Explain Flood Hazard in Northland, New Zealand</p>
<p>4. How can local laws and indigenous knowledge be integrated into flood risk management to enhance community flood resilience in Northland, New Zealand?</p>	<p>A. To investigate the role of governance in strengthening flood resilience and optimising disaster management.</p> <p>B. To explore the role of indigenous and local knowledge in shaping culturally appropriate, sustainable flood management strategies.</p>	<p>i. What is the role of local laws in regulating and encouraging flood resilience at the community level in New Zealand?</p> <p>ii. How does indigenous knowledge contribute to flood risk management and resilience?</p> <p>iii. What are the gaps in the current legal and policy frameworks for flood risk management in New Zealand?</p> <p>iv. What strategies can be employed to create a comprehensive and culturally appropriate flood resilience framework?</p>	<p>Chapter 7: Legal and Governance Frameworks for Flood Resilience – From Policy to Practice</p>
<p>5. How to enhance land-use planning policies and strategies to mitigate flood risks in the Northland</p>	<p>A. To investigate the reasons behind the continued development of floodplains in New Zealand</p>	<p>i. Why does development continue the floodplain knowing the risks?</p> <p>ii. How can land use and planning policy be made more effective in restoring the natural functionality of floodplain areas, considering the extensive urban development?</p>	<p>Chapter 7: Legal and Governance Frameworks for Flood Resilience – From Policy to Practice</p>
<p>6. How does the Northland community perceive and respond to recurring flood hazards?</p>	<p>A. To evaluate the effectiveness of existing flood protection infrastructure and community-led initiatives.</p> <p>B. To provide actionable recommendations for enhancing</p>	<p>i. What are the existing community-led and council-supported flood resilience strategies in Northland?</p> <p>ii. How can indigenous knowledge and practices be integrated into flood risk management?</p>	<p>Chapter 8: Learning from floods – How a community develops future resilience</p>

	community and council collaboration on flood risk management.	iii. What lessons can be drawn from recent flood events to improve preparedness and resilience?	
7. How do intergenerational knowledge gaps impact community flood preparedness, and what strategies can bridge these gaps to enhance disaster resilience?	<p>A. To investigate the mechanisms contributing to the intergenerational attenuation of disaster preparedness knowledge.</p> <p>B. To identify and assess the impact of traditional and modern disaster preparedness strategies on flood resilience.</p> <p>C. To propose actionable recommendations for integrating ancestral knowledge with contemporary approaches to sustain flood preparedness across generations.</p>	<p>i. What are the key factors leading to the erosion of disaster preparedness knowledge across generations?</p> <p>ii. How do flood experiences influence preparedness behaviours among affected and unaffected community members?</p> <p>iii. What role does traditional ecological knowledge play in modern flood preparedness efforts?</p> <p>iv. How can educational initiatives and community spaces like libraries facilitate cross-generational learning in disaster preparedness?</p>	Chapter 9: Preserving Community Resilience: Embracing Tradition and Innovation in Disaster Preparedness

## 1.9 Research Design and Context

This research design outlines the structured plan for obtaining answers to the research question. It follows the framework established by (Kor & Teah, 2009) which includes defining research objectives and questions, justifying the chosen methods, detailing data collection methods, and specifying data analysis techniques. The study employs a qualitative research approach, utilising multiple case studies to gather data for analysis, discussion, and recommendations. Figure 6 and **Error! Reference source not found.** illustrates the sequence of research steps and phases, beginning with the literature review and culminating in the study's conclusions.

### 1.9.1 Conceptual Framework

For this research, Chapters 1, 2, and 3 collectively establish the foundation for this study within the conceptual framework. Chapter 1 introduces the research context and significance. Chapter 2 explores the variables related to floods as disasters, and Chapter 3 outlines the methods used to investigate these variables and their relationships. Chapters 4 to 9 are the findings that visualised the cause-and-effect relationship by identifying moderating variables, independent variables, mediating variables, dependent variables, and controlled variables for this research. Chapter 10 integrates the findings from the study within the broader conceptual framework. It discusses how the data collected from research aligns with the theoretical constructs and concepts outlined in earlier chapters. Chapter 11 serves as the conclusion of the thesis, where it summarises the main findings and contributions of the research.

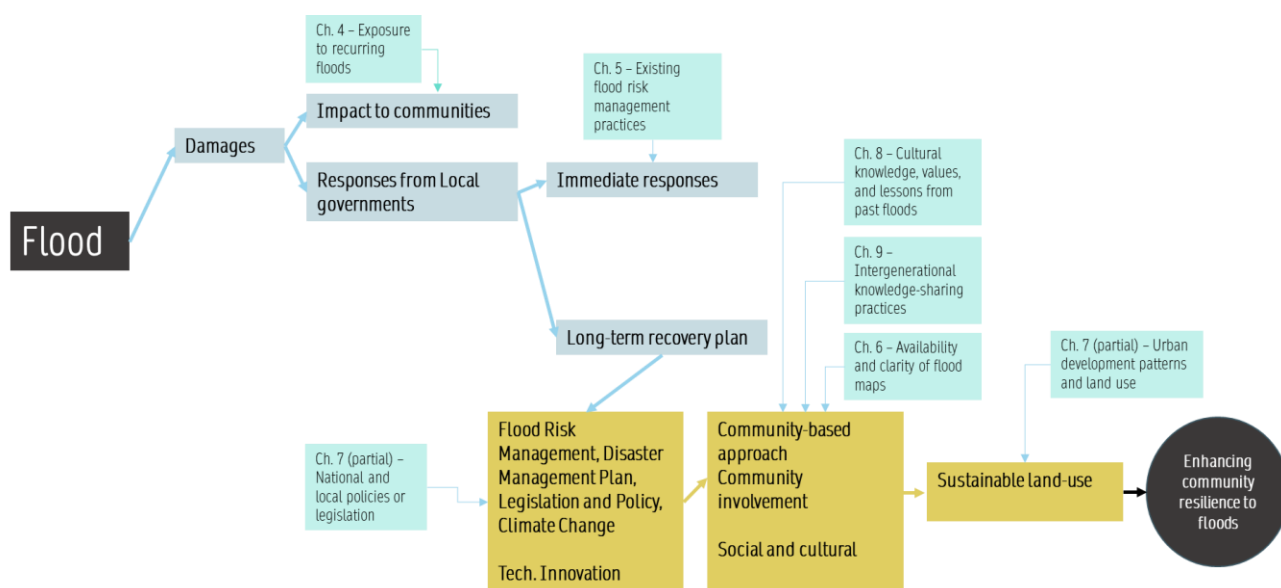


Figure 6 Conceptual Framework

### 1.9.2 Research Significance

This study addresses a critical issue in Northland: recurrent floods and community resilience. While the challenge of recurring floods is well-recognised, the research investigates why the community struggles to strengthen its resilience against these events. This inquiry aims to deepen understanding of the Northland community and its resilience, providing insights crucial for future disaster management strategies.

While the issue of recurrent floods is not new, the novelty of this research lies in its holistic approach. It combines historical data analysis, community perspectives, and government assessments to understand the factors influencing resilience comprehensively. The research makes a significant contribution to existing knowledge in several ways. Firstly, it comprehensively examines the dynamics of the Northland community amidst recurrent floods, offering insights applicable to disaster management practices beyond Northland. Secondly, it advocates for a balanced approach in Flood Risk Management (FRM) plans, integrating both proactive and reactive measures in alignment with the Sendai Framework for Disaster Risk Reduction. This approach represents a nuanced strategy for enhancing flood resilience. Lastly, the study underscores the importance of community-centred approaches in legislation and FRM plans, emphasising the role of local knowledge and cultural sensitivity in bolstering community resilience.

### **Ethical Considerations**

This research involved direct engagement with community members, local government representatives, and other stakeholders. As such, ethical approval was obtained from the **Massey University Human Participants Ethics Committee (Approval Number: 4000024164)** prior to commencing fieldwork. The approval process ensured that all research activities adhered to strict ethical guidelines, including obtaining informed consent, maintaining participant confidentiality, and demonstrating cultural sensitivity. Further details of the ethical approval process and supporting documentation are provided in Section 3.5.5, with Human Ethics Notifications included in Appendix F.

## **1.10 Thesis Structure**

### Chapter 1: Introduction

This chapter sets the stage for the thesis by introducing the background, significance, and scope of the study. It outlines the increasing frequency and impact of small, recurrent floods in Northland, New Zealand, highlighting the lack of attention given to these events compared to catastrophic floods. The chapter presents the research questions and objectives, emphasising the need for proactive, community-driven flood risk management strategies to enhance resilience.

### Chapter 2: Understanding Flood as a Disaster and Managing the Risks

This chapter provides a comprehensive review of the theoretical framework and literature on flood risks, resilience, and management. It explores the concepts of floodplain management, disaster risk reduction, and the balance between structural (e.g., infrastructure) and non-structural (e.g., community engagement) measures. The chapter also examines New Zealand's flood risk management in the context of global practices and the challenges posed by climate change.

### Chapter 3: Research Methods

This chapter outlines the mixed-methods research approach employed in the study, encompassing both qualitative and quantitative methods. It describes the data collection processes, such as surveys, interviews, community workshops, and GIS-based mapping, conducted in Northland. The chapter also outlines the methodological challenges and limitations, ensuring transparency and rigour in the research design.

### Chapters 4-9: Findings Chapters

The core findings of the thesis are presented in these chapters, each of which represents a published or publishable paper that focuses on a specific aspect of the research.

#### Chapter 4: Community Vulnerability to Floods

Explores the factors contributing to Northland's vulnerability, including geographic, socioeconomic, and infrastructural dimensions.

**Chapter 5: Flood Risk Management in New Zealand: A Case Study from an Urban Community**  
Examines the effectiveness of flood management strategies in urban Northland, with a focus on integrating structural and non-structural measures.

#### Chapter 6: Using Community-Based Flood Maps to Explain Flood Hazard in Northland, New Zealand

Highlights the role of community-led flood mapping in identifying localised risks and empowering residents to take proactive measures.

#### Chapter 7: Overview of New Zealand Legislation for Flood Resilience

Analyses the legislative framework for flood management in New Zealand, identifying gaps and opportunities for improvement. **Enhancing Flood Resilience through Effective Land-Use Planning Policies in New Zealand**

Discusses the challenges and solutions associated with floodplain development and land-use planning.

#### Chapter 8: Learning from floods – How a community develops future resilience

Explores the integration of Māori and local knowledge, emphasising the value of cultural practices in enhancing community resilience.

#### Chapter 9: Preserving Community Resilience: Embracing Tradition and Innovation in Disaster Preparedness

Focuses on education and policy recommendations to bridge knowledge gaps and foster long-term flood preparedness.

### Chapter 10: Integration of Findings

This chapter synthesises the key findings from Chapters 4–10, drawing connections between community vulnerability, governance, policy, and resilience strategies. It evaluates how each chapter addresses the research objectives and highlights limitations. The chapter also explores the interplay between top-down governance and bottom-up community initiatives, proposing a framework for integrated flood risk management.

### Chapter 11: Conclusion and Recommendations

The final chapter summarises the key contributions of the research, emphasising its implications for policy, practice, and theory. It provides actionable recommendations for local and central governments, communities, and other stakeholders to improve flood resilience. Suggestions for future research include exploring the long-term impacts of community-driven initiatives, the role of emerging

technologies in flood management, and the application of findings to other regions with similar flood challenges.

## Chapter 2

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Understanding Flood as a disaster and managing the risks

## Aim and Structure

The purpose of this literature review is to critically examine existing research, theories, and practices related to floods as a natural hazard, flood risk management, and community resilience, with a particular focus on the Northland region of New Zealand.

This chapter serves three key aims:

1. To provide a theoretical and conceptual foundation for understanding floods as a hazard and the frameworks used to manage their impacts at multiple levels.
2. To identify gaps and challenges in current flood management approaches, particularly the imbalance between short-term response and recovery versus long-term, proactive risk reduction and preparedness.
3. To establish the context for this research by demonstrating how community-based, bottom-up governance and local knowledge integration can enhance flood resilience in vulnerable communities.

By fulfilling these aims, the literature review directly supports the overall research aim of this thesis:

**To enhance the resilience of the Northland community to recurring flood events through sustainable, proactive, and community-driven flood risk management strategies.**

The insights gained from this chapter provide a foundation for the research questions and objectives outlined in Chapter 1. Specifically, the literature review highlights:

- The theoretical underpinnings of disaster management, flood resilience, and community engagement.
- Key factors influencing community vulnerability and preparedness, such as social, cultural, and environmental drivers.
- The strengths and weaknesses of current flood governance structures and opportunities for improvement.

This chapter is organised into the following sections:

- **Sections 2.1 to 2.3** provide historical and contemporary perspectives on floods as a natural hazard and disaster.
- **Sections 2.4 to 2.6** explore the causes, types, and impacts of floods.
- **Section 2.7** examines frameworks for managing flood risks, including both structural and non-structural measures.
- **Section 2.8** research gaps found from the literature review
- **Sections 2.9 and 2.10** conclude with a synthesis, highlighting key knowledge gaps that informed the research design presented in Chapter 3.

## 2.1 Background

Floods, a prominent weather-induced disaster, have the potential to cause significant damage to both humans and infrastructure (Petrow et al.). Typically, high water flow is contained within natural or artificial levees; however, when floodwaters exceed the capacity of these boundaries, they inundate surrounding areas that are usually dry (Viglione & Rogger, 2015). The extent of the flood is determined

by various factors, including the volume of water, its velocity, and the surrounding topography (Rak et al., 2016). While heavy precipitation and high tides are commonly cited as causes of flooding, additional factors such as low-lying land and narrow waterways can exacerbate its impact. Flooding along watercourses can occur annually, but it is the consequences on human life, livelihoods, and property that elevate floods to the status of disasters (Tockner & Stanford, 2002). Therefore, it is important to recognise that human actions or inactions can contribute to the occurrence and severity of floods, despite their natural origins.

Floods have the capacity to inflict a wide range of consequences, varying from relatively minor inconveniences, such as submerged roads and overwhelmed sewer systems, to significant devastation that includes damage to property and land, displacement of populations, and substantial disruptions to affected communities. Within the category of rapid-onset events, floods hold a distinct characteristic. Unlike many other rapid-onset events, floods can often be predicted, anticipated, and to some extent, managed (Kundzewicz et al., 2010). Meteorologists, for instance, are capable of forecasting conditions favourable for flash floods, albeit with limited lead time for actual warnings (Smith et al., 2017). In contrast, forecasts for flooding along major rivers can be made days in advance and local knowledge often helps in this prediction (Acharya & Prakash, 2019).

Originally, a flood referred to a sudden and excessive flow of water. However, the term now encompasses various water-related events such as tidal, flash, river, and coastal flooding. Over time, our understanding of floods has deepened, recognising them as significant and often devastating occurrences (Merz et al., 2014). Within the academic community, floods are defined as situations where water exceeds the capacity of natural or artificial drainage systems, resulting in the accumulation of water on non-submerged land (Schanze, 2006). Factors like heavy rainfall, snowmelt, storm surges, or the failure of dams or levees can trigger these floods. Their effects include extensive damage to infrastructure, homes, communities, displacement of populations, and loss of life (Cross, 2001; Khayyam, 2020). Consequently, academia and international frameworks stress the need for disaster risk reduction measures like early warning systems (Smith et al., 2017), floodplain management (Freitag et al., 2012), land-use planning (Glavovic et al., 2010), and infrastructure development (Northland Regional Council, 2018a) to minimise the impact of floods on vulnerable populations.

By understanding the origins and defining characteristics of floods, we can gain insights into their causes, impacts, and potential strategies for managing and mitigating their effects. This comprehensive analysis will contribute to our knowledge of floods and enhance our ability to develop resilient communities in the face of such natural hazards.

## 2.2 Correct terminology to address flood as a natural hazard

There is a growing acknowledgement that the term "natural disaster" no longer accurately reflects the reality of most disasters (Chmutina & Von Meding, 2019). Even events that may appear entirely natural, such as floods, are often aggravated or even induced by human activities (Blaikie et al., 2014). Therefore, employing the term "natural disaster" is considered inappropriate as it wrongly implies that the disaster is solely the outcome of natural forces and lies beyond human influence (Smith, 2006). Characterising a disaster as purely natural can foster a misconception that the catastrophe was inevitable or that there is no recourse to prevent its recurrence.

Having the wrong term (e.g. using natural disaster instead of natural hazards) can inadvertently neglect or underestimate the role of human factors in shaping the impact of a disaster and the requisite response measures (Kelman, 2020). This can result in emergency response efforts that are inadequate or ill-suited to address the root causes of vulnerability. Conversely, by acknowledging the human dimensions of disasters, individuals can collaborate to develop more effective and sustainable solutions that reduce their impact and enhance resilience. Consequently, it is increasingly common to refer to events like floods as "humanitarian disasters" or "socio-natural disasters," rather than categorising them solely as "natural disasters" (Smith, 2006).

In essence, disasters are severe disruptions that surpass a community's capacity to cope using its internal resources. They can be triggered by natural, human-made, and technological hazards, as well as various factors that influence a community's exposure and vulnerability. These disasters themselves are not inherently natural; instead, they are shaped by human values, attitudes, behaviours, and choices, particularly when individuals with power and resources force others into vulnerable positions. While numerous events labelled as "natural disasters", such as tornadoes, droughts, or hurricanes, do originate from natural causes, human influences can exacerbate their frequency or severity. Nevertheless, it is essential to emphasise that when these events occur in areas devoid of human habitation, they do not qualify as disasters but rather as hazards. Likewise, a hurricane slams into a land where no one lives; it remains a climatic occurrence or a weather event, not a disaster.

However, this can appear different when discussing the dissemination of information to the public for flood preparedness. While there is a consensus on the importance of using the correct term ("natural hazards" instead of "natural disaster") to describe a flood event, some researchers believe that this terminology is not as crucial as the public's understanding and perception. If "natural disaster" is an easier term that can explain a phenomenon to the broader public, especially those without a scientific background, and if "natural hazard" is perceived as something different, then using the more familiar term might be preferable to introducing a new one and risking the loss of the entire objective of communication. The primary goal is to communicate risk, ensure it is easy to understand, and keep people safe, which takes precedence over maintaining different terms for the sake of scientific precision.

In summary, the term "natural disaster" is increasingly viewed as inappropriate because it disregards the impact of human activities on disasters such as floods. By recognising the human dimensions of disasters, we can develop more effective solutions to reduce their impact and enhance resilience. However, when it comes to disseminating information to the public for flood preparedness, some argue that using the more familiar term "natural disaster" may be more effective in communicating the risks and ensuring public safety, even if it does not align with the scientific understanding of the term. Ultimately, the goal is to ensure precise and understandable communication to keep people safe, outweighing the need for scientific precision in terminology.

In addition, some propose that a gradual transition or educational efforts should be made to make communities more familiar with the correct terminology surrounding disasters. During this transition period, it may still be necessary to use the language that people are accustomed to, such as "natural disaster," to effectively communicate the urgency and risks associated with events like floods. Balancing the need for clear communication with public safety concerns can help shift towards more

accurate terminology, ultimately creating a better understanding and response to these events in the long term.

### 2.3 Understanding floods through history

Floods have been a persistent natural hazard throughout human history, profoundly shaping societies and landscapes. In ancient times, these events were often perceived through a lens of divine intervention or supernatural causation, as seen in flood myths from many cultures, such as the Great Flood narratives of Mesopotamian, Hindu, and Chinese traditions. While mythological accounts attributed floods to moral failings or divine anger, the underlying causes were hydrological phenomena, such as excessive rainfall, snowmelt, or river overflows caused by natural climatic variations (Smith & Ward, 1998).

#### 2.3.1 Historical Examples of Flood Impacts on Civilisations

The impact of floods on ancient civilisations is evident in archaeological and historical records. The ancient city of Mohenjo-Daro, located in the Indus Valley, was once a flourishing urban centre that faced repeated flooding from the Indus River around 1800 BCE. Archaeological evidence suggests that these floods damaged critical infrastructure and agricultural systems, contributing to the city's eventual decline (Kennedy, 2008). Similarly, the Mesopotamian Epic of Gilgamesh, written around 2100 BCE, recounts a great flood with parallels to the Biblical story of Noah, reflecting both the historical reality of floods in the Tigris-Euphrates Basin and the cultural significance of these events (Leick, 2002).

In China, the legendary floods of the Yellow River, particularly during the reign of Emperor Yao (circa 2300 BCE), are among the earliest recorded examples of organised flood management. Ancient texts describe the engineer Yu the Great's efforts to control floods through innovative canal and irrigation systems, marking a milestone in hydraulic engineering (Needham, 1974).

Floods also played a role in shaping the ancient Nile River civilisation. While seasonal flooding was essential for replenishing agricultural lands, excessively high inundations could destroy crops and settlements. The ancient Egyptians developed a sophisticated understanding of flood patterns, using nilometers to measure river levels and predict annual floods, which were critical for agricultural planning (Butzer, 1976).

In medieval Europe, floods continued to shape societies. The St. Lucia's Flood of 1287, which devastated parts of the Netherlands and Germany, is one of the most catastrophic floods recorded in European history, claiming tens of thousands of lives and reshaping the coastal landscape. This event highlighted the vulnerabilities of low-lying regions to storm surges and led to early attempts at constructing dikes and other flood defences (van de Ven, 2004).

#### 2.3.2 Early Systematic Observations of Floods

Documentation of floods began to improve with the rise of written records. In Paris, the flood of 1099 was chronicled by Orderic Vitalis, who described the destruction of crops, buildings, and lives along the Seine River. These accounts represent some of the first systematic observations of flood events in Europe, paving the way for a more scientific understanding of hydrological phenomena (Hingst, 2005; Vitalis, 1969).

During the Renaissance, developments in natural philosophy and hydrology expanded humanity's capacity to analyse water flow and its impacts. The 17th and 18th centuries saw significant advances in the field of hydraulics, including the work of Pierre Varignon and Leonhard Euler, whose studies of fluid dynamics laid the foundation for modern flood analysis (Rouse, 1983).

### ***2.3.3 The Role of Floods in Urban Evolution***

Floods have not only caused destruction but also shaped urban planning and development. Many ancient cities were located along rivers to access water resources, fertile soils, and trade routes. However, this proximity made them vulnerable to flooding. Historical adaptations to flood risks included raised platforms, embankments, and channel modifications. For example, the ancient city of Venice, built on a lagoon, utilised early flood management techniques, including a network of canals and tidal barriers, to mitigate rising water levels.

In medieval Japan, cities like Kyoto faced frequent flooding from rivers due to seasonal typhoons. The construction of flood-diverting canals and levees during the Heian period (794–1185 CE) reflected growing recognition of engineering solutions to mitigate flood impacts (Takeuchi, 2001).

### ***2.3.4 Flood as Catalysts for Social and Technological Progress***

Floods have often catalysed innovation and cooperation. For example, in the Netherlands, centuries of struggle against flooding from the North Sea led to the development of advanced water management systems, including dikes, polders, and drainage mills. The Delta Works Project, initiated in response to the devastating North Sea Flood of 1953, is one of the most ambitious flood defence systems in the world, illustrating the ongoing evolution of flood management strategies (van de Ven, 2004).

Floods have also prompted changes in governance and social organisation. In ancient China, the need to manage frequent floods of the Yellow River led to centralised control over water resources, which played a crucial role in the emergence of the Chinese state (Needham, 1974). Similarly, in medieval England, the creation of floodplain maps and water rights laws reflected growing state involvement in managing flood risks (Cosgrove & Petts, 1990).

### ***2.3.5 Learning from History and Preparing for the Future***

Despite advancements in science and technology, floods remain unpredictable and multifaceted phenomena. Climate change, urbanisation, and deforestation are exacerbating flood risks in many parts of the world, as seen in increased rainfall intensity, rising sea levels, and extreme weather events (IPCC, 2022).

The history of floods provides critical insights into resilience and preparedness. Studies emphasise that while floods cannot be completely eliminated, their impacts can be mitigated through proactive planning and governance (Smith et al., 2020; Kundzewicz et al., 2019). Four key lessons emerge from historical flood events:

1. The inevitability of floods:

Floods are recurring natural hazards that cannot be entirely prevented, but the damage can be reduced through risk-based land-use planning and resilient infrastructure (Merz et al., 2015; Di Baldassarre et al., 2020).

### 2. Importance of early warning systems:

Historical events such as the 2022 Auckland floods demonstrate that communities with robust early warning systems experience lower mortality and property losses (UNDRR, 2023; Jongman et al., 2018).

### 3. Community participation:

Resilience is enhanced when local communities actively participate in preparedness and recovery (Cutter et al., 2016; Aitsi-Selmi & Murray, 2015).

### 4. Governance and adaptive learning:

Governments must continually adapt their policies, drawing lessons from past failures, such as the insufficient coordination during the 2023 Cyclone Gabrielle response in New Zealand (NEMA, 2023; Schipper et al., 2020).

Modern examples like the Delta Works Project in the Netherlands illustrate how societies can proactively mitigate risks through innovative design and long-term planning. These systems combine engineering expertise with environmental considerations, creating more sustainable approaches to flood management (van de Ven, 2004).

Floods, though devastating, also serve as reminders of the interdependence between natural systems and human societies. Understanding their causes, impacts, and management requires continuous research, collaboration, and innovation. The goal is not to eradicate floods but to equip communities with the knowledge and tools to adapt and thrive in an era of increasing environmental uncertainty.

## 2.4 Understanding Types and Causes of Floods

Flooding is a complex phenomenon that presents diverse risks to individuals, property, and ecosystems due to its varying characteristics, including depth, velocity, duration, rate of onset, and associated hazards. The impacts of flooding are expected to intensify with climate change, which is likely to alter the frequency, patterns, and severity of flood events, making them increasingly unpredictable and amplifying risks to human and environmental welfare (IPCC, 2021). Floods can be broadly categorised into coastal flooding and inland flooding, both driven by distinct mechanisms but often interacting with anthropogenic factors such as urbanisation, land-use changes, and infrastructural failures.

### 2.4.1 Coastal Flooding

Coastal flooding occurs when seawater intrudes onto land, primarily caused by elevated sea levels during storm surges, tidal events, or a combination of the two. The key factors contributing to coastal flooding include:

1. **High Tide Levels:** When combined with other contributing factors, high tides can significantly raise water levels, exacerbating flood risk.

2. **Storm Surges:** Generated by low atmospheric pressure and strong winds, storm surges are often associated with cyclones or hurricanes and can lead to catastrophic flooding along coastlines.
3. **Wave Action:** Wind-driven waves can cause additional flooding and coastal erosion, with severity influenced by wind speed, direction, and the topography of the coast (Hughes & Masselink, 2003).

Coastal flooding is closely linked to coastal erosion, wherein the removal or degradation of natural defences such as sand dunes or mangroves increases vulnerability. Planning for coastal areas should integrate erosion considerations to reduce risk (Temmerman et al., 2013). Response strategies to coastal flooding include building protective infrastructure, such as seawalls, flood barriers, and storm-surge barriers. Additionally, establishing evacuation plans and early warning systems for low-lying coastal communities is critical for minimising loss of life and property damage (Nicholls & Cazenave, 2010).

### 2.4.2 Inland Flooding

Inland flooding, resulting from prolonged or intense rainfall, encompasses several forms:

1. **Overland Flow:** When rainfall exceeds the ground's absorptive capacity, excess water flows across land surfaces, accumulating in low-lying areas. This form of flooding often occurs rapidly in response to heavy rainfall, leading to localised flooding in urban or agricultural areas (Clent, 2021).
2. **River Flooding:** Also known as fluvial flooding, this occurs when a river's flow exceeds its channel capacity, spilling over onto the floodplain. Factors such as heavy precipitation, snowmelt, or blockages (e.g., ice jams or debris) exacerbate river flooding. Mitigation measures include the construction of levees, embankments, and floodgates, as well as implementing land-use planning to regulate floodplain development (Pinter et al., 2008).
3. **Urban Flooding:** Common in cities, this form of flooding arises when stormwater drainage systems are overwhelmed, often due to high rainfall intensity or blockages. Urban flooding is intensified by impervious surfaces such as roads and rooftops, which increase runoff. Effective stormwater management, including the use of green infrastructure like permeable pavements and rain gardens, is essential to mitigate urban flooding (Dawson et al., 2005; Jha, 2012).
4. **Groundwater Flooding:** Prolonged rainfall can cause the water table to rise, resulting in groundwater flooding. It typically occurs gradually and can persist for weeks or months, posing risks to infrastructure and agriculture. Pumping water from affected areas and designing structures to withstand prolonged water exposure are standard preventive measures (Macdonald et al., 2012).
5. **Estuarial Flooding:** This occurs where riverine and tidal flows converge. High river discharge coinciding with high tide levels can cause water to back up, leading to flooding along estuaries. Managing estuarial flooding often requires coordinated river and coastal management strategies.

### **2.4.3 Anthropogenic and Compound Flooding**

Human activities also contribute to flooding. Dam failures, urbanisation, deforestation, and poor infrastructure maintenance can exacerbate or trigger floods. For example, urban development reduces the soil's absorptive capacity by increasing impervious surfaces, thereby intensifying surface runoff. (Bates, 2009). Similarly, deforestation and land-use changes disrupt natural water retention, amplifying flood risks downstream (Bradshaw et al., 2007). Compound flooding, where multiple factors such as coastal surges and heavy rainfall combine, represents an emerging risk under climate change scenarios. Understanding these interconnected processes is critical for developing integrated flood management strategies (Zscheischler et al., 2020).

Moreover, an increase in flood risk due to new development can stem from alterations upstream or downstream. Upstream development may restrict the capacity and conveyance function of the watercourse and floodplain system. Downstream development may reduce the volume available for flood storage on the floodplain, alter flow pathways, or change the channel, increasing flow downstream. Changes in land management and the introduction of impermeable surfaces, such as roads, roofs, and parking lots, can also increase runoff, contributing to an elevated flood risk.

## **2.5 Understanding Flood Risk Factors**

Floods arise from a combination of natural and human-induced factors, primarily resulting from disruptions in the water cycle's equilibrium. This cycle, driven by solar energy, involves the continuous movement of water between the Earth's surface, atmosphere, and oceans. Any imbalance, such as intense rainfall or rapid snowmelt, can lead to water accumulation, which in turn can result in floods. Elements such as climate and weather patterns, geological and topographical features, and human activities can amplify flood risks.

### **2.5.1 Climate and Weather Events**

Severe flooding often results from atmospheric conditions, leading to heavy precipitation or rapid snowmelt. Prolonged rainfall can saturate the soil, reducing its ability to absorb additional water and leading to surface runoff that can cause flash floods. Likewise, intense rainfall may overwhelm infiltration rates, leading to increased runoff into river systems and a higher flood risk.

#### **A. Climate Change's Impact on Flooding**

The interplay between water and climate change is well-documented, as rising global temperatures disrupt precipitation patterns and the water cycle. Warmer climates increase atmospheric moisture through enhanced evaporation, leading to more intense downpours and an elevated risk of flash and urban floods (IPCC, 2021). Additionally, changes in precipitation distribution and timing affect river flows, potentially exacerbating droughts and floods in different regions.

For example, Northland, New Zealand, experiences frequent floods during winter and droughts in summer due to shifting climatic patterns. Similarly, rising sea levels associated with global warming heighten the risks of coastal flooding, particularly during storm surges. Events like Hurricane Katrina (2005) and Cyclone Gabrielle (2023) demonstrate the catastrophic potential of intensified storms in coastal and hilly terrains (Kates et al., 2006). While climate change is a critical driver of increased flood risks, it interacts with other factors, such as urbanisation, land-use changes, and inadequate infrastructure. Effective management strategies must combine climate adaptation (e.g.,

infrastructure improvements and land-use planning) with mitigation measures addressing the root causes of climate change (Kelman et al., 2015).

### B. Climate Change and Its Uncertainty

The IPCC's Fourth Assessment Report confirms unequivocal global warming, with growing consensus on its influence on flood risk (IPCC, 2007). However, uncertainties remain due to varying global emission scenarios, policy responses, and climate models. These uncertainties complicate flood-risk predictions, particularly in regions with diverse topographies or undefined floodplains.

Uncertainty in climate science underscores the importance of flexible decision-making and proactive measures. For example, early warning systems and adaptive infrastructure planning can help mitigate the impacts of floods. Simultaneously, strategies like wetland restoration and forest regeneration contribute to carbon sequestration and reduce long-term risks (Mitsch & Gosselink, 2015).

### 2.5.2 Influence of Topography and Geology on Flood Dynamics

The shape and elevation of land significantly influence water flow and the likelihood of flooding in each area. Floods occur when excess water cannot be absorbed or drained away quickly enough, as discussed previously in this section. This principle highlights that floods can occur in areas of varying elevation, from low-lying floodplains to mountainous terrain.



Figure 7 Flood in the hilly village (Hawke's Bay New Zealand, 2023)

While areas at higher elevations may seem less prone to flooding, steep mountainous regions can be particularly vulnerable. In such landscapes, rainfall rapidly runs off into rivers, potentially causing flash floods. For instance, the devastating floods during Cyclone Gabrielle in 2023 disproportionately affected the hilly and mountainous terrains of New Zealand's Hawke's Bay region. This region is characterised by varied topography, including coastal hills, floodplains like the Wairoa River in the north, the fertile Heretaunga Plains in the south, and the rugged Kaweka and Ruahine Ranges inland (Figure 7). The cyclone traversed multiple areas, but Hawke's Bay suffered the most significant damage, demonstrating how topography influences flood impact (Harrington et al., 2023).

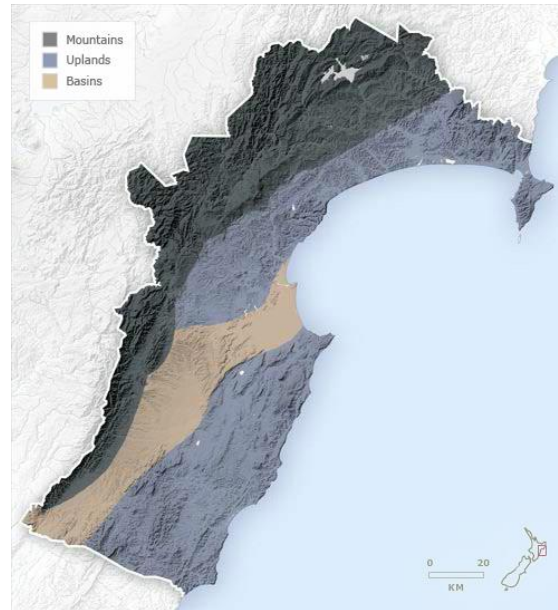


Figure 8 Hawke's Bay Land Formation (Pollock, 2015)

In mountainous areas, heavy rainfall can lead to rapid water accumulation, causing downstream flooding. The steep terrain accelerates water flow, amplifying its force and increasing the risk of flash floods, landslides, and debris flows. Valleys and canyons further exacerbate these effects by channelling water flow into concentrated areas. Moreover, the underlying geology plays a crucial role in flood dynamics (Figure 8). Permeable rock structures allow water infiltration, whereas impermeable rocks lead to increased surface runoff. For example, valleys with impermeable rock formations are more susceptible to flooding due to limited water seepage (Gurtz et al., 2003).

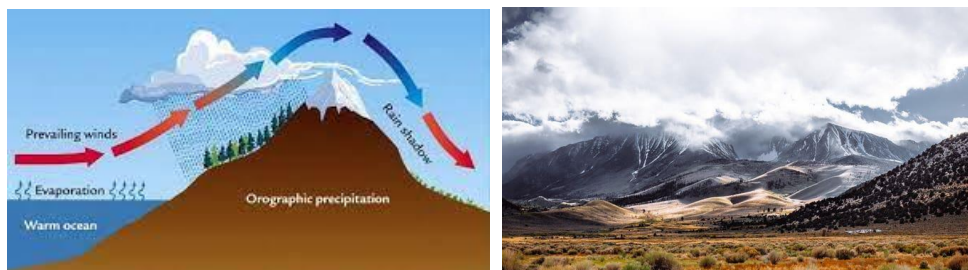


Figure 9 Orographic Effect and Rain Shadow Precipitation. Adapted from (Gochis et al., 2015)

Another critical factor in mountainous regions is the orographic effect (Figure 9), which occurs when moist air ascends a mountain range, cools, and condenses, resulting in heavy precipitation. This effect often contributes to severe flood events. For instance, the 2013 Colorado floods resulted from prolonged heavy rainfall amplified by the Rocky Mountains' orographic influence, leading to catastrophic flooding (Gochis et al., 2015). Similarly, the 2005 Mumbai floods were exacerbated by the Western Ghats' mountainous terrain, which intensified rainfall through orographic lifting (Gupta, 2020).



Figure 10 Low-Lying Areas Flooded (Hurricane Katrina, New Orleans, 2005)

Low-lying areas, including floodplains and coastal regions, are inherently vulnerable to flooding due to their proximity to water bodies and lower elevation. Storm surges, driven by strong winds, can push seawater inland, causing significant coastal flooding (Figure 10). For example, during Hurricane Katrina in 2005, New Orleans' low-lying geography and levee failures contributed to widespread devastation (Kates et al., 2006).

Urban development in low-lying regions can exacerbate flooding by increasing impervious surfaces, such as pavements and buildings, which reduce natural water infiltration. Furthermore, human activities such as deforestation and urbanisation contribute to heightened flood risks by accelerating runoff and diminishing the land's capacity to slow water flow (Smith & Ward, 1998).

It is important to note that floods in low-lying areas are not solely caused by heavy rainfall. Other factors such as storm surges, tidal flooding, and riverine overflows also play significant roles. Proactive land management and sustainable urban planning are essential for mitigating these risks and enhancing community resilience.

### 2.5.3 Human Interference

Human activities can significantly alter the natural hydrological cycle, contributing to increased flood risk. Deforestation, urbanisation, and floodplain overdevelopment are significant factors that disrupt natural water flow and increase surface runoff while reducing water infiltration. These changes not only exacerbate the risk of flooding but also influence the surrounding ecosystems.

#### A. Deforestation and Flood Risk

Deforestation, or the large-scale clearing of trees, disrupts the natural interception of rainfall by vegetation. Trees and plants play a critical role in absorbing water through their roots and reducing surface runoff. Their root systems stabilise the soil and act as a natural sponge, storing excess water and mitigating flood risk. When forests are cleared, this natural capacity for flood mitigation is lost. Deforestation leads to soil erosion, reduced water absorption, and increased surface runoff, which can exacerbate flooding.

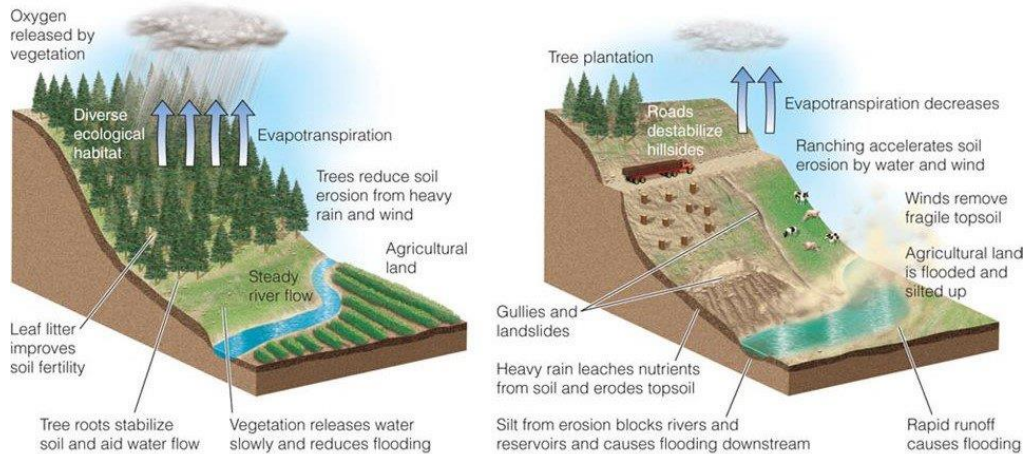


Figure 11 Low-lying areas flooded (Hurricane Katrina, New Orleans, 2005)

For instance, Figure 11 shows widespread deforestation linked to increased flooding and landslides, causing significant loss of life and property damage. The removal of tree cover in mountainous areas has left the soil vulnerable to erosion, reducing its ability to retain water and leading to severe flooding during heavy rainfall events.

### B. Urbanisation and Increased Flooding

Urbanisation transforms natural landscapes into built environments, replacing permeable surfaces with impermeable ones such as roads, pavements, and buildings. This reduces the land’s natural capacity to absorb water and increases surface runoff (Figure 12). Additionally, urban drainage systems often struggle to cope with the sudden surge in runoff during heavy rainfall, resulting in localised flooding.

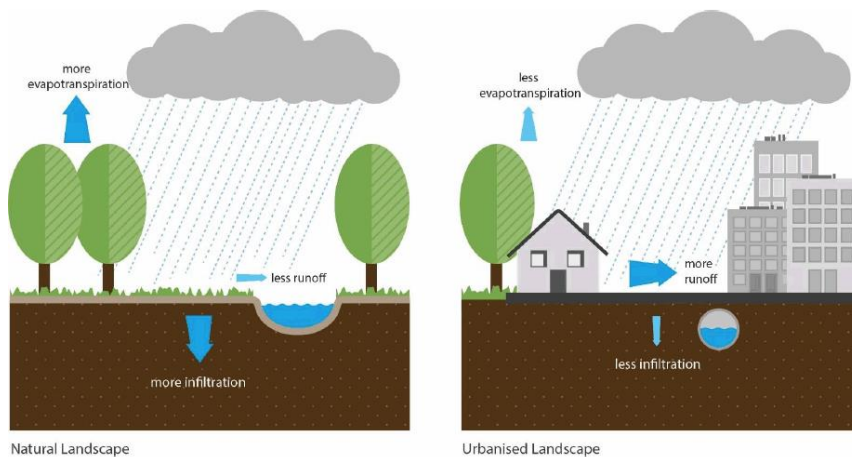


Figure 12 Urban flood diagram, before urbanisation (left) and after (right) (NRC, 2024)

Mumbai, India, exemplifies the challenges of urbanisation and flooding. Rapid urban expansion and inadequate drainage infrastructure have led to recurrent flooding during monsoon seasons, particularly in low-lying areas (Patankar & Patwardhan, 2016).

### C. Overdevelopment of Floodplains

Floodplains naturally store and channel floodwaters, mitigating the impact of flooding. However, overdevelopment of these areas for housing or infrastructure often ignores the risks associated with flooding. Development can constrict the natural flow of water, increasing flood levels in adjacent areas. In Houston, Texas, the 2017 flooding caused by Hurricane Harvey was exacerbated by extensive development in flood-prone areas, leading to increased surface runoff and reduced water infiltration (Brody et al., 2014)

### D. Positive Impacts of Human Activities

While human activities often exacerbate flooding, certain actions can mitigate flood risks and even benefit ecosystems. For instance, wetland restoration enhances the natural capacity of ecosystems to manage floodwaters. Wetlands act as natural sponges, absorbing and slowly releasing water, thereby reducing downstream flooding. The restoration of wetlands in the Florida Everglades has not only lowered flood risk but also improved water quality and created habitats for wildlife (Mitsch & Gosselink, 2015).

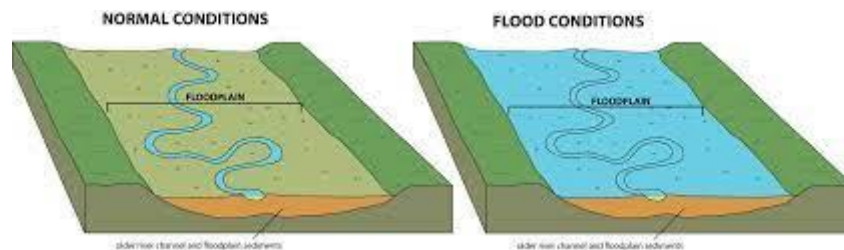


Figure 13 Wetlands during normal and flood (Mitsch & Gosselink, 2015).

While human activities can contribute to the risk of flooding, they can also have positive impacts on the environment and ecosystem. For example, wetland restoration can increase the capacity of natural systems to absorb floodwaters. Wetlands act as natural sponges, storing and slowly releasing water, reducing the risk of downstream flooding. The restoration of wetlands in the Florida Everglades (Figure 13) has reduced the risk of flooding while also providing habitat for wildlife and improving water quality.

Floods can also provide ecological benefits. For example, the annual flooding of the Nile River historically enriched the surrounding land with nutrients, enabling agriculture in an otherwise arid region. Periodic flooding prevents sediment buildup in rivers, promoting healthy aquatic ecosystems. Additionally, certain fish species, such as salmon, rely on natural flooding events to create favourable conditions for spawning and migration (Montgomery et al., 1999).

## 2.6 Understanding Flood Impacts

Flooding is a complex natural hazard with wide-ranging impacts on communities, infrastructure, and ecosystems. These impacts are often categorised into direct and indirect effects, both of which can have long-term consequences for social and economic systems. Direct impacts include physical damage to properties, infrastructure, and agricultural land, as well as the immediate threat to human lives. Indirect impacts often involve the long-term economic burden on affected communities, environmental degradation, and disruptions to local economies (Penning-Rowsell & Becker, 2019).

Flooding results in a multitude of consequences for human communities. These include property damage, economic losses, public health risks, and the displacement of populations (UN, 2015). Economic impacts can be particularly severe in flood-prone regions, where both short-term costs (such as emergency response and recovery) and long-term costs (such as reduced property values, lost productivity, and infrastructure repair) are common. For instance, the 2010 Pakistan floods resulted in an estimated economic loss of \$43 billion (Arshad & Shafi, 2010).

Additionally, the environmental consequences of flooding are significant, with floods often leading to the destruction of ecosystems, contamination of water resources, and the degradation of soil quality (Kundzewicz et al., 2014). Floodwaters can wash away valuable agricultural land, disrupt biodiversity, and introduce harmful chemicals into the environment, further exacerbating long-term challenges for affected regions. In many cases, these ecological impacts linger long after the floodwaters recede, posing challenges for recovery and resilience.

The social impacts of flooding are equally critical. Floods disrupt communities, leading to temporary or permanent displacement, with vulnerable groups such as low-income families, the elderly, and those with limited mobility being disproportionately affected (Allen, 2006; Ntontis et al., 2019). The aftermath of a flood event can leave communities fractured as individuals and families face the loss of homes, possessions, and livelihoods. Moreover, floods can also lead to significant psychological impacts, such as trauma, anxiety, and post-traumatic stress disorder (PTSD), which persist long after the physical damage has been addressed (Ahern et al., 2005). Social recovery is, therefore, a critical aspect of long-term resilience, necessitating a focus not only on physical rebuilding but also on community mental health and well-being.

In addition to these immediate consequences, floods can have cascading effects on broader sectors, such as transportation, communication, and healthcare systems. These indirect impacts are often underappreciated, but they can significantly hamper recovery efforts, particularly in rural or isolated areas (Henderson et al., 2020). Disruptions to critical services can prolong the suffering of affected populations, slowing recovery and impeding future resilience-building efforts.

Flood impacts are often influenced by a range of factors, including the severity and frequency of flood events, the socio-economic conditions of affected regions, and the pre-existing vulnerability of communities (Sayers et al., 2013). For example, regions with high population densities, poorly maintained infrastructure, or inadequate flood management systems are typically more vulnerable to the destructive effects of flooding. As climate change exacerbates the frequency and intensity of extreme weather events, it is expected that the impacts of flooding will increase, further straining disaster response systems and heightening the need for sustainable flood risk management (IPCC, 2014).

In conclusion, flooding is a multi-dimensional hazard with far-reaching implications for communities, economies, and ecosystems. Understanding the diverse and interconnected impacts of flooding is essential for developing effective flood risk management strategies, fostering resilience, and improving recovery efforts.

## 2.7 Managing the Impacts of Flooding

Comprehending flood risk is a crucial step in mitigating the impacts of flooding. Flood risk encompasses both the likelihood of a flood occurring and the potential consequences of the event. Over time, the understanding and management of flood risk have evolved significantly, transitioning from traditional reactive approaches to more integrated and proactive methods.

Traditional flood management primarily relied on reactive measures, such as structural solutions to separate rivers from their floodplains, to minimize exposure and vulnerability to flood-related damages. However, these ad hoc interventions often addressed the symptoms rather than the root causes of flood risk and proved insufficient in mitigating long-term impacts (Sayers et al., 2013). In contrast, contemporary flood risk management integrates strategies for risk avoidance and reduction, emphasising a multidisciplinary approach to enhance resilience and sustainability (Hegger et al., 2016).

The Integrated Flood Management (IFM) approach, developed under the European Directive of 2007, endorses flood management within the broader context of water resource management. IFM promotes a coordinated strategy to optimize social and economic benefits while safeguarding ecosystem sustainability. This holistic approach views river basins as interconnected systems where changes to land and water resources affect each other, necessitating a comprehensive strategy that addresses both horizontal and vertical dimensions of flood management (Kundzewicz et al., 2014).

### 2.7.1 Managing Land Use

Land use plays a significant role in flood risk. Floodplain management offers opportunities to reduce risks in new development areas, while addressing flood risks in existing developed areas poses greater challenges. Strategic land-use planning, supported by floodplain management plans, can mitigate flood impacts by influencing development patterns and infrastructure design.

#### A. In New Development Areas

Floodplain management plans provide strategic guidance for development in new areas, ensuring that risks are minimized from the outset. Zoning regulations play a key role in directing development away from primary flood flow paths, preserving these corridors as green spaces, and reducing risks to people and property (Hegger et al., 2016).

Development conditions, such as minimum land-fill levels and building floor heights, can further reduce exposure to flooding. For instance, critical infrastructure like hospitals should be in flood-free zones to remain operational during flood events. Properly enforced building codes and design standards also contribute to reducing structural vulnerability to floods (Jha, 2012).

#### B. In Existing Development Areas

Managing flood risks in established communities is more complex due to pre-existing infrastructure and rights to develop. Here, three primary approaches are typically employed: altering flood behaviour (e.g., levees or diversions), protecting properties (e.g., flood barriers), and enhancing community response systems (e.g., early warning systems). A combination of these methods often yields the best results in reducing risks to acceptable levels (Lamond, 2012).

### **C. Comprehensive Flood Management**

To mitigate the negative effects of human activities on flood risk while harnessing their potential benefits, a balanced approach is essential. Strategies include implementing green infrastructure, avoiding construction in flood-prone areas, and enhancing stormwater management systems. For example, incorporating permeable pavements and rain gardens into urban landscapes can reduce surface runoff and enhance water infiltration. Therefore, policymakers should consider the dual impacts of human activities on both flooding and ecosystems, adopting holistic flood management strategies that integrate natural and engineered solutions.

#### **2.7.2 Managing Water Resources**

Water Resource Management (WRM) encompasses the planning, development, and sustainable utilisation of water resources, balancing economic and social benefits with environmental sustainability. As outlined by the Global Water Partnership, WRM addresses issues such as flood and drought prevention, water quality management, and efficient resource allocation (Agarwal et al., 2000).

There are two primary approaches to WRM:

1. **Top-Down Approach:** Centralised institutions develop comprehensive water management plans, often effective in addressing large-scale issues but sometimes facing resistance due to a lack of stakeholder engagement.
2. **Bottom-Up Approach:** Local stakeholders, including communities and non-governmental organisations, collaborate to develop adaptive and inclusive management strategies (Pahl-Wostl, 2007).

The modern shift toward Integrated Water Resources Management (IWRM) emphasises a demand-oriented, multi-sector approach to balance diverse and sometimes competing water needs (UN-Water, 2018).

#### **2.7.3 Managing Flood Risk**

Flood risk arises from a combination of the probability of a flood occurring and the consequences it has on individuals, assets, and infrastructure. The extent of these consequences depends on the community's exposure to flooding and the vulnerability of its residents, assets, and infrastructure to the flood's impacts.

Effective flood risk management involves reducing either the likelihood of a flood or the community's exposure and susceptibility to its impacts (Figure 14). However, strategies must be tailored to specific local contexts, as no single solution applies universally. Typically, a combination of structural (e.g., levees, dams) and non-structural (e.g., land-use planning, community education) measures is needed to mitigate risks effectively (Lechowska, 2018; Pahl-Wostl, 2007).

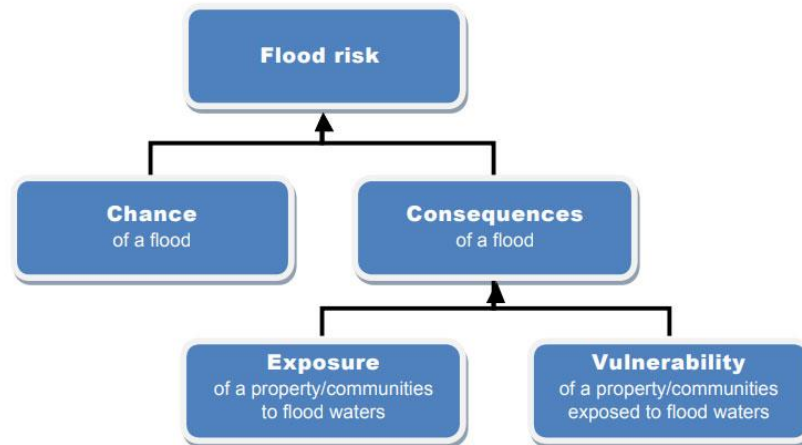


Figure 14 Flood risk relation to vulnerability and exposure. Author's own work (2024).

Flood likelihood is often expressed as the probability of a flood of a given magnitude occurring within a year. For example, a flood with a 1% annual exceedance probability (AEP) is one expected to be surpassed, on average, once every 100 years. Flood impacts vary based on factors such as water depth, velocity, onset time, duration, wave effects, and water quality. Community vulnerability further depends on the age and health of the population, infrastructure resilience, and the presence of mitigation measures (Aldrich & Meyer, 2015; Lamond, 2012).

Flood risk management is inherently collaborative, requiring engagement between government agencies and affected communities. Decisions about flood mitigation strategies should incorporate community perspectives to ensure that they effectively address local needs.

#### 2.7.4 Lessons Learned from Flood Events Over Time

Disasters have provided valuable lessons in enhancing resilience and preparedness for future occurrences. A prime example of this is Hurricane Katrina, which caused catastrophic flooding in New Orleans and other Gulf Coast areas in 2005. The flooding resulted from a combination of storm surge, levee breaches, and heavy rainfall. The event highlighted the importance of having adequate infrastructure and effective emergency management practices in mitigating the impacts of flooding. This disaster also prompted substantial improvements in flood forecasting and warning systems in the United States, along with increased awareness of the risks associated with hurricanes and extreme weather events.

In New Zealand, various flood events have contributed to a collective understanding of flood management and resilience. For instance:

- i. The 1938 floods in the Hawke's Bay region led to the development of flood control infrastructure, like stop banks and floodgates, and the establishment of a regional flood control authority.
- ii. The 1978 floods in the Bay of Plenty region emphasised the need for better coordination and communication between local and central government agencies in managing flood risks.
- iii. The 2004 floods in the Manawatu region spurred the development of new flood warning systems and measures to enhance the resilience of critical infrastructure, such as water treatment plants.

- iv. The 2011 Canterbury earthquake and subsequent flooding underscored the importance of considering multiple hazards, such as earthquakes and floods, in disaster planning and response.
- v. The 2021 floods in the South Island, caused by heavy rainfall, highlighted the necessity for improved land use planning, management practices, community resilience, and preparedness.

These flood events have contributed to the evolution of enhanced flood management practices and strategies in New Zealand, encompassing improved infrastructure, enhanced communication and coordination between agencies, and heightened community awareness and preparedness. These past flood events have also influenced the governance framework in New Zealand.

In the global context, flood governance has also evolved in response to significant events:

- i. The National Flood Insurance Act of 1968 (US) was enacted following major flood events, leading to the establishment of the National Flood Insurance Program, which provides insurance to property owners in flood-prone areas and promotes sound floodplain management.
- ii. The Flood and Water Management Act 2010 (UK) was a response to severe flooding in 2007, requiring local authorities to develop and implement flood risk management strategies and providing new powers for managing flood risk.
- iii. The Water Act 2014 (UK) addressed water scarcity and flooding concerns by introducing measures for managing flood risk, including the Flood Reinsurance Scheme for affordable flood insurance in high-risk areas.
- iv. The Flood Disaster Protection Act of 1973 (US) was enacted to address the lack of flood insurance coverage in flood-prone areas, mandating federally regulated lenders to require flood insurance for properties in designated flood hazard areas.

Moreover, flood governance has evolved globally in response to specific events in Asia, Europe, and the Pacific, such as the 2011 Thailand floods, the 2002 European floods, the 2021 New South Wales floods, and the 2018 Japan floods. These events have led to the establishment of new agencies, initiatives to enhance flood control infrastructure, and the development of early warning systems.

In New Zealand, the Resource Management Act 1991 (RMA) serves as the primary legislation for managing natural resources, including flood management. The act empowers regional councils to address natural hazards, including floods, by developing regional policy statements and plans. Additionally, the government's response to the 2004 and 2010/2011 Canterbury earthquakes resulted in the introduction of the Canterbury Earthquake Recovery Act 2011. This act established the Canterbury Earthquake Recovery Authority (CERA), responsible for leading recovery efforts. CERA worked on improving flood resilience and implementing measures to mitigate future flood risks.

### **2.7.5 Action Plan: From Flood Control to Flood Resilience**

Flood risk management requires a shift from traditional flood control strategies toward building flood resilience. This involves integrating planning, floodplain management, sustainable drainage systems (SuDS), and river and catchment management into a cohesive framework. Practical action plans must recognise the interconnectedness of these approaches and emphasise sustainability and collaboration to achieve effective results.

### A. Planning for Flood Risk Management

Proactive planning is essential to ensure future development minimises flood risks and avoids exacerbating vulnerabilities. Planning processes work in tandem with flood risk management, being mutually dependent, and aim to guide sustainable development in both urban and rural settings. This principle aligns with global best practices, such as the concept of "adaptive pathways" in climate-resilient urban development (Haasnoot et al., 2024).

### B. Floodplain Management

Floodplains and wetlands play a crucial role in mitigating flood risks by acting as natural buffers that retain excess water and facilitate its controlled release. These areas store floodwaters and reduce peak flows, benefiting both upstream and downstream regions. The philosophy of "leaving space for water" is widely recognised in international flood risk management strategies (Hooijer et al., 2004), advocates preserving and restoring natural floodplains as a sustainable approach to managing flood hazards.

To enhance flood resilience, safeguarding floodplains from inappropriate development is critical. Local councils and environmental agencies are increasingly adopting guidelines for constructed wetlands, which mimic natural processes to attenuate flood hazards, improve water quality, and support biodiversity (Mitsch & Gosselink, 2015).

### C. Sustainable Drainage Systems (SuDS)

Urbanisation often replaces permeable surfaces with impermeable ones, increasing surface runoff and overwhelming drainage systems. SuDS offer an effective solution to this challenge by promoting natural water infiltration, storage, and controlled release. Techniques such as swales, infiltration basins, retention ponds, and permeable pavements not only manage runoff but also enhance water quality, reduce pollution, and provide ecological and recreational benefits (Cotterill & Bracken, 2020).

SuDS have become a key element of urban flood risk management in regions facing rapid urbanisation, aligning with global trends in sustainable urban planning. For example, SuDS implementation in the UK and Europe has demonstrated significant reductions in peak flood flows and improvements in urban water ecosystems (Ashley et al., 2005; Lamond, 2012).

### D. River and Catchment Management

Healthy river and catchment systems are fundamental to flood resilience. Effective river management mitigates soil erosion, reduces sedimentation, and enhances water quality, thereby minimising flood-related damage. Additionally, well-managed catchments support recreational activities and sustain aquatic ecosystems.

Collaboration between regional authorities, such as the Northland Regional Council, and landowners is essential for maintaining river systems and preventing flood damage. Integrated catchment management (ICM) approaches, which consider the entire catchment area and its hydrological processes, have proven effective in balancing flood risk reduction with environmental conservation (Northland Regional Council, 2022a; Pahl-Wostl, 2007).

## 2.8 Research gaps found in this literature review research

This literature review has critically examined the theories, frameworks, and practices surrounding floods as a natural hazard, flood risk management, and community resilience, with a particular focus on New Zealand and the Northland region. While a substantial body of research exists on the physical processes of flooding and the immediate response to major disasters, several apparent gaps remain that this study aims to address.

First, an imbalance exists between short-term, reactive approaches and long-term, proactive strategies for managing flood risk. Much of the existing literature emphasises emergency response and post-disaster recovery, particularly following catastrophic, large-scale events. However, there is comparatively little research into sustained, forward-looking measures such as risk reduction, preparedness, and resilience building at the community level. This imbalance has contributed to recurring vulnerabilities in regions like Northland, where frequent, smaller-scale flood events are often overlooked despite their cumulative socio-economic and environmental impacts.

Second, there is a lack of integration between top-down governance structures and community-based, bottom-up approaches. While international frameworks such as the Sendai Framework for Disaster Risk Reduction and New Zealand's National Disaster Resilience Strategy provide strong overarching principles, their translation into effective local action remains inconsistent. The literature suggests that local councils and communities often face fragmented decision-making processes, limited resources, and policy-practice gaps. Yet, few studies explore how local knowledge and indigenous practices can be systematically incorporated into formal flood governance to create culturally appropriate and context-specific strategies.

Third, limited attention has been given to recurring flood events and their unique challenges. The majority of flood research in New Zealand focuses on catastrophic floods that capture national headlines. However, recurring, smaller-scale floods—such as those frequently experienced in Northland—receive far less attention in academic studies and policy discussions. These events can cause long-term damage to infrastructure, disrupt local economies, and erode community resilience, but they remain underrepresented in both the literature and planning frameworks.

Fourth, while extensive research exists on the physical and environmental drivers of flooding, there is a lesser emphasis on the social and cultural dimensions of vulnerability and resilience. Key factors such as community cohesion, cultural values, and local decision-making processes are often discussed in isolation rather than being integrated into comprehensive flood management strategies. This creates a gap in understanding how social dynamics influence preparedness, response, and recovery.

Finally, there is a shortage of region-specific studies for Northland, despite its status as one of New Zealand's most flood-prone regions. Existing national and international studies provide valuable insights but may not fully capture the unique environmental, cultural, and governance context of Northland. This lack of localised research limits the ability to design tailored strategies that address the region's specific vulnerabilities and strengths.

## 2.9 Conclusion: Understanding Flood and managing their risks

In this chapter, a comprehensive review of flooding and flood risk management has been presented. The discussion examined the types and causes of floods, the factors contributing to flood risk, and the wide-ranging impacts of floods on infrastructure, the environment, the economy, and society. Additionally, various strategies for flood risk reduction and management were explored, including both structural and non-structural measures.

The review highlights that while floods are unavoidable natural phenomena, the resulting disasters are shaped by human choices and actions. Factors such as urbanisation, deforestation, and climate change can significantly increase the likelihood and severity of flooding. Proactive, sustainable planning — including green infrastructure, adaptive land use, and stormwater management — is essential for mitigating these risks.

Importantly, flood risk management must be a collaborative process involving government agencies, local communities, and other stakeholders. Effective decision-making requires transparency, community consultation, and an understanding of both the environmental and societal impacts of floods.

This understanding provides a critical foundation for advancing strategies that enhance community resilience and preparedness, ensuring that future development aligns with long-term flood risk management goals.

## 2.10 Synthesis and Connection to Research Aim and Objectives

The findings of this literature review directly inform the overall aim of this thesis, which is: To enhance the resilience of the Northland community to recurring flood events through sustainable, proactive, and community-driven flood risk management strategies. The review identified three critical gaps that shaped the research design and objectives:

1. Overemphasis on reactive measures such as emergency response and recovery, with insufficient focus on proactive preparedness and long-term risk reduction.
2. Limited integration of local and indigenous knowledge into flood risk governance and planning.
3. Poor accessibility of technical tools, such as flood hazard maps, to non-expert users, reducing their effectiveness for at-risk communities.

These gaps align with and support the research objectives, as shown below:

**Table 2 Key literature insights**

<b>Key Literature Insights</b>	<b>Corresponding Research Objectives</b>
<b>Reactive focus dominates current flood management.</b>	Evaluate the strengths and weaknesses of current flood risk management strategies in Northland.

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<b>Community voices and knowledge are often excluded.</b>	Identify and analyse factors influencing community resilience, including intergenerational knowledge and stakeholder collaboration.
<b>Flood maps and technical tools are inaccessible to many.</b>	Propose improvements to tools and strategies that empower communities in preparedness and planning.

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The literature also informed the theoretical and methodological perspective of this study. The recognition of multiple, interconnected drivers of flood risk necessitated a mixed-methods approach (Chapter 3), which combined qualitative and quantitative data to capture diverse institutional and community perspectives. Moreover, the emphasis on community-driven governance shaped the selection of case studies and the development of a conceptual framework for integrated resilience planning.

In summary, the literature review not only builds a comprehensive understanding of flood risk and management but also identifies clear pathways for research and action. These insights directly shaped the research design, data collection, and analysis strategies presented in Chapter 3, ensuring that this thesis addresses both theoretical and practical needs for enhancing flood resilience in Northland and beyond.

## Chapter 3

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Research Methods used in general

## Overview

This chapter presents a comprehensive overview of all research methods employed throughout the sections. As this research is research by publications, the structure of sections with published work will vary; however, the methods used will be almost identical.

### 3.1 The choice of mixed methods for this research

In flood research, the traditional view has often held that qualitative and quantitative methodologies are inherently incompatible due to their distinct underlying reasoning processes—inductive versus deductive (Creswell & Creswell, 2017). This perspective, first articulated by Smith (1983), has historically led to the belief that the integration of these methods is not feasible. However, in recent years, this viewpoint has been increasingly challenged, especially in research focused on community resilience in the face of natural hazards. In particular, mixed methods approaches have become widely recognised for their ability to provide a more comprehensive understanding of complex phenomena, such as flood risk and community preparedness (Bergman, 2008; Lewin et al., 2009).

This research adopts a mixed-methods framework to address the multifaceted nature of flood resilience, which requires both an in-depth exploration of community experiences and an objective measurement of flood risks and preparedness behaviours. The use of mixed methods allows for the strengths of both qualitative and quantitative approaches to be combined, offering a more nuanced understanding of how communities perceive and respond to flood risks. By using qualitative methods (such as interviews and case studies), we gain rich, contextual insights into local experiences and attitudes towards flood preparedness. In contrast, quantitative methods (such as surveys and statistical analyses) provide broader, generalizable data that can highlight patterns and trends across different communities.

The rationale for this dual approach lies in the belief that each method compensates for the limitations of the other. Qualitative data provides depth and context, which is essential for understanding the complexities of community behaviour and decision-making processes (Johnson & Onwuegbuzie, 2004). Quantitative data, on the other hand, offers statistical rigor that enables the testing of hypotheses and generalisation of findings to larger populations. The integration of these methods allows for triangulation—cross-verifying results from different sources to increase validity and reliability, a key advantage in research where both individual perceptions and broader trends are equally important (Tashakkori, 2010).

This chapter aims to justify the choice of mixed methods by demonstrating how they align with the research objectives and questions. It will present a comparative analysis of mixed-methods research in relation to traditional qualitative and quantitative approaches, outlining the advantages and challenges specific to flood resilience research. Practical examples from the field will illustrate how mixed methods were applied to develop more effective, community-based strategies for flood resilience.

The following sections will describe the research design, fieldwork procedures, participant selection, and ethical considerations, all of which were shaped by the adoption of a mixed-methods approach. Ethical approval was obtained from the Massey University Human Participants Ethics Committee, and the fieldwork was conducted in the Northland Region, where both qualitative and

quantitative data were gathered. The chapter will also explain the data analysis strategy and the methods used for data validation, further emphasising the rigorous and integrative nature of this research approach.

### 3.2 Research Requirement

Flood resilience in the built environment is an interdisciplinary research field which brings together a wide range of researchers from different backgrounds and different research traditions. For developing a suitable research strategy for this study, the main aims were first, to determine what are the best practices for overall flood risk management viewed from the emergency management cycle, and second is to find out the best framework for the community in Northland to be resilience towards the recurring flood events.

Each of the specified research questions was associated with another set of objectives, described in section 1.8 of the first chapter. The unique characteristic of the location prone to flood and the urban development in the northland needed to be analysed as well as the complexity of community engagement and stakeholder involvement in flood risk management in the Northland. The overall research design was carefully selected to fit with the aim of the study, and the following section will explain the research philosophy that governed and guided the research strategy used.

### 3.3 Research Paradigm

Early studies on disasters, such as Fritz and Marks (1954) Groundbreaking research highlighted the significant challenges of obtaining valid and trustworthy information in disaster situations. They noted that the extreme pressures and conditions of disaster environments could not be replicated in controlled laboratory settings, thus limiting the effectiveness of traditional experimental research methods. Recognising these limitations, Fritz and Marks applied rigorous scientific methodologies while also acknowledging the need to incorporate additional data to support their findings. This pragmatic approach ultimately led them to adopt a mixed-methods research strategy, blending qualitative and quantitative methods to strengthen the robustness of their conclusions.

Over time, disaster and emergency management research has evolved, with contemporary scholars delineating various research paradigms to guide scientific inquiry. Creswell and Creswell (2017) identifies four key paradigms: post-positivist, advocacy/participatory, constructivist, and pragmatic. The pragmatic paradigm, which emphasises the alignment of research philosophy with the specific research problem rather than adherence to a particular methodology, has become particularly prominent in disaster and emergency management research (Creswell & Creswell, 2017; Saunders, 2014). Pragmatism allows researchers to select methods based on the research question, making it compatible with mixed-methods approaches, where both qualitative and quantitative data are integrated to address complex problems (Creswell & Creswell, 2017). The key aspects of Creswell's paradigms are summarised in Figure 15.

<p><b>Post-Positivism</b></p> <ul style="list-style-type: none"> <li>■ Determination</li> <li>■ Reductionism</li> <li>■ Empirical observation and measurement</li> <li>■ Theory verification</li> </ul>	<p><b>Social Constructivism</b></p> <ul style="list-style-type: none"> <li>■ Understanding</li> <li>■ Multiple participant meanings</li> <li>■ Social and historical construction</li> <li>■ Theory generation</li> </ul>
<p><b>Advocacy/Participatory</b></p> <ul style="list-style-type: none"> <li>■ Political</li> <li>■ Empowerment issue oriented</li> <li>■ Collaborative</li> <li>■ Change oriented</li> </ul>	<p><b>Pragmatism</b></p> <ul style="list-style-type: none"> <li>■ Consequences of actions</li> <li>■ Problem centered</li> <li>■ Pluralistic</li> <li>■ Real-world practice oriented</li> </ul>

*Source: Creswell (2014, p. 6).*

Figure 15 Creswell's paradigm (Creswell & Creswell, 2017)

Pragmatism is grounded in the idea that knowledge is best gained through practical inquiry, where the choice of methods is driven by their ability to provide meaningful insights into the research question (Saunders, 2014). This flexibility allows researchers to combine various data sources and analytical techniques that best suit the inquiry at hand. In the context of disaster research, pragmatism allows for a more comprehensive understanding by using a range of methods that capture the diverse aspects of disaster resilience and preparedness. This aligns well with the complex, multifaceted nature of flood risk and community resilience, which require both in-depth qualitative insights and broad quantitative analysis to develop effective strategies.

Sidani and Sechrest (1996) observed that the growing trend toward pragmatism in mixed-methods research addresses some of the challenges inherent in relying solely on one methodological approach. Pragmatists are more inclined to select methods based on their appropriateness for the research problem, rather than being restricted by preconceived methodological preferences (Onwuegbuzie & Leech, 2006). This approach is particularly valuable in disaster and emergency management, where the research context is shaped by diverse social, historical, political, and environmental factors, all of which can influence the phenomena under study (Rivera & Miller, 2011). By embracing pragmatism, researchers in this field can draw upon a variety of research techniques, data collection strategies, and analytical approaches, choosing the most effective combination to address their specific research questions (Creswell & Clark, 2017).

The roots of mixed methods research can be traced back to the early days of the social and behavioural sciences, particularly in the work of early anthropologists and sociologists who recognised the value of integrating qualitative and quantitative methods. For example, Hollingshead's (1949) work in sociology exemplified early attempts to combine these approaches to gain a more comprehensive understanding of social phenomena. This historical precedent underscores the utility of mixed methods in addressing complex, multifaceted research questions—such as those encountered in flood and disaster research—by providing a richer, more nuanced view of the phenomena under investigation.

Given the challenges in studying disaster-related issues, which often involve both human behaviour and physical environmental factors, the adoption of a pragmatic, mixed-methods paradigm in this research is not only appropriate but necessary. By integrating qualitative and quantitative data,

this research aims to capture both the contextual, lived experiences of flood-prone communities and the broader patterns that shape their vulnerability and resilience.

### 3.4 Research Process

The research approach for this study was guided by the pragmatist research paradigm, combining qualitative methodology for the main study with mixed methods, including quantitative data collection in the initial phase. This approach was designed to achieve the research objectives: to identify best practices for managing flood risk and to develop a framework for enhancing community resilience in the face of recurrent flooding in the Northland region. The research process was structured into four primary phases:

#### i. Initial Phase: Defining the Research Focus

This phase focused on establishing the research scope. It involved a comprehensive and critical review of flood impacts at the community level, flood management plans, and factors contributing to community vulnerability. The assessment encompassed global, national, regional, and community scales, providing a historical context for flood-related issues and the evolution of flood awareness and management, particularly in rural versus urban settings.

A preliminary visit to the Northland region was conducted in June and July 2021. During this visit, historical flood data were accessed from local databases and libraries, and areas susceptible to flooding were inspected according to flood exposure maps provided by the Northland Regional Council. A pilot survey was distributed via social media and community centre platforms in the region. Data from this pilot survey were quantitatively analysed and used to inform the development of the primary survey. These initial activities helped identify critical issues and shape the formulation of the research questions. The Massey University Human Participants Ethics Committee approved ethical considerations. This preliminary visit also provided valuable insights for designing subsequent field trips.

#### ii. Data Collection Phase: Gathering Data

Ethical considerations guided all data collection efforts, with methods chosen to align with the research objectives and the pragmatist paradigm. Mixed-methods research was employed, combining quantitative surveys and qualitative interviews. The initial data collection involved desktop research and a series of interviews with flood and climate experts, which informed the design of stakeholder interviews.

Three field trips were conducted across the Northland region:

1. **Whangarei District:** Focused on urban communities and the impact of urban development on flood risks.
2. **Far North District:** Concentrated on rural towns, examining the distinctive characteristics and flood management challenges in rural communities.
3. **Kaipara District:** Covered both rural and urban areas, allowing for analysis of the interaction between the two environments.

Subsequent community visits and online meetings were organised to validate the collected data and observe flood-related group discussions in the case study area. Adjustments were made to interview methods and participant interactions during these visits to ensure the research adhered to travel restrictions during the COVID-19 lockdown period (2021 – 2022) in New Zealand.

### iii. Data Analysis and Synthesis Phase: Analysing the Data

The analysis of quantitative data from stakeholder interviews and surveys formed the basis of this phase. Additionally, focus group discussions with river catchment groups and on-site observations contributed to the data synthesis. The analysis was framed within the context of the emergency management cycle and was interpreted according to the research framework, allowing for a comprehensive understanding of the data.

### iv. Findings Discussion Phase: Synthesizing Results (2024)

This phase focused on discussing the analysed data and drawing final conclusions. The first step involved synthesizing information from the flood risk management plans, followed by discussions to assess the effectiveness of current community resilience strategies. The findings were used to identify the most suitable framework for enhancing resilience in the face of recurrent flooding.

The conclusion summarised the research findings, offering recommendations for improving the community resilience plan. Research limitations were also addressed, and areas for future research were highlighted to guide further investigation into flood risk management and community preparedness.

## 3.5 Research Design

This study employs a mixed-methods research design, grounded in the pragmatism paradigm. The design integrates both qualitative and quantitative methods to address the multifaceted nature of flood risk management and community resilience. By combining the strengths of both approaches, the study aims to gain a comprehensive understanding of flood impacts, community responses, and strategies for enhancing resilience.

### 3.5.1 Research Paradigm and Approach

This research considers the paradigm and approach as follow:

- i. **Pragmatism Paradigm:** Pragmatism underpins this research, prioritising practical outcomes and actionable insights. This paradigm is particularly well-suited for addressing complex, real-world challenges, such as flood resilience, which require interdisciplinary approaches and flexible methodologies.
- ii. **Phenomenological Approach:** A phenomenological approach was adopted to capture the lived experiences of flood-affected communities and stakeholders. This approach facilitates a deeper understanding of subjective experiences, motivations, and behaviours, which are critical for designing effective resilience strategies.
- iii. **Case Study Methodology:** Urban areas in the Northland region were selected as case studies due to their high population density, socio-economic diversity, and infrastructural challenges. The case study method enables an in-depth exploration of community resilience dynamics in these settings, providing insights that can be adapted to similar regions globally.

### 3.5.2 Research Objectives and Questions

The study is guided by the following research objectives:

1. To identify best practices in flood risk management from global and local perspectives.
2. To understand community and stakeholder roles in managing flood risks.
3. To develop actionable recommendations for enhancing community resilience in the face of recurrent flooding.

Key research questions include:

- How can Northland improve its flood management strategies to effectively prepare for, respond to, and recover from recurrent flood events?
- What are the key factors influencing community resilience to floods in Northland, and how can these factors be optimised to minimise flood impacts and enhance disaster management processes?

The sub questions coming from these two key questions are detailed in Figure 5 Distilled sub questions

### 3.5.3 Data Collection Methods

The study employs a phased data collection strategy:

#### (a) Historical Data Analysis

- **Sources:** Historical flood data was collected from Northland libraries (e.g., Whangarei, Dargaville, Kerikeri) and integrated with the New Zealand Historic Weather Events Catalogue.
- **Purpose:** To analyse past flood events and their impacts, providing context for understanding current challenges.

#### (b) Surveys

- **Target Group:** Community members from flood-prone and flood-affected areas.
- **Distribution:** Online platforms and in-person survey booths at libraries and community centres.
- **Purpose:** To gather quantitative data on flood experiences, preparedness, and perceptions of flood management.

#### (c) Interviews

- **Participants:** Key stakeholders, including local government officials, emergency responders, and community leaders.
- **Purpose:** To explore qualitative insights into flood risk management practices and community dynamics.

- **Ethical Considerations:** Informed consent was obtained, and interviews were conducted in a manner sensitive to participants’ experiences.

**(d) Focus Group Discussions and Observations**

- **Setting:** Community flood meetings and catchment group discussions.
- **Purpose:** To understand stakeholder interactions, decision-making processes, and community concerns.

**(e) Field Observations**

- **Scope:** Observations were conducted during site visits to flood-prone areas and community meetings.
- **Purpose:** To capture non-verbal dynamics, physical settings, and real-time decision-making processes.

The Table 3 below shows the data collection method used in the finding chapters tailored to best answer the research questions and achieve the objectives in each chapter.

**Table 3 Methods used in each chapter**

Relevant Chapter	The data collection method used	Notes
Chapter 2	Literature Review Historical Data Analysis	Literature review of floods as complex hazards, exploring their causes, impacts, and management strategies. The purpose is to set the base knowledge on the discussed topic
Chapter 4	Survey Questionnaire Interviews	A purposely designed semi-structured questionnaire comprising a mixture of closed and open-ended questions was designed to elicit information on the perception of flood risk by residents of selected flood-affected areas in the town.  The questionnaire was administered by face-to-face interviews. The higher response rates achieved by face-to-face interview surveys relative to postal and other types of surveys have been acknowledged.
Chapter 5	Document Analysis Focus Group Discussion Observations Interview and Surveys	The data was collected through a field tour and attendance at three Northland flood working group meetings.
Chapter 6	Pilot survey Field observations In-depth interviews	The survey was developed and validated through a process of disseminating it to colleagues and the final revisions was posted online and promoted to using various local social media advertisements. The survey was kept open for 30 days and

		targeting only users from the areas of Northland Region. Site observation and interview surveys were conducted in public libraries and community halls within the Northland area. The observation of river catchment meetings was also conducted. The results from the survey helped in mapping the area for field observations and conducting the in depth interviews.
Chapter 7	Desktop analysis - Critical literature review and Comparative review with consultation	The academic literature and the government documents were critically analysed, and the summary was drawn upon the flood management theme. The legislation mentioned in the data collection was thematically grouped specifically to address the issues of uncoordinated flood management at the community level and the inclusion of Indigenous communities to develop a culturally sound and integrated local law. This chapter also comprehensively examines floodplain management policies, guidelines, and academic literature from the practitioner perspectives.
Chapter 8	Interview and Survey Catchment group meetings and field observations Desktop Analysis	Data collection conducted in the Northland Region within the priority catchment, including Mangere, Doubtless Bay, Waitangi, Pouto, Whangarei, Ngunguru, and Hatea catchment
Chapter 9	Online survey In-Person Survey Booths Semi structured interview	Survey booths were set up at libraries and community centres. Out of 30 identified areas, 18 libraries were available for participation.

### 3.5.4 Data Analysis Methods

The data analysis process was aligned with the **emergency management cycle**, focusing on prevention, preparedness, response, and recovery phases.

#### (a) Quantitative Analysis

- Survey data were analysed using statistical techniques to identify trends, patterns, and correlations related to community preparedness and perceptions of flood risks.

#### (b) Qualitative Analysis

- Interview transcripts and focus group discussions were analysed thematically, using coding frameworks to identify key themes and insights.
- Observational data were synthesised to complement interview and survey findings.

#### (c) Triangulation

- Multiple data sources and methods were used to validate findings and enhance reliability. This included comparing survey results, interview data, and historical documentation.

### 3.5.5 Ethical Considerations

Ethical approval was obtained from the Massey University Human Participants Ethics Committee. Ethical considerations included ensuring informed consent from all participants, maintaining confidentiality and anonymity of responses, and adhering to ethical guidelines during fieldwork and online interactions.

The ethical consideration of this research, including conflict of research interest, conceptualising risk, privacy about research involving human subjects, will be peer-reviewed by the supervisory team. All issues regarding conflict of interest and risks will be identified and mitigated or managed in advance through changes in research design, especially participant recruitment and the provision of information. The collection of personal information for research purposes will follow the principles of the Privacy Act 1993. Moreover, the researcher will take any precautions throughout the research to manage sensitive information for the participants. Documents prepared for this ethics during data collections are the confidentiality agreement, information sheet, participant consent form, and transcript release authorisation.

This project has been evaluated by peer review and considered to be low risk. Ethics Notification Number: 4000024164. Human Ethics Notification presented in **Appendix E**.

### 3.5.6 Expected Outcomes

The research aims to produce the following outcomes:

- i. A comprehensive understanding of flood risk management in Northland.
- ii. Recommendations for best practices in community resilience.
- iii. Actionable recommendations for a community resilience plan tailored to flood-prone communities, with potential applicability to other regions facing similar challenges.

These outcomes will be answered through the publications, and each chapter will answer and feed to research objectives identified in Chapter 1.

### 3.5.7 Limitation and mitigations

While this study is designed to provide robust insights into flood risk management and community resilience, certain limitations are anticipated:

#### 1. Geographic Scope

- The study is limited to Northland, New Zealand, and findings may not fully generalise to regions with different environmental, social, or governance contexts.

#### 2. Data Availability and Quality

- Historical data on flood events and impacts may be incomplete or inconsistent, particularly in rural areas.

- Reliance on archived records and community-sourced data introduces potential biases or gaps.

### 3. Participant Representation

- Community engagement may face challenges in achieving a balanced representation, particularly from hard-to-reach or marginalised groups.
- Participation in surveys, interviews, and focus groups may be influenced by prior flood experiences, leading to potential bias in responses.

### 4. COVID-19 Restrictions

- Fieldwork was conducted during a period of COVID-19 restrictions, which necessitated online meetings and limited face-to-face interactions. This may have impacted the depth of engagement and observational opportunities.

### 5. Temporal Constraints

- The dynamic nature of flood events means that findings reflect a snapshot in time and may not fully account for long-term trends or changes in community resilience over time.

### 6. Complexity of Data Integration

- Combining qualitative and quantitative data can pose challenges in interpretation and integration, particularly when findings from different sources diverge.

### 7. Ethical Sensitivities

- Engaging with flood-affected communities requires sensitivity to their experiences and emotions, which may influence the willingness of some participants to share openly.

### 8. Resource Limitations

- The scope of fieldwork, particularly in remote or rural areas, was constrained by time and logistical resources.
- Limitations in funding or staffing could have restricted the breadth of data collection and analysis.

To mitigate these limitations, the study employs the following strategies:

- i. Triangulation: Using multiple data sources and methods to enhance validity and reliability.
- ii. Targeted Outreach: Implementing targeted recruitment strategies to engage underrepresented groups.
- iii. Contextual Analysis: Situating findings within the specific socio-environmental and policy context of Northland while discussing transferability to other regions.

- iv. Ethical Safeguards: Maintaining high ethical standards to foster trust and encourage participation.
- v. Adaptive Methods: Adjusting data collection techniques to account for COVID-19-related challenges and logistical constraints.

### 3.6 Geographical context

The geographical contexts discuss the reason for flooding in New Zealand in general and in the Northland region, looking through the climate, environment, and possibility of urbanisation impact.

#### 3.6.1 New Zealand

New Zealand consists of two large islands (North and South Islands) and several smaller islands like Waiheke Island in the northern part and Stewart Island. The country located in the southwest Pacific Ocean between 34 degrees and 47 degrees of latitude south (Ministry for the Environment, 2007). Situated on the boundary of the Pacific and Indo-Australian tectonic plates, over two-thirds of New Zealand landforms are hilly and mountainous resulted from the earth movement created by the plates. The tectonic movements also resulted in frequent earthquakes in most are in the country and volcanic activity in the central North Island (Ministry for the Environment, 1997).

**Table 4 Geographic factors and their impact on the climate**

<b>Factors</b>	<b>Impacts on climate</b>
<b>Located in latitude zone with prevailing westerly winds</b>	Steering ex-tropical cyclones
<b>Surrounded by ocean</b>	Influence in storing solar radiation, distributing heat and moisture around the globe, and driving weather systems
<b>Mountain chains</b>	modify weather systems as they move eastward so that climatic contrasts are much sharper from west to east than they are from north to south
<b>Tropical weather patterns</b>	Redeveloping storms that happened in other areas once the winds come to the region

Flood is one of the critical risks that New Zealand face from climate change which have a strong relationship with the social and geographic feature of the country (Ministry for the Environment, 2008b, 2010). Its vulnerability is mainly because of the urbanisation in coasts and floodplains, affecting the community in many ways (Ministry for the Environment, 2009; The Royal Society of New Zealand, 2016). Living in coastal areas poses the risks of sea-level rise, coastal erosion, inundation of low-lying areas, relocation of settlements, and salination of groundwater (IPCC, 2014; Ministry for the Environment, 2009). Living on floodplains have the risks of overflowed riverbanks, flash-flood, and decreased drainage (IPCC, 2014; The Royal Society of New Zealand, 2016). Significant settlement development in the coasts and flood plain areas relates to New Zealand surrounded by the ocean. The community relies on freshwater availability. The economy depends on reliable international connectivity such as export-import activities, tourists preferences, and migrations (The Royal Society of New Zealand, 2016).



Figure 16 New Zealand geography map (Ministry for the Environment, 2007, chapter 2)

New Zealand has one of the longest coastlines of any country globally (Figure 16), given more than 18,000 kilometres of its land area (approximately about 270,000 km<sup>2</sup>) is coastlines (Ministry for the Environment, 2007). Moreover, the country's weather is more variable than other larger continental countries. This is because the climate is influenced by New Zealand's geographical factors: westerly winds, ocean climate, mountain chains, and tropical weather patterns (Ministry for the Environment, 2007). Regions exposed to weather from the west and southwest experience showery weather, and rain falls in these areas on about half of the days of the year. The rest of the country experiences much lower rainfall, particularly in eastern regions.

### 3.6.2 Northland

Northland is a narrow peninsula located in northern New Zealand's North Island (NRC, 2018). The region administered by Northland Regional Council governing Kaipara, Whangarei, and Far North Districts (Figure 17). Generally, Northland has around 2000 hours of sunshine and 1500-2000 mm rainfall per year, making Northland the warmest region in the country (NRC, n.d.). Having about 1,700 kilometres long of coastline, Northland has a sub-tropical climate which creates a warm and humid summer and mild in winter. However, the weather often affected the performance of local rivers created droughts in summer and floods during winter (Chappell, 2013).

Over 250 million years ago, the geological process shaped Northland, and many times, the size and seas have advanced ever since (Caludia Orange, 2015) . Although the typical inland landscape is hilly and plateau is rare, flatland is found primarily in the coastal and narrow river valleys. Numerous

short river and streams with a small catchment dissect the Northland's ground. Prolonged dry season reduces the flow in the smaller river and water catchment, leading to droughts. At the same time, intense rainfall creates flash floods and contaminates freshwater sources.



Figure 17 Northland region with local authority council boundary (Northland long term plan 2018-2028, pg. 12)

Northland's soil categorised as heavy clays with thin topsoil and low subsoil fertility. This leached and warm type of soils resulted from the deep layers of highly acidic litter produced by Kauri trees centuries ago before the forests were removed (Caludia Orange, 2015). The influence on soil formation resulted in poor soil, and this type of soil was despair for the early farmers in the area. This situation makes the Northland ground is better suited for forestry than for agriculture. However, drainage and fertilisers helped to improve the soil's productivity in the ideal environment. The improvements made the agriculture and farming industry critical in Northland after the manufacturing industry (Infometrics, 2019).

Following the flatland and availability of fresh water, most of the towns and cities in Northland located on the coasts and flood plain of major rivers (The Royal Society of New Zealand, 2016). However, with a prediction of precipitation increment due to climate change (Chappell, 2013), these areas are categorised as prone to flooding hazards by storm, erosion, and heavy rainfall (NIWA, 2016b). In the riverside area, the climate and the geographic element like soil and groundwater are mattered to determine flood risk. For example, a higher proportion of rainfall in a flood-prone area will become surface runoff that increased peak flood discharges and sea-level rise.

Rainwater from the hills, adding to surface water runoff and rising streams/river waters. The excess rainwater soaked into the ground giving the groundwater more saturation. The river level was growing because of rain, melting snow, and surface water runoff. Those rising waters damaged property and infrastructure, threatening the community livelihood.

### 3.6.3 Historical data of flood in Northland

Since most towns in Northland are built partly on floodplains, flooding is the most widespread and frequently occurring hazards in the region (Northland Regional Council, 2002). The flooding is a repetition hazard since the early settlement in Northland, mainly started by the heavy rain and storm, ended with damaged properties, inundation, and erosion. A record by NIWA (2018) summarised that between 1873 and 2017, there were more than 130 major flooding events in Northland. Floods not only cause damage to properties but also damage the local community's lifestyle and economy. Such events have reopened the question of risk management and the Northland's vulnerability to flooding. Therefore, the outlook of historical development becomes a key concern for Northland risk management stakeholders.



Figure 18 Map of towns affected by flooding and landslide

In 1957, The Soil Conservation and Rivers Control Council provided the database of the flood events in New Zealand between 1920 and 1953. The first documented record of the surge in the Northland is the event in 1917 that caused enormous damages to the infrastructures, forests, and hillside. The occurrence also considered being one of the most disastrous floods in the area before

1920 until the Cyclonic Storm in February 1936 crossed the country and caused most regions of New Zealand, including the Northland region, severe damages and major inundated in the broad areas of farmland (Porter, 1957). With many events in between, another extra-tropical cyclone (Cyclone Bola) in 1988 struck most North Island regions, including Northland, bringing widespread damage with combinations of heavy rain, flooding, high winds, and heavy seas (NIWA, 2018).

### 3.7 Community Context

#### 3.7.1 *Awareness of the Māori community largely shape Northland community character*

When conducting research in New Zealand, it is crucial to address ethical considerations, especially when Māori communities are included as part of a broader study on vulnerable populations. These ethical considerations should be integrated into the overall research ethics, even if the research does not explicitly target the Māori community. Cultural competency and awareness are essential, with an understanding of the importance of tikanga Māori and Te Reo Māori. Engaging with Māori participants or communities involves consultation with Māori leaders or representatives to gain insights into their perspectives and priorities. Informed consent should be obtained from all participants, with an explanation of the research's purpose and potential benefits provided in a culturally appropriate manner.

Demonstrating how the research can specifically benefit Māori communities is crucial, as it highlights how the findings can address their unique needs and concerns. Researchers should show respect for Māori values, traditions, and viewpoints, ensuring cultural sensitivity when research activities intersect with Māori customs or practices. Data ownership and control should be discussed with Māori participants or communities, giving them a say in how the data is used and shared. Building trust and rapport with Māori communities, respecting their preferences for communication and collaboration, is vital. Ethical review and approval for the overall research project should be sought, with an explicit acknowledgement that Māori communities are part of the vulnerable population and that their ethical considerations are integrated into the research plan.

Cultural sensitivity should be maintained throughout the research process, from data collection to analysis and reporting. Researchers should also adhere to marae protocols if research activities involve a marae, seeking guidance from local iwi or marae representatives. The research should be consistent with the principles of the Treaty of Waitangi, which emphasises partnership, protection, and participation. These considerations ensure a respectful and inclusive approach, acknowledging that Māori communities have unique perspectives and needs, even when they are part of a broader study on vulnerable populations (based on general ethical guidelines and principles of cultural sensitivity).

#### 3.7.2 *Research booths in the community centre and libraries*

Lists of Libraries visited in the Northland, as the first introduction to the community, in grey, indicate the locations unavailable for conducting research. The libraries are also used for interviews with community members.

Table 5 Research survey booth areas

Region	Organisation/Community	Area/address
Far North	Kaitaia Library	Corner of State Highway One and Matthews Avenue, Kaitaia
Far North	Kaeo library and service centre	30 Leigh Street, Old Post Office Building, Kaeo 0448
Far North	Procter Library, Kerikeri	6 Cobham Road, Kerikeri 0230
Far North	Kaikohe Library	Marino Place, Kaikohe 0440
Far North	Kawakawa Library	62 Gillies Street, Kawakawa 0210
Far North	Paihia Library	6 Williams Road, Paihia 0200
Far North	Russell Public Library	York Street, Russell 0202
Far North	Broadwood Community Library	Broadwood Area School, 1041 Broadwood Road, Broadwood
Far North	Kohukohu Community Library	1387 Kohukohu Road, Kohukohu
Far North	Mangonui Community Library	Mangonui Community Hall, Waterfront Drive, Mangonui
Far North	Rawene Public Library	4 Parnell Street, Rawene
Kaipara	Kaipara District Library / Dargaville Public Library	71 Normanby Street, Dargaville, 0310, New Zealand
Kaipara	Paparua Community Library	Brook House 1980 Paparua Valley Road State Highway 12 Paparua 0571
Kaipara	Kaiwaka Community Library	2 Kaiwaka-Mangawhai Road Kaiwaka, 0542
Kaipara	Maungaturoto Community Library	Centennial Building 150 Hurndall Street Maungaturoto 0520
Kaipara	Mangawhai Community Library	Mangawhai Library Hall Corner Moir and Insley Streets Mangawhai 0505
Whangarei	NorthTec Library	51 Raumanga Valley Road, Whangarei, 0110, New Zealand

Whangarei	Northland District Health Board Staff Library	Hospital Road, Whangarei, 0110, New Zealand
Whangarei	Whangarei Central Library	5 Rust Avenue, Whangarei, 0110, New Zealand
Whangarei	Hikurangi Community Library	10A King Street, Hikurangi 0114
Whangarei	Ngunguru Community Library	1895 Ngunguru Road, Ngunguru 0173
Whangarei	Kamo Library	583 Kamo Road, Kamo, Whangarei
Whangarei	Onerahi Library	159 Onerahi Road, Onerahi, Whangarei
Whangarei	Tikipunga Library	83 Paramount Parade, Tikipunga, Whangarei
Whangarei	Matapouri Community Library	Matapouri Hall grounds, Matapouri Road, Matapouri, on the east coast, 35 km from Whangarei
Whangarei	Ruakaka Community Library	Takutai Place, Ruakaka
Whangarei	Tauraroa Community Library	Located at Tauraroa Area School, corner Tauraroa and Omana Roads, Maungakaramea, 24km southwest of Whangarei.
Whangarei	Waipu Community Library	49 The Centre, Waipu village, 41km southeast of Whangarei.
Whangarei	Whananaki Community Library	Whananaki North Road, beside the Whananaki Store and behind the Whananaki Hall.
Whangarei	Whangarei Heads Library	28 School Road, in Whangarei Heads School grounds.

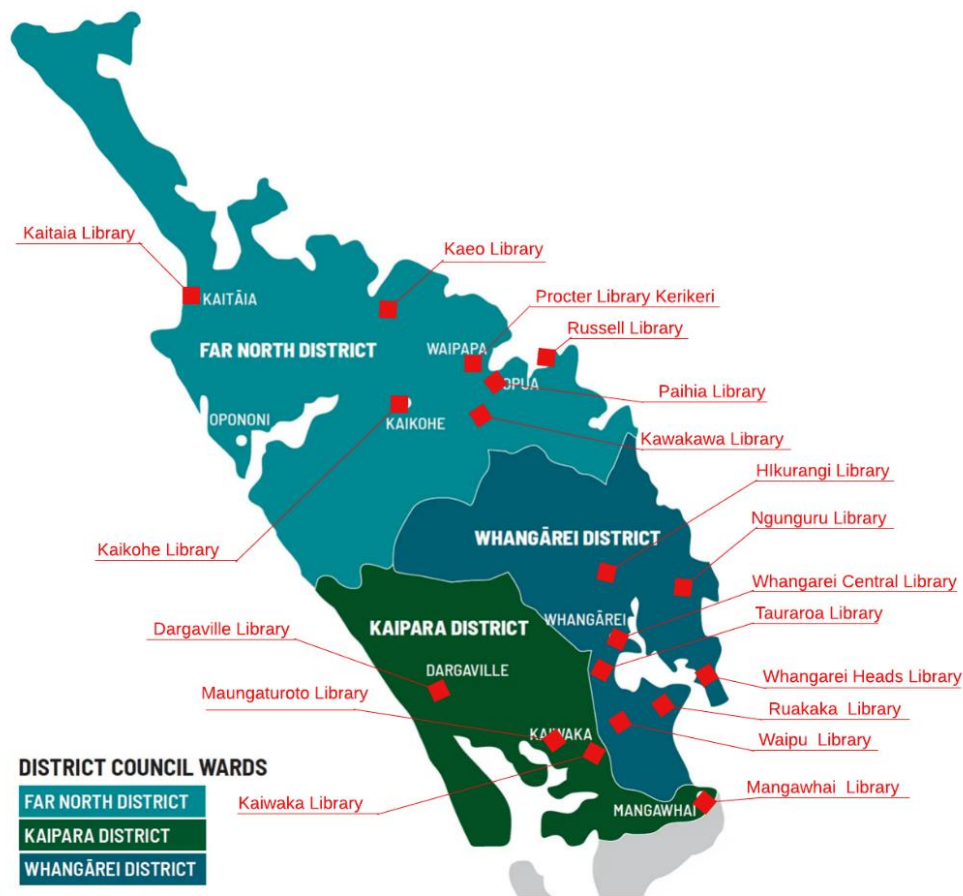


Figure 19 Areas visited on maps

### 3.8 Summary and Transition to the Next Stage of the Research

This chapter has outlined the research design and methodological framework employed in this study. It described the rationale for adopting a mixed-methods approach, which integrates both qualitative and quantitative data collection and analysis to comprehensively address the complex, multi-level issues surrounding flood risk management and community resilience. The chapter detailed the key components of the research process, including the philosophical underpinnings, research design, fieldwork strategies, participant selection, and the analytical techniques applied to the collected data.

The choice of a mixed-methods approach was guided by the need to capture diverse perspectives, including institutional viewpoints through surveys and interviews, as well as community experiences through case studies and participatory engagement. This integration enabled the research to bridge the gap between top-down governance structures and bottom-up, community-driven insights, ensuring that the findings are both contextually grounded and theoretically robust.

The chapter also addressed the ethical considerations underlying the research, including the approval process through the Massey University Human Participants Ethics Committee (Approval Number: 4000024164), to ensure that all procedures were conducted with integrity and respect for participants. This ethical foundation was critical for working with vulnerable communities and handling sensitive information, which will be reflected in the interpretation of results.

The methodological framework and processes outlined here directly shape the structure and content of the following chapters.

- Chapter 4 builds upon this foundation by presenting the first set of findings, focusing on community vulnerability to floods and the factors influencing resilience.
- Chapter 5 extends this analysis by examining the effectiveness of current flood risk management strategies in Northland, combining institutional and community perspectives.
- Chapter 6 explores community-based flood mapping, demonstrating the application of participatory approaches in practice.
- Chapter 7 focuses on the flood issue in the context of regional planning and legislation. Desktop studies and discussions with experts are the primary approaches to validate the findings, comparing them with the literature and practicality.
- Chapter 8 highlights the community perspectives and views on how resilience is perceived. Using a case study, interviews and results from the field study. The community meetings also feed into this research.
- Chapter 9 addresses the challenge of sustaining disaster resilience across generations. Taking the following action to remember the effort. How to not forget the community and plan for how the government can support it. The approach to this is a discussion with the community, government representatives, and gathering suggestions from experts to validate the findings.

Together, these chapters progressively address the research questions and objectives introduced in Chapter 1, using the methodology described in this chapter as the guiding framework.

In summary, this chapter has provided a comprehensive overview of how the research was designed and executed, ensuring alignment between the research aim, questions, and methods. By combining qualitative depth with quantitative breadth, the mixed-methods approach offers a holistic understanding of flood risk management and community resilience. The next chapter builds on this methodological groundwork, presenting the first key findings and beginning the process of linking evidence to the development of a practical framework for sustainable, community-based flood resilience.

## Chapter 4

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### Community Vulnerability to Floods

## Overview

While Chapter 3 presented the research design and methodology, outlining the mixed-methods approach that integrates qualitative and quantitative techniques to address the complexity of flood risk management and community resilience. The methods described — including surveys, interviews, and case studies — were specifically designed to capture both institutional perspectives and community-level experiences in Northland, New Zealand. This chapter 4 builds directly on that foundation by presenting the first set of research findings, which focus on understanding community vulnerability to floods. These findings address the first research question and related objectives outlined in Chapter 1, examining the key factors that influence vulnerability and resilience among Northland’s communities.

The chapter begins with a brief review of relevant literature, providing context for interpreting the results. This is followed by a detailed presentation of the methods applied in this phase, including participant selection and data analysis techniques as described in Chapter 3. The findings are then presented, highlighting themes such as socio-economic conditions, intergenerational knowledge gaps, and community-level preparedness.

By exploring these factors, this chapter provides critical insights into the drivers of vulnerability and lays the groundwork for the next stage of the thesis. The results presented here form the basis for Chapter 5, which evaluates the effectiveness of current flood risk management strategies in Northland, linking the community-level findings to broader institutional practices and governance frameworks.

### Chapter 4 Notes:

This paper is prepared for a future conference. The inclusion of this paper sets the stage for why this research is necessary to examine community vulnerability.

For examiners' review, please follow the guidelines of Massey University Thesis with Publication.

This chapter will answer the following research questions:

<b>Research Question:</b>	
<b>What is the status of the flood problem in New Zealand and its impact on the community?</b>	
<b>Research Objective A:</b>	
<b>To identify factors that contributed to the vulnerability</b>	
<b>Research Objective B:</b>	
<b>To assess community perceptions of flood risks and their preparedness behaviours.</b>	
<b>Sub Question i</b>	What characteristics make the Northland community more vulnerable to flood risk impacts?
<b>Sub Question ii</b>	How will impacts be experienced differently by the more vulnerable?
<b>Sub Question iii</b>	What strengths do they also have that will assist in responding to impacts and adapting to recurring floods?

## 4.1 Introduction

Vulnerability is a socially constructed phenomenon influenced by systemic inequalities rather than an innate characteristic (Wisner, 2004). These inequities are perpetuated by historical and institutional structures that disproportionately disadvantage specific groups, including women, ethnic minorities, and economically marginalised populations. In the context of disaster risk reduction, vulnerability has emerged as a critical area of study, with scholars emphasising the role of demographic variables such as age, gender, race, ethnicity, and socioeconomic status in shaping disaster outcomes (Rodríguez et al., 2007). Understanding these dynamics is essential to designing inclusive and effective disaster management strategies, particularly in the face of recurring and intensifying flood risks.

Flood risks are inherently tied to community vulnerability, which determines the degree to which populations are exposed to, affected by, and capable of recovering from such events. Vulnerability is not uniform; it varies significantly across geographic locations, demographic groups, and socioeconomic contexts. Recognising this heterogeneity is crucial for developing strategies that align with the specific needs, capacities, and resources of at-risk communities. Without this foundational understanding, flood management strategies risk inefficacy, inequity, and the perpetuation of existing vulnerabilities.

This paper explores the critical importance of understanding community vulnerability as a prerequisite for effective flood management. Several dimensions underscore the significance of this focus. First, it enables tailored strategies that reflect the unique circumstances of different communities, thereby enhancing the relevance and impact of interventions. Second, a nuanced understanding of vulnerability facilitates efficient resource allocation, ensuring that limited resources are directed toward the most vulnerable populations to achieve equitable outcomes. Lastly, recognising the challenges and strengths within communities fosters engagement and trust, enabling cooperative efforts to mitigate risks and enhance resilience.

The research presented in this paper is situated in Northland, New Zealand, a region characterised by diverse flood risks and community dynamics. Through an examination of community vulnerabilities and adaptive capacities, this study aims to address the following research questions:

1. What characteristics make Northland communities more vulnerable to flood risk impacts?
2. How are flood impacts experienced differently by more vulnerable groups?
3. What strengths exist within these communities that can support their response to and recovery from recurring floods?

By addressing these questions, the paper seeks to provide insights into how vulnerability analysis can inform adaptive, equitable, and community-centred approaches to flood management. This research contributes to the broader discourse on integrating vulnerability frameworks into disaster risk reduction, offering practical implications for policy and practice in flood-prone regions globally.

## 4.2 Literature review

### 4.2.1 *Studying Vulnerable Communities and Ethical Considerations*

For decades, disaster research has centred on the experiences and conditions of vulnerable populations—groups disproportionately affected by hazards due to their limited capacity to prepare for, respond to, and recover from disaster events (Blaikie et al., 2014; Cannon, 1994; Wisner, 2004). Vulnerability is characterised by the interaction of social, economic, and environmental factors that reduce resilience and adaptive capacity. Vulnerable populations often lack access to critical resources that could enhance disaster preparedness and recovery, leaving some unable to achieve full recovery after disasters (Giddens, 1994; Yoon, 2012).

However, the concept of vulnerability has evolved into a broad and sometimes abstract construct, leading to definitional and methodological challenges within the research community. As Sartori (1970) noted is the overextension of vulnerability in disaster studies, which can create ambiguity, making it difficult to differentiate among populations considered vulnerable. Levine et al. (2007) further highlighted the need for clarity in understanding how vulnerability varies across different groups and contexts. Despite these challenges, research on vulnerable populations remains ethically imperative. Excluding these groups from disaster research risks losing valuable insights that are essential for equitable and effective disaster risk management (Packenham et al., 2017).

Ethical considerations are critical in research involving vulnerable populations. Researchers must navigate challenges such as ensuring informed consent, minimising harm, and addressing power imbalances. The ethical inclusion of vulnerable groups not only enriches the research but also ensures that disaster risk reduction (DRR) strategies are inclusive and equitable. This paper addresses these ethical considerations in the methods section, providing a framework for engaging with vulnerable populations in disaster contexts.

### 4.2.2 *Vulnerability in the Disaster Context*

Vulnerability in disaster contexts refers to the susceptibility of individuals, communities, or systems to harm due to exposure to hazards, compounded by their inability to cope or recover (UN, 2015). Factors influencing vulnerability include physical location, socioeconomic status, and institutional support. For example, individuals living in flood-prone lowlands are inherently more vulnerable than those in elevated areas.

Understanding community vulnerability requires examining both biophysical and social dimensions. Biophysical vulnerability relates to the direct impacts of hazards, such as flood exposure, while social vulnerability stems from systemic inequalities, including poverty, marginalisation, and limited access to resources. Vulnerable groups, such as the poor and marginalised, are particularly at risk due to their reduced capacity to adapt and recover (Wisner, 2004). This understanding underscores the importance of flood risk management strategies that incorporate a community resilience framework, recognising the diversity of vulnerabilities and harnessing local capacities for adaptation.

Vulnerability disparities between developing and developed countries are well-documented, with urban areas in developing nations often facing greater challenges due to inadequate infrastructure, limited resources, and competing development priorities (Cea & Costabile, 2022). However, even developed countries like New Zealand face vulnerabilities rooted in socio-economic inequalities. In Northland, communities face marginalisation and resource constraints, which exacerbate their susceptibility to floods, despite the country's overall high level of development.



**Figure 20 Moerewa flood 2020 (Stuff, 2020)**

Flood events in 2020 underscore these vulnerabilities. A 2022 government report identified 44 communities across 12 regions in New Zealand as facing severe flood risks, including several in Northland such as Kaitaia, Kerikeri, and Ruawai (McAnulty, 2022). These communities often lack the financial capacity to implement protective measures, with low median household incomes hindering the implementation of local tax-based solutions. Historical flooding events, such as the catastrophic July 2020 floods in Moerewa and Whangarei, further highlight Northland's exposure Figure 20 and Figure 21. The Northland Civil Defence Emergency Management group noted extensive damage across the region, emphasising the economic and social toll of such events.



Figure 21 Moerewa flood in houses 2020 (Source: Stuff, 2020)

This evidence underscores the need for targeted, community-centred flood risk management strategies that address both physical vulnerabilities and the social determinants of resilience. By integrating these insights, disaster management efforts can more effectively mitigate risks, enhance readiness, and support recovery in vulnerable communities.

### 4.2.3 Tools to Measure Vulnerability

Measuring community vulnerability to natural hazards is essential for developing targeted interventions and enhancing resilience. Massey University has developed an environmental health indicators framework to assess social vulnerability to natural hazards, updated in December 2021 (Figure 22).

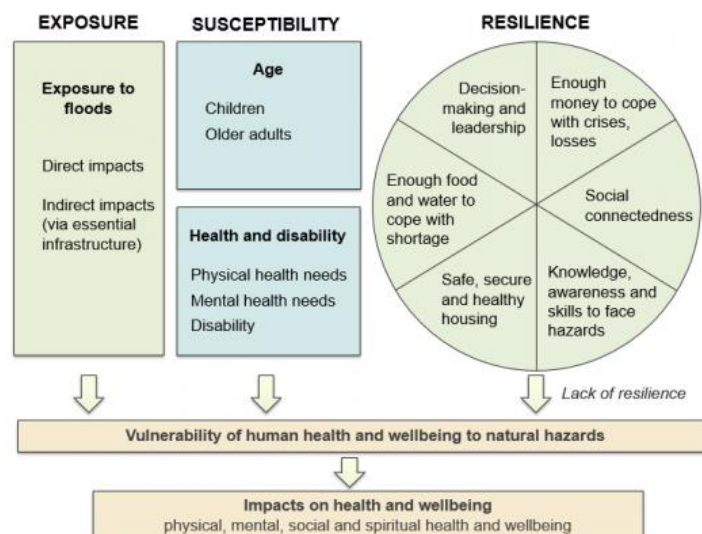


Figure 22 Vulnerability to natural hazard assessment tool (Mason et al., 2019)

This conceptual framework provides a structured approach to evaluating vulnerability across key dimensions:

- a) **Location:** Ensuring safe, secure, and healthy housing.
- b) **Community Knowledge:** Promoting awareness, skills, and preparedness to face hazards.
- c) **Financial Capacity:** Having sufficient resources to cope with crises, including access to food and water.
- d) **Community Engagement:** Strengthening social connectedness, decision-making capacity, and leadership.

This framework aligns with research emphasising that climate change exacerbates vulnerability through direct and indirect impacts, such as rsuch as Bangladesh, India, Indonesia, and Thailand also making significant contributions as low-lying areas are particularly at risk due to rising sea levels and intensified storm events.

### A. Increasing Occupation of Flood-Prone Areas

Globally, humans now occupy more than twice the land in flood-prone areas than they did four decades ago. Rapid urbanisation has significantly increased disaster risk, particularly in developing countries. A study published in *Nature* highlights that over half of this expansion occurred in China and Vietnam, with countries like Bangladesh, India, Indonesia, and Thailand also contributing significantly. This trend underscores the urgent need for improved disaster preparedness, especially in urbanizing regions. In contrast, developed countries like the United States, the Netherlands, the United Kingdom, and New Zealand have made notable progress in building safer housing in flood-free areas. However, despite these efforts, development in vulnerable areas still occurs, perpetuating flood risks.

### B. Characteristics of Flood-Safe Areas

Areas inherently less prone to flooding possess several protective features:

1. **Higher Elevation:** Locations above nearby water bodies are less likely to flood during heavy rainfall or storms.
2. **Distance from Water Bodies:** Properties far from rivers, lakes, or oceans face reduced flood risks.
3. **Well-Draining Soils:** Sandy or gravelly soils facilitate efficient water infiltration, reducing surface water accumulation.
4. **Stable Topography:** Flat or gently sloping terrains with effective drainage patterns divert water away from infrastructure.
5. **Flood History:** Avoiding areas with recurring floods minimizes exposure to risk (*source needed for specific recommendations*).

### C. Community Engagement as a Resilience Factor

Social connectedness and community engagement are critical components of resilience. These factors enhance a community's capacity to prepare for, respond to, and recover from disasters. Community engagement has gained renewed attention in disaster management, with governments and organizations investing in capacity-building and training initiatives. However, the term often leads to confusion due to varied interpretations. Nonetheless, its emphasis on empowering communities remains central to fostering resilience against recurring floods.

### D. Flood Vulnerability in Aotearoa New Zealand

Flooding is New Zealand's most frequent and costly natural hazards. Approximately two-thirds of the population resides in flood-prone areas (The Royal Society of New Zealand, 2016). Many towns and cities are built on floodplains, increasing exposure to risks. On average, a major flood occurs every eight months, with estimated annual costs exceeding \$125 million. Between 2009 and 2018, New Zealand experienced 28 flood-related events where insurance damages surpassed \$1 million (inflation-adjusted) (ICNZ, 2022). These figures highlight the urgency of addressing vulnerabilities, particularly in regions like Northland, where frequent flooding imposes significant social and economic burdens. By leveraging tools like Massey University's vulnerability assessment framework and emphasising community engagement, New Zealand can enhance its adaptive capacity and mitigate flood risks in both urban and rural settings.

## 4.3 Methods

A combination of theoretical and non-theoretical methods including residents' self-perceived vulnerability and concerns about flood risk was employed to examine perception of flood risk by residents of flood-affected locations in the Northland. Affected areas identified as being affected by floods in newspaper reports in July 2021 were surveyed to confirm media reports before the administration of questionnaires. Additional vulnerable areas were identified from the Northland flood risk maps and from the record of the recurring flood problem in the past and from the vulnerability assessment published in August 2022. The areas selected for the case study are Kaitaia, Kerikeri, Hokianga Harbour/Region, Helena Bay, Ruawai, Moerewa, and Whangarei.

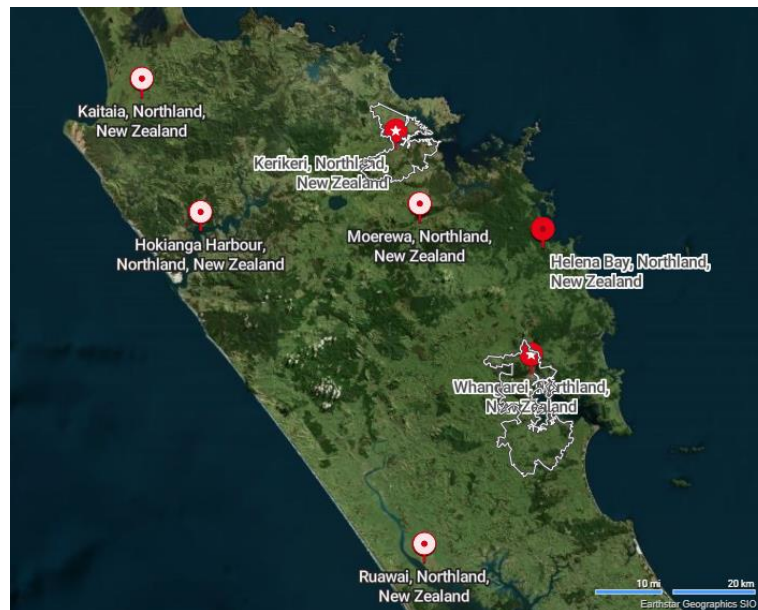


Figure 23 Location studied

A purposely designed semi-structured questionnaire comprising a mixture of closed and open-ended questions was designed to elicit information on the perception of flood risk by residents of selected flood-affected areas in the town. Respondents' household experience of the July 2020 flood event considered to be the worst flood event (1 in 500-year storm) in Northland in decades was also examined. Questions being asked to support the desktop analysis was as following:

1. Socio-demographic and residential characteristics of respondents: sex, age, educational attainment, occupation, residential status, duration of stay in flood-affected areas, etc.
2. Exposure indicators: distance of building from river or coastal
3. Sensitivity indicators: type of building structure, insured building
4. Respondent's past flood experience
5. Respondent's concern and perception of flood risk
6. Respondents' ratings of flood risk characteristics, overall level of flood risk and one seriousness-impact dimension

The questionnaire was administered by face-to-face interviews. The higher response rates achieved by face-to-face interview surveys relative to postal and other types of surveys have been acknowledged. Self-reported vulnerability was directly assessed by asking respondents to rate how vulnerable they perceived themselves to be to flood risk. The purpose was to understand perceived vulnerability using a risk-focused approach. By understanding how people think about a particular risk, insight is gained into how they think of themselves in relation to it and how they might respond to such risk.

## 4.4 Findings: Factors Influence Vulnerability

### 4.4.1 Location

Summarised from the literature, ideal areas that are inherently safe from flooding typically possess several characteristics that make them less prone to flood risks, such as higher elevation, distance

from water bodies, well-draining soil, flat and stable topography, and have no history of flooding. However, Northland's geography and climate make it a region with some flood-prone areas. Townships and settlements located near water bodies, on low-lying land, or with clayey soils are more vulnerable to flooding.

Assessed from the characteristics mentioned above, detail below is the assessment for the Northland region in general:

**Table 6 Northland vulnerability based on the location**

<b>Characteristic</b>	<b>Assessment</b>
<b>Elevation</b>	Northland has a diverse landscape, but some areas are at lower elevations, especially near the coast and rivers. This lower elevation can make some townships and settlements more susceptible to flooding.
<b>Proximity to Water Bodies</b>	Many of Northland's townships and settlements are situated near rivers, estuaries, and the coastline. This proximity to water bodies increases the potential for flood risk, particularly during heavy rainfall or storm events.
<b>Well-Draining Soil:</b>	While Northland does have well-draining soils in some areas, it also has regions with clayey soils that can retain water. Areas with clayey soil are more prone to flooding.
<b>Topography:</b>	Northland's topography varies, but the region does have some flat and low-lying areas, especially near rivers and coastal plains. These flat areas can be more susceptible to flooding.
<b>History of Flooding:</b>	Northland has experienced several notable flood events in the past, indicating a history of flooding in some areas. These past flood events suggest that certain townships and settlements may be at higher risk.

During an interview with the natural hazard coordinator, it was stated that ideally, what we (government agency) would like to see is that human settlements are avoiding these flood zones. However, rather than gradually reducing exposure to flood hazards, people are seeming to rapidly be increasing it. This does not only happen specifically in Northland, but also in the other growing township in the other region as well, not to mention the megacity like Auckland.

The reasons construction takes place despite the danger can be many, mainly due to the safest land might already be occupied, forcing new development to occur in hazardous areas that had once been avoided. Governments also want property-tax revenues. People want second homes. And waterfront living has long had a certain appeal. Other reason that is unique to New Zealand is because

the cultural value and respect to the occupied area, as it is believed that for Māori (native local community in New Zealand) who lived close to their ancestral marae were more likely to experience a range of positive cultural outcomes, and own their homes, than those who lived further away. Therefore, although some Marae (communal or sacred place that serves religious and social purposes) located in the flood prone area, it was difficult for the community to move as it mean more than a location or a space for them. Assessment from the site observation following the vulnerable location characteristic provided in the table below:

Table 7 Assessment from the site observation following the vulnerable location characteristics

	<b>Elevation</b>	<b>Proximity to Water Bodies</b>	<b>Well-Draining Soi</b>	<b>History of Flooding</b>
<b>Kaitaia</b>	Kaitaia is relatively flat and at a lower elevation	It is located near the Awanui River and close to the coast, which increases the risk of flooding.	The soil type may vary, but the proximity to the river and coast can influence the drainage characteristics.	Kaitaia has experienced some flooding events in the past.
<b>Kerikeri</b>	Kerikeri is situated at varying elevations, and some areas are lower lying.	It is close to the Kerikeri Inlet and the Kerikeri River, which can pose flood risks, particularly in low-lying areas.	Soil types vary in the area, and local conditions can influence drainage.	Kerikeri has had instances of flooding, particularly during heavy rainfall.
<b>Hokianga Harbour</b>	Hokianga has a diverse landscape, but some areas are at a lower elevation.	It is located along the Hokianga Harbour and has various rivers, which can lead to flood risk in specific areas.	Soil types can vary in the region, affecting drainage characteristics.	The area has a history of flooding during heavy rainfall and storm events.
<b>Helena Bay</b>	Helena Bay can have varying elevations, with some areas being elevated.	It is situated along the coastline, and while some areas may be elevated, proximity to the ocean can pose coastal flooding risks.	Soil conditions can vary in the region.	Coastal areas may be susceptible to storm-related flooding.
<b>Ruawai</b>	Ruawai is near the Kaipara River, with some areas at a lower elevation.	The Kaipara River's presence increases the potential for riverine flooding in certain areas.	Soil types can influence drainage characteristics.	Ruawai and the surrounding areas have experienced riverine flooding in the past.
<b>Moerewa</b>	Moerewa is at varying elevations, with some low-lying areas.	It is close to rivers, increasing the risk of riverine flooding.	Soil types can vary in the region, affecting drainage.	Moerewa has experienced riverine flooding in the past.
<b>Whangarei</b>	Whangarei is diverse in terms of elevation, but low-lying areas near rivers and the coast can be flood prone.	he presence of the Whangarei Harbour and river systems can contribute to flood risk in specific areas.	Soil types vary, and local conditions influence drainage.	Whangarei has experienced riverine and coastal flooding in the past.

The Northland Regional Council and other government agencies in New Zealand have undertaken various initiatives to help reduce the vulnerability of Northland communities to flooding. These initiatives aim to enhance resilience, provide flood protection, and mitigate flood risks. The two main pieces of legislation relevant to climate change and flood risk management are the Resource Management Act 1991 (RMA) and the Civil Defence Emergency Management Act (CDEM) 2002. The RMA requires regional authorities to control the use of land for the avoidance or mitigation of natural hazards. And in the building code, it is clearly stated that Homes should be built to withstand a 1-in-50-year flood event.

However, from the interview conducted in July 2020 during data collection, the government representative mentioned that if construction of a new building goes ahead on a site prone to flooding, minimise the risk by: ensuring the building is located on the highest section of the site building away from natural drainage paths or channels making the finished floor level of the lowest floor well above (600 mm minimum) the maximum flood level. the New Zealand government, in collaboration with experts and local authorities, provides recommendations and guidelines for building houses to mitigate flood risks. These recommendations can vary depending on the specific region and its susceptibility to flooding. For example, regarding the finished floor level, the council may have specific requirements under section 72 of the Building Act 2004. However, it is also highlighted that the first approach should be to limit or avoid building in the flood-prone location in the first place.

### **4.4.2 Climate**

The impacts of climate change in New Zealand, including Northland, are becoming increasingly evident. Climate change, as experienced globally, is already affecting the country. New Zealand's low-lying coastal and inland settlements are particularly vulnerable to the consequences of climate change, such as sea-level rise, intensified storm events, and more frequent flooding. In Northland, these challenges are exacerbated by the region's unique geography. Its extensive coastline and cultural significance to the Māori people make it particularly susceptible to rising sea levels and coastal erosion.

Northland's firm reliance on agriculture and tourism means that changing weather patterns and extreme events have direct economic repercussions. To address these challenges, the Northland community must engage in proactive and localised responses. These should encompass immediate strategies for addressing flooding and coastal erosion, such as enhanced flood defences and managed retreats, as well as long-term plans that enhance resilience. Effective responses should also involve knowledge sharing and community engagement, ensuring that affected communities are actively involved in shaping their own future.

Building resilience is essential, as some individuals and businesses may become more vulnerable due to potential disruptions. Ultimately, adapting to climate change should align with a shared vision for a positive future, incorporating both responsive and anticipatory changes that bring enduring benefits to people, businesses, and communities.

### **4.4.3 Community Knowledge and Experience**

In the context of flood risk management, risk perception is now widely acknowledged as a crucial aspect of subjective risk analysis. An understanding of community issues can be as valuable as providing a flood protection plan, as the end user of this plan will be the community. If it is not fit for

purpose, no matter how well we make it, the plan will not work. In the observation, it was found that intensive knowledge attainment and learning represent a prerequisite for community engagement in flood risk management and play an important role in the inclusion of the community groups.

The knowledge and the experience of the community translated into the response and decision to stay in the area. In the studied area, the communities have provided some insights based on their experiences. The majorly discussed flood event was summarised in each location.

**Table 8 Community decision to stay**

<b>Flood events</b>	<b>Response</b>	<b>Decision to stay</b>
<p><b>Kaitaia flood 2007</b> In March 2007, Kaitaia experienced significant flooding, particularly in low-lying areas. Many homes and businesses were affected</p>	<p>The community expressed concerns about the lack of flood protection infrastructure and the impact of heavy rainfall on the area.</p>	<p>Some residents chose to stay in Kaitaia due to various reasons, including ties to the community, and made efforts to improve their flood resilience through home modifications and drainage improvements.</p>
<p><b>Kerikeri flood 2007</b> Kerikeri has seen several flood events, with the most notable occurring in July 2007. Heavy rainfall resulted in significant flooding, causing damage to properties.</p>	<p>After these flood events, there were discussions within the community about the need for improved drainage and flood protection measures.</p>	<p>Many residents remained in Kerikeri, as it is a significant township in Northland, and they undertook flood mitigation efforts, such as raising their homes and improving drainage.</p>
<p><b>Hokianga Harbour – Cyclone Wilma 2011</b> The Hokianga region, including Rawene, experienced flooding during Cyclone Wilma in January 2011. Flooding affected homes, roads, and various types of infrastructure.</p>	<p>The community expressed concerns about flood vulnerability and coastal erosion.</p>	<p>Some residents in Hokianga chose to remain in the area due to strong community ties and historical significance. However, they also engaged in discussions about coastal protection and flood resilience measures.</p>
<p><b>Northland flood 2020 and 2023</b> Ruawai has experienced its share of riverine flooding, with events occurring during periods of heavy rainfall.</p>	<p>Kaipara has been identified as one of New Zealand's most affected climate change-affected regions. Ruawai is at risk of constant flooding, and up to 200km of the district's roads are at risk. Community members have discussed the need for better flood warning systems and improved river management to reduce flood risks.</p>	<p>Residents who have lived in Ruawai for generations have chosen to stay, while some have elevated their homes or built on higher ground to reduce flood risk. In 2021, the Raupo drainage committee, Ruawai, addressed the concern of the Northland regional council's newly released coastal flooding hazard maps.</p>
<p><b>Moerewa flood 2020</b> Moerewa, situated near the Kawakawa River (which receives tributaries from Otiria and</p>	<p>Community members have raised concerns about the impact of flooding on homes and infrastructure. Close to the Moerewa town, Otiria</p>	<p>Many residents have chosen to stay in Moerewa due to cultural and historical connections to the area and have worked on community-</p>

Waiharakeke Streams), faces riverine flooding during heavy rain and storm events.	community also greatly vulnerable to flood as in a big flood, about 80 percent of the water from the Otiria Stream spills over nearby land as does 70% from the Waiharakeke Stream.	based flood resilience initiatives. New bridge underway in March 2023 as part of Otiria-Moerewa flood works.
<b>Whangarei flood 2020, 2022, and 2023</b> Whangarei, with its river systems and coastal location, has experienced various flood events, including riverine and coastal flooding.	The community has called for improved flood protection infrastructure and better urban planning to address flood risks.	Whangarei is a significant urban centre in Northland, and residents have made efforts to adapt to flood risks by elevating homes and participating in community initiatives focused on resilience.

#### 4.4.4 Financial capacity

This section examines the intricate interplay between financial capacity, vulnerability to flood events, and the utilisation of flood insurance in Northland, New Zealand. A comprehensive understanding of these factors is vital in developing effective flood risk management strategies that enhance community resilience in flood-prone regions. The vulnerability of individuals or households to flood events is multifaceted and can be influenced by various socio-economic factors. Low income, age, poor health, low-quality housing, lack of social connectedness, limited education, and underemployment have been identified as contributors to greater vulnerability. In Northland, as of 2021, the Socioeconomic Deprivation Index (SocDep Index) serves as an aggregate measure, reflecting socio-economic conditions based on various Census indicators.

Despite being situated in flood-prone areas, the survey shows that approximately 50% of households in Northland have chosen not to obtain flood insurance. Several factors contribute to this phenomenon. Financial considerations are a key determinant, as some households find the cost of flood insurance prohibitive due to limited financial resources or competing financial priorities. For these households, insurance may be viewed as a discretionary expense. The perceived risk of flooding can also influence the decision to forgo insurance. Households that have not experienced recent or severe flood events may underestimate the potential impact, leading them to perceive insurance as unnecessary. Additionally, some households that have experienced previous floods and incurred damages may opt not to purchase insurance, speculating that the damages may not be severe enough to justify the insurance cost.

There are factors like the unique cultural values of the Māori community in Northland, which play a significant role in the decision-making process as well. For some, the deep cultural connection to the land takes precedence over potential flood risks. This cultural attachment influences the choice to remain in flood-prone areas. However, for those willing to relocate to safer areas, financial capacity limitations can become a barrier. To address the challenge of low flood insurance coverage in Northland and to enhance community resilience, several measures are proposed by the community. These include the development of subsidised insurance schemes for low-income households, comprehensive public awareness campaigns to educate residents about the importance of flood

insurance, culturally sensitive approaches that respect Māori cultural values, and the promotion of community-based flood preparedness initiatives. Additionally, government support for relocation options for those living in high-risk areas can help mitigate the impact of financial capacity limitations. Therefore, in conclusion, a multi-faceted approach that considers financial capacity, risk perception, cultural factors, and community-based strategies is essential to address the complex issue of flood insurance coverage in Northland. By promoting awareness and offering targeted support, Northland can enhance its community resilience and preparedness for flood events.

### **4.4.5 Community engagement**

Community engagement plays a vital role in flood risk management, impacting a community's vulnerability and resilience to flooding in several key ways. First, it contributes to land use planning. Communities actively involved in planning can ensure that new developments, infrastructure, and zoning regulations account for flood risk. Without such engagement, land use decisions may neglect local knowledge and priorities, potentially increasing vulnerability. Second, during emergencies, well-engaged communities are more likely to respond effectively to flood events, aiding neighbours and first responders through spontaneous volunteering. Third, organised community groups that form because of community engagement are trained and prepared to respond to floods, playing crucial roles in evacuation, rescue, and relief efforts.

Until recently, the government's approach in New Zealand typically involved public consultations and community involvement in flood management plans. Educational programs to increase public awareness about flood risks and preparedness are essential. A unique aspect for Northland is its rich Māori heritage and traditions. Engaging with local Iwi (Māori tribes) and recognising their unique cultural values and traditional knowledge related to the region's environment and waterways can be a significant step in building community resilience in Northland.

Learning from other best practices, internationally, countries like the Netherlands, Japan, and the United States offer valuable examples of effective community engagement in flood management. The Netherlands involves local communities in flood defence planning and management, fostering a tradition of cooperative water management. Japan's approach includes community-based disaster risk reduction, with local disaster management committees working closely with communities to develop evacuation plans and conduct drills. In the United States, the Community Rating System (CRS) program under the National Flood Insurance Program incentivises communities to engage in flood risk reduction activities.

Considering Northland's unique cultural value and Māori traditions, a tailored approach could involve engaging with local Iwi and incorporating their traditional knowledge into flood risk management plans. Supporting and promoting Māori-led community groups involved in flood response and resilience-building efforts is crucial. Emphasising the importance of preserving cultural heritage in flood-prone areas and incorporating it into land use planning can further strengthen community engagement. Developing bilingual or culturally sensitive educational materials on flood risk and preparedness is also essential to ensure that the entire community is informed and engaged.

Therefore, regularly reviewing the state of community engagement and adapting strategies based on the unique characteristics and challenges of the Northland region is crucial. Collaboration with local authorities, government agencies, and the community itself should continue to be at the

forefront of flood risk management efforts to enhance community engagement and reduce vulnerability in Northland.

### 4.5 Discussion

This study has addressed three central research questions to explore the dynamics of flood risk, vulnerability, and community resilience in Northland. By linking the findings with existing literature, it becomes evident that Northland's flood risks are shaped by both biophysical and socio-economic factors, which vary significantly across different community segments.

#### **What characteristics make Northland communities more vulnerable to flood risk impacts?**

A combination of geographic, economic, and social factors shapes Northland's vulnerability to flood risks. Geographically, the region's extensive coastline and low-lying topography expose it to coastal inundation and erosion, compounding the risks associated with rising sea levels and intensifying storms due to climate change (Mason et al., 2021). This geographic susceptibility aligns with findings by McAnulty (2022), who highlighted that coastal and low-lying areas are particularly at risk from flooding, especially as climate change accelerates extreme weather events.

Economically, Northland's dependence on agriculture and tourism makes it particularly sensitive to the effects of climate change, as both sectors are vulnerable to flooding and extreme weather (Mason et al., 2021). Additionally, limited financial resources and inadequate flood protection infrastructure exacerbate the region's vulnerability, echoing the findings of (Wisner, 2004), who emphasised that areas with lower financial resources often struggle to implement effective mitigation measures.

Furthermore, varied levels of community knowledge and awareness regarding flood risks contribute to differential vulnerability. As discussed in the literature, individuals with limited awareness or understanding of climate change are less likely to take proactive measures to reduce their flood risk (Levine et al., 2007). This highlights the importance of education and awareness in building resilience against future floods, a key point also emphasised by McAnulty (2022).

#### **How will impacts be experienced differently by the more vulnerable?**

The study's findings indicate that vulnerable populations within Northland experience the effects of flooding differently, with significant disparities in access to resources for resilience. Communities with limited financial means face higher vulnerability, as they often lack the capacity to implement mitigation measures or recover from flood events. This finding is consistent with the literature on social vulnerability, which highlights that marginalised groups, including low-income households, face greater challenges in dealing with the impacts of disasters (Wisner, 2004).

Moreover, uneven access to information and resources exacerbates these vulnerabilities. As discussed by (Levine et al., 2007), the overuse and abstraction of vulnerability in disaster management literature can lead to confusion, but it is clear that differential access to preparedness information and flood response resources contributes to the varied experiences of vulnerable groups. In Northland, this disparity in preparedness and response reflects the broader trends seen globally, where vulnerable populations often bear the brunt of disaster impacts due to systemic inequalities (Cannon, 1994; Yoon, 2012).

### **What strengths do they also have that will assist in responding to impacts and adapting to recurring floods?**

Despite the vulnerabilities, the findings also highlight several strengths that Northland communities can leverage to respond to and adapt to recurring floods. Local knowledge, based on historical experiences of flooding, serves as an important asset in adapting to future flood risks. Communities such as those in Kaitaia, Kerikeri, and Hokianga have demonstrated resilience through home modifications, drainage improvements, and active participation in community discussions about flood resilience, as highlighted in the literature on community-based disaster management (Packenham et al., 2017). The literature emphasises the importance of local knowledge and community engagement in building resilience, a theme reflected in the study's findings, where community-led initiatives were key in flood preparedness.

Additionally, Northland's strong cultural ties to the land and coastline provide a unique source of resilience. As noted by the Mason et al. (2021), community engagement is crucial in fostering resilience, and in Northland, this engagement is deeply rooted in cultural and historical connections to the land. The sense of identity and community cohesion, strengthened by these ties, fosters collective action and a shared commitment to resilience, particularly in the face of flood risks. This aligns with the broader research on the role of social networks and community-based action in disaster recovery and preparedness (Giddens, 1994).

Furthermore, the agricultural and tourism sectors in Northland, though vulnerable to climate change, also present opportunities for economic recovery and adaptation. The strengths of these sectors, when harnessed effectively, can contribute to long-term resilience. The ongoing efforts of local organisations, supported by government and community-based initiatives, underscore the potential for resilience building in Northland through the integration of cultural, economic, and community strengths.

## **4.6 Conclusion**

Flood management in Northland, as in many other regions, has traditionally been governed by top-down decision-making and scientific expertise (Puzyreva et al., 2022). However, as flood risks become more unpredictable due to climate change, this study reinforces the need for a shift towards a more community-based approach. As the findings show, the involvement of local communities in flood risk management is critical for reducing vulnerability and enhancing resilience. This aligns with the literature emphasising the importance of community participation, as seen in Mason et al. (2021) and the research by Packenham et al. (2017).

To promote resilience in Northland, it is crucial to address key aspects of community vulnerability, including location, climate impact, awareness, financial capacity, and engagement. As McAnulty (2022) highlights, regions like Northland face significant challenges in adapting to flood risks, but these challenges also present opportunities for collective action. The study suggests several strategies for enhancing flood resilience, including:

- i. Promoting education and awareness campaigns to increase understanding of flood risks and preparedness.

- ii. Strengthening the local economy and financial resilience to support recovery from flood impacts.
- iii. Implementing effective early warning systems and improving forecasting and monitoring.
- iv. Collaborating with experts and agencies to develop comprehensive flood management plans.
- v. Encouraging community participation to empower residents in resilience-building efforts.
- vi. Investing in resilient infrastructure, including flood defences and disaster recovery mechanisms.

By addressing these aspects and taking proactive measures in each category, the Northland community can significantly enhance its flood resilience, reduce vulnerability, and adapt to the challenges posed by climate change. This study underscores the importance of community engagement and local action in disaster preparedness and recovery, which, if supported by appropriate policies and infrastructure, can lead to a more resilient future for Northland.

### 4.7 Author's Comments

The findings of this study significantly contribute to the broader discourse on flood risk management and resilience, offering valuable insights into the unique challenges and opportunities faced by Northland communities. The study emphasises the importance of integrating local context, cultural values, and community-based approaches into flood risk management strategies. These contributions align with the overarching thesis that effective flood management cannot solely rely on top-down, expert-driven solutions but must also incorporate grassroots engagement and local knowledge.

- a) **Enhancing Understanding of Community Vulnerability:** The study's findings provide a nuanced understanding of community vulnerability to flood risks, underscoring the complexity of factors that elevate vulnerability. The integration of geographic, economic, and social dimensions into the analysis highlights the multifaceted nature of flood risk, which is consistent with the existing literature (McAnulty, 2022; Wisner, 2004). By identifying the specific characteristics of vulnerability—such as reliance on agriculture and tourism, cultural ties to the land, and economic constraints—the study contributes to the broader thesis by emphasising the importance of tailored flood risk management strategies that consider local vulnerabilities and capacities. This is essential for designing targeted interventions that effectively reduce risk and enhance resilience.
- b) **Differentiated Impact on Vulnerable Groups:** A key contribution of this research lies in its focus on how different groups within the community experience flood impacts in varied ways. The study confirms findings from previous research (Levine et al., 2007) by demonstrating that vulnerable groups—those with fewer resources, limited access to information, and less awareness of flood risks—are disproportionately affected by flood events. These findings extend the literature on social vulnerability by showing how these disparities hinder recovery and adaptation efforts. This highlights the need for inclusive flood management strategies that specifically address the needs of vulnerable populations, ensuring equitable resilience-building opportunities.

- c) **Community Strengths as Assets in Resilience Building:** The study also contributes to the body of knowledge on flood resilience by exploring the strengths within Northland communities that support adaptive responses to recurring floods. As demonstrated by the active engagement of residents in flood mitigation efforts and the use of local knowledge and historical experience, the research aligns with the thesis that local engagement and community-based responses are essential for long-term resilience. By linking these community-driven efforts to the broader concept of resilience, the study adds depth to the literature on participatory flood risk management and underscores the role of social capital in enhancing flood resilience (Puzyreva et al., 2022).
- d) **Integration of Cultural and Social Capital in Flood Risk Management:** Northland's strong cultural ties to the land, particularly in communities like Hokianga and Moerewa, represent an underexplored but critical dimension of flood resilience. This study contributes to the thesis by illustrating how cultural and social capital can be harnessed to strengthen community response and recovery efforts. By emphasising the value of community cohesion and cultural attachment in flood risk management, the research calls for a more integrated approach that acknowledges the role of culture and identity in shaping resilience. This aligns with Levine's (2004) argument that cultural values and community identity can be powerful drivers of resilience, especially when leveraged in flood mitigation and adaptation planning.
- e) **Community-Based Governance in Flood Risk Management:** The study reinforces the thesis that flood risk management should evolve from a top-down, expert-driven approach to one that emphasises community-based governance. By highlighting the importance of local knowledge, collaboration, and active community participation, the findings demonstrate that bottom-up approaches are not only feasible but essential for building resilience in flood-prone areas. The research supports the broader shift towards more inclusive, participatory flood management frameworks that empower communities to take ownership of their flood risks and solutions. This contributes to the growing body of literature advocating for the decentralisation of flood risk management.
- f) **Practical Implications for Flood Resilience Policies:** The study's findings have practical implications for policy and decision-making in flood risk management. By identifying the critical factors that contribute to both vulnerability and resilience, the research provides a foundation for developing more effective flood management strategies that prioritise education, infrastructure investment, and community engagement. The insights gained from Northland's experience can inform broader policy discussions about flood resilience, offering a model for integrating local knowledge and community-based initiatives into flood management plans. This directly contributes to the thesis by suggesting that resilience is not just about mitigating flood impacts but also about building adaptive capacity through community involvement and support.

## Chapter 5

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Flood risk management in New Zealand: A case study  
of the Northland urban community

Published

**Chapter 5 Notes:**

This research was presented in CIB World Building Congress 2022.

The paper was published in open access journal, IOP Conference Series: Earth and Environmental Science, Volume 1101, Future-Proof Cities in 2022, with title: Flood risk management in New Zealand: A case study of the Northland urban community.

For examiners' review, please follow the guidelines of Massey University Thesis with Publication.

This chapter will answer the following research questions:

<b>Research Question:</b> <b>How can flood risk management (FRM) in Northland, New Zealand, be improved?</b>	
<b>Research Objective A:</b> <b>To identify current gaps in Northland’s flood management strategies, focusing on preparedness, response, and recovery.</b>	
<b>Research Objective B:</b> <b>To explore how flood risk management (FRM) in Northland can be enhanced through the integration of structural and non-structural measures.</b>	
<b>Sub Question i</b>	How effective are the current structural flood risk management measures in Northland (e.g., dams, stop banks, floodways) in mitigating flood risks, particularly during extreme events?
<b>Sub Question ii</b>	In what ways can community-based flood risk management (CBFRM) improve flood resilience in Northland, and what is the role of local flood working groups in this process?
<b>Sub Question iii</b>	What are the strengths and limitations of the legislative frameworks governing flood risk management in Northland, and how do they influence flood preparedness and response strategies?
<b>Sub Question iv</b>	How does urban expansion in floodplain zones affect flood risk in Northland, and what strategies can be implemented to address these risks through integrated planning and flood management practices?

**Abstract:**

The Northland River is characterised by having a short stream and large catchments. Heavy rains in the region trigger the rapid rise of the water levels and causes flooding, affecting the urban community in the flood plain with flash floods and river overflow as double threats. The government-initiated programs to protect urban communities such as 'predict and mitigate' but primarily focuses on physical infrastructure protection. While providing infrastructure is beneficial, developing a resilient community comprises more holistic strategies. There is a need for improving the local capacity to enhance resilience. A resilient, human-focused mitigation strategy which includes the affected communities, as well as the existing infrastructure, can reduce flood risks more efficiently. This paper explores the ways the Northland communities follow to mitigate existing flood risks, including their perceptions of the current flood protection strategies. This study investigates also the social and cultural elements that influence responses to flood risks. The main recommendation, of the study advocates a community-based risk management plan to complement the government's strategy to efficiently mitigate flood risk in the urban Northland.

Keywords: Community-based risk management, flooding, and urban community

### 5.1 Introduction

Over the last few decades, the notion of flood risk management (FRM) has become increasingly popular worldwide (Sayers et al., 2013). In the case of urban flooding, a thorough understanding of the influence of urban expansion on flood risk is a necessary component of good flood risk management. (Hemmati et al., 2020). There is a belief that integrating non-structural approaches is more beneficial than adopting infrastructure-focused approaches for flood management decision-making and practices (Sayers et al., 2015). The steering committee in New Zealand argues that the country requires the most nuanced possible flood risk management framework to minimise the distress and disruption caused by floods (Ministry for the Environment, 2008a). The steering committee highlighted the need for collaboration between central and local governments and the community in managing essential elements that contribute to flood hazards.

Flooding in Northland erodes public trust in the government's ability to manage water resources, lead responsible urban growth, and prepare for and respond to recurring and unpredictable emergencies (ANZ, 2020; Clent, 2020a; NRC, 2018; Reese et al., 2011). Flood management issues are typically caused by inadequate involvement in the FRM process with citizens, the private and non-private sectors, and civic volunteers (Head, 2007). Thus far, most flood protection efforts in the Northland have focused on physical infrastructures, such as flood protection infrastructure, erosion management, and channel maintenance (NIWA, 2016a; Northland Regional Council, 2012, 2022c). Individuals and communities are required to undertake primary responsibility for their health, safety, and livelihoods due to floodplain urbanisation (Albrito, 2012; Coles & Buckle, 2004; Snel et al., 2020). Both government and communities played the current leadership role in the FRM for its short-term and long-term plans (McSweeney, 2006; NRC, 2018). The local community is the finest resource for discovering insights gained from previous experiences and recommending future practices (Albrito, 2012; Kenney & Phibbs, 2015; King et al., 2007; Proctor, 2010).

This study uses a qualitative research method including an open-ended questionnaire, key informant interviews, and ethnographic interpretation. The study explores ways on how the central and local Governments can best manage elements contributing to flooding risk in collaboration with the affected communities. The study also documents the legislative, social, and cultural elements that influence the communities' risk response to flooding in the Northland. Furthermore, because climate change and uncontrolled development are expected to increase urban flooding in the future, general improvements to FRM could be made, such as developing long-term integrated strategies using planning tools and practices to address growing risk (Chan et al., 2018). We encourage governments to bring diverse viewpoints and build flood governance initiatives beyond engineering-based flood protection plans.

### 5.2 Literature review

A major cause of urban flooding is by poorly managed urbanisation (Jha, 2012), increasing areas of impermeable surfaces (Rubinato et al., 2019), poor flood management strategies (Tanwattana, 2018), lack of flood early warning systems (Bouramtane et al., 2021), and disposal of solid waste in drainage lines (Cook et al., 2019). Whilst urban flood issues are prevalent in almost every megacity globally, it also happens in small towns built on floodplain like in many cases within New Zealand. Ignoring policy

and regulations, people worldwide continue to encroach on flood-prone areas, narrowing the channel and reducing its carrying capacity (WMO, 2016). The New Zealand Steering Group for Flood Risk Management (2008) recommends respecting environmental limits and integrating FRM with sustainable land management to protect urban areas (Ministry for the Environment, 2008a). As a result, we must comprehend flooding in urban areas, the evolution of flood risk management (FRM), and flood policy and regulation.

### **5.2.1 Flooding in the urban environment**

Approximately two-thirds of New Zealand's population lives in flood-prone areas (Mason et al., 2019). A flood is a runoff into a river or stream that exceeds the channel's capacity and inundates typically dry terrain next to the channel (NIWA, 2016c). Flooding is a natural process, but it becomes a hazard when it impacts human lives or property. Floods may very well be predicted by monitoring rainfall and water flow patterns, and New Zealand can forecast all of this year's floods within a few hours (Morgan, 2015). In contrast, a flash flood is hard to predict and might occur unexpectedly, which can be caused by a storm or a dam leakage. Any flood can have economic, social, and cultural consequences for populations living in floodplain regions next to rivers and streams (Smart & McKerchar, 2010), as well as environmental consequences such as soil and channel erosion and instream habitat alteration (Cook et al., 2019; Richardson et al., 2014). Since floods first affected livelihoods, people have attempted to manage floods to protect lives and property (Penning-Rowsell & Becker, 2019; Sayers et al., 2015).

In the popular study about urban theory, Short (2014) writes that the insensitivity of urban planners to environmental challenges, also known as 'wounded cities,' has resulted in urban areas being prone to disaster, thus fostering public distrust. The probability of flooding has grown due to the rapid increase in impermeable surfaces and urban expansion (Rubinato et al., 2019). Likewise, when rain falls over an extended period, the intensity of urban floods increases. The likelihood of urban flooding is predicted to rise more as the climate changes (O'Donnell & Thorne, 2020). Like many other regions of the country, many townships in the Northland are built near rivers and the sea, making them vulnerable to both urban and coastal floods and flash floods exacerbated by the Northland's hilly terrain.

### **5.2.2 Global flood risk management compared to New Zealand**

Approaches to flood risk management established in Asia, New Zealand, the United Kingdom, and the United States are all heading in the same direction. Previously, they implemented a large-scale structural strategy to flood control, with all movement focused on flood protection structures. In today's practice, global flood management is increasingly shifting away from traditional technical standard-based methods and towards a risk management strategy that prioritises governance, policy, and community concerns. However, the implementation varies according to each country's characteristics, capacity, and challenges.

Each flood management approach recommends a particular set of treatments since flooding issues are always specific (Sayers et al., 2015). With the adoption of FRM in New Zealand, a longer-term, catchment-wide strategy is now feasible (Rouse, 2011). The decision-making process is based on an alternative trade between minimising life-cycle risks, promoting opportunities, and allocating resources (Sayers et al., 2013). Consequently, integrating the structural and non-structural measures becomes the centre stage in FRM research (Day, 2005). New Zealand introduced a catchment-based

strategy in 1941 for flood protection control at the local level (Hutchings et al., 2019). A portfolio of integrated multisector solutions can represent the benefits of a catchment-based approach. In New Zealand, it is comprised of structural and non-structural measures, as well as risk management tools.

### 5.2.3 Community-based flood mitigation

'How to invest in community engagement?' is a critical subject to consider while implementing community-based solutions (King & Cruickshank, 2010). To answer these questions, one must examine the government's current initiatives. The Northland Regional Council, for example, established the Communications and Engagement Strategy in 2018 to accomplish the council's long-term strategy's goals and priority areas (NRC, 2018). The regional council formed the catchment flood working group in response to the national government's pronouncement that "people should be consulted in decision-making regarding acceptable risk levels and mitigation efforts for local groups." (CAE NZ, 2005; Ministry for the Environment, 2010; NRC, 2018).

Local community groups have established a deep understanding of local environmental hazards based on their history and close contact with the land and resources (King et al., 2007). Knowing where the hazards are and how to effectively manage land are the first steps towards comprehensive urban flood management (Bignami et al., 2019; O'Donnell & Thorne, 2020; Wheeler & Evans, 2009). Furthermore, the local community believes that people may be protected from flood hazards by keeping the water safe and protecting the land (Gain et al., 2017; Zhang et al., 2018). Combining research and local knowledge provides valuable guidance for managing land use and protecting the catchment, allowing us to mitigate such threats.

Storm, flood, and landslide information and wisdom are prominently documented in Māori (indigenous people of Aotearoa New Zealand) oral stories and traditions (King et al., 2007; Saghir, 2019). The details of these events assist in explaining the causes of disasters and warning people about the nature of local environments (Kenney & Phibbs, 2015; King & Goff, 2010). Oral histories, songs, naming locations, and tales about natural hazards are part of the culture and offer a wealth of knowledge that contributes to understanding local natural hazards and future hazard management and mitigation (King et al., 2018; King et al., 2007).

Furthermore, it is critical to recognise that incorporating local culture and expertise into FRM entails more than just documenting and reporting. That is, the process should include members of the local community, their culture, and their knowledge. By allowing the community to take responsibility for hazard planning, response, and recovery, the knowledge they hold will become more than simply traditional wisdom and will play an essential role in all decision-making processes (Hickey et al., 2015; Šakić Trogrlić et al., 2019).

## 5.3 Methods

Three case study regions were chosen (Whangarei, Kaipara, and Far North districts). Key informant interviews, an open-ended questionnaire, and document analysis supported the research study. A qualitative approach was adopted, considering the need for an in-depth discussion with participants. The case study approach is a recognised qualitative design seeking meaning and understanding, using the researcher as the primary data collector and analyser (Merriam, 2002).

According to Williams (2007), qualitative data approaches allow for discovery within the study process (Williams, 2007). The importance of local factors in affecting flood occurrences and flood control measures prompted a more in-depth examination. As a result, interacting with community members allowed for a more in-depth discussion of these aspects, which are difficult to quantify statistically.

### 5.3.1 Study area and demography

Northland is one of New Zealand's sixteen local government areas, located on the northern side of the nation, surrounded by the Pacific Ocean and the Tasman Sea. The shoreline and river floodplain are home to most of the Northland population. Northland is the country's most rural region, yet its population is evenly distributed between urban and rural areas (Table 9). In the Northland, around half of the population resides in urban areas, a stark contrast to the rest of New Zealand, where urban areas account for 86% of the population and rural regions for only 14%. The regions were chosen because the town represents a small developing urban area, with most of its people coming from the surrounding rural areas. Many towns around the country share Northland's regional centre's characteristics (Figure 24), and it differs significantly from urban areas in metropolitan areas such as Auckland, Wellington, Christchurch, and Dunedin.

Table 9. Northland population by place of residence

Parameter	Region	As of June 2011,	
		Number	% Region total
Total Population	Northland	158,200	100%
	New Zealand	4,405,200	100%
	Position among 14 regions <sup>1</sup>	8th	n.a.
Place of residence			
Urban	Northland	80,120	51%
	New Zealand	3,795,460	86%
	Position among 14 regions <sup>1</sup>	10th	14th
Rural	Northland	78,080	49%
	New Zealand	609,740	14%
	Position among 14 regions <sup>1</sup>	3rd	1st

<sup>1</sup> The 14 regions are Northland, Auckland, Waikato, Bay of Plenty, Gisborne, Hawkes Bay, Taranaki, Manawatu-Wanganui, Wellington, Tasman/Nelson/Marlborough,

West Coast, Canterbury, Otago, and Southland. Source: Statistics New Zealand, Population Estimates and Projections, Census for 2001 and 2006 in Northland Regional Council information page: Society. (Statistics New Zealand, 2018)

Northland is one of the regions that have the lowest Gross Domestic Product (GDP) per capita of all New Zealand regions in 2020 (Statistics New Zealand, 2021). In contrast to the GDP, the region's urbanisation increases fast (MBIE, 2020). Following WWII, the community (mainly in the Northland) relocated from the countryside to the city, searching for paid jobs. During the 50 years from 1936, the world recorded the fastest urbanisation rates in history, as the migration of 83 per cent of New Zealand's indigenous population from rural to urban areas happened in the Northland (Derby, 2011; Caludia Orange, 2015). While Northland is New Zealand's least urbanised region, it has 194,600 people living in cities (Statistics New Zealand, 2021). As a result of urbanisation in flood plain zones, Northland is also one of New Zealand's most cyclone-prone and flood-prone locations (NIWA, 2016a).

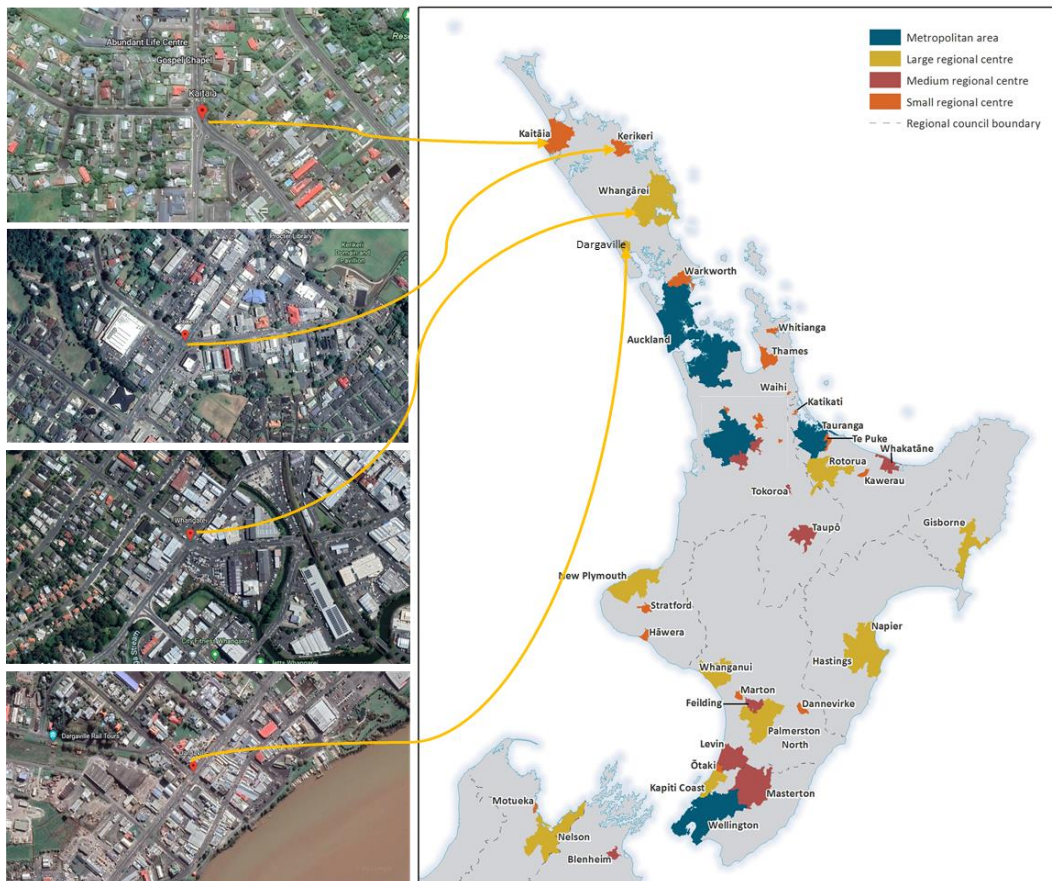


Figure 24. New Zealand urban area map and study area (Author 2025)

### 5.3.2 The area after flood events

Even though Northland has seen several local floods ranging from minor to significant occurrences over the centuries, the national popularity of flooding is lower than in any other significant region in the country. Flooding in Northland is challenging to anticipate due to various factors such as debris,

ground conditions, river channel, and fallen trees. From historical events, the 2007 floods were the worst in over 150 years, destroying 3,000 hectares of farmland in the Far North, 5,000 hectares of garlands in Hikurangi, and causing significant damage to crops, livestock, houses, communication infrastructures, highways, and business assets (NIWA, 2018; Westmount School, 2007).

Still, in 2007, after the towns had recovered from the March flooding, another massive flood struck in July, causing further devastation. Further, due to the flood in 2020, half of the population in the region was cut off from the major road network due to landslides, infrastructural damage, and submerged access (Clent, 2020b). The flood events have mainly affected the houses (Figure 25) and disrupted infrastructure to the point that the region's State Highway 1 (SH1) access has been closed for about a year for repairs from 2020 to 2021 (NZTA, 2021a, 2021b).

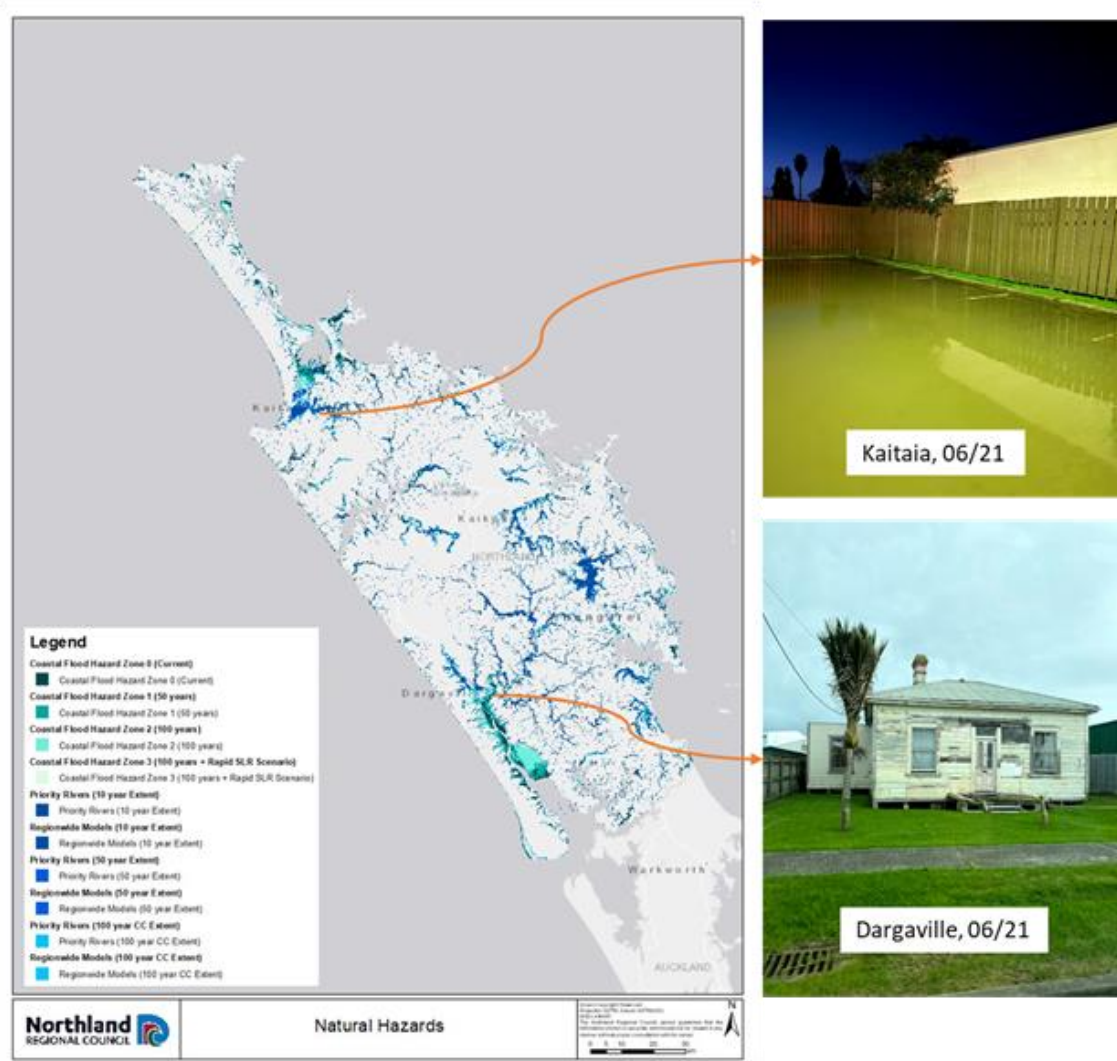


Figure 25. After flood illustration in flood zone for Kaitia and Dargaville

### 5.3.3 Data Collection and analysis

The data was collected through a field tour and attendance at three Northland flood working group meetings. The data then analysed under three themes: Structural measures, non-structural and

legislative measures, and emergency management measures. The open-ended questionnaire, key informant interviews (Table 10), and ethnographic interpretation were qualitative methods. The open-ended questionnaire obtained 110 qualified responses. The meeting was attended by representatives from local administration organisations and centralised agencies responsible for natural hazard emergencies and impacted company owners and households. The council and the flood group committee convened the meeting to review the flood mitigation strategy implemented in respective catchment regions. Every meeting session was written down, summarised, and utilised as a reference for the next scheduled meeting.

Table 10. Key Informants

<b>Categories</b>	<b>Identifier</b>
<b>Government Agencies:</b>	G.1
<b>Northland Regional Council, Whangarei district Council, Far North District Council, and Kaipara District Council</b>	G.2
	G.3
	G.4
<b>Experts:</b>	E.1
<b>Flood related engineers</b>	E.2
	E.3
<b>Community representatives:</b>	C.1
<b>Business, Cultural, and Farming sectors</b>	C.2
	C.3
<b>Flood meeting observation:</b>	F.1
<b>Kawakawa, Kaihu and Dargaville, and Kaeo Catchments</b>	F.2
	F.3

Document analysis. The literature review enhances and consolidates the knowledge base and helps integrate the finding in the study (Kumar, 2019). Planning papers were a significant foundation of the study since a significant emphasis of the research was researching how local governments responded to and managed the consequences of flood hazards. Documents used for this study included Northland Regional Council Long-Term Plan 2018-2028, Whangarei District Plan, Kaipara District Plan, Far North District Plan, Ministry for the Environment guidelines for local Government in New Zealand, and Northland Infrastructure strategy: Flood protection and control. Documents were chosen based on their relevance to the topic. Local government documents can be used to investigate how the local geographical setting influences policy and decision-making in these areas (Department of Prime Minister and Cabinet, 2019). The literature review helps to set the base knowledge to form the survey and interview questionnaire.

Site observation. A field trip to the Northland region was conducted in May-June of 2021 to allow face-to-face interviews with key informants, with the interview following a semi-open-ended structure. The other purpose is to see and experience the area, river system, drainage system, and flood protection infrastructure that operate in the area. The trip consisted of interviews in three districts and site visits, which were accomplished via a private vehicle. The site observation focused

on the areas with a history of the flood and areas marked in the Northland's flood hazard map as flood prone.

Interview and survey. Interviews were conducted with individuals identified as key informants, with the interview following a semi-open-ended structure for the case study based on Yin (2003) to make the point that critical informants can offer their insights (Yin, 2003). The approach also proposes different and new avenues of research that can be pursued, making them a valuable addition to any research (Yin, 2014).

The findings were then discussed with government representatives and the engagement representative during the flood discussion with the community. Input was made, and clarification on the events or conclusions taken from the interviews.

### 5.4 Findings

The study highlights several key aspects of flood risk management (FRM) in Northland, New Zealand, with a focus on structural, non-structural, and legislative measures.

#### 5.4.1 Structural Measures

Northland's flood protection infrastructure, including dams, stop banks, and floodway, dates to the 1950s. Despite its increasing asset value and growing urban development, the infrastructure's performance is limited when it comes to extreme flood events. As population centres and land use intensify within floodplain zones, the existing flood control measures are proving insufficient for large-scale flood events. The study indicates that while structural measures remain vital for managing ordinary floods, a more integrated approach is necessary to address the risks posed by extreme flood events.

#### 5.4.2 Non-Structural and Legislative Measures

Non-structural measures such as community engagement, flood preparedness, and legislative frameworks play a critical role in Northland's FRM. Community-based flood risk management (CBFRM) is a prominent feature in the region, particularly with flood working groups under national catchment authorities. These groups help design flood management policies, promote awareness, and encourage local involvement in flood preparedness. Additionally, New Zealand's flood-related legislation—such as the Local Government Act (2002) and the Civil Defence Emergency Management Act (2002)—supports regional councils and local governments in managing flood risks and coordinating emergency responses. The study found that these measures, although beneficial, require further integration and refinement to effectively address the challenges posed by climate change.

#### 5.4.3 Emergency Management Techniques

The role of emergency management agencies, including the National Emergency Management Agency (NEMA), is pivotal in coordinating flood responses. The study finds that partnerships between local authorities, regional councils, and agencies such as the NZ Defence Force are crucial for effective emergency response and recovery operations. Furthermore, NEMA's guidance on preparedness, response, and recovery has helped strengthen regional flood management frameworks. However, the study points out that while emergency management strategies are in place, improvements in community awareness and preparedness are needed to reduce vulnerability during major flood events.

## 5.5 Discussion

The findings of this study have several important implications for the future of flood risk management (FRM) in Northland and beyond.

### 5.5.1 Repurposing Structural Measures for Climate Change Adaptation

Most river management, drainage, and flood control projects date back to the 1950s. The value of the assets covered by these schemes has steadily risen to the point that it is now highly substantial. The scale of surrounding urban development has also increased. The sort of land use activities on this protected territory is more intensive than that originally anticipated during plan design and construction. A new view on the critical role that schemes play is now necessary.

The central government's long-term plan generally emphasises the structural management and floodproofing asset. However, less attention was given to the non-structural aspects of flood management, in this case, community resiliency measures. Efforts within flood risk management must create a solution based on community characteristics and cultural values. One of the focal points in flood risk management is preparing and increasing community awareness and the capacity of local government authorities to handle local flood situations. After many significant floods, the government launched several flood protection projects; however, it mainly focused on constructing a dam, a floodway, stop banks, and a floodwall.

The Awanui flood scheme, the Keo-Whangaroa flood scheme, and the Hopua te Nihotetea detention dam near Whangarei are the three primary flood management measures in Northland (Northland Regional Council, 2022c). The cumulative asset value of these three schemes is \$22.7 million (Northland Regional Council, 2018a). The council's flood infrastructure is minimal compared to other regions; however, this infrastructure strategy includes additional flood systems in response to demand. The need for flood protection and control works, unlike many other forms of infrastructure, is not directly connected to population expansion.

The data found that the need for flood protection and control works in Northland, unlike many other forms of infrastructure, is not directly connected to population expansion. Instead, demand is influenced by the following factors: a geographic expanse of population centres and assets located inside floodplain zones; public perceptions of flood danger and tolerable levels of flood risk and public perceptions of flood risk; and population density in flood zone that has an impact on service level expectations.

In the Northland, structural measures including stop banks, dams, dikes, and groynes are necessary and effective in preventing ordinary floods, which are relatively frequent. However, they have a limited performance against the extreme events that also occasionally happen. In many circumstances, providing adequate flood protection to settlements in Northland is neither physically viable nor financially feasible. An integrated strategy is required in this setting, such as working with communities to identify and map flood-prone regions, build community response plans, issue flood warnings, and carry out local river work to decrease flood risks.

### **5.5.2 Non-structural measures: The Importance of Community-Based Flood Risk Management (CBFRM)**

One of the study's critical insights is the importance of community-based approaches in enhancing flood resilience. Community flood working groups play a significant role in informing and guiding local flood management strategies, providing a platform for communities to participate in decision-making, and promoting flood preparedness. The study emphasises that CBFRM can complement traditional structural measures by integrating local knowledge and fostering a sense of ownership and responsibility within communities. This finding supports the growing trend in flood management literature, which advocates for a more inclusive approach that recognises the value of community engagement in building resilience (Albrito, 2012; Sayers et al., 2015).

#### **A. Catchment-based flood working group.**

Northland has the direction to utilise community-based flood risk management by having a flood working group under the national catchment authorities. The flood working group could be the platform to enhance the non-structural flood management approach. Aside from discussing the infrastructure for flood protection with the community, a risk-based approach and educational strategies can be introduced. Further, collaborating with the community to design the policy and regulations help to keep people away from flooding by controlling the land use and activities in areas subject to flooding. Also, involving the community in emergency management planning and emergency responses enable the communities to respond and recover from flooding effectively and efficiently.

The current national program for flood inundation and risk assessment provides an investigation of flood exposure according to the type of land use and risk to buildings, infrastructure networks, and long-term sustainability of flood schemes or defences (Serrao-Neumann et al., 2022). The flood working group can complement the program by providing a forum for researchers, iwi, stakeholders, and the government to discuss flood inundation hazards and risks and co-develop strategies for a more flood-resilient Aotearoa New Zealand. Each catchment group should work with case study communities to understand how they react to flood hazards and increasing climate change impact and to help them develop adaptation strategies.

#### **B. Regulatory framework in national and local level**

Many legislations in New Zealand exist to accommodate flood risk management. These legislations – Local government Act 2002, soil conservation and rivers control act 1941, and rivers board act 1908 – relate to hazard control measures such as providing stop banks, channel maintenance and clearance, dams, and the land drainage act 1908 for the drainage schemes. Several agencies also provide flooding information and education, including scientific and practical information about flooding and ways to minimise the impact of flood events (LIM & Local government official information and meetings act 1987). Civil Defence and Emergency Management Act 2002 provides the legislative framework for flood hazard preparedness, responses, and recovery measures (CDEM Act, 2002). Moreover, the government also provides disaster relief funding to assist local communities with the large-scale flood; however, flood loss insurance and financial assistance were usually provided by the Earthquake Commission ("Earthquake Commission Act 1993," 1993).

Based on the literature overviewing New Zealand legislations in flood management, this study summarises the legislative relation of the flood management and protection action work in the Northland Region (Figure 26) and the recommended change for improvement (Figure 27). Six main entities were linked based on their power and responsibilities to achieve this multi-level relationship chart.

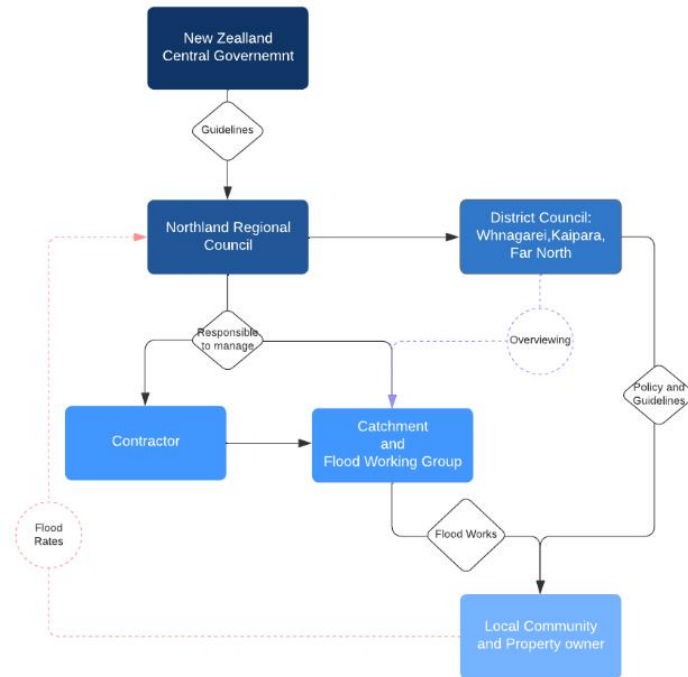


Figure 26 Legislative relation from central to local in FRM. (Adapted from NZS 9401:2008)

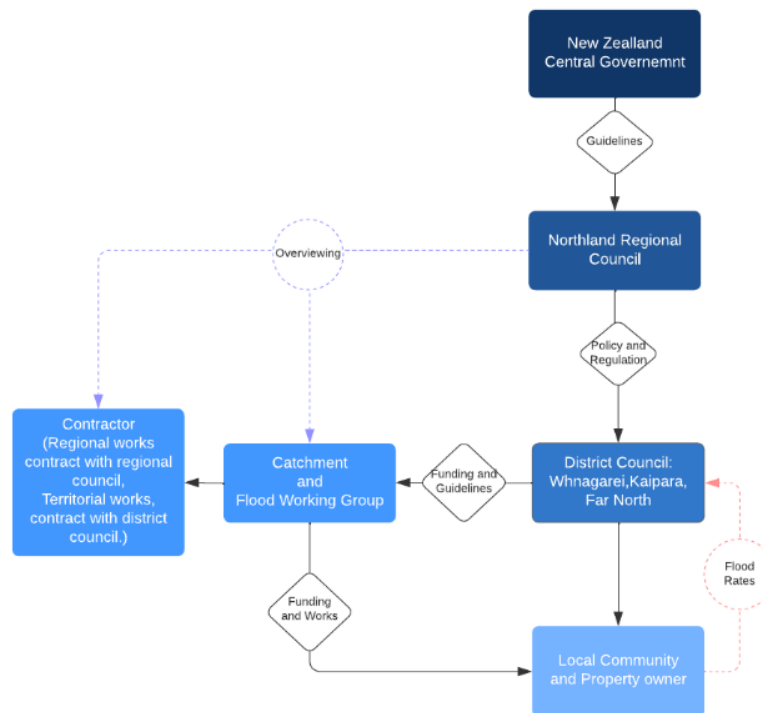


Figure 27. Recommended relation from central to local in FRM.

The central government gave the national direction to the local government in the sustainable management of natural and physical resources. Following this direction, FRM works managed under the Local Government Act 2002 and Soil Conservation and river control act 1941. However, the ministry can intervene in all local decision making to fund and facilitate flood mitigation works undertaken by the local council except for River Board Act 1908 (RBA) and the Land Drainage Act 1908 (LDA) (McSweeney, 2006). Since 1987, the central government has discontinued funding for flood control schemes, and there is no new regulation.

Following the standard NZS 9401:2008 and some other directions from the central government, the regional council is responsible for facilitating the consistent administration of the flood management act. The regional council also must ensure that the local policy is implemented. In flood works, the regional council is responsible for managing the flood working group under the national catchment authorities. In flood working groups, the council facilitates local communities' representatives and private landowners to discuss flood management. Further, the regional council is also responsible for managing stakeholders as contractors in carrying the flood work project.

The local government is then responsible for addressing soil conservation and flood management at the local level to give flood emergency disaster relief. They are also responsible for providing funding for a private owner, initiating flood and river management, stormwater, and drainage infrastructure. The local government also needs to ensure flood and drainage works' environmental and safety issues. Further, the local government supports private owners doing the flood work and the private landowner responsible for paying rates.

The central government managed the rates and distributed them to the catchment authorities and flood groups. The working group provides the funding for private landowners to carry the flood works in neighbourhoods. The flood working group committee is the representative chosen by the community group using the Term of Reference (TOR) created by the regional council, which have content specific depending on the diverse character of the community in the catchments.

Table 11. The flood risk management standard NZS 9401:2008

NZS 9401:2008	Current implementation in Northland
<b>Catchment-based management to provide a natural framework within which to manage the flood risk</b>	There are 28 priority catchments identified that provide flood protection under the flood working group. However, there are areas not included in the priority catchment that also prone to flood.
<b>Sustainable management brings natural and social systems together over the long term to provide a context for flood risk management decisions.</b>	The local government adopts the latest good practice and acknowledges and actively manages residual risk. Local councils in the Northland are provided with the resources, tools, and information about future climate change impacts. The study summarised by NIWA, conducted in 2018 'Climate change impact in the northland'. The study can be the baseline for decision-making in flood management.
<b>Adaptive management ensures that changes in natural processes, hazards, exposed values, and vulnerability are identified by monitoring and addressed on time.</b>	The adaptive management combining structural with the non-structural approach has already been initiated. However, the operation is at a slow pace. Adaptive management focuses more on the structural based solution. Even though the regional council facilitate the flood work meeting with the community representatives, the program and solution for Flood management still focus on infrastructure, river channel, flood gate, and river cleaning. More programs are demanded by the communities, such as educational seminars, workshops in flood mapping, understanding the early warning system or evacuation strategy.
<b>Risk management to encourage a broader assessment of strategies and options, anticipation of change, and awareness of residual risks.</b>	NIWA leads initiatives to quantify the risk of natural flood hazards and climate change impact. The risk management strategies are also embedded in the river and flood mitigation works, floodplain and catchment management, and infrastructure strategy.
<b>Comprehensive risk treatment strategies include reduction, readiness, response, and recovery.</b>	Following the New Zealand concept, Northland also implement the 4 Rs in the natural hazard management practices. However, the implementation of its strategy varies between the three districts of Northland (Kaipara, Far North, and Whangarei districts)

The literature concludes that New Zealand FRM is more regional with less involvement in national-level planning policy related to flood management. This situation may lead to inconsistency between regional councils. However, this approach equally allows different regions to implement the effective local solution to manage the flood. Moreover, the flood risk management standard NZS

9401:2008 and The Northland River Management Policy recommends a decision-making process and is not technical, prescriptive, or performance based.

### **5.5.3 Emergency management technique**

A partnership is needed to facilitate emergency operations. Coordination between governmental agencies, military forces, and other stakeholders in an emergency is essential. The National Emergency Management Agency (NEMA) provides important policy direction and advice to regional and territorial authorities on flood emergency preparedness, response, and recovery. NEMA becomes involved in emergency response. When more than one region is involved, international coordination is required, or national or central government resources (such as the NZ Defence Force) are required. The Ministry of Social Development can also assist people affected by floods. For example, residents affected by the floods can be provided with emergency payments for food, clothing, and bedding needs; reimbursements for items not covered by insurance including food or damaged property; payment for hotel, motel accommodation for people evacuated; financial assistance for people who have been evacuated and lost their livelihood; and Taskforce Green assistance to help with clean-up operations.

A Civil Defence Management Group (CDEMG) with representatives from all local, territorial authorities in the region and the Regional Council oversees regional emergency management. The CDEMG collaborates with the police, fire department, lifeline organisations, and other emergency response associations. Rainfall, river flows, and lake levels are all monitored by regional agencies, and flood protection is maintained. Staff from the council also calculate the expected rises in river and lake levels downstream and provide communities with warning information. Both regional and territorial authorities are required to monitor the state of the environment. Every five years, Councils must make available to the public the results of its monitoring of the effectiveness of its plans. Resource consents must also be monitored. This monitoring ensures those plan policies and rules remain effective in addressing issues such as flood management.

## **5.6 Conclusion**

Northland's lesson has pointed out that flood risk management implemented by communities and local government is crucial for urban flood protection. Communities and local governments can design solutions that are adaptable to the needs of their local communities and are consistent with the local culture, policies, and priorities. From the people's view, the flood risk management mechanism does not have to focus on the prediction and action approach, generally used for physical protection measures. Some catchments in rural Northland's experience showed that the success of flood risk management lay in community involvement which urban communities can learn and apply. Effective flood risk management requires close coordination among all areas, including floodplain and non-floodplain communities. Policymakers and urban development experts, both tangible and intangible aspects, should be well advised to listen to the communities and empower them to be the front part of the solution.

Further, the Northland region cannot be separated from the fact that rural areas have the most significant portion despite its population moving to the urban side. As rural and urban have different characteristics, different methods and measures should be taken to conduct the research. A study focused on rural flood risk management, and resiliency could contribute tremendous additional knowledge and contribution to the overall project.

## 5.7 Author's Comments

This research significantly contributes to the theme of flood risk management (FRM) and community resilience, advancing understanding of how integrated approaches can improve flood preparedness and response, especially in the context of Northland, New Zealand. The study provides critical insights into the limitations of existing flood protection infrastructure and highlights the essential role of community-based strategies in enhancing resilience to flood risks. By focusing on both structural and non-structural measures, the research offers a comprehensive view of how flood management can evolve to better address the challenges posed by climate change, urban expansion, and varying levels of community preparedness.

One of the major contributions of this study is its exploration of community-based flood risk management (CBFRM), demonstrating that flood resilience is not solely dependent on physical infrastructure but also on fostering a proactive, informed, and engaged community. The findings suggest that community participation in flood management processes—such as decision-making, flood preparedness, and policy development—plays a pivotal role in improving long-term resilience. This aligns with the broader discourse in the literature, which advocates for a more inclusive, collaborative approach to flood management.

Moreover, this research contributes to the understanding of the legislative and governance frameworks that support flood risk management, providing insights into how current policies can be improved and better integrated with local-level practices. It emphasises the need for coordination between central and local governments, as well as between governmental agencies and local communities, to ensure a comprehensive response to flood risks.

### **Key Notes for Government Consideration**

**Enhance Community Engagement and CBFRM:** Governments should prioritise community-based flood risk management approaches. Empowering communities to take a proactive role in flood preparedness and response—through initiatives like flood working groups—can significantly improve local resilience. By fostering community ownership, governments can ensure that flood management strategies are not only more effective but also better aligned with local needs and concerns.

**Integrated Approach to Flood Risk Management:** While structural measures (e.g., dams, stop banks, and floodways) remain important, the research underscores the need for a more integrated flood risk management approach that balances both structural and non-structural strategies. Governments should work with communities to identify flood-prone areas, develop comprehensive response plans, and enhance early warning systems to mitigate risks more effectively.

**Adaptation to Climate Change and Urban Expansion:** Given the increasing risks posed by climate change and urban expansion, the research calls for long-term, adaptive flood management strategies. This includes updating infrastructure to cope with larger flood events, revising land-use planning policies to limit development in flood-prone zones, and integrating flood risk considerations into urban planning processes.

**Strengthening Legislative and Policy Frameworks:** The study highlights gaps in the current legislative framework and suggests the need for refined and integrated flood management policies. Governments should consider creating more flexible, dynamic frameworks that allow for the

adaptation of flood management strategies in response to changing environmental conditions. Additionally, clearer guidance for local authorities on managing flood risks, coupled with more coordinated national and regional policies, could improve the effectiveness of flood mitigation efforts.

*Increased Focus on Preparedness and Education:* Governments should invest in public education and awareness programs that focus on flood preparedness, response, and recovery. The research suggests that enhancing community understanding of flood risks, improving flood mapping, and offering practical information on how to respond to flood warnings can significantly increase the community's ability to cope with and recover from flooding events.

In conclusion, this research provides valuable contributions to both the academic understanding of flood risk management and the practical implications for policy and governance. By incorporating both community-based and structural approaches, it offers a roadmap for creating more resilient communities and highlights the critical role that governments play in facilitating these processes. The findings offer a strong case for the need to reframe flood risk management as a collaborative, multi-layered effort that integrates infrastructure, legislation, and community engagement.

## Chapter 6

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Using community-based flood maps to explain flood hazard in Northland, New Zealand

Published

### Chapter 6 Notes:

Presented at the APRU Multi Hazards conference in 2021.

Published in the Progress in Disaster Science Journal in 2022 titled “Using community-based flood maps to explain flood hazard in Northland, New Zealand”

For examiners' review, please follow the guidelines of Massey University Thesis with Publication.

This chapter will answer the following research questions:

<b>Research Question:</b> <b>What is the status of the flood problem in New Zealand and its impact on the community?</b>	
<b>Research Objective A:</b> <b>To evaluate the usability and accessibility of current flood hazard maps for non-expert users in Northland.</b>	
<b>Research Objective B:</b> <b>To propose improvements to flood map design and dissemination, incorporating community-based knowledge and preferences to better serve flood-prone communities.</b>	
<b>Sub Question i</b>	How effective are the current flood hazard maps in communicating flood risks to communities in Northland, New Zealand?
<b>Sub Question ii</b>	What are the barriers to the accessibility, comprehension, and usability of existing flood maps for the public?
<b>Sub Question iii</b>	How can community-based approaches be integrated into flood map development to enhance flood risk communication?

### Abstract

Floods are among the most common and destructive disasters in New Zealand, and climate change is anticipated to make them even more frequent and severe. A clear and comprehensive flood map is critical to communicating flood hazard to communities at risk. Mitigation, adapting, and informed decisions making could be efficiently accomplished with the clear flood maps. However, existing flood maps appear to have been developed for professionals, and are complex, and not easily available for communities living in flood hazard areas. This study examines how, using flood maps, risk communication between local authorities and the communities can be improved. Observational surveys and in-depth interviews were used to acquire descriptive information and in-depth understanding of risks within the communities in the Northland, New Zealand. Thematic analysis of the findings revealed that the current flood maps are not easy to acquire and hard to comprehend. Without knowledge, communities develop a false sense of security, especially where there is inadequate risk communication and engagement with local authorities. This study highlights the need for a greater understanding of integrating community knowledge and experience with the current risk communication plans. Additionally, this study recommends developing more comprehensive and user-friendly flood maps using community-based information.

*Keywords: Community-based approach, Flood map, Flood risk, Risk communication*

## 6.1 Introduction

Flood risk communication and flood risk management are the keyways for reducing flood impacts. In Northland, extreme flood events, such as 2007 and 2008 in Kaeo, 2014 in Kaipara and Whangarei districts, 2017 floods in the Far North district, and 2020 floods in Whangarei, Kawakawa, and Moerewa, have shown how vulnerable communities are to flooding. The frequency and intensity of flood events in New Zealand may increase in the future as a result of climate change and therefore create new challenges both for science, authorities, and the population in general (Hagemeier-Klose & Wagner, 2009).

Based on the New Zealand Civil Defence Emergency Management – CDEM, flood risk management follows four phases under their emergency management plan: Reduction, Readiness, Response and Recovery. In Northland, a region in New Zealand, the river flood management program, together with New Zealand's flood preparation guide, suggests that readiness represents the most effective protection against local flood risks (Ministry for the Environment, 2008a, 2010; Northland Regional Council, 2018a). The government demands more detailed and extensive flood hazards and flood risk mapping and development to mitigate the effects of flooding (Ministry for the Environment, 2008a, 2010; Northland Regional Council, 2018a). The high frequency of flood events, response and recovery processes need to be effectively communicated to the public to prevent or reduce the impacts of flooding. Communicating the hazard using comprehensible and culturally informed flood maps to the public is an essential element in implementing and improving the New Zealand flood management strategy.

Flood hazard maps and flood risk maps have long been important tools in flood management (Crawford et al., 2018; Penning-Rowsell & Becker, 2019). A flood hazard map displays areas at risk of flooding and graphically depicts the extent and depth of inundation during major flood events, sometimes in conjunction with velocity profile (EU Flood Directive, 2007). Flood risk maps provide detailed information on the projected implications of major flood scenarios, such as affected people, physical damage, and economic loss (Dottori et al., 2018; Wedawatta et al., 2014).

Whereas experts can operate and interpret the information from the flood maps, untrained people find interpretation of flood maps challenging (Fang et al., 2021). The challenge in communicating hazards through maps has the potential to raising risk awareness but awareness raising is often not achieved (Stieb et al., 2019). Most of the flood hazard map design did not align with general people needs and preferences (Fang et al., 2021). Visuals, language, or access can be difficult for the public to understand and follow. Literature commonly cites that hazard and risk maps are generally vulnerable to an "all-purpose" approach, meaning that target users, hazard types, and risk characteristics are often generalised (Crawford et al., 2018; Fang et al., 2021).

In this paper, an observational survey and in-depth interviews were conducted to evaluate current flood hazard maps, used for communicating flood risk to public, both in print and on web mapping services. The objective was to understand how current flood maps could be enhanced with community-based information. The results contributed to enhanced flood risk communication by improving map products for the public because they included local information, cultural knowledge, and special requirements of the community of content, readability, and usability.

## 6.2 Literature review

As part of a flood risk management strategy, maps can be a useful tool for building a sense of personal responsibility in flood preparedness among communities and empowering them to make informed decisions (Mudashiru et al., 2021). Providing information alone to the public is not enough, but combining maps with information about reducing floods and disseminating it at regular times, through various channels, helps people to protect themselves and support initiatives at the local, provincial, and national levels. As part of this process, local governments also need guidance on how to communicate hazard risk, how to provide comprehensive information, and how to develop maps that integrate community-based information to encourage flood protection actions.

### 6.2.1 Risk communication

Communities' perceptions of flood resilience are influenced by a range of issues. For instance, how impressions of past events are translated, affects communities ability to resist, cope with, and recover from adverse flood impacts (Chowdhoree et al., 2019). Information about flood risks, flood protection, and personal safety measures is communicated through flood risk communication (Hagemeier-Klose & Wagner, 2009). The concept of risk communication is defined as the exchange of interactive information about the nature, opinions, issues, and strategies related to risks, between stakeholders – individuals, groups, or institutions – to perform informed decision making (DiClemente & Jackson, 2017; Hagemeier-Klose & Wagner, 2009). A flood risk communication program is a valuable way to connect the expertise and management implemented by practitioners with the development of local-level resilience in flood-prone communities (Rollason et al., 2018).

By communicating risks, people can develop a stronger sense of responsibility as well as to increase risk awareness among the population at risk and motivate them to take preventive actions and be prepared in case of an emergency (Maidl & Buchecker, 2015; Samaddar et al., 2012). The current flood risk management in New Zealand encourages individual-level responsibility to protect their own safety (Ministry for the Environment, 2008a, 2010). However, only part of the Northland's population at risk is aware of self-protection for flood, and only a few that actually doing something in their property (Reese et al., 2011). Many people think that flood protection measures are the responsibility of the government (Clent, 2020a). With risk communication, the knowledge level about personal responsibility about local flood hazards should be improved (Hagemeier-Klose & Wagner, 2009).

Studies in Germany, UK, and US have shown that people's perception towards hazard risks differ from what responsible authorities assessed. For instance, Handmer (2000) found that people perceive their neighbourhood to be relatively safe from floods, despite being located in the high-risk areas (Handmer, 2000). The purpose of flood risk communication tools, such as flood maps, is to inform the people about the flood risks in their particular area or location (Dransch et al., 2010). Additionally, risk communication can build trust, decrease tension, and increase confidence of local community to manage flood effects (Maidl & Buchecker, 2015). Flood maps need to incorporate specific needs of communities at risk to give them the possibility of making informed decisions according to preparedness and personal safety measures.

However, despite having a high risk and recurring flood events, the distribution of information of flood hazards is still ineffective due to various reasons (Hughes & Sharman, 2015). Inadequate information about past flood history, out of date information, and insufficient flood protection investment are

reasons for ineffective flood risk management (Febrianto et al., 2016; Mudashiru et al., 2021). Local distribution of flood risk information is often ineffective, and education and training are needed to engage the community and raise community participation (Handmer, 2000; Hughes & Sharman, 2015). Communicating hazards through maps has potential in enhancing flood management, but strategies to communicate and deliver the information through maps need to be improved.

### **6.2.2 Information in the flood maps**

The New Zealand government has been raising public awareness about flood hazards and encouraging the development of catchment-based flood mitigation (Finnis, 2004; Ministry for the Environment, 2010). In 2010, the government developed a number of initiatives in flood risk management to assist local governments in better managing flood risk and preparing for climate change (Ministry for the Environment, 2010). In one of the initiatives, flood map information, design, and publication were required to integrate community knowledge, culture, and preferences to avoid the gap caused by scientific language, uncommon references, and incomprehensive information (Dransch et al., 2010; Hagemeyer-Klose & Wagner, 2009; Rollason et al., 2018; Stieb et al., 2019).

For example, the 100-year flood term is frequently misconstrued by the public as a prediction that such a flood will occur just once every 100 years, while it actually refers to the likelihood of a flood occurring (Pitman et al., 2021). The idea of a 100-year flood compared to different flood return intervals is the most commonly referenced depiction of risk in New Zealand flood maps when expressing the hazard through maps (Walsh et al., 2020). The term "100-year flood" refers to the 1% possibility of a flood occurring in a given year (Ministry for the Environment, 2010; Pitman et al., 2021).

In New Zealand, the nomenclature and content of the information displayed on flood maps are held to a different standard (Haughton & White, 2018). The Northland region, for example, creates maps that illustrate a 10-year flood event as a base flood (Northland Regional Council, 2018b), while a conservative map uses a 100-year flood (Ministry for the Environment, 2010; New Zealand Ministry for the Environment, 2010). Consistency in how councils create flood maps, and standardisation in flood mapping language, is critical in developing the expected standard for the entire country (Law, 2017; Walsh et al., 2020). This type of development helps authorities clarify flood risk for the public.

The information provided in flood maps vary in different countries. Generally, in the Europe, flood maps include information to reduce the financial impact of flooding on individuals and businesses and limit the effect of flooding on new and improved infrastructure (Penning-Rowsell & Becker, 2019). Flood maps in the UK are mainly used for enforcing basic floodplain management laws (EU Flood Directive, 2007). In the US, flood maps provide accurate information as part of their policy to reduce the flood up to local level (USNRC, 2009). In Malaysia, maps contain information allowing residents to evacuate safely and efficiently under the uncertainty of flood hazard, thereby reducing the loss of life and the cost of damage (Ali, 2018). However, in New Zealand specifically in the Northland region, flood maps focus mostly on the zoning identification for flood risk (Northland Regional Council, 2021). Although it is helpful as a guide to the community about their risk of flooding, the zoning can create a false sense of security for communities living outside the flood zone boundaries (Day, 2005; Pralle, 2019). There is no disclaimer that floods may occur outside the flood zones.

In New Zealand, the Ministry for the Environment promotes flood maps created by professionals to identify flood-prone areas and enable appropriate responses to minimise flood impacts (Day, 2005; Rouse, 2011; Walsh et al., 2020). According to Treaty of Waitangi and the Resource Management Act 1991, the operational management of flood risk is the responsibility of regional government (Day, 2005; Rouse, 2011). Since flood management is handled locally, flood maps are also the responsibility of regional, unitary and territorial authorities. Figure 28 shows examples of river flood maps developed by Northland Regional Council (Northland Regional Council, 2021). Containing similar information, with the addition of potentially hazardous activities within the industry areas, Figure 29 shows the hazard maps developed by Local District Council (Whangarei District Council, 2021).



Figure 28 Regional council hazard maps for Whangarei area (Northland Regional Council, 2021)

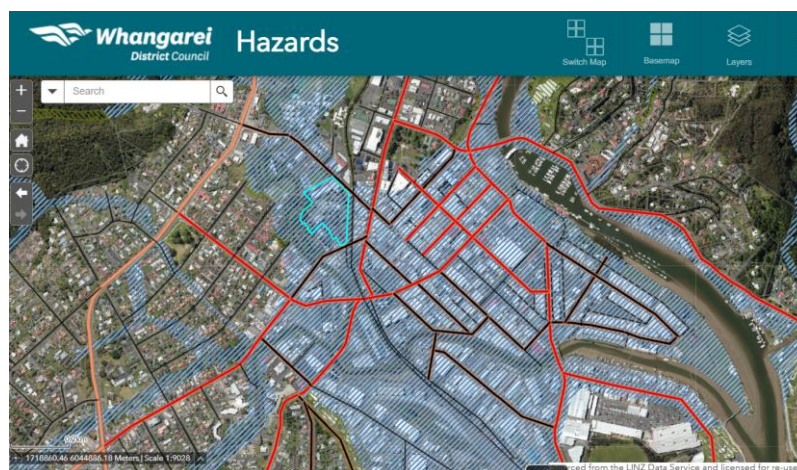


Figure 29 Whangarei district council flood hazard maps (Whangarei District Council, 2021)

Most hazard maps required expert interpretation (Thompson et al., 2015). Nonetheless, the purpose of publicly available flood maps to communicate risk cannot be met if the public is unable to use them. There are other limitations of the flood maps in evaluating and comprehending actual flood risk for any given property. Regions depicted on maps only indicate the area at risk for a particular flood occurrence called the base flood (Ali, 2018). Therefore, the property outside the specified flood hazard zone should not be understood to imply that it is not also at risk of flood damage (Lamond,

2012). Because flood occurrences greater than the specified base flood, such as 500-year or 200-year floods, occur unpredictably, such as the Northland flood in 2020 (Leahy, 2020) and the Canterbury flood in 2021 (Morton, 2021). Consequently, while property located outside the projected flood hazard zone may have a lower chance of flood damage, it cannot be deemed risk-free.

### **6.2.3 Flood maps and mapping process**

Flood mapping and flood zoning are necessary to mitigate the adverse effects of flooding by estimating flood characteristics such as depth, velocity, and frequency (Baghel, 2018; Mudashiru et al., 2021). Over the past few decades, effort has been made in understanding, predicting, analysing, and quantifying floods and their impacts. Common practice of flood mapping is by creating a computerized GIS database for the flood prone areas combined with hydraulic modelling software (Baghel, 2018). Recent studies about flood mapping often integrate the methods, or combine tools, to develop flood maps that works for pre, during, or post disaster following their objectives and needs (Mudashiru et al., 2021).

Research has developed more technology-based approaches, such as maps depicting flood susceptibility and hazard perception developed in Rwanda by Mind'je et al. (2019). Combining GIS, computer vision, and crowdsourcing, Alizadeh et al. (2021) challenges the conventional methods of mapping process in the USA by developing an intelligent decision support systems that integrates street level flood inundation mapping and data-driven routing system which works in real-time flood event situations. For post flood maps, Syifa et al. (2019) combined remote sensing imaginary and artificial intelligence techniques to develop water contamination maps as post-flood damage information that can be beneficial for mitigation action for future flood events.

Following the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR)(UN, 2015) to provide the protection at local level, community-based approaches are encouraged. The Sendai Framework promotes a transparent process and encourages consultation between stakeholders. Community-based approaches provide an infrastructure for efficient knowledge-sharing. Integrating community-based information in the flood mapping aligns the Sendai Framework approach with flood hazard risk management (Šakić Trogrlić et al., 2018; Tripathi, 2018), flood mitigation (Shaw, 2006; Smith et al., 2017), and also flood preparedness (Allen, 2006; Shariff & Hamidi, 2019). Sendai Framework goals are to actively engage community in their national, regional, or local disaster management programs. The process begins with participatory risk assessments and preparedness measures (Tripathi, 2018), local capacity building (Allen, 2006), developing early warning systems (Smith et al., 2017), and/or linking community activities with local policy development (Shaw, 2006).

In the early 2000s, Volunteered Geographic Information (VGI) arose in the public through online platforms such as OpenStreetMap (OSM). The platform accommodated the rise of community mapping projects to collect geographical data for pre-disaster, during-disaster, and post-disaster management (Louise et al., 2020). Community mapping is defined as the action of producing a map of a certain location together with, or by, the residents often featuring local knowledge and resources (Parker, 2006). The basic objectives to community mapping aim to collect data in order to create a map of community assets and resources within a defined area (Louise et al., 2020). A community map highlights people, physical structures, organizations, and institutions that can be utilized to create a meaningful local information. Using the technique of community mapping with local knowledge-based

information and community engagement, and advance tools in integrated flood mapping, flood map making can create visible and commonly understood information.

To create preparedness at a local level, flood maps created for the community must be used by them to be valuable. New methods and concepts, for example integrating community based information, local tradition and indigenous knowledge with Remote Sensing (Del Rio et al., 2018), Geographical Information Systems - GIS (Membele et al., 2021; Tran et al., 2009), and geo-located information have provided communities with participatory mapping solutions (Klonner et al., 2021). In this way, the affected community can increase their risk awareness, take responsibility for their own preparedness, and take part in the governance at a local level.

### 6.3 Methods

Observational surveys and in-depth interviews were used to acquire descriptive information and in-depth understanding of risks within the communities in the Northland, New Zealand. Thematic analysis of the findings revealed that the current flood maps are not easy to acquire and hard to comprehend. Without knowledge, communities develop a false sense of security, especially where there is inadequate risk communication and engagement with local authorities. This study highlights the need for a greater understanding of integrating community knowledge and experience with the current risk communication plans. Additionally, this study recommends developing more comprehensive and user-friendly flood maps using community-based information.

The research used a mix of quantitative and qualitative methods. Mixing quantitative and qualitative as a research approach is an appropriate option to investigate research questions that cannot be answered by either method alone (Ivankova et al., 2006; Shorten & Smith, 2017). To do this, a purposeful mix of data collection, analysis, and interpretation is required. By integrating data, researchers can gain a holistic view of their research landscape, viewing phenomena from multiple perspectives and through a variety of research lenses (Shorten & Smith, 2017). In this study, quantitative data were collected for evaluating the current flood maps, flood map usage, flood protection choices, and local flood risk management knowledge. The qualitative data were captured to gain an understanding into individuals' information preferences, decision making, flood experience, and factors that influenced their decisions on flood protection activities.

#### 6.3.1 Study Area

This study focuses on the area prone to floods and the floodplains in the entire territory of the Northland Region of New Zealand (Figure 30). The region is managed by three district councils, the Far North District, the Kaipara Districts, and the Whangarei District. Northland covers an average area of 13,789 km<sup>2</sup> bounded to the west by the Tasman Sea, and to the east by the Pacific Ocean (Caludia Orange, 2015). The region is characterized by hilly terrain with the highest point of 781m at Te Raupua which also the highest mountain across both Northland and Auckland (Northland Regional Council, 2022b). The geographical features contribute to the changes in the weather patterns and flooding incidences in the region (NIWA, 2016a). In fact, in the winter season (Figure 31), the area receives much rainfall resulting in landslides and flooding, while during summer (Figure 32) Northland is

vulnerable to droughts due to the climate characteristic and low rainfall intensities (NIWA, 2016a). Generally, floods in the Northland happen as a result of different factors such as climatic, topographic nature, environmental settings, ecosystems, and land development (NRC, 2012a).

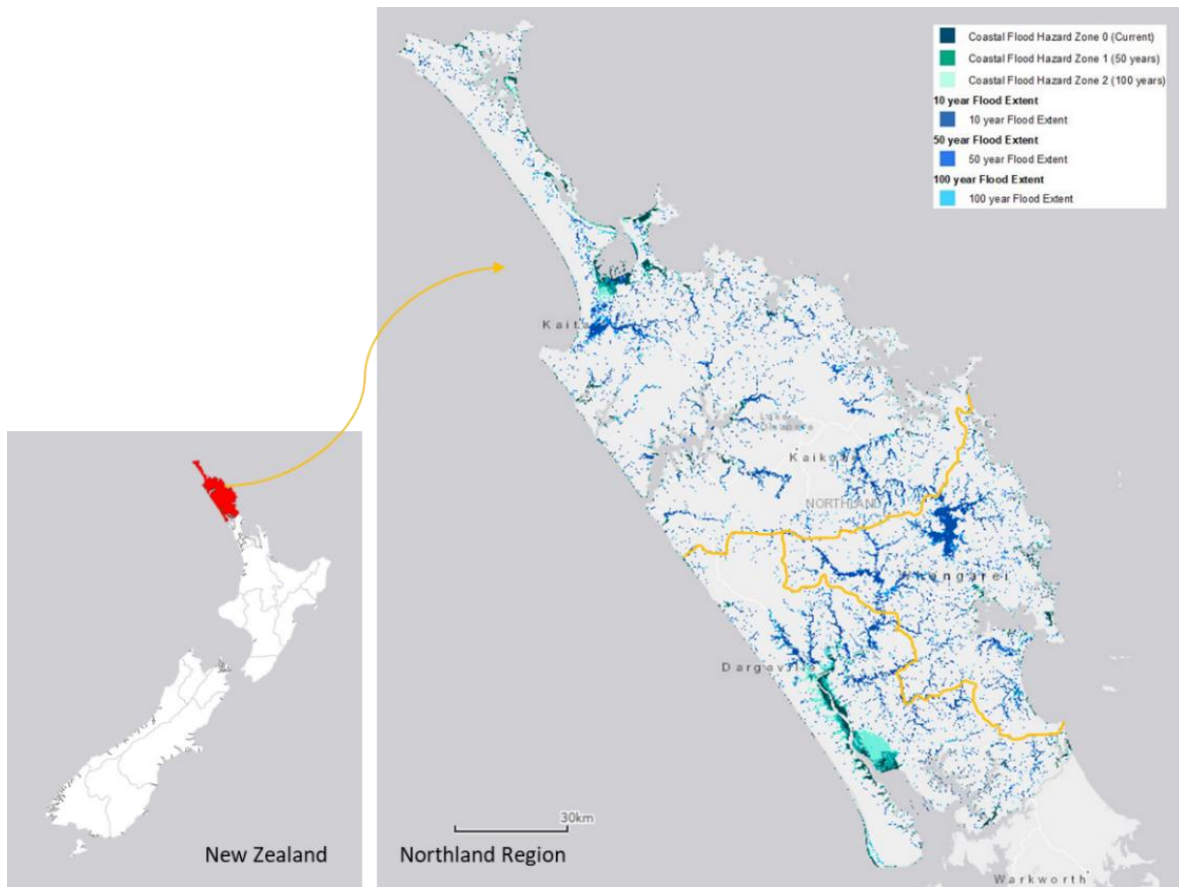


Figure 30 Northland Region in flood susceptibility maps modified from Northland Regional Council (2021)

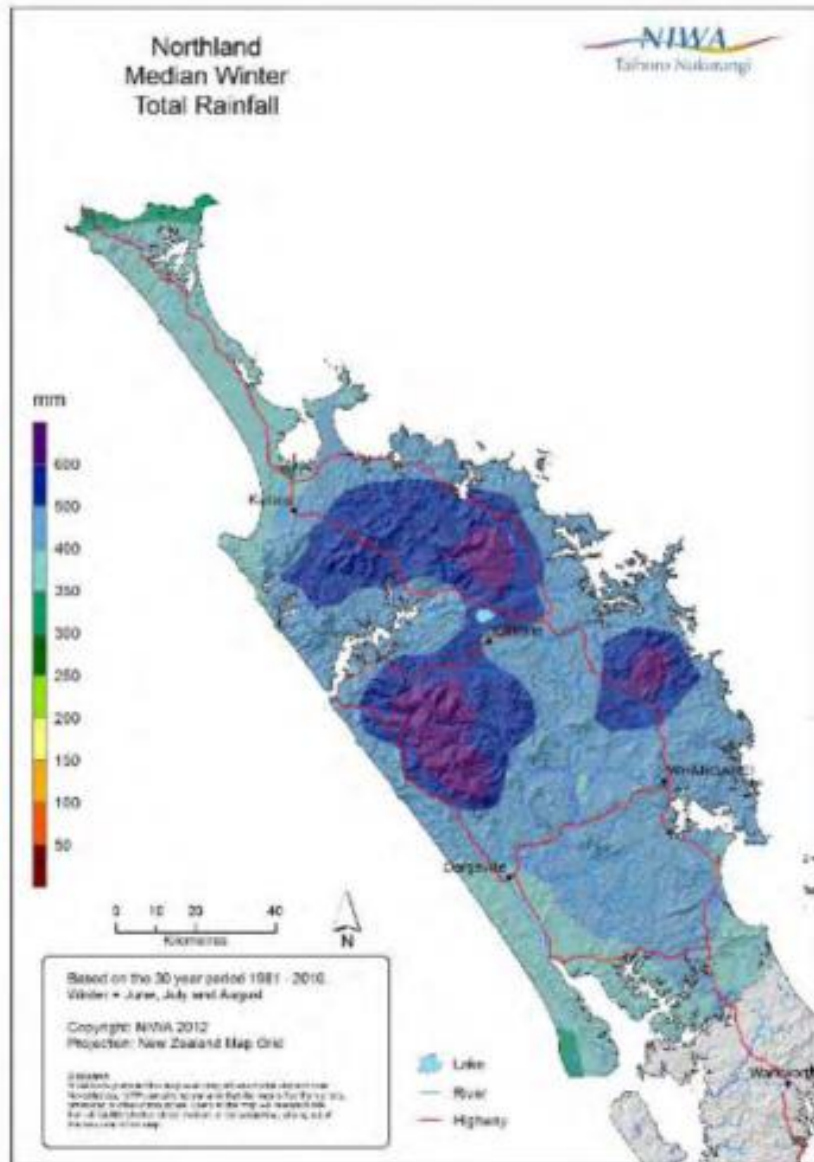


Figure 31 Winter rainfall median (NIWA, 2016a)

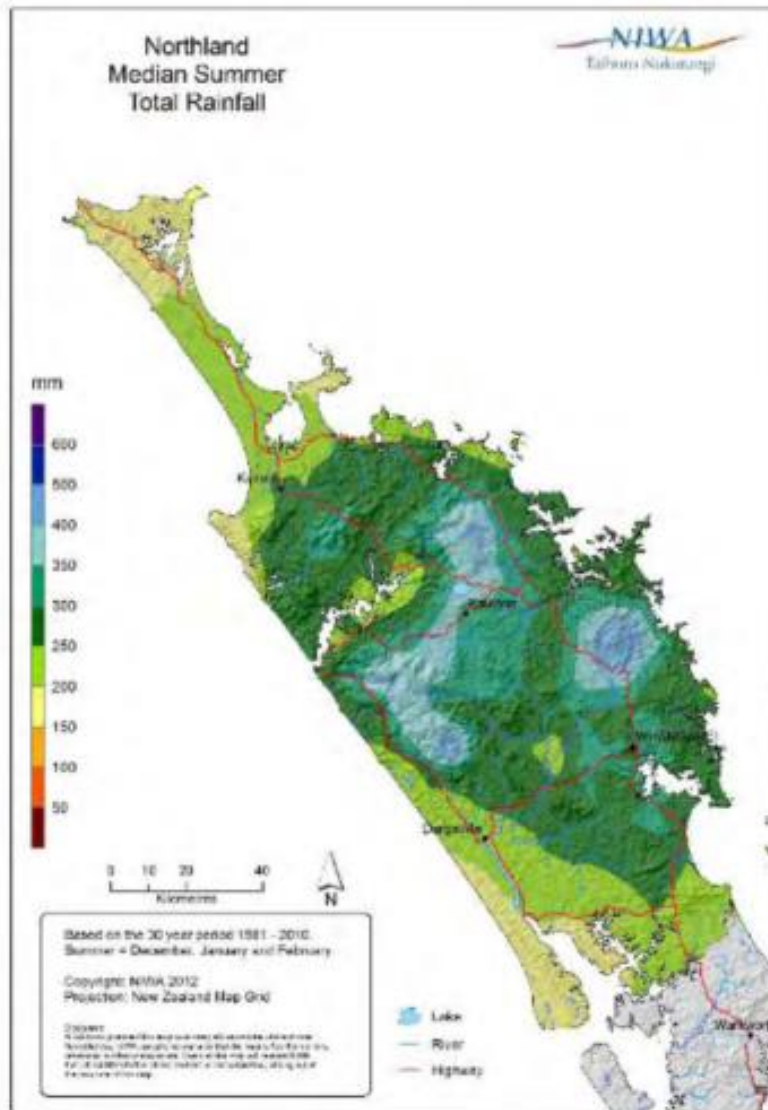


Figure 32 Summer rainfall median (NIWA, 2016a)

### 6.3.2 Survey

The study initially utilised a survey to collect data from communities vulnerable to flooding. The chosen sample consisted of communities at risk of flood hazards from three local districts in Northland. The survey was developed and validated through a process of disseminating it to colleagues and the final revisions was posted online and promoted to using various local social media advertisements. The survey was kept open for 30 days and targeting only users from the areas of Northland Region. The survey questions focused on three themes, population-at-risk identifications, risk communication management, and flood map evaluation (Table 12). In addition to the online survey interviews were carried out. Site observation and interview surveys were conducted in public libraries and community halls within the Northland area. The observation of river catchment meetings was also conducted. The results from the survey helped in mapping the area for field observations and conducting interviews.

Table 12 Survey questionnaire themes

Question themes	Data collected
Population at risk identification:  Demographic and household information  Flood experience and impacts	Data on affected areas, households, community, industries, and general information that affects the understanding of maps and flood risk. Further the questions ask about the impact on flood events in Northland from 2010 onward. This section discusses how the community responded to the flood events.  Key question: Do communities know their flood risk?
Risk communication and FRM:  Community and government perspectives	Collaboration is significant in flood risk management. This section provides information on the risk communication role and impact, protection actions, current flood works, and community participation  Key question: What are the current risk communication and floor risk management practices?
Flood map:  Publication, knowledge, and use	This section provides information on how the community views accessibility, instructions, features, visuals, and communication for reducing the impacts of flooding. This section also finds information on awareness and its effect on individual decision-making  Key question: What are the things that can make flood maps user-friendly?

### 6.3.3 In-depth Interviews

The qualitative data collection method allows for the collection of a large amount of information about behaviour, attitude and perception of interview participants (Kumar, 2019). This method helps to uncover more detailed and in-depth information to complement survey results. While conducting the interviews, it is important to avoid influencing participants but at the same time maximising the accuracy with which questions are answered (Fowler Jr, 2013). The in-depth interviews targeted experts, community representatives, and government agencies (Table 13), consisting of open-ended questions detailing the experience, awareness and knowledge level, and opinion for flood program improvement. Furthermore, the research used an interview approach suggested by Carpiano (2009), while conducting the interviews with community representatives, the researcher accompanied individual participants on outings in their familiar environments, such as a farms and neighbourhoods to gain more understanding of the flood problems being discussed.

Table 13 Key Participants for Interviews

Categories	Identifier
Government Agencies:	G.1
	G.2

Northland Regional Council, Whangarei district Council, Far North District Council, and Kaipara District Council	G.3 G.4
<b>Experts:</b> Flood related engineers	E.1 E.2 E.3
<b>Community representatives:</b> Business, Cultural, and Farming sectors	C.1 C.2 C.3

### 6.3.4 Analysis

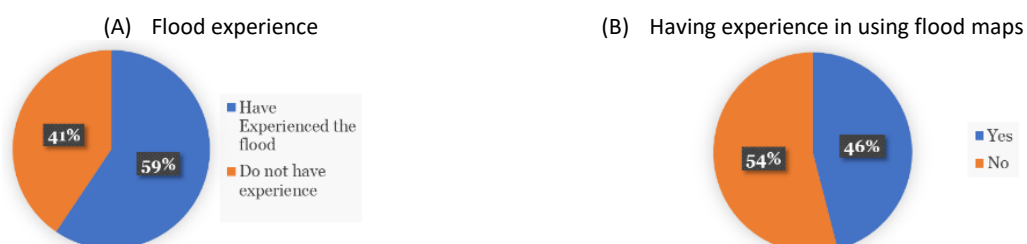
The survey and interviews were analysed using standard statistical techniques. Statistical analysis, thematic analysis was conducted on the data. Questionnaire data were analysed using Qualtrics software and their result summary excluded the incomplete and high value of nonresponses questionnaire result. While interviews were transcribed using standard description of the situation and thematic expression, as suggested by Kumar (Kumar, 2019). The interview transcripts were analysed using a thematic approach with the software NVIVO. The visual results of tables and figures were illustrated using various tools: GIS map, Photoshops, PowerPoint, and Excels.

## 6.4 Findings

The results are drawn from the findings summarising data of 185 surveys, 10 key informant interviews, 3 flood risk management meetings and 15 flood prone area observations. The results presented discuss the flood work program and risk communication issues, flood map influence in decision making, and public preferences for flood maps.

### 6.4.1 Communication and community engagement

Given the history of flooding in Northland, most people are aware of the flood risk as, from the results, it has directly affected 59 per cent of the research participants. Northland Regional Council has comprehensive approaches to managing floods. The Council published river flood hazard maps in 2016 for 28 priority river catchments with the greatest potential flood risk (Northland Regional Council, 2018b, 2021). These flood susceptible maps were developed mainly for flood hazard and risk assessment purposes and do not cover the whole river catchments. The maps are used to develop flood mitigation programs. When asked about knowledge of current flood work programs, 45 per cent of research participants were aware of government flood work initiatives in their communities. In addition to the government flood work programme, community level flood protection plays a more substantial role in protecting private homes. 62 per cent of research participants were satisfied that the community helps them better plan for flood protection at the household level.



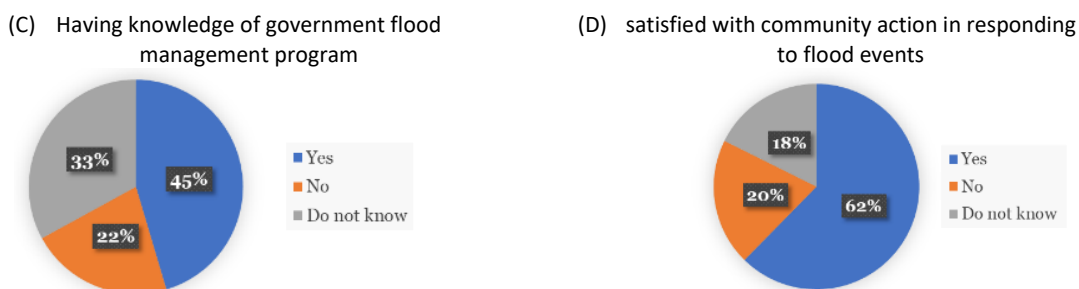


Figure 33 Flood experience (A), Flood maps experience (B), government flood work familiarity (C), Community response satisfaction (D).

Community meetings in the Northland are one of the efforts of engaging communities in flood works programs. However, lack of knowledge of community events and community programs exist. Several interviewees, as illustrated by the below quotes, felt that there was minimal public response in certain areas regarding the publication of the flood work programs and believed such programs were not well distributed among the community:

*The problem is not that they do not want to participate. It is because the majority [of residents] have no idea about the program update. People knew about the program, but they did not know about the meeting. (E2 and C2)*

*They do not even know about the meeting. They do not realise it until the representative comes or someone asks permission to access their land. (C.3)*

Regarding information distribution, the local government representative highlighted an information line where all citizens can ask questions regarding the systems and the transparency of the program. All meetings, schedules, and programs are available online and distributed to individuals who have subscribed to the mailing lists. Furthermore, the government encourages communities to share information on any public platforms that are available:

*The council website provides various information. All meetings, publications, and schedules were published there. Council also has people to assist the residents with any information they need from us. (G.2)*

*Anyone can attend flood works meetings; we collaborate with the communities. We encourage the community to circulate the information, we utilise community platforms available. However, we are also working to improve the publication system as we are also aware that some of the residents cannot access these platforms. (G.1)*

While nearly half of the residents were unaware of the government's flood work programme (Figure 6), the strong community ethos of protecting one another helps fill the gap in flood work programme publication. The use of online platforms to distribute information between communities

is encouraged. However, for some community members, who are unfamiliar with the online platform, or who have difficulty accessing such information, other strategies, such as using community notice boards in public places, posters, newspapers, and announcements in public places (groceries stores, libraries, prayer rooms, or schools) were suggested.

### 6.4.2 Northland risk communication issue

Because most of the Northland's towns are constructed on flood plains, affected interviewees were keen to learn about, and discuss, flood risk while discussing flood events. Unaffected people, however, tended to be uninterested in flooding and flood risk, since they are not personally affected. In some situations, analysis of flood maps showed their property was just outside of the flood zone, giving them a possible false sense of security, especially with climate change conditions increasing flooding in the area.

*Most people already know that the area has flood risk, but they are not happy with increasing the flood rates for extra protection because they are not directly affected. (E.3)*

*I think people living in the higher ground will not be interested in discussing this [flood risk] unless their access got affected (G.2)*

*Furthermore, it was asserted that locals were already aware of the flood risk in their regions due to the area's history of floods.*

*This town is well-known for its flood. Even the former Prime Minister visiting this town after a major flood in the past once said, "Geographically speaking, the town should not be built in here". But this is where my family is living, and this is my family land. Here people learn to live with the flood. (E.1)*

---

In other words, flood maps may not provide much benefit to those who have experienced floods and are familiar with the area's flood history and have mitigation strategies in place.

According to the research, most people believed flood maps are advantageous, with less than 5% stating the flood maps are not helpful. Those who felt them unhelpful, believed that many of the regions depicted on the maps were incorrect. However, the majority want to be informed about flood risk and potentially involved in the map-making process to improve map accuracy. The government provides a platform for public feedback on flood maps. The following show the level of understanding of flood maps and their uses.

*I do not use flood maps, but I know that my areas are prone to flood. My farm was flooded last year [2020] and 2019 too. (C.3)*

*I checked the flood maps on the last flood meeting, but the areas shown to be at risk is wrong. It said my land was not affected, but it flooded in a previous couple of years. They should consult with residents that living in the area. (C.2)*

*The maps are developed using computer models considering historic flood levels, topography, rainfall, and river flow to indicate areas potentially exposed to flood risk. (...) if you have information that you think may not have been considered, get in touch with the regional council (E.3)*

---

The research results showed that communities appear to value flood protection infrastructure and technical solutions as flood risk reduction measures because they believe this approach directly works to protect the area at risk. However, each region has limited funds for flood mitigation and raising the flood rate payment is problematic for the community. Northland Regional Council allocates the flood rate payment for mitigation projects. However, because not all community representatives attend the meetings, and some decline or do not get invitations, tensions can arise between members of the community and Council on fund use:

*They [Council] only invite groups that support them and leave us with a problem [proposed program]. Suddenly they came and said the community representative agreed on it. I do not feel represented. (C.2)*

---

Council response to those with complaints to the flood management programs can be seen in the following:

*All are welcome to the meeting. The group have TOR for nominating the representative; everyone should be represented as this work is for them and to help them. The regional council facilitates the meeting, but the flood work committees agree on the works. (G.3)*

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Limited funding, limited capacity, and disagreement with communities, combined with increasing flood management demand, are some of the issues being managed by the Council and community.

### **6.4.3 The relevance of information in flood maps for encouraging individual protection**

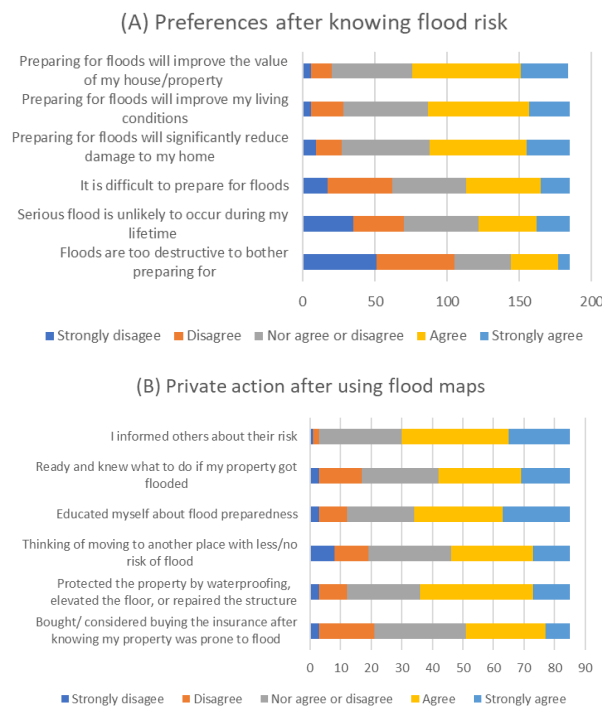
Local councils agree that flood maps assist in informing residents about the flood risk to their properties (G.2, G.3, and G.4). The local council advises individuals to examine their flood risk before purchasing land and constructing a home. The regional council's maps were regarded as one of the most essential components for promoting flood awareness and giving information for personal and community protection:

*The [flood] map is a great tool to show people their risk. You can say, "This is your house, and it is located in the flood zone. Here is the information about*

*flood insurance you might need, this is [the guidance] for saving your belonging, this is [the information] for planning the evacuation" (G.3)*

*Flood maps support the engineers to explain the flood works area to the public. They can show [to the public] the flood depth and flood return period and even explain land use or areas where building houses is not permitted. When your area gets flooded, to prevent the water going inside the house, having a flood gate or sandbags ready is always good" (G.2 and G.4)*

Further, the majority of those surveyed agreed that preparing for floods improves living conditions and that property values can also be improved. Most also agreed that flood protection is essential to reduce damage.



**Figure 34. Actions after knowing the risks (A) and using the maps (B)**

According to the survey results, the community believed it was their responsibility to prepare for flood risk, and flood maps gave helpful information. Almost every interviewee had a story on how communities help one other during floods. Shared knowledge has led to encouraging individuals to:

- i. Use flood-proof structure protection
- ii. Follow floodplain regulations.
- iii. Prepare an evacuation plan and a private flood response strategy.
- iv. Consider getting flood insurance

- v. Be more cautious when storing investments (farming tools, goods appliances that can be destroyed by floodwater)

When discussing with those who owned floodplain property and the options for improving personal safety, the following sentiments were expressed:

*We are our land. Our land provides our life. Finding another place is not an option, (...) we will lose our identity. We can protect our land and our house. (C.1)*

*People here know their risk. We are living [with the flood] and no problem. Everyone would understand and get ready if someone knew something, (...) helping each other during a difficult time. (E.1)*

*The residents actively protect the property after the flood, claiming insurance or raising the house level, cleaning the sewer, and building the wall. The local government supports every protection action by the community if they need any primary job done, which was discussed during the flood work meeting. (G.3)*

---

Flood maps highlight the risks, which empowers the community at the individual level of protection. However, one of the representatives stated that the technical terminology (e.g., return period) used in the maps meant nothing to the public unless they had personally experienced the flood (C.3).

#### **6.4.4 Public preferences and use of the maps**

As the flood maps are used for communicating flood risk to the community, knowing what kind of features, design, and operation that are preferable by the community on these maps is important. While all government representatives say that the community was involved in developing the flood hazard map, local council representatives (G.2 and G.3) noted that the mapping is mainly managed by the engineer in the regional council. The public can provide feedback on how to improve the maps. The current flood maps are regarded as a passive method of communication because flooding information is only offered to residents who request it, and input comes from those who are familiar with it:

*There was a recent update in the hazard maps in end of 2021, and the council encouraged the public to see and give their opinion. (...) we provide information when a resident requests or inquiries for further flood information. For example, "is my area in the floodplain? How deep is the water level? How frequent is the flooding?" for the answers, we will refer to the maps and other guidelines, all accessible on the website. (E.3)*

---

Personal local experience and awareness demonstrates the use of these maps:

*When my family was about to purchase some land for expansion, we had to comply with the resource and building consent, so we need to know if it is in the*

*flood zone because how we construct relates to where it is located [in terms of flood zone]. (C.1)*

*Some people believe that they will not be directly affected by the flood and just build the land as they own it, and some (buildings) are not recorded. The problem happens when they later need to claim the damage after the flood, without insurance, without a consent record, it is hard for the household to get help. (G.1)*

---

However, an interviewee believed that flood maps had little impact without wider distribution:

*The maps may be helpful in some people dealing with floods directly. However, the distribution to all residents must be conveyed; otherwise, such a good communication tool sits in the website corner waiting to be used. (E.2)*

---

In Northland, the government tried to develop a more proactive approach to flood mitigation by forming priority catchment grouping meetings. The maps helped to illustrate the problem and give the foundation data for flood mitigation efforts in the affected areas. Hazard maps were explained at the meetings, along with techniques for residents to secure their property, as well as guides for self and community protection, insurance, and how to safeguard their farms and businesses. The results of the survey showed that information can be hard to understand.

*After looking into flood maps and flood works proposals. The new infrastructure works might stop the flood in one area, but how to ensure that it will not impact the land surrounding it? (...) now we cannot build in our land as the access often get flooded because of the river channelling. (C.2)*

*I don't really understand where I can get the required data for insurance or construction purposes when I need information. I cannot get the printed document too. I often contact the council directly, or sometimes the property agent. I don't really know what I can and cannot do in my area [property located in flood zone area] (C.3)*

---

Furthermore, the surveys show that flood maps provide certain information about the flood risk to the area and that the language and instructions are straightforward for most people to understand. However, more than a quarter of respondents (44%) claimed that it is not easy to access, to print, and locate their property on maps (Figure 35). Although the functionalities are simple for some, users must become accustomed to the design and graphics before completely comprehending the information provided in the maps.

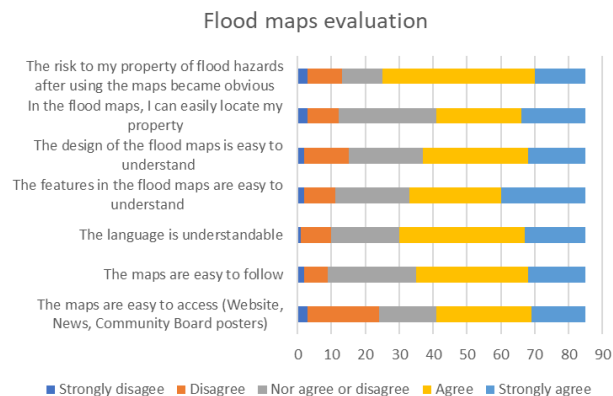


Figure 35 Existing flood maps evaluation (before the December 2021 flood maps update)

## 6.5 Discussion

The research has demonstrated how flood maps are used in Northland. The result provides information about Northland risk communication, flood management, and current flood maps capacity as a tool to communicate flood risk. One way to improve flood risk communication to the community in the Northland is to find a more effective way to disseminate the information to those that find it difficult to access current information, including providing developing more user-friendly, less technical maps.

According to researchers, hazard mapping quality, content, and visual design are not the only variables that must be considered (Klonner et al., 2021; Tripathi, 2018). Effort is required to make the map design more appealing and intuitive to the community (Hughes & Sharman, 2015). The findings from the surveys indicate that some individuals do not understand the maps and are not engaged in the community forums which promote flood risk management mitigation. The results showed that the community generally wants to be included in the flood management process, including in designing flood management programs. The flood works forum has been used to create more active communication between the Northland Councils and the communities (Northland Regional Council, 2022b). However, further work needs to be done to make sure all those who want to participate can attend the forums and have their say. Currently, to get the data community needs a person to be proactive by requesting information from the Council.

Flood risk management in New Zealand encourages individual-level responsibility (Ministry for the Environment, 2008a, 2010). However, based on the survey results, not all of Northland's population at risk are aware of how self-protection for flooding works, and fewer appear to be doing something to protect their property. Reasons for this include a belief that Council is responsible for flood protection measures funded by the local flood rates. To improve the community knowledge of flood impact and flood risks, effective distribution of information as well as community engagement are crucial to develop flood resiliency. One aspect of flood protection from the results was the strong community bonds and the reality of protecting each other in adversity.

The research showed that half of the respondent living on the flood plain in Northland did not feel the threat of flood hazards as their property was not in the high-risk zones. Ali and Lamond have shown that even though property outside of the projected flood hazard zone may have a lower risk of

flood damage, it cannot be deemed risk-free because susceptible maps only show the area at risk for one particular flood event (Ali, 2018; Lamond, 2012). Respondents living outside flood zones still require flood management information.

Hagemeier-Klose & Wagner suggest that when the community becomes involved in the flood mapping development process, the Council will understand community preferences better, and the community will understand flood mapping better by participating in flood mapping creation (Hagemeier-Klose & Wagner, 2009). In Northland, the Council encouraged people to give feedback on the flood maps, suggestions to incorporate local knowledge and how to make the maps more usable for the local community.

The Northland flood maps were developed using computer models taking into consideration historic flood levels, topography, rainfall and river flows to provide an indication of areas potentially exposed to flood hazards and subsequent potential risk (Northland Regional Council, 2018a, 2021). As the results show, the maps' display can be difficult for people to use. In the study, more than half of the participants can follow the instructions on the flood maps platform, but other participants require additional support to fully comprehending the material. Therefore, efforts to improve map quality, information, visual design, and how maps are displayed and communicated are critical to develop maps for community at risk. This includes helping people gain access and utilise technology and making the maps easier to interpret.

### 6.6 Conclusion

Flood hazard maps can effectively communicate the hazard risk and help people to improve protection of people and places. Flood maps can clarify the risk and demonstrate the impact of climate change associated with flood hazards, improve people's knowledge and enabling discussion about the risk at the local or individual level. This study showed the use of flood maps and how the use of these maps can be improved. The outcome shows that the current flood prevention program has certain challenges with disseminating information among community groups. The flood working groups for priority catchments try to reach as many people as possible, but in future might need to develop ways of reaching all vulnerable community members.

However, what is evident from the research is that the region has a strong sense of community and community assisting each other in times of adversity and that people are interested and willing to be involved in flood map development and flood management programs. Internationally, risk communication assists people in minimising damage by being prepared and knowing how to respond to a hazard. Community-based flood maps are critical for raising awareness and strengthening social networks, improving community resilience. Councils in Northland are already working closely with communities, but this research should help strengthen areas where there are identifiable problems, including suggestions on how to make improvements.

### 6.7 Author's Comments

This research evaluated the effectiveness of current flood hazard maps in Northland, New Zealand, and proposed strategies for improving flood risk communication through community engagement. The findings addressed the research questions and objectives by revealing key barriers to accessibility, comprehension, and usability of the maps and identifying actionable steps to overcome these challenges.

The study demonstrated that current flood maps, while useful for professional applications, are not fully effective for community-level risk communication. The primary barriers include technical language, visual complexity, limited distribution, and insufficient integration of local knowledge. These limitations hinder community awareness and preparedness, thus highlighting a critical gap in existing flood risk communication strategies.

By involving community feedback, the research provided evidence that integrating local knowledge into map design can enhance both trust and usability. Recommendations included simplifying map visuals and language, ensuring consistent and comprehensive distribution, and actively involving the community in the map development process. These steps align with the study's objective to develop user-friendly maps that improve flood risk communication and empower communities.

### **Contribution to Flood Risk Management and Resilience Strategies:**

This research contributes to the broader thesis on Flood Risk Management and Resilience Strategies for New Zealand Communities in several critical ways:

- i. **Enhancing Risk Communication Strategies:** The findings highlight the importance of improving communication tools like flood maps to bridge the gap between technical information and public understanding. This insight is crucial for designing effective communication frameworks within this thesis.
- ii. **Promoting Community Participation:** By demonstrating how community-based approaches can enhance map usability and trust, the study supports the broader argument that resilience-building efforts must actively involve local communities. This aligns with resilience principles outlined in this thesis, emphasising the integration of local knowledge and experiences.
- iii. **Policy and Practice Recommendations:** The recommendations for simplifying flood maps, ensuring their accessibility, and standardizing content can feed into this thesis's exploration of policy and governance strategies for flood risk management. These findings can inform how local and regional authorities develop and implement resilience measures.
- iv. **Resilience at Multiple Scales:** The emphasis on community-level preparedness and participation ties into the broader need for multi-scale strategies—connecting individual, community, and institutional efforts.
- v. **Addressing Vulnerability and Social Equity:** The study's findings on accessibility barriers underline the need to consider vulnerable populations in resilience planning, a key component of holistic flood risk management strategies.

In achieving its objectives, this research not only addressed immediate gaps in flood map design and usage but also provided actionable insights into how such tools can strengthen resilience strategies for flood-prone communities. By feeding into this overall thesis, this study reinforces the interconnectedness of effective risk communication, community engagement, and policy frameworks in building resilient communities across New Zealand.

## Chapter 7

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### Legal and Governance Frameworks for Flood Resilience – From Policy to Practice

Partially Published in Proceedings

### Chapter 7 Notes:

This chapter combines the content of two previously separate research papers, originally presented as **Chapter 7** and **Chapter 8**. Based on examiner feedback, these papers have been integrated into a single, cohesive chapter to improve the clarity and flow of the thesis.

The first section of this combined chapter introduces the theoretical and practical aspects of flood resilience legislation in New Zealand, while the second section builds upon this foundation by exploring practical implementation strategies and stakeholder engagement. Together, these sections provide a comprehensive analysis of the legal, governance, and operational frameworks necessary for enhancing flood risk management and community resilience.

The paper "Overview of New Zealand Legislation for flood resilience" was presented at Western Sydney University, Australia, for the 45th AUBEA Conference 2022. This has been published in the proceedings titled 45<sup>th</sup> AUBEA Conference 2022: Global Challenges in a Disrupted World: Smart, Sustainable and Resilient Approaches in the Built Environment, Australia.

The paper "Enhancing Flood Resilience through Effective Land-use Planning Policies in New Zealand" was presented at Massey University, New Zealand, for the 46th AUBEA Conference 2023.

For examiners' review, please follow the guidelines of Massey University Thesis with Publication.

### Abstract

Floods affect more people worldwide than any other natural hazard and present a significant barrier to achieving the United Nations Sustainable Development Goals (SDGs). Effective flood risk management requires a shift from traditional, protection-based approaches to risk-aware, resilience-focused strategies that integrate land-use planning, community engagement, and sustainable governance systems. In New Zealand, national legislation and local government policies provide a strong foundation for this shift. However, increasing climate change impacts, combined with challenges in implementation and compliance, are intensifying risks and raising questions about the long-term sustainability of flood management practices, particularly at the community level.

This chapter combines two interconnected studies to provide a comprehensive analysis of policy and practice in flood risk management. The first part uses a literature and document review to evaluate the extent to which local government documents and policies align with the six pillars of the National Disaster Resilience Strategy (NDRS). While national frameworks outline clear objectives for leadership, preparedness, and community partnership, the review identifies critical gaps, especially in knowledge sharing, participatory governance, and long-term planning.

The second part examines land-use planning and floodplain management, exploring why local governments continue to grant building consents for developments in high-risk floodplain areas. Through desktop analysis of planning documents, policies, and best-practice guidelines, the study highlights the tension between urban development pressures, such as housing shortages and historical-cultural land use, and the imperative to protect flood-prone areas. Findings show that prohibiting floodplain development remains the most effective strategy for reducing vulnerability, but

practical compliance requires tailored, community-centred policies that balance resilience with social and economic realities.

By integrating policy analysis with on-the-ground challenges, this chapter exposes a persistent policy-practice gap: while New Zealand's legislative framework promotes resilience in theory, its implementation at local and community levels remains fragmented. The chapter concludes with recommendations for strengthening collaborative governance models, embedding local and indigenous knowledge into decision-making, and enforcing land-use strategies that prioritise safety and resilience. These insights directly inform the integrated resilience framework presented in Chapter 10.

### **Keywords:**

Flood resilience, Land-use planning, Disaster governance, NDRS, Floodplain management, Community engagement, Sustainable development

## **7.1 Introduction**

### **7.1.1 Global and National Context**

Flood hazards are becoming increasingly frequent and severe worldwide due to the combined effects of climate change and land-use change (Mehryar & Surminski, 2021; Rogger et al., 2017).

- Climate change drives long-term shifts in rainfall patterns and sea levels, increasing the likelihood and intensity of flood events (Auliagisni et al., 2022c; IPCC, 2022; Lawrence & Quade, 2011).
- Land-use changes, such as urbanisation, industrial development along rivers, and settlement near water bodies, reduce natural floodplain functionality and expose more people to hazard risk (Florina, 2007).

Despite the existence of flood-related regulations, non-compliance remains a major problem worldwide. Many riverside developments ignore legal requirements or fail to meet technical standards, heightening risk for residents. Examples include informal riverside settlements (Carrasco & Dangol, 2019), blocked waterways on private land (Bodoque et al., 2016), and construction within prohibited floodplain zones (Komac et al., 2008).

Traditional reactive flood management approaches, focused mainly on response and recovery after disaster events, are no longer sufficient to achieve sustainable flood resilience (Huck et al., 2020). A proactive, risk-aware approach is needed — one that integrates structural measures (e.g., stop banks) with non-structural strategies, such as land-use planning, riparian zone management, risk communication, and enforcement of building codes (Benson et al., 2018; Ministry for the Environment, 2010; Piyumi et al., 2021; Saifulsyahira et al., 2016).

### **7.1.2 The role of governance and local laws**

Governance systems play a central role in shaping how communities prepare for and respond to flood hazards.

In New Zealand, flood risk management (FRM) responsibilities are divided between:

- Central government, which develops national policies and legislation, and
- Local authorities, which implement these frameworks through district and regional plans, flood management strategies, and civil defence planning (Lawrence & Quade, 2011).

Local authorities are tasked with protecting communities through both physical works (e.g., stop banks, river channel maintenance) and non-physical measures (e.g., education, emergency planning, and resilience action plans). Regional councils control land-use decisions, while territorial authorities manage the environmental and social impacts of development (NRC, 2018). Ideally, this system integrates national guidance with local knowledge to produce effective, context-specific solutions.

However, gaps often emerge. For instance, well-intentioned community-driven flood protection efforts, such as privately constructed stop banks, can create unintended downstream impacts, worsening flooding for other areas. Similarly, while traditional and indigenous knowledge offer valuable insights for resilience, these perspectives are often overlooked or poorly integrated into formal governance systems (Auliagisni et al., 2022b; Harmsworth, 2002; Senanayake, 2006).

The NDRS six pillars — leadership and governance, knowledge development, risk identification, preparedness, response, and community partnerships — provide a national framework for disaster resilience. Yet, as discussed later in this chapter, local documents often show uneven alignment with these pillars, revealing a gap between national strategy and local implementation.

### ***7.1.3 Land-Use Planning and Floodplain Management***

A key component of FRM is land-use planning, which plays a decisive role in protecting people and property by directing urban development away from flood-prone areas (Hartmann, 2011). Globally, the most effective flood risk mitigation strategy is preventing settlement on floodplains and preserving their natural functionality (Kiedrzyńska et al., 2015).

In New Zealand, however, local governments continue to grant building consents for housing developments on floodplains, despite well-documented risks and national-level policies advocating for risk reduction (Glavovic et al., 2010; Mclean & Watson, 2009).

Several factors drive this problem:

- Housing shortages, which create strong pressure to develop available land, even in hazardous areas.
- Cultural and historical land ownership patterns, particularly Māori land tenure, which complicate decisions about land use (Saunders & Kilvington, 2016; Stewart, 2023).
- A false sense of security created by flood infrastructure, such as levees and stop banks, which encourages development in high-risk areas (Jongman, 2018; Schipper, 2020).

This chapter examines why floodplain development persists, highlighting the tensions between urban development pressures and flood resilience goals, and explores how land-use policies can be redesigned to promote compliance and community acceptance.

### 7.1.4 Research Questions and Objectives

This integrated chapter addresses three interrelated questions:

1. Policy Alignment: How well do local government documents align with the six pillars of the NDRS?
2. Implementation Gaps: Why does development in flood-prone areas continue despite existing policies and regulations?
3. Resilience Pathways: How can land-use planning and governance be strengthened to bridge the gap between national strategy and community-level outcomes?

The chapter aims to provide actionable insights for improving flood resilience by combining policy analysis with an understanding of practical, on-the-ground challenges.

This chapter directly supports the thesis aim:

**To enhance the resilience of the Northland community to recurring flood events through sustainable, proactive, and community-driven flood risk management strategies.**

By analysing both governance structures and practical land-use challenges, this chapter provides critical insights into how national strategies are operationalised at the local level and how systemic barriers can be overcome to create sustainable, community-centred flood resilience.

### 7.1.5 Methods

This chapter combines two interrelated studies, each employing qualitative approaches to investigate different but connected dimensions of flood risk management in New Zealand. The overarching aim is to explore how governance systems, local laws, and land-use planning practices shape flood resilience, particularly in flood-prone communities such as those in Northland Region (Figure 38).

By merging these studies, the chapter provides a comprehensive analysis of both policy frameworks and practical challenges, addressing two key questions:

1. Why does development continue to occur on floodplains despite known risks?
2. How can local laws, land-use planning, and community participation enhance long-term flood resilience?

#### A. Study Area

Northland was selected as the focal region because it is highly prone to recurring floods and represents a context where community-led resilience is already evident. Active community engagement, regular flood work meetings, and transparent information-sharing practices make Northland a valuable case study for examining the interaction between top-down policies and bottom-up community actions.



- **International frameworks**, including United Nations guidance and the Sendai Framework for Disaster Risk Reduction.
- **Organisational reports**, including those from NIWA, NEMA, Zurich Flood Resilience Alliance, and the New Zealand Red Cross.
- **Regional planning documents**, such as the Northland Regional Council's long-term plans, Civil Defence Group Plans, infrastructure plans, and flood scheme work plans.

Analysis process:

- Documents were thematically grouped to address issues of uncoordinated community flood management and the inclusion of indigenous perspectives in law and governance.
- Special attention was given to the alignment between local governance documents and the six pillars of the National Disaster Resilience Strategy (NDRS).

### C. Literature Review and Practitioner Engagement

The second component focused on floodplain development and land-use planning policies, employing a qualitative literature review combined with practitioner validation.

Sources included:

- Academic journals on floodplain ecology, risk reduction, and planning.
- Government reports and planning guidelines.
- International best-practice studies on prohibiting floodplain development.

To ensure practical relevance, findings were discussed with a panel of practitioner experts, including:

- Urban planners,
- Project managers,
- Engineers,
- Building consultants,
- Disaster management specialists,
- Sustainability and community engagement practitioners.

This process helped refine the research focus and validate findings on:

1. Why development persists in high-risk floodplains.
2. How tailored land-use policies can restore and protect natural floodplain functions.

### D. Thematic Focus

The combined methodology generated two streams of analysis that form the backbone of this chapter:

1. **Governance and Policy Analysis:** Identifying how local laws and institutional structures influence flood resilience, with a focus on Northland as a case study.
2. **Land-Use and Planning Analysis:** Examining inconsistencies in floodplain management and identifying strategies to align land-use decisions with risk reduction goals.

These two streams converge to provide a holistic understanding of the policy-practice gap and to develop actionable recommendations for integrating top-down policies with community-driven solutions.

### **7.1.6 Summary**

This chapter examines the intersection of policy, governance, and practice in flood risk management. It highlights how decisions about land use, governance structures, and community participation collectively shape resilience outcomes. By integrating national strategy with local realities, the chapter provides a foundation for developing the comprehensive framework presented in Chapter 10, aimed at creating a resilient future for Northland and other flood-prone regions.

## **7.2 Legislative and Governance Framework for Flood Resilience in New Zealand**

Flood risk management (FRM) in New Zealand operates under a multi-level governance system that combines central government direction, regional and local authority implementation, and community participation. While this framework is robust in theory, the complexity of responsibilities and the impacts of climate change have created challenges for consistency and effectiveness at the local level.

Legislation plays a foundational role in FRM, ensuring that both structural measures (e.g., stop banks and drainage systems) and non-structural measures (e.g., land-use planning and risk communication) are coordinated to reduce risks. In traditional flood control systems, the unintended downstream impacts of interventions — such as urbanisation and stop bank construction — were often overlooked. These actions sometimes increased risks elsewhere in the catchment (Cirillo & Albrecht, 2015). Modern FRM frameworks, therefore, seek to balance flood protection with environmental and social considerations, promoting integrated, sustainable river basin management.

### **7.2.1 The background of flood management law**

The global evolution of flood management law has been shaped by international agreements. A key milestone was the 1992 UNECE Water Convention, which encouraged countries to consider floods not merely as isolated disasters but as part of broader river basin management systems (Cirillo & Albrecht, 2015). In 2000, this vision was strengthened through a focus on intergovernmental cooperation and policy coordination, recognising that floods are natural events, but their impacts are amplified by human interventions and land-use decisions (Nwokike, 2021; UNECE, 2009). The development of a long-term management of the river basin, are the core model for flood risk management. The development process includes a continuous exchange of hydrological and meteorological data, preparation of studies, surveys, flood plains, flood areas and risk maps, flood risk assessments. In the

support of the Sendai framework for disaster risk reduction 2015-2030 (UN, 2015), the UNECE offering a road map with concrete examples to help address water related disasters, especially in situations where the transboundary context adds to the complexity of risk reduction (UN, 2018). Although during UNECE meeting in the Hague, stated that only human intervention or interference can cause the worst consequences or amplify the damages as the basic principle, recent studies stated that extreme weather, sea level rise, and other climate change impacts with human behaviour are equally to blame for the increasing flood risk (Auliagisni et al., 2022c; Miller & Hutchins, 2017; Tabari, 2020).

Mehryar and Surminski (2021) emphasise that national legislative systems play a critical role in defining rules, responsibilities, and enforcement mechanisms for flood risk governance. While studies on water laws, environmental laws, and floodplain regulations (Hartmann & Albrecht, 2014; Shrubsole et al., 1997) provide valuable insights, they are often country-specific and generalised, lacking focus on local implementation. This gap is significant because flood dynamics are inherently local, meaning that national-level policies must be adapted to fit regional contexts.

In New Zealand, legislation is also guided by the Treaty of Waitangi, signed in 1840, which establishes a partnership between the Crown and Māori. This requires that Māori perspectives and traditional knowledge be incorporated into decision-making processes for environmental management, including flood risk governance (Hudson & Russell, 2009; Claudia Orange, 2015).

This principle is especially important in flood management, where Māori communities often live in flood-prone areas and possess rich indigenous knowledge about waterways and ecosystems (Harmsworth, 2002; Harmsworth & Awatere, 2013). The inclusion of Māori representation in policy development strengthens both equity and effectiveness, ensuring culturally appropriate strategies for resilience.

### **7.2.2 Local law for flood protection and drainage**

New Zealand employs a bottom-up governance model, giving regional and local councils significant power to tailor flood risk management strategies to their communities (Blakeley, 2016). This approach is particularly relevant in Northland, one of the regions most impacted by climate change-related flooding (NIWA, 2016a). Local councils develop a range of instruments to manage flood risks, including Flood protection and drainage by-laws; Infrastructure and river management plans; and Flood hazard maps and early-warning systems.

Examples include the Bay of Plenty, Christchurch, and Otago regions, where by-laws define rules for activities near waterways. In Bay of Plenty, any works must be kept at least 12 metres away from the lip of a drain (Figure 37), while earthworks for flood defences must adhere to specified distances (Figure 38)(Bay of Plenty Regional Council, 2020). These rules aim to protect the integrity of flood protection infrastructure, ensuring that private landowners' actions do not inadvertently increase downstream flood risks.

Flood protection assets such as stop banks and drainage systems were originally built to increase land productivity and reduce community hardship, but they require careful maintenance and regulation (Archie et al., 2018; Brennan, 2015). Without proper oversight, privately built structures can worsen flooding downstream, as seen in Northland, where privately constructed floodwalls diverted floodwaters into neighbouring areas.

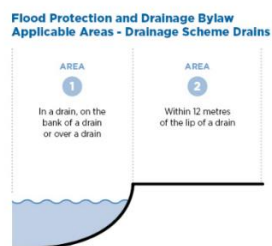


Figure 37 Local law for drainage scheme drains  
Source: Bay of Plenty Regional Council (2020)

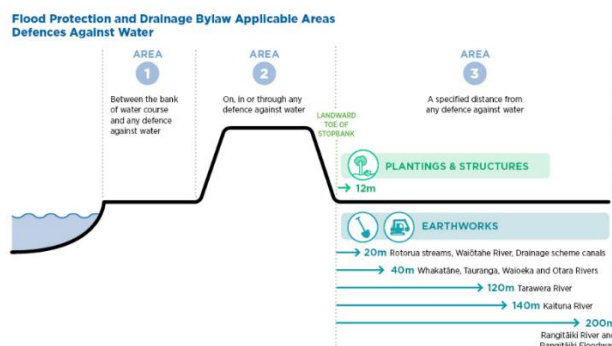


Figure 38 Local law for defence against water  
Source: Bay of Plenty Regional Council (2020)

To support the local law in the regional area, there is also a common law, or the responsibility of property owners. The common law requires people to be responsible for using the property or land in a way that does not increase the risk of flooding to a neighbouring property. Basically, it is to keep the drain always clean inside the property, and maintain the property's flood defence level, as failure to do this could make the property owner face a claim in negligence. Therefore, living in or near the floodplain comes with the rights and duties that are liable to the individual.

### 7.2.3 Climate change and future risks

The International Panel on Climate Change (IPCC) Fourth Assessment Report (IPCC, 2014) and subsequent studies confirm that climate change has already affected New Zealand, increasing the frequency and severity of extreme rainfall and flooding (The Royal Society of New Zealand, 2016). Northland, in particular, faces heightened risks due to its geography, low-lying coastal areas, and reliance on agriculture and rural infrastructure. Future scenarios predict more frequent storm surges, landslides, and riverine floods, requiring councils to integrate climate adaptation into local plans and infrastructure investments.

While local governments have been given tools to respond, many continue to prioritise short-term, reactive responses over long-term resilience building. This reflects a broader challenge in FRM worldwide: balancing immediate community protection with the need for sustainable, forward-looking strategies (Blakeley, 2016).

## 7.3 Governance Challenges and Alignment with the NDRS

The National Disaster Resilience Strategy (NDRS) provides a unified vision for disaster resilience in New Zealand. Its six pillars serve as benchmarks for evaluating local governance effectiveness:

1. Leadership and Governance
2. Knowledge Development and Sharing
3. Risk Identification and Awareness
4. Preparedness and Planning
5. Response and Recovery
6. Community Engagement and Partnerships

This section evaluates the alignment between these pillars and local government documents, such as District Plans, Regional Policy Statements, Civil Defence Emergency Management Group Plans, and Flood Management Strategies. The analysis draws from a document review of planning policies, bylaws, and reports from the Northland region.

**Leadership and Governance:** Local government documents demonstrate a clear commitment to collaborative governance. Partnerships with iwi and inter-agency cooperation are evident in regional policy statements and civil defence plans. However, conflicts between councils often undermine decision-making. For example, Regional councils focus on catchment-wide environmental management, while territorial councils face pressure to approve development to meet housing demands. This misalignment results in contradictory policies, where new developments are approved in high-risk floodplains despite regional plans emphasising hazard avoidance.

**Knowledge Development and Sharing:** Scientific knowledge is abundant, with hazard mapping and hydrological modelling provided by NIWA and other agencies. Challenges include: Limited public accessibility to data due to overly technical formats; Weak integration of indigenous and local knowledge, which could enhance planning and foster culturally relevant solutions (Harmsworth, 2002; Auliagisni et al., 2022b).

**Risk Identification and Awareness:** Flood hazard mapping is a strength of regional councils, with detailed maps incorporated into planning documents. However, maps are not regularly updated to reflect climate change projections and public awareness campaigns are underfunded, reducing community understanding of risks.

**Preparedness and Planning:** Civil Defence Emergency Management (CDEM) plans provide guidance for preparedness, such as evacuation routes and emergency shelters. Yet, rural communities remain under-resourced, limiting their ability to plan effectively, and planning processes tend to be top-down, with limited community co-design.

**Response and Recovery:** New Zealand’s emergency response network is well-developed and highly effective during crises. The weakness lies in recovery planning, which focuses on short-term repairs rather than transformative adaptation, such as managed retreat or climate-resilient infrastructure.

**Community Engagement and Partnerships:** Community engagement remains the weakest pillar, as public consultations are required but often tokenistic, occurring late in planning processes. Also, engagement is dominated by technical experts, with insufficient inclusion of local voices and indigenous knowledge.

**Table 14 NDRS Pillars and identified gaps**

<b>NDRS Pillar</b>	<b>Evidence of Alignment</b>	<b>Key Gaps Identified</b>
<b>Leadership &amp; Governance</b>	Collaborative frameworks with iwi mentioned in plans.	No mechanisms to resolve inter-council conflicts.
<b>Knowledge Sharing</b>	Hazard maps and technical studies available.	Data inaccessible to public; limited indigenous knowledge use.

<b>Risk Identification</b>	Hazard mapping integrated into planning.	Outdated maps; limited public education.
<b>Preparedness</b>	CDEM plans outline preparedness.	Under-resourced rural communities; top-down process.
<b>Response &amp; Recovery</b>	Strong emergency response systems.	Recovery remains reactive, lacking adaptation strategies.
<b>Community Engagement</b>	Public consultations legally required.	Consultations are passive, not participatory.

This analysis reveals a clear policy-practice gap in New Zealand's flood risk management system. While national strategies, such as the *National Disaster Resilience Strategy (NDRS)*, provide comprehensive and well-structured guidance, their implementation at the local level remains fragmented, particularly in areas of community engagement, preparedness, and climate change adaptation. This misalignment weakens the overall effectiveness of flood risk governance and leaves vulnerable communities exposed to recurring disasters.

Bridging this gap requires stronger collaboration across councils, ensuring consistency and shared responsibility in flood management planning and execution. Equally important is the integration of indigenous and local knowledge into decision-making processes, recognising the value of culturally grounded and place-specific insights for building resilience. Additionally, greater investment in participatory planning tools is essential to empower communities, promote transparency, and foster inclusive governance that aligns national policies with local realities.

The gaps identified in this section are not merely theoretical but have real-world consequences for communities living in flood-prone areas. The next section explores these issues further through case studies in Northland, illustrating how misalignment between policy and practice directly affects community resilience, preparedness, and long-term sustainability.

The review of the documents including New Zealand major statutes for flood management, framework from international organisation, and local government bylaw including Northland Regional Council flood protection strategy. The flood risk statutes in New Zealand includes New Zealand major statutes for flood management, Resource Management Act 1991, Building Act 2004 (and Building Code 1992), Local Government Act 2002, Land Drainage Act 1908, Soil Conservation and Rovers Control Act 1941, Rivers Board Act 1908, and Civil Defence Emergency Management Act 2002 (McSweeney, 2006).

Other relevant statues such as Public Works Act 1981, Local Government Official Information and Meetings Act 1987, Earthquake Commission Act 1993, the Environment Act 1986, and the Local Government Act 2002 also reviewed although it had not majorly talk about flood risk. Documents from organisations such as United Nations, NIWA, Zurich flood Resilience Alliance, Red Cross, NEMA, and Ministry for the Environment were studied. Further, documents from Northland Regional Council such

as the long-term plan, civil defence group plan, infrastructure plan, and flood schemes work plan were considered for supporting the analysis.

The academic literature and the government documents were critically analysed, and the summary were drawn upon the flood management theme. The legislations mentioned in the data collection were thematically grouped specifically to address the issues of uncoordinated flood management in community level and the inclusion of indigenous community to develop a culturally sound and integrated local law.

### 7.4 Transition from policy to practice

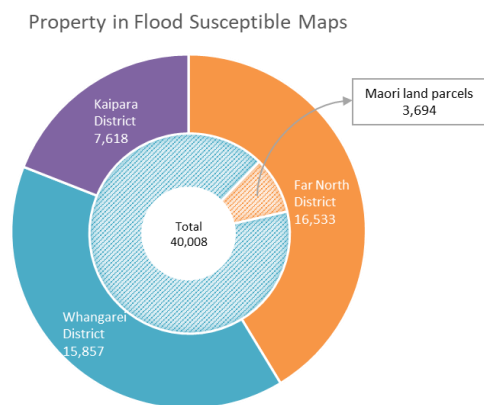
While national strategies, such as the National Disaster Resilience Strategy (NDRS), articulate ambitious goals for building resilience, these aspirations can only be achieved if they are translated into effective local actions. The next sections examine the practical challenges of land-use planning and floodplain management in Northland, demonstrating how misalignments between policy intent and on-the-ground implementation create significant vulnerabilities for communities.

Earlier in Section 7.3, misalignments were identified between local government documents and the six pillars of the NDRS. However, the real-world consequences of these governance gaps are most visible at the community level, where flood risk management is not only about policies and regulations but also about decisions regarding where people live, build, and work.

Approximately two-thirds of New Zealand's population resides in areas prone to flooding, with Northland being one of the most vulnerable regions. For instance, in Auckland, New Zealand's most populated city, more than 55,000 houses are located within flood zones, many of which were recently inundated during severe rainfall events (Newton, 2023). In Northland, despite being less urbanised, there are 40,008 identified properties at risk of flooding, as shown in the region's flood susceptibility maps (Figure 39). These figures raise a critical question: Why does development in floodplains continue, and how can it be prevented?

The persistence of floodplain development reflects a policy-practice gap. National policies strongly promote risk avoidance and resilience, yet local implementation often enables or even encourages risky development, perpetuating vulnerabilities rather than reducing them. The following sections explore this tension in detail, using land-use planning as the primary lens for understanding how governance systems ultimately shape community-level outcomes.

While national strategies such as the NDRS articulate ambitious goals for resilience, these aspirations can only be achieved if they are realised through effective local actions. The next sections examine the practical challenges of land-use planning and floodplain management in Northland, demonstrating how misalignments between policy intent and implementation create vulnerabilities for communities.



**Figure 39. Northland Region: Property in flood susceptible maps**  
(Source: Northland Regional Council, 2023 and illustrated by: Authors, 2023)

## 7.5 Land-Use Planning and Floodplain Development Challenges

New Zealand is highly exposed to both coastal and river flooding, making it the costliest natural hazard-related cause of disaster when considering both tangible and intangible losses. Floodplains play a critical role in flood risk management (FRM), acting as natural buffers that absorb excess water during high-flow events and mitigate the impacts of flooding on surrounding communities.

Floodplains are flat areas adjacent to rivers that are highly functional when they are inundated approximately once every one to two years. These regular flooding cycles support the development of wetlands, side channels, and diverse ecosystems that contribute to overall environmental resilience (Christin & Kline, 2017; Entwistle et al., 2019). These natural systems provide essential ecosystem services, including water filtration, nutrient cycling, and the creation of habitats for a variety of species (Opperman et al., 2010). However, when floodplains are isolated or disrupted by human interventions such as levees, stop banks, or urban development, their natural functions are significantly diminished. This loss of function leads to increased flood severity, higher peak water flows, and the degradation of surrounding ecosystems (Cloke, 2020).

In New Zealand, many floodplains have been extensively modified since the arrival of Māori and European settlers. By the 1970s, major rivers such as the Waikato and Waitaki had been dammed, while widespread deforestation, channel straightening, and the construction of flood control works had dramatically reduced the natural capacity of floodplains to manage floodwaters (Richardson et al., 2014; Young, 2007). As a result, local councils are now locked in a costly cycle of reactive management, spending millions of dollars annually to maintain river channels, repair stop banks, and rebuild infrastructure damaged by recurring flood events. This cycle highlights the urgent need to shift toward sustainable, proactive approaches that prioritise the preservation and restoration of natural floodplain functions as a cornerstone of modern flood risk management.

### 7.5.1 Drivers of Floodplain Development

Despite known risks, development in flood-prone areas persists due to several interrelated factors:

Table 15 Drivers of floodplain development

Driver	Description	Supporting Literature
<b>Housing Shortages</b>	Urban centres like Auckland face high demand for housing and limited availability of safe land, pushing development into marginal areas.	Newton, 2023; NZ Infrastructure Commission, 2022
<b>Cultural and Historical Ties to Land</b>	In rural areas, especially where Māori ancestral land is involved, relocation discussions are sensitive and complex.	Stewart, 2023; Marden et al., 2012
<b>False Sense of Security</b>	Communities perceive flood management infrastructure (e.g., levees, stop banks) as providing absolute protection, encouraging continued settlement.	Jongman, 2018; Schipper, 2020
<b>Economic Incentives</b>	Floodplain land is often cheaper and therefore attractive to developers seeking lower costs.	Saunders & Kilvington, 2016

This complex web of drivers explains why, even after severe floods, rebuilding often occurs in the same vulnerable areas.

As example from case study of 2023 flood in Auckland and Northland highlighted the devastating consequences of poorly managed floodplain development. Thousands of people were displaced, infrastructure sustained severe damage, and economic losses reached millions of dollars (Stats NZ, 2023). These impacts extended well beyond the immediate physical damage, encompassing psychological distress, prolonged business disruption, and significant long-term recovery challenges. Such events illustrate the urgent need for risk-informed land-use planning that prioritises long-term resilience over short-term development gains.

### 7.5.2 Policy Analysis and International Lessons

Land-use planning is a deliberate process undertaken by public authorities to determine the most appropriate use of land while balancing economic, social, and environmental objectives (MPI, 2017). At the global level, risk-based planning has been strongly promoted by organisations such as the United Nations International Strategy for Disaster Reduction (UNISDR) and the Sendai Framework for Disaster Risk Reduction, both of which emphasise the importance of controlling development in high-risk areas to reduce disaster vulnerability (UN, 2015; Aitsi-Selmi & Murray, 2015).

In New Zealand, the current planning framework for natural hazard management is shaped by four key statutes. The Resource Management Act 1991 (RMA) governs land and water use, while the Building Act 2004 sets building standards, including those relevant to flood risk. The Civil Defence Emergency Management Act 2002 outlines emergency planning and response requirements, and the Local Government Act 2002 defines the roles and powers of local councils.

Despite this seemingly comprehensive framework, many councils remain reluctant to strictly apply hazard management provisions, largely due to concerns about limiting development and

economic growth (Saunders & Kilvington, 2016). This reluctance has resulted in inconsistent enforcement and, in some cases, the continued approval of developments in known flood-prone areas, undermining the overall effectiveness of the legislation.

International lessons provide valuable insights for strengthening New Zealand's approach. In Ireland, for example, a progressive ban on new floodplain construction was introduced between 2003 and 2015, with only limited exceptions for essential infrastructure (Tubridy & Lennon, 2021). These measures were driven by escalating flood risks and the recognition that the cost of relocation is far less than the repeated costs of disaster recovery (Sayers et al., 2020). Similarly, the United Kingdom has increasingly adopted stricter planning controls to discourage high-risk development. New Zealand can draw on these examples to strengthen its own planning regulations, particularly as climate change intensifies future flood risks.

### **7.5.3 Summary**

The analysis highlights several key findings. First, floodplain development in New Zealand reflects a persistent disconnect between policy intent and practical implementation. Existing planning tools, while comprehensive in scope, are insufficiently enforced and fail to address the long-term impacts of climate change on flood risk. Second, comparative lessons from Ireland and the United Kingdom demonstrate the value of proactive, restrictive measures to prevent development in flood-prone areas. Finally, the research underscores the importance of community-centred strategies to ensure public support, compliance, and long-term resilience in the face of increasing climate-related flood risks.

## **7.6 Participatory Approaches and Community Engagement**

While policies and regulations are essential, flood resilience ultimately depends on the actions of communities. Participatory approaches ensure that local voices are included in decision-making processes, making flood management strategies both culturally appropriate and practically relevant. These approaches recognise that communities are not only affected by floods but are also active agents in building resilience.

### **7.6.1 Importance of Community Engagement**

Communities are the first responders during flood events, often taking action long before external assistance arrives. Their involvement provides valuable, context-specific insights, especially through local and indigenous knowledge, which offers a deep understanding of historical flood patterns and effective adaptation strategies (Harmsworth, 2002; Senanayake, 2006). Community engagement also aligns closely with the sixth pillar of the National Disaster Resilience Strategy (NDRS), which emphasises partnerships and shared responsibility between government bodies, civil society, and local groups.

### **7.6.2 Barriers to Effective Engagement**

Despite its importance, community engagement often faces significant challenges. In many cases, consultations are informative rather than participatory, limiting the extent to which local voices influence decision-making. Technical documents, such as hazard maps and planning reports, are often

complex and difficult for non-experts to interpret, reducing their usefulness and accessibility. Furthermore, marginalised groups, including rural and Māori communities, are frequently underrepresented in decision-making processes, leading to gaps in understanding and inequities in resilience planning.

### **7.6.3 Practical Tools for Engagement**

Several practical tools can be used to strengthen community participation. Participatory mapping enables communities to co-create visual flood risk data, making hazards easier to understand and fostering shared ownership of information. Community-led emergency drills provide hands-on experience in preparedness, helping to build confidence and readiness for future flood events. Additionally, the integration of traditional Māori knowledge with modern scientific approaches ensures that strategies are both culturally respectful and scientifically robust, enhancing overall flood management effectiveness.

### **7.6.4 Link to Governance and the NDRS**

Strong community engagement has a direct and positive impact on broader governance systems. It enhances other pillars of the NDRS, including Preparedness, Knowledge Sharing, and Leadership. When communities are actively involved, compliance with land-use regulations improves, as policies are better understood and more widely supported. Furthermore, participation fosters trust between government authorities and citizens, creating a collaborative environment for managing flood risks.

### **7.6.5 Summary**

Participatory approaches are critical for bridging the policy-practice gap. Without meaningful engagement, even the most advanced policies and strategies risk failing to translate into real-world resilience. The challenges and strategies outlined in Sections 7.4 to 7.6 demonstrate that achieving effective flood resilience requires a multi-layered approach, integrating top-down governance with bottom-up community action. The following section synthesises these findings and offers recommendations for bridging the gap between policy design and practical implementation, ensuring that flood management is both inclusive and sustainable.

## **7.7 Findings and Discussion**

New Zealand is highly exposed to both coastal and riverine flooding, with flooding representing the country's most costly natural hazard, particularly when both tangible and intangible losses are taken into account. Northland is one of the most flood-prone regions, having experienced multiple severe flood events over recent decades. The three district councils in the region—Whangārei, Kaipara, and Far North—implement planning laws within the regional framework provided by the Northland Regional Council (NRC). Increasingly, the region has been shifting toward a risk-aware, community-based approach to flood management, recognising the need for sustainable, long-term strategies rather than purely reactive measures.

This section synthesises findings from the combined analysis of national policy frameworks, regional bylaws, local practices, and challenges related to land-use planning. It highlights the ways in which legislation, indigenous and local knowledge, and community action intersect, while also identifying the gaps that continue to undermine effective flood risk management (FRM).

### ***7.7.1 New Zealand Legislation and the Role of Indigenous and Local Knowledge***

Flood risk management in New Zealand is primarily guided by two key legislative instruments: the Resource Management Act 1991 (RMA) and the Civil Defence Emergency Management (CDEM) Act 2002. The RMA assigns responsibility to regional authorities to control land use with the aim of avoiding or mitigating natural hazards, while territorial authorities are tasked with preventing or minimising the effects of land development that could exacerbate such hazards. The Resource Management (Energy and Climate Change) Amendment Act 2004 further strengthens this framework by requiring local authorities to explicitly consider the effects of climate change when managing resources.

The CDEM Act complements this approach by promoting sustainable hazard management, emphasising community resilience and public safety through a four-stage framework: risk reduction, readiness, response, and recovery. In addition to these core laws, other relevant statutes—such as the Building Act 2004, the Local Government Act 2002, and the Soil Conservation and Rivers Control Act 1941—support different aspects of flood management.

In 2019, inspired by the Sendai Framework for Disaster Risk Reduction (2015–2030), the Ministry for the Environment launched the National Disaster Resilience Strategy (NDRS), which was subsequently adopted by regional councils, including Northland. This strategy signalled a major shift away from traditional, response-focused approaches, instead prioritising risk reduction and preparedness. It acknowledges that disaster resilience is a shared responsibility involving central and local governments, the private sector, NGOs, scientific bodies, and community groups (MCDEM, 2019).

However, climate change has created new and complex challenges that no single knowledge system can address in isolation. Māori communities, having occupied Aotearoa for centuries, possess rich layers of mātauranga Māori (indigenous knowledge) derived from close observation of the environment and intergenerational survival strategies (Doyle, 2022; Proctor, 2010). The NDRS integrates these values into six guiding pillars:

- Manaakitanga: respect and care for others.
- Whanaungatanga/Kotahitanga: fostering partnerships through inclusive collaboration.
- Kaitiakitanga/Tūrangawaewae: protecting cultural and natural heritage for future generations.
- Mātauranga: integrating scientific, historical, and local knowledge.
- Tikanga: embedding ethical cultural practices and accountability.
- Rangatiratanga: promoting values-based leadership and self-determination.

In Northland, these principles translate into practical flood resilience actions. For example, Manaakitanga is evident in the voluntary mobilisation of community members during emergencies, while Whanaungatanga drives collaboration with multiple stakeholders in both flood mitigation and recovery. Kaitiakitanga informs environmental stewardship practices such as riparian planting and river ecosystem restoration, while Tikanga ensures culturally grounded, ethical post-flood clean-up operations.

The inclusion of Māori representation in flood planning and governance is therefore essential, reflecting obligations under the Treaty of Waitangi. Indigenous perspectives offer tailored, localised solutions, which are particularly important given that flood protection strategies must reflect the unique geographical and cultural contexts of communities like Kaitaia, Kaeo, or Whangārei. By combining local knowledge with scientific data, New Zealand can move toward a more comprehensive, culturally sensitive approach to FRM.

### 7.7.2 Local Laws and Community Flood Resilience

Despite the implementation of flood management practices, the increasing frequency of floods and their growing impacts reveal a persistent gap between policy and practice. Local bylaws play a vital role in bridging this gap by regulating the use and protection of flood management assets such as stop banks, drainage systems, and floodways.

In Northland, flood protection has often relied on structural measures like stop banks and floodwalls. While these interventions may protect individual properties, they can create downstream problems, including increased flood risk in low-lying areas. For instance, when upstream floodwaters are contained, downstream communities may face double threats from both riverine inundation and landslips caused by blocked drainage outlets, especially in areas surrounded by hills.

Regional councils across New Zealand maintain asset management systems under the Local Government Act 2002, yet performance varies depending on resources and regional priorities. Local laws are designed to prevent inappropriate modifications or damage to flood infrastructure, with certain activities—such as digging new drains or placing structures near waterways—requiring prior approval. Table 16 provides an overview of the key infrastructure elements protected by regional bylaws and the activities that require formal approval before work can proceed.

**Table 16 Infrastructure and activities protected by local law**

<b>Infrastructure Protected by Local Law</b>	<b>Activities Requiring Approval from Authorities</b>
<b>Drains and Small Watercourses</b>	Widening, deepening, or infilling any drain or small watercourse
<b>Floodway</b>	Altering, damaging, or interfering with any drain or small watercourse, defences against water, flood protection vegetation, hydrological equipment, or survey benchmarks
<b>Defences Against Water (e.g., stop banks, rock protection, groynes)</b>	Placing any material or structure in, on, or near a drain, small watercourse, or defence against water
<b>Floodgates and Culverts</b>	Connecting any pipe, channel, or other conduit to a drain or small watercourse

<b>Flood Protection Vegetation</b>	Allowing stock to damage drains, watercourses, flood protection vegetation, or defences against water
<b>Hydrological Devices and Equipment</b>	Damaging, relocating, or removing hydrological equipment
<b>Survey Benchmarks</b>	Moving or interfering with benchmark locations

However, these processes are not well-suited to emergency situations, where communities may act unilaterally to protect property. To address this, the NRC has developed a comprehensive community engagement framework, including catchment-based flood meetings, hui with iwi and hapū, and formal consultations. This participatory approach ensures that local perspectives are incorporated into policy-making and that there is a shared understanding of minimum service levels for new and existing infrastructure. Table 17 provides a comparison of flood-related bylaw requirements in urban and rural areas, demonstrating how these differ depending on local needs.

**Table 17 Comparison of Flood-Related Local Laws in Urban and Rural Areas**

<b>Local law/ Regional bylaw required</b>	<b>Urban</b>	<b>Rural</b>
<b>Riparian plantings</b>	-	ü
<b>Horticultural development</b>	-	ü
<b>Dairy effluent system upgrades</b>	-	ü
<b>Digging a new drain or upgrading a culvert</b>	-	ü
<b>Water intake structures</b>	-	ü
<b>Subdividing a property</b>	ü	ü
<b>Geotechnical investigations</b>	ü	ü
<b>Planting/removing trees or shrubs</b>	ü	ü
<b>Landscaping involving earthworks</b>	-	ü
<b>Building/removing fences, garden sheds</b>	ü	ü
<b>Building/extending a house, shed or adding a deck</b>	ü	ü
<b>Constructing/removing a retaining wall</b>	ü	-
<b>Constructing/removing an in-ground swimming pool</b>	ü	-

Importantly, decisions about service levels must consider intergenerational equity, ensuring future generations are not left with disproportionate flood risks.

### **7.7.3 Persistence of Development on Floodplains**

Over recent decades, development has expanded into floodplains across New Zealand, driven by a combination of economic pressures, housing demand, and limited enforcement of planning regulations. The flat terrain and proximity to rivers make floodplains attractive for urban and industrial growth, but these same characteristics heighten vulnerability to flood events.

Restricting development has been historically difficult due to land ownership rights. Without statutory authority to prohibit construction outright, governments have relied on non-binding guidelines, such as safe building practices in flood-prone zones (Saunders & Kilvington, 2016). As a result, new developments continue to appear in high-risk areas.

This persistence is further compounded by misleading perceptions of safety. New flood infrastructure projects, outdated flood maps, and public confidence in engineered solutions have created a false sense of security (Schipper, 2020; Auliagisni et al., 2022c). Developers and homeowners may therefore underestimate the actual level of risk.

The outcome is a vicious cycle of flood damage and reconstruction, with increasing costs for councils, insurers, and communities. Breaking this cycle requires robust, enforceable land-use planning measures, paired with community engagement to build understanding of flood risks and support compliance.

### 7.7.4 Towards Effective Land-Use Planning and Policy

Restoring the natural functionality of floodplains is a critical strategy for reducing flood risks. Healthy floodplains absorb excess water, slow peak flows, and provide ecosystem services such as water filtration and habitat provision (Opperman et al., 2010; Entwistle et al., 2019). Conversely, when floodplains are degraded through channelisation, deforestation, or urbanisation, their ability to manage floodwaters is severely diminished, increasing hazard intensity.

In New Zealand, current planning is guided by the RMA, Building Act, CDEM Act, and Local Government Act. While these statutes provide a comprehensive framework, their effectiveness is undermined by variable enforcement at the local level. Some councils hesitate to implement strict hazard controls for fear of limiting growth, creating inconsistency across regions (Saunders & Kilvington, 2016).

Table 18 Key Guidelines for Floodplain Management

Key Guidelines	Developed by	Functionality
Good Practice Guide for Land Development and Subdivision in Flood-Prone Areas	Ministry for the Environment	Provides recommendations and best practices for land development and subdivision in flood-prone areas, covering flood hazard assessment, land-use planning, building design, stormwater management, and flood protection measures.
New Zealand Building Code	Ministry of Business, Innovation and Employment	Sets requirements for the design and construction of buildings, including flood risk considerations, foundation design, floor levels, and the use of flood-resistant materials to ensure building resilience.
Regional and District Plans	Local Authorities	Outline rules and regulations for land use in flood-prone areas, including setbacks from waterways, flood protection requirements, and building restrictions; vary according to regional needs.
New Zealand Coastal Policy Statement (NZCPS)	Prepared under the Resource Management Act (RMA)	Provides national policy direction for managing coastal areas, including erosion, sea-level rise, and flood hazards, to guide sustainable development in flood-prone coastal zones.

Lessons from countries like Ireland and the UK demonstrate the value of clear, enforceable restrictions. Ireland, for example, progressively introduced a ban on new floodplain construction between 2003 and 2015, recognising that relocation costs are ultimately lower than repeated disaster recovery costs (Tubridy & Lennon, 2021).

For New Zealand, harmonising national and local policies is essential. This includes:

- Prohibiting new development in high-risk floodplains and low-lying coastal areas.
- Incorporating nature-based solutions, such as wetland restoration, into planning frameworks.
- Integrating Māori governance principles to ensure culturally appropriate decision-making.
- Encouraging flexible guidelines that reflect the diverse needs of communities across regions.

By aligning land-use planning with flood resilience goals, these measures can reduce long-term costs and safeguard both people and ecosystems.

### 7.7.5 Synthesis of Findings

The findings demonstrate a clear policy-practice gap in New Zealand's FRM. While national strategies like the NDRS provide ambitious frameworks for resilience, local implementation remains fragmented. This misalignment is most evident in three areas:

1. Engagement – Limited participation of communities, especially marginalised groups, in decision-making.
2. Preparedness – Over-reliance on structural solutions without adequate investment in risk reduction or education.
3. Climate adaptation – Insufficient integration of indigenous knowledge and scientific insights into local policy.

Bridging these gaps requires:

- a. Stronger collaboration between central and local authorities.
- b. Greater inclusion of indigenous perspectives and local knowledge systems.
- c. Participatory planning tools that empower communities to co-create solutions.

Ultimately, achieving sustainable flood resilience depends on building a governance system that connects high-level policy intent with practical, place-based action, fostering adaptive communities capable of addressing both current and future flood challenges.

## 7.8 Conclusion

This chapter has brought together two closely connected areas of investigation: firstly, the role of legislation, governance frameworks, and indigenous knowledge in shaping flood risk management and community resilience; and secondly, the challenges of land-use planning and floodplain development,

with a particular focus on why construction persists in high-risk areas and how the natural functions of floodplains can be revitalised to reduce flood risks.

Through an in-depth analysis of national policies, regional bylaws, and local practices in the Northland region, the study revealed a significant policy-practice gap. At the national level, frameworks such as the Resource Management Act (RMA), Civil Defence Emergency Management (CDEM) Act, and the National Disaster Resilience Strategy (NDRS) provide strong strategic direction. These policies emphasise risk reduction, readiness, and the integration of diverse knowledge systems, including mātauranga Māori. However, while these frameworks are comprehensive in their design, their translation into effective local action remains inconsistent and fragmented.

Local councils and communities often struggle with limited enforcement tools, fragmented decision-making processes, and the socio-economic pressures that influence development choices. Issues such as housing shortages, land scarcity, and cultural land ownership complexities contribute to ongoing development in floodplains. At the same time, there is a continued reliance on ad hoc private flood protection measures and reactive, short-term responses rather than proactive, long-term strategies for resilience building.

The findings of this chapter emphasise that legislation alone is insufficient for reducing flood risk. Effective and sustainable flood management requires a more comprehensive and integrated approach. This includes:

- The establishment of robust enforcement mechanisms to prevent inappropriate development in flood-prone areas.
- Community-inclusive governance models that engage local stakeholders and integrate both indigenous and scientific knowledge.
- The adoption of nature-based solutions, such as wetland and floodplain restoration, to complement traditional engineered infrastructure.

Revitalising the natural functionality of floodplains is particularly crucial for reducing the intensity of hazards and enhancing the provision of vital ecosystem services. Furthermore, comprehensive land-use planning is needed to align development decisions with both environmental sustainability and cultural priorities, ensuring that growth does not exacerbate future flood risks.

By merging insights from governance analysis and land-use planning, this chapter highlights the urgent need for a multi-level, collaborative approach to flood resilience. National policies must not only articulate ambitious goals but also provide clear, enforceable mandates, while regional and local authorities must engage meaningfully with communities to develop context-specific, culturally appropriate strategies.

The lessons drawn from Northland have wider implications for other flood-prone regions, both within New Zealand and internationally. They demonstrate that sustainable flood resilience depends on bridging the divide between policy intent and practical implementation, fostering adaptive systems that can address both current challenges and the escalating risks posed by climate change. This collaborative, future-focused approach is essential for safeguarding communities,

protecting ecosystems, and ensuring long-term resilience in the face of increasingly frequent and severe flooding events.

## 7.9 Author's Comments

New Zealand's formal legislative system plays a vital role in setting rules and frameworks for flood risk governance (FRM). While the national legislative framework provides a solid foundation, it also presents both strengths and weaknesses. The responsibility for flood mitigation is devolved to local councils, such as the Northland Regional Council (NRC) and its district councils, which allows for localised approaches that reflect the unique environmental and cultural characteristics of each community. This decentralised model enables flood risk management to be integrated with other local responsibilities, including land use planning and asset management.

However, the level of support and resources provided to district councils and communities varies significantly across the region. For example, some areas face underfunded flood protection infrastructure, creating inequities in flood resilience. Several key points emerge from this research:

1. **Localised Responsibility:** Flood risk management is primarily the responsibility of local councils, enabling regional and territorial authorities to tailor best practices to community needs and local environmental conditions.
2. **Integration of Local and Indigenous Knowledge:** Solutions for sustainable flood resilience should combine local and indigenous knowledge with science and technology to develop culturally appropriate and comprehensive local laws.
3. **Inclusive Decision-Making:** The active inclusion of indigenous representatives in flood management meetings is crucial, ensuring decisions reflect traditional knowledge, cultural values, and long-term community wellbeing.
4. **Adaptive Policy Change:** Policy reviews should be integral to the post-disaster recovery phase, as flood events present opportunities to assess the effectiveness of existing frameworks and to design policies that meet both current and future needs.

Despite growing awareness campaigns discouraging floodplain development, the lack of enforceable restrictions allows construction to continue in highly vulnerable areas. These developments are often driven by the appeal of lower land prices, scenic views, and housing shortages, particularly in regions like Northland. This research reveals a persistent gap between awareness and regulation, raising critical questions about the effectiveness of current policy frameworks. Stronger regulations and enforcement mechanisms are needed to prevent further development in flood-prone zones.

The restoration of functional floodplains offers significant ecological and risk reduction benefits. Healthy floodplains reduce peak flood flows and velocities while supporting biodiversity and providing essential ecosystem services. These natural systems align with the thesis's emphasis on nature-based solutions, offering a dual benefit: reducing flood risks and enhancing environmental sustainability.

Community-based management emerges as a vital complement to top-down governance. Integrating local knowledge and fostering community engagement not only empowers individuals but

also results in inclusive, participatory policymaking. These efforts are essential for building trust and ensuring that flood risk management strategies are tailored to the specific needs of affected communities.

The research also highlights policy inconsistencies and systemic governance challenges, particularly the disconnect between national frameworks and local implementation. Cultural and land ownership issues further complicate floodplain development, underscoring the importance of culturally sensitive strategies such as managed retreat and equitable land-use policies. Addressing these issues requires harmonised policies that bring together central, regional, and local authorities, along with indigenous and community voices.

Finally, insights from international case studies, such as Ireland's ban on floodplain construction, offer valuable lessons for New Zealand. While global best practices cannot be adopted wholesale, they provide inspiration for proactive, enforceable policies that balance development needs with long-term flood resilience.

In conclusion, this chapter bridges technical findings with practical policy implications, demonstrating that effective flood risk management depends on aligning legislation, land-use planning, and community engagement. By fostering collaboration between government and communities, strengthening enforcement mechanisms, and leveraging natural systems, New Zealand can move toward a sustainable, resilient future for its flood-prone regions.

## Chapter 8

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### Learning from floods – How a community develops future resilience.

Published

“Learning from floods – How a community develops future resilience” was published in the MDPI Open Access Water Journal 2022

**Chapter 8 Notes:**

This paper “Learning from floods – How a community develops future resilience” was published in the MDPI Open Access Water Journal 2022

For examiners' review, please follow the guidelines of Massey University Thesis with Publication.

This chapter will answer the following research questions:

<b>Research Question:</b> <b>How does the Northland community perceive and respond to recurring flood hazards?</b>	
<b>Research Objective A:</b> <b>To evaluate the effectiveness of existing flood protection infrastructure and community-led initiatives.</b>	
<b>Research Objective B:</b> <b>To provide actionable recommendations for enhancing community and council collaboration on flood risk management.</b>	
<b>Sub Question i</b>	What are the existing community-led and council-supported flood resilience strategies in Northland?
<b>Sub Question ii</b>	How can indigenous knowledge and practices be integrated into flood risk management?
<b>Sub Question iii</b>	What lessons can be drawn from recent flood events to improve preparedness and resilience?

**Abstract**

Settlements close to rivers, the sea, and hills are among those most vulnerable to floods. The hilly terrain region experiences higher rainfall than the lowlands due to the orographic effect. As a result, excessive rains feeding major rivers cause a rapid rise in water level resulting in frequent breaks of the riverbanks. The flood hence covers the inhabited lowlands with water and silt, causing loss of lives and properties. The affected communities need practical coping alternatives to deal with the intensity and the increasing exposure to floods. The Sustainable Development Goals (SDG6) identify the sustainable management of water and sanitation as one of their key objectives. This study identifies resilience in practice focusing on how communities create resilience and develop sustainable river catchment management. A qualitative method was used, involving observations, interviews, and community surveys with one of the most flood-prone populations, the New Zealand Northland community. A desktop study containing government publications and flood records compliments the thematic analysis result and strengthens the discussions. Social connections, participation in self-protection training, and maintaining the catchment were among the main findings of the study. This study recommends for community-led response plans integrated with infrastructure improvements and collaboration with councils to reduce the risk of future floods.

Keywords: collaboration, community resilience, floods, integrated management, recurring floods

**8.1 Introduction**

Floods are the world's most common disaster, and climate change has detectably influenced several water-related variables that increase the hazard risk, jeopardising the ecosystem, built environment, and human lives (IPCC, 2022). With over a hundred cities and towns located on flood plains, New

Zealand has a long history of living with floods. Making decisions on how best to protect life and property from floods is an ongoing challenge. However, due to climate change, the number of flood hazards and communities at risk is expected to increase (The Royal Society of New Zealand, 2016). The changing patterns of risk exposure have led to a growing understanding that flood risk cannot be eliminated, and structural flood defences do not guarantee communities' resilience (Auliagisni et al., 2022c; Ogie et al., 2020). Through this understanding, New Zealand manages its current flood risk by adapting to future climate change, including focusing on risk management and resilience building (reductions and readiness) rather than crisis management (response) and recurring recovery (Ministry for the Environment, 2008a; Rouse, 2011).

Flood has significantly impacted many townships in the region, especially towns in the low-lying areas, due to the orographic effect, river rise, and development in the floodplain (see Figure 40). According to the past flood events in Northland listed in Table 16, at least one major flooding event has occurred almost every year. For example, during 15-18 July 2020, Northland was hit by a one-in-500-year storm that caused flooding due to the river flows reaching over 200-400% (Council, 2020). This is higher than expected typical river flows for the month, generally between 40-60<sup>th</sup> percentiles. Another flood and landslip occurred in Kaeo, Kerikeri, and Kawakawa in July 2021 and another flood in 2022. These floods collectively affected people, road infrastructure, safety, and floodplain settlements. Recovery is still ongoing from the recent floods, and preparations for the next flood are already underway.

Flood hazard is not new to the local communities as it has been there for thousands of years (McSaveney, 2006). The resilience to floods was first time recorded in 1863 when the colonial settlers faced flood hazards and documented the resilience of the indigenous community to floods (McSaveney, 2006). Flood resilience can be defined as being prepared, ready to respond, and able to cope and recover from a flood event (McClymont et al., 2020; Zevenbergen et al., 2020). Resilience is not only about the capacity to bounce back to the original state after adversity but also about advancing in it by learning from past experiences and adaptation (Munawar et al., 2021). Resilience strategies focus on reducing the impacts of floods through better prevention and preparedness (Gersonius et al., 2016). There is a saying in Māori that underpins the strength of communities: *“Hei aha te mea nui i tenei Ao? He tangata, he tangata, he tangata – What is the greatest thing in the world? It is people, it is community”* (NRC, 2021). Following that pearl of wisdom, increasing community resilience may decrease the impacts of a hazard. Therefore, building community resilience has become one of the fundamental techniques for dealing with floods in New Zealand's local councils (Blakeley, 2016).



Figure 40 Flood impacts in the Northland  
(Kaeo Library, 2021)

Table 19 Lists of major floods in Northland from 2012 to 2022

Flood events	Date	Flood Return Period (probabilities)
2022 Northland Flood	21 – 23 March 2022	150-year flood
	24 – 26 July 2022	100-year flood
	18 August 2022	
2021 Surface flooding	12 July 2021	100-year flood
2020 Northland Storm Flooding	17-18 July 2020	500-year flood
2017 Northland Flooding / Far North Flooding	7-13 March 2017	100-year flood
	22 - 23 June 2017	500-year flood
2016 Northland Storm	10 August 2016	100-year flood
2014 New Zealand Storm	9 – 11 June 2014	500-year flood
	8 – 12 July 2014	<10-year flood
2013 New Zealand Storm	4 May 2013	100-year flood
2012 North Island Storm	18 – 20 March 2012	150-year flood

A thriving and empowered community is the cornerstone of the local council's community resilience plan, especially in Northland (NRC, 2021). Due to the interdisciplinary nature of resilience, top-down and bottom-up FRM approaches need to be integrated (McClymont et al., 2020). In practice, however, communities still rely more on their traditional understanding and techniques to recover from disasters, even though the government has defined and planned flood management guidelines. The local community in Northland has developed their own concept of resilience and uses its own strategy to overcome adversity. This study aimed to understand how Northland's community understands what to do when flooding occurs and how to prepare more generally for natural hazards and climate change. As part of the process, a literature review was conducted, data collection and analysis methods were prepared, and the results were discussed to formulate the conclusion. A significant outcome of this study is that it identifies ways for communities to learn from past floods and how they use this knowledge to improve their resilience in the future.

### 8.2 Literature review

Flood risk management has been practised across the globe for decades. The Sustainable Development Goals (SDG6) (United Nations, 2015) include the provision to support and strengthen the participation of local communities in improving water and sanitation management (Binns, 2022). However, implementation remains challenging to achieve (Makarigakis & Jimenez-Cisneros, 2019). Understanding flood risk management includes understanding the consequences that come with the risk and developing strategies to minimise or mitigate the risk (Lechowska, 2018). Regarding risk reduction efforts, resilience and adaptive capacity decrease the negative consequences of flood risk. Adaptive capacity refers to the ability of a community to adjust to potential damage by the recurring flood and climate change, learn, and take any opportunity to cope with the consequences (Kuang & Liao, 2020; McClymont et al., 2020). Additionally, understanding the dynamic and interrelation of Source-Pathway-Receptor-Consequences (SPRC) models (Schanze, 2006) helps to improve flood risk resilience.

#### 8.2.1 The concept of flood risk

Flood risk can be modelled using the Source-Pathway-Receptor-Consequences-Model (SPRC-Model) (Fleming, 2002; Schanze, 2006) which demonstrates an essential chain that runs from meteorological and hydrological events (Sources) on the inland or at the coastlines (Pathways) to the physical impacts on components at risk (Receptors) and the evaluation of effects (Consequences) (Fleming, 2002; Schanze, 2006). The chain represents the physical process that links Source, Route, and Receptor, while the judgement of the Negative Consequence is a subject of social values.

In particular, the source is defined by the likelihood of flood episodes caused by torrential rain or high weather events (NIWA, 2016b) and the risk is reduced by interventions such as early warning systems (Reese et al., 2011; Smith et al., 2017) and the retention capacity of in-land floods (WMO, 2016). The path is described by river or coastal overflow and flooding [23] with diverse qualities and decreased by flood control intervention. The receptors determine susceptibility with interventions from efforts to promote resilience and increase resistance (Hutter, 2006; Narayan et al., 2011). The consequences represent the damages and are reduced by attempting to decrease or compensate for the damages values (Hutter, 2006).

The chain of SPRC-Model occurs for each element at risk and flood hazard (Schanze, 2006). A complex interrelation exists, and a system that includes all related features and processes can be called a flood risk system (CAE NZ, 2005; Schanze, 2006). In the system, there are the hazard which is flood, probability which is estimation of flood occurrence and exposure, which is the increased risk of flooding due to development in floodplain areas. People and assets are often exposed to the risk of floods due to an uninformed community and poor risk communication (Maidl & Buchecker, 2015; Rollason et al., 2018). Facing natural disturbances such as floods are perceived to have an essential source of resilience-building knowledge for the community (Kuang & Liao, 2020). As a result, assisting the community in preparing for future floods and giving resources to expand capacity by providing guidance will safeguard assets such as property (Boobier, 2011; Proverbs & Soetanto, 2008) and infrastructure (Abhijeet et al., 2011) and reduce the impacts on health, discomfort, and trauma (Tapsell et al., 2002).

### **8.2.2 Response and recover from floods**

Inland flood retention capacity, flood control, resilience, and compensation are all viewed as forms of flood management. Compensation here is the reduction of the negative consequences of floods and acts of protection, such as insurance against flood damages or repayment to flood victims (Hutter, 2006). However, flood risk cannot be avoided in New Zealand (Hermans, 2018; Willis, 2014). There will always be some level of risk, regardless of whether risk reduction measures are implemented or strengthened (CAE NZ, 2005; Ministry for the Environment, 2008a). Floods can affect several catchments or regions, affecting several communities simultaneously. During floods, the government directs people not to wait for official warnings; instead, they are advised to head to higher ground and stay away from floodwater (MCDEM, 2019; Samaddar et al., 2012). In addition to flood information, the central government provides a web platform for flood response and recovery, including food safety, livestock safety, road conditions, and weather warnings and forecasts. Flood response is an action taken immediately before, during, or directly after an emergency to save lives, protect property, and help communities recover (NEMA, 2021). In response to a disaster, recovery refers to coordinated efforts and processes to rehabilitate and enhance a community holistically (NEMA, 2021). The recovery action involves restoring, redeveloping, and revitalising flood-affected communities.

The disaster response level is determined by the event's severity, complexity, and consequences. Generally, when higher response levels are activated in New Zealand, the government either assumes overall responsibility for the incident or supports the response of other agencies (MCDEM, 2019; Northland-CDEM, 2021). In terms of the disaster response at the community level, local, regional, and national levels can be involved (Management, 2010; NEMA, 2021). While planning for response and recovery, risk perception should be understood and owned by all groups as it is an essential component of building resiliency (Agrawal et al., 2020). Thus, Northland has developed a Community Response Plan with the community representatives that are activated when facing emergencies, including flood events (Northland Regional Council, 2022a).

**Table 20 Response level of New Zealand, modified from the Northland Emergency Management Group Plan 2021-2026 (Northland-CDEM, 2021)**

Response Level	Description	Examples
National	Includes agency coordination centres, national level sector coordinating entities, and government coordination across national agencies. Coordinated from National Coordination Centres (NCCs)	A large ex-cyclone storm or tsunami impact will require a response from all levels.
Regional	Includes Civil Defense and Emergency Management Group's (CDEMG) stakeholders and partners. Coordinated from Emergency Coordination Centres (ECCs) or Emergency Operation Centres (EOCs)	Wide-scale flooding across the region will require a regional, local, incident, and community response.
Local	Includes district councils, stakeholders and partners at the local (district/city) level. Coordinated from ECCs or EOCs	A major flood in townships removes people from their homes for an extended time. Support may be required from a local, incident, and community level.
Incident	The first official level of agency response. It includes first responders. Coordinated from Incident Control Points (ICP)	A road closure or road traffic accident due to surface flooding will require an incident-level response.
Community	The public, including individuals, families/whanau, community groups and businesses	

Despite having national and regional plans, there is no assurance that the community will follow the response plan during floods (Auliagisni et al., 2022c; Grothmann & Reusswig, 2006). The reality of understanding the impact of a flood and the urgency of response and recovery is difficult to comprehend unless people have firsthand experience (Mason et al., 2021; Samaddar et al., 2012). No matter how a flood occurs, the safety rule is the same: go for higher ground and stay out of the floodwaters (Kempen, 2017; Reich & Wadsworth, 2008). The ability to adapt and learn over time allows for greater resilience in the community to cope with more significant, unpredictable flood events (McClymont et al., 2020). Having a plan can help diffuse the sense of crisis by knowing who is responsible for doing what and where to turn for help (Garcia, 2006).

As an integral part of the risk reduction process, recovery is coordinated and planned to recognise the escalation of the impacts of an emergency. Recovery entails more than just rebuilding infrastructure. Shaw (2014) identified that recovery requires local community participation, community social capital, strong local governments, and a recovery framework (Shaw, 2014). Regardless of the size of the town or the nature of the catastrophe, the local government in New Zealand is responsible for managing an emergency. Adapting from the national emergency plan (MCDEM, 2019), the Northland Regional Council (NRC) recovery plan follows the national strategic planning and actively supports the national recovery manager.

Following the shift of focus in New Zealand towards risk management consisting of reduction and readiness approaches, a community-based action plan is usually prepared (Chinh et al., 2016). The action plan includes raising community awareness by building effective hazard risk communication (Agrawal et al., 2020; Handmer, 2000; Maidl & Buchecker, 2015), supporting the community from all backgrounds and financial abilities (Yodsuban & Nuntaboot, 2021), and a guide for property level and small-scale businesses protection and repairing strategies (Boobier, 2011; Kuang & Liao, 2020; Proverbs & Soetanto, 2008), supporting local knowledge (King et al., 2007) and traditional practices whenever relevant (McLachlan & Waitoki, 2020; Proctor, 2010). Such a community-based approach empowers a community to take measures to achieve resilience from floods.

### **8.2.3 Community Response Plan (CRP)**

Many communities can become isolated during flooding in Northland, making self-reliance even more critical. To address these issues, Northland Civil Defense and Emergency Management have been working with local communities to develop Community Response Plans or CRP (see Supporting material Table A1). Moreover, 54 Community Response Plans have been completed over the past ten years, as seen in Figure 41. According to the Northland Regional Council, the CRP development process and the outcomes have been very successful (Northland-CDEM, 2021).

Response plan objectives and information include hazard identification, communication strategies, and resource management (Auliagisni et al., 2022c). In Northland, response plans assist communities in identifying hazards and risks and collectively understanding how they will handle future events (Northland Regional Council, 2022a), including assigning roles, responsibilities, and resources. Additionally, response plans assist communities in identifying local leaders or volunteers willing to be involved in and lead emergency management groups (Garcia, 2006). Emergency-related information is communicated to the community by the leader, and community concerns are relayed to the emergency group support structure of the local authority. Finally, response plans should outline the community's resources and how they can be used in emergencies (Management, 2010; Northland Regional Council, 2022a), such as communications, community-led centres, and physical equipment.

As a foundation for improving community resilience, The Northland Civil Defense and Emergency Management Group (CDEMG) has identified public education as one of its key priorities (Northland-CDEM, 2021). In addition to community response plans, Northland CDEMG has invested in Business Continuity Programs, Visitor Action Plans, and Vulnerable Group Projects (Northland-CDEM, 2021; NRC, 2021). A technological solution has also been developed to ensure that information for any emergency caused by weather occurrences is available on the website. Several existing networks have been utilised to support and leverage national initiatives, including Facebook, for



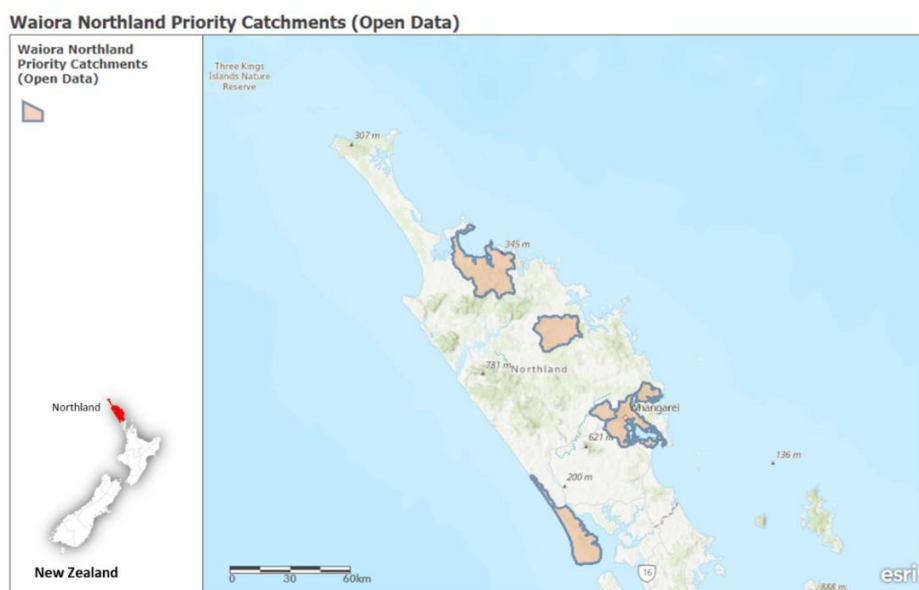


Figure 42 Map of the study area (Source: Authors, modified from Northland priority catchment open data maps)

### 8.3.1 Interview and surveys

Face-to-face and online interviews were conducted in June and July 2021. Participants for the interviews came from the agencies involved in flood management, members of the flood working group, residents of communities at risk, and members of the council of the study area. Key components of the interview included a focus on understanding community perceptions of resilience. All the responses were audio-recorded to ensure that the key participant views were accurately captured. A community survey with open-ended questions and satisfaction scale was distributed by opening information and survey booth in the local library and community centre. There are 185 surveys qualitatively analysed together with the interview results using thematic approach. A primary objective of this interview and survey was to investigate how these communities coped with the recurrent flood hazards.

### 8.3.2 Catchment group meeting and field observations

Three catchment group meetings were observed to understand how community address the issues to the government and other stakeholders. The relationship and interaction between community and different stakeholders are critically observed to understand the reason behind the community's decision for flood protection and to see how the community take part in providing the solution. In terms of field observation, the researcher used the opportunity to inspect the study area while interviewing members of the flood working group and at-risk communities. The observations were conducted in July-August 2021 and August 2022, and the information recorded via photographs and note-taking.

### 8.3.3 Desktop analysis

Desktop analysis enables the researcher to collect factual and interpretative information regarding implementation procedures. The analysis includes the documents from agencies such as local and

regional councils<sup>1</sup>, the National Emergency Management Agency (NEMA), the National Institute of Water and Atmospheric Research (NIWA), and the New Zealand Red Cross. The data obtained were then triangulated to add credibility and internal validity to the findings and present a more comprehensive view of the research. The data collected from the desktop analysis were cross-checked against the data collected from interviews and site observations.

### 8.4 Findings and Discussion

To understand how communities develop resilience from floods, it is important to understand the vulnerability of communities to floods, and the flood impacts. There were no casualties from the major floods in the Northland in 2020, 2021 and 2022, but damage to homes, businesses, and infrastructure was extensive. Houses, public buildings, highways and bridges, water and sewer systems, and telecommunications were all affected. The ability of the Northland communities to implement a response plan and move quickly to recovery after the flood water drains out suggests that most residents are familiar with the flood hazard and are aware of the risk. However, lesson learned from flood experience does not always increase flood resilience (Kuang & Liao, 2020). Therefore, community engagement in the Northland region was developed to support community's preparedness for recurring floods, including a catchment flood group meeting, Māori engagement, and a community response plan (Management, 2010; Northland-CDEM, 2021). Such meetings reduce community vulnerability.

#### 8.4.1 Flood response and recovery at the community level

Communities (such as in Kaihu, Taumarere, and Whangaroa river catchment area) with experience in past floods were able to respond faster than those that have not experienced flooding. However, community response and recovery also depended on knowledge and risk awareness. For example, during the floods in Far North and Whangarei in 2020, people without a proper understanding of responding to floods relatively chose to stay back in their houses despite the flood warning and instruction to evacuate.

In the Northland, people shelter in place (in the location they are already occupying – generally their homes) unless there is a mandatory evacuation. Communication between the affected residents and the relevant government agencies is crucial. This is because services such as evacuation and rescue operations and the setting up temporary shelters for the victims must be established immediately (Hutter, 2006; Munawar et al., 2021). In flooded areas, the Northland Red Cross, Firefighters, Police, and Northland CDEMG are among the first organisations to arrive as they manage evacuations and operate temporary shelters. If there is communication and collaboration, community leaders, with the help of all the support organisations, contact all residents in their *whanau* (community group) to ensure their safety.

Nevertheless, there are sometimes residents that either resisting to stay or not following the instruction to evacuate during an emergency, as seen at the flooding event in the Moerewa and Kaeo area of the Northland Storm Flooding, 17-18 July 2020. During the flooding event, some residents wanted to leave their homes for a safer place despite the instruction to stay put and the fact that

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<sup>1</sup> Whangarei District Council (WDC), Kaipara District Council (KDC), Far North District Council (FNDC), and Northland Regional Council (NRC)

driving on the flooded road is hazardous. In contrast, residents who need to be evacuated refused to leave for various reasons, such as being financially unable to move out, not having anywhere to evacuate, or fear of burglary.

People who have previously experienced flooding are generally more prepared, such as having food supplies and emptying the areas that could get flooded to minimise damage. Inexperienced people, however, are at greater risk of safety and vulnerability (Grothmann & Reusswig, 2006). When a flood occurs, the affected areas can often become isolated (such as in most areas of the Far North district during 2020 flood and Kaitaia during 2022 flood) due to road closures, surface flooding, or road damage, and cleaning up will take some time. Community response plans for the flood regions (Ministry for the Environment, 2008a; Northland Regional Council, 2022a), provided information including communication plans and infrastructure for emergencies, so communities had the tools to manage their safety (Blakeley, 2016; Handmer, 2000). The response plans also supported decision-making for emergency response (Mason et al., 2021) and established guidelines for flood survival (Proctor, 2010; Rouse, 2011) so the community was better prepared.

During flooding events, such as the 2020 and 2022 floods, emergency response teams were in high demand, for instance, to protect people, manage roads and evacuate vulnerable residents. First responders in these teams encouraged residents to look after the safety of their neighbours, especially the elderly and children. Community assets including a truck, boats, safe shelters, blankets, and other necessities were made available to the community, so that community members felt they could rely on their neighbours for assistance. Community resilience was demonstrated through sharing assets and concern for neighbours' safety.

### A. Volunteer

Resilience can be demonstrated through the availability and willingness of volunteers in the community to respond when needed. Volunteers play an essential role in the Northland during floods. Whenever possible, Regional CDEMG offers guidance and support to community-led recovery efforts. Taking part in the response and recovery process, the community demonstrates *Whakawhanaungatanga* (establishing relationships) and *Manaakitanga* (showing respect, generosity, and care to those who use services, their families and communities)(MCDEM, 2019; Proctor, 2010). Three types of volunteer groups are included in the Northland CDEMG disaster resilience plans (MCDEM, 2019):

- i. Volunteers who have connected with CDEMG training, provided or facilitated by CDEMG
- ii. Affiliated volunteer organisations such as Northland Red Cross
- iii. Spontaneous volunteers who are members of the public or community groups who respond spontaneously to emergencies
- iv. During the Northland Storm Flooding in 2020, all three groups were visible and collaborated to respond. The volunteers focused on residents' safety in the flooded areas including managing access and providing advice.

### B. Working together after flood

Community resilience can be identified by how the community are able to effectively recover by working together. Even though various precautions have been taken to minimise the impact of flooding, there are still damages to property observed in the inundated communities. For instance, in the Far North, flood in 2020 affected 11 areas and caused considerable damage to the affected properties (see map in Figure 41). After the flood, the Northland community cleaned up as soon as the water drained from properties and roads. The rural areas affected by the flood often have limited resources to recover and are especially vulnerable if they have no flood insurance. In the July 2020 flood, more than half of the households were thought to have no insurance, so residents offered some practical help on the best ways to clean after flooding Table 21:

**Table 21 Usual flood damages in property in Northland and cleaning process (BRANZ, 2021) modified and combined with research data collected in July 2021)**

Damages	Long term consequence	Clean-up action
Mud on the walls	Dried mud is harder to clean and can deteriorate the structure	Wash with clean water, soap, and vinegar solution, as bleach is more harmful to the environment. However, too much acid is not recommended as it can damage the walls.
Cavities	Dirty areas support the growth of disease-causing microorganisms carried in floodwater.	Clean with high-pressure water and use Liquid household cleaners to remove mud, silt, and greasy deposits.
Mud on the floors and carpet	Not adequately cleaned floor can damage the structure of the floors and cause mould growth and other disease-causing microorganisms.	Shovel the mud, remove the coverings, clean pressurised water, disinfects, and dry before reapplying the covering. A carpet cleaner company also can help to make sure the covering is safe and germ-free
Heating duct	Breathing chemicals or biological pollutants in conditioned air	Replace or hire professionals to clean
Wet lining board	Mouldy and crack when it dries	Clean with a damp cloth and disinfect before dry
Swollen doors	Growing mould or jammed	Clean with disinfectant and use a dehumidifier, heat gun, or hair dryer to dry the doors. If still jammed after it dries, sand the doors.
Electricity and gas	Fire hazard risk, and electricity failure or electrocuted	Use a torch when entering, do not use candles or any open fire. Switch off the electricity supply at the fuse box and gas supply if it is safe. If it is affected by water, seek professional advice. Unplug damaged electrical appliances and assess the condition before use.
Water	Health problem	Do not use until it is clean and even after it comes out clean, still treat the water before use. Boils the water or buy fresh water for safety.
Furniture	Damaged and mouldy furniture	Move to the clean and dry area, clean with a cloth, and disinfects before drying.
Paddocks	Cutting the access and affecting the plants or live	Clean access ways, be aware of hazards and check the water supply. Assess each paddock for damage and soil test slit before regressing. Some paddocks

stocks. Contaminated slits or slips can happen.

need immediate action, while others need to dry before action, depending on the situation.

The practice of repairing flood-damaged properties by households is part of the community response resilience towards recurred flood events (Munawar et al., 2021). Further, the existence of a guide to restoring flood-damaged properties provides a means of managing the damage.

#### 8.4.2 *Involvement of communities in flood protection strategies*

Local councils protect the community from flood risk, including flood protection infrastructure, drainage schemes, and river management. In areas most heavily impacted by flooding, the community works closely with the council through local river working groups to develop plans to reduce flood risk. River flood protection infrastructure (Northland Regional Council, 2018a; NRC, 2021) in the Northland is grouped into ‘schemes’ that provide integrated management of river catchments. The infrastructure project for mitigation includes flood control dams and reservoirs, channel modifications, floodwalls, and levees. This infrastructure plan has significantly contributed over the years to reducing the flood impact; for example, the Whangarei dam stopped about 300,000 cubic metres of water from flooding into Whangārei CBD in July 2020 (NRC, 2020), and the Awanui scheme that protects two Far North townships from going underwater caused by the torrential rain in August 2022 (NRC, 2022).

Drainage schemes have been built in the wetland areas around the region to increase the flood resilience of the floodplain areas. Some examples of flood protection can be found in Table 19. The scheme includes building up the river’s embankment (using stop banks) to prevent river flooding. To protect communities downstream, some river stop banks have floodgates that can be opened to spill flood water onto less densely settled farmland.

**Table 22 Flood protection plan and community involvement**

Protection Plan	Program	Community involvement
	Awanui	
	Kaeo-Whangaroa	
Flood protection infrastructure	Whangarei dam Kerikeri-Waipapa Taumarere	Involvement of community members in the planning, construction, decision-making and ongoing management
	Raupo drainage scheme	
Drainage scheme	Hikurangi swamp Kaitaia swamp	Maintain property’s healthy drainage system around property and neighbourhood

Erosion control		
	Clearing blockages	Landowners are responsible for the normal maintenance of rivers and streams on and around their property.
River management	Gravel management	
	Vegetation management	

In Northland, good river management can help protect people, land, and property from damage from flooding (Northland Regional Council, 2022c; Reese et al., 2011). It can also reduce the impact of erosion and sedimentation, improving water quality and habitat for native aquatic plants and animals (CAE NZ, 2005; Northland Regional Council, 2022c; Proctor, 2010). In carrying out river management works, consideration is given to river and stream systems, providing a coordinated approach to what happens on the ground. The works include maintaining the vegetation around the rivers to prevent waterway obstruction; clearing obstructions and preventing plants and other objects such as logs from blocking waterways; erosion control along the waterways; and gravel management on the riverbeds to avoid the normal deposition of gravel and the smaller-sized sands and silts. Northland communities, through the local river working groups can communicate their needs to the council on what are the most appropriate management systems to use. Creating a communication channel for river and flood management builds the community’s resilience to future flooding events.

From the recurring floods, the Northland community understands that they cannot give all the responsibilities to the government and rely solely on the infrastructure, as flood protection infrastructure works are a long-term solution (which takes time). There is also no guarantee that the infrastructure will always be effective in limiting the flood impact. Communities are also liable to protect themselves and need to own the problems by acknowledging the risk (Auliagisni et al., 2022c). To live with recurring flood problems, people need to be able to respond and recover effectively during and after the emergency. Communities demonstrate it by volunteering and working together to clean up after the flood and combine new and indigenous knowledge to prepare for the next flood. This example of community risk management actions helps them bounce back from adversity, evaluate the situation, and better prepare them for the next flood events. Those are the effort of Northland community in building their resilience towards floods.

The ability of a community to cope with an emergency is based largely on the measures it takes before the emergency occurs. However, getting communities to participate in actions that enhance preparedness and create resilience to disasters has often proven to be challenging for councils and emergency management. Engagement is also a key to developing community resilience and reducing the negative consequences of flood risk. Building awareness and risk perception at the community level helps to build resiliency in practice (Agrawal et al., 2020). In addition to local river working groups Northland, community engagement efforts for flood management also include flood meeting groups, Māori engagement, and a community response planning.

### 8.4.3 Community engagement in the Northland

Northland Regional Council identified 28 catchments (priority rivers) around the Northland as priorities for flood risk planning. The rivers and streams in these priority catchments pose a higher potential risk to lives, buildings, road access, infrastructure, and agriculture than other regions. The regional council presented these findings in the region's river flood maps. Such flood maps contribute to mitigating risk and building a well-informed and well-prepared community (Auliagisni et al., 2022c; Maidl & Buchecker, 2015).

To provide flood protection for the area at risk, the council, experts, and communities are working together to understand better the river system involved, including how flooding affects the areas physically and its impact on the communities. Such collaboration targets community-based solutions for recurred floods (Management, 2010; Willis, 2014) and creates adaptive capacity for future floods (Jakku & Lynam, 2010; Kuang & Liao, 2020). After the 1 in 500-year storm flood 2020 in the Northland, the council worked with the affected communities and stakeholders to better understand flood frequency and identify people at risk.

The council identified the assets and buildings requiring protection from the floods in the community's local areas and presented the river management plan, maps, and reports. The risk and project information, planning, construction, evaluation, and maintenance of the assets were discussed through the flood management working group, which included a series of meetings held around interest, such as Taumarere Flood Management Working Group, Kaihū River Working Group, and Kāeo River - Whangaroa Catchment (see Appendix A. Table A2). The flood working group displays collaboration in action when solving flood management problems in Northland.

The indigenous peoples of New Zealand, Māori, have land and a presence in Northland, including the *iwi* (tribes) of *Te Aupōuri*, *Ngāti Kuri*, *Ngāti Kahu*, *Te Rarawa*, *Ngāi Takoto*, *Ngāti Kahu/Ngāpuhi ki Whaingaroa*, *Ngāpuhi*, *Ngātiwai* and *Ngāti Whātua* (NRC, 2012b). Māori have a significant role to play in developing resilient communities, as their communities are often affected by floods (Kowhai, 2022). The culture of *Whakawhanaungatanga* (the process of establishing relationships) and *Manaakitanga* (the process of showing respect, generosity and care) complements processes with several capability and capacity-building characteristics. The translation of this culture demonstrated in the collaboration, respect for the law, volunteering during an emergency, and working together and helping each other to recover from floods and prepare for the next coming flood.

The respect to *Tikanga* (customs and traditional values) shows the identity of this indigenous community in responding and providing the solution to overcome adversity. Inclusion of Māori in river and flood management informs and enriches work in the emergency management sector leading to better outcomes for all our communities by promoting inclusive engagement that supports decision-making. Land and infrastructure development has reduced the ability of Māori to exercise *Kaitiakitanga* (guardianship) over natural resources and has led to a loss of *mana* (control). Therefore, to initiate the engagement, the government, through local councils, is exploring ways to restore this *Kaitiakitanga*. This practice also translated to a more nature-based solution for flood protection and actions during the cleaning up after the flood, by reducing to create more harm to nature during the clean-up and overall recovery phase.

One way to build resilience in Northland is to develop meaningful and inclusive relationships with Māori communities (Northland-CDEM, 2021). The council is committed to working with Māori and has recognised inclusive relationships with Māori communities as one of the region’s four key focus areas. Regarding the flood risk management strategies, the council has set up several catchment groups, which are linked to the catchment-based flood working group, to address the new policy direction. Each of these groups is a sub-committee of the council and includes Māori representatives. In practice, while involving Māori representatives in the catchment group is necessary (McLachlan & Waitoki, 2020; Proctor, 2010), the connection outside this group needs to be strengthened, for example, by showing more support at community events, traditional ceremonies, and being visible at other cultural activities.

## 8.5 Conclusion

Communities on flood plains are especially vulnerable and need to develop resilient ways of living. The floodplain is home to many Northland communities discussed in this paper. The paper has shown that developing community resilience takes many forms, such as infrastructure mitigation measures, community flood groups and council interactions. The analysis of interview and observation results reveals that indigenous practices are strongly bound within the community, including in the emergency response.

The practice of *Whakawhanaungatanga* (establishing relationships) means that the collaboration between community and stakeholders and within the community group was essential for them. The course of *Manaakitanga* (showing respect, generosity, and care to those who use services, their families and communities) were demonstrated through the availability and willingness of volunteers in the community to respond when needed. The respect for *Kaitiakitanga* (guardianship) over natural resources and *Tikanga* (customs and traditional values) practice were applied in every flood works in respect of nature and indigenous knowledge value.

This study’s limitations include the distribution of information when opening information booths, engaging with the specific indigenous community, and access to certain areas due to road closure caused by floods and landslips. However, despite its limitation while collecting the data, this research has demonstrated resilience in action, through identifying collaborative approaches between Council and the affected communities. Analysis and discussion found that such interactions have led to action plans and local community action to reduce their vulnerability to floods and to learn how to develop resilient practices from flooding. Community-led response plans together with infrastructure improvements and collaboration with councils mean that future flooding events may not be as destructive.

## 8.6 Supporting Material

**Table A1.** Community response action plans in Northland (Source: Authors)

Objectives	Actions	Lead Agency
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Increase the level of business and community awareness through public education and consultation	<ul style="list-style-type: none"> <li>• Develop, monitor and report on a Public Education Strategy, which identifies priority groups, key messages and delivery methods and a detailed action plan.</li> <li>• Include consideration of how communities engage in determining risk tolerance levels and risk reduction priorities.</li> </ul>	CDEMG
Improve community participation and preparedness through community-based planning	<ul style="list-style-type: none"> <li>• Complete the remaining CRPs</li> <li>• Establishing a process for maintaining existing CRPs (web-based).</li> <li>• Proactively undertake (or support the community to undertake the activities identified as needing improvement in the plans, including extending plans to include recovery and hazard risk reduction.</li> <li>• Provide opportunities for community plan leaders to attend Coordinated Incident Management System (CIMS) courses and other professional development activities, such as training and exercises.</li> </ul>	CDEMG, in partnership with Community Groups
Provide effective warning systems to enable agencies and the communities to respond rapidly to potential events	<ul style="list-style-type: none"> <li>• Maintain the existing warning network and proactively review and consider technological advances that may enhance all hazards warnings in the region</li> </ul>	CDEMG

**Table A2.** Example of flood meeting in three catchments 2021 (Source: Authors)

Main project	Identified Issues	Offered solutions
<b>Taumarere Flood Management Working Group Friday, 6 August 2021</b>		
<ol style="list-style-type: none"> <li>1. Investigations are underway for the stormwater network.</li> <li>2. Soakage testing is now complete and added to models.</li> <li>3. Surveying will be undertaken to identify houses at risk of flooding.</li> <li>4. Borehole tests will be undertaken</li> </ol>	<ol style="list-style-type: none"> <li>1. More significant and frequent storm events exceed the soakage capacity of the existing network of shallow soak pits.</li> <li>2. Overland flow paths are influenced by the flat topography and railway so that the floodwater is moving along Otiria Rd and ponding in the Pembroke St and main retail area.</li> <li>3. Flat topography resulting in ponding while the railway line prevents drainage into the Waiharakeke Stream.</li> <li>4. Wider community still don't know what is happening at the meeting</li> <li>5. Need the guide for <i>Tikanga</i> (customs and traditional values) practice</li> <li>6. Man-made change affecting the existing place and family in the affected area</li> </ol>	<ol style="list-style-type: none"> <li>1. Flood alleviation works by NRC – remediation plans</li> <li>2. Kiwirail- installing pipeline under the rail corridor</li> <li>3. Pay attention to the community resource plan</li> <li>4. There is a discussion to allow the public to participate in the meeting, not only the representatives.</li> <li>5. more funding for flood work</li> <li>6. Community distributes the information through the <i>Facebook</i> group</li> </ol>
<b>Kaihū River Working Group Friday, 13 August 2021</b>		

1. Boat trip inspection by NRC	1. Biosecurity issue	1. LIDAR data help for clearance project
2. Boat spraying and Heli-spraying (environmentally friendly component)	2. Funding issues	2. Irrigation work was done by NRC but handed over to the trust
3. Machine cleaning	3. Possibility of land use change in areas	3. More work to do in moving water around the districts
4. Tree removal on the riverside	4. Contractor came without a proper briefing (did not bring the correct gear for tree cutting that was blocking the river)	
<b>Kāeo River - Whangaroa Catchment Group</b>		
<b>Friday, 30 July 2021</b>		
1. Matangirau trial – Whanau are happy with the trial; there is 80% buy-in from landowners.	1. Circulation of communication and information between the council and community and within the community itself	1. Gravel Extraction
2. Erosion maps and new physiographic maps	2. Awareness of flood maps and relation to climate change	2. Investigate the feasibility of using drones to get the overall images of the problem
3. Kaeo catchment spillway project and current land use	3. Community group representative elections	3. Circulating and communicating the new flood maps.
4. Willow Removal – problematic willow has been removed from near Pupuke marae	4. Action for future flood protection	4. Prewarning system: the notifications of triggers on the river to prepare (2-3 hours in advance) by hydro team forecast
5. Tauranga Bay – estuary was blocked, and a cut was made at low tide to allow the estuary to drain. Incoming tide and wind filled it during one tidal cycle. After sufficient rain, the river mouth is now open.		5. Providing the catchment-based information
		6. Adopting base information to create future project and scheme development.

## 8.7 Author's Comments

This chapter provides a significant and insightful contribution to the thesis by offering a detailed case study of flood risk management and resilience strategies in Northland. The case study effectively emphasises the importance of combining structural measures, such as flood protection infrastructure, with community-driven initiatives and indigenous knowledge. This dual approach underscores the thesis's broader focus on building community resilience through adaptive and inclusive strategies.

The integration of Māori traditions like Whakawhanaungatanga (relationship-building), Manaakitanga (hospitality and care), and Kaitiakitanga (guardianship of natural resources) is a particularly valuable aspect of the study. These principles offer a culturally rich perspective on how traditional practices can support and enrich modern flood risk management efforts. The chapter highlights how these traditions can not only enhance community engagement but also provide a sustainable, long-term framework for managing flood risks.

By identifying gaps in communication, participation, and preparedness, the research validates the need for a hybrid governance approach—blending top-down policies with bottom-up community action. This is a key finding that directly supports the thesis' advocacy for a more inclusive and participatory flood risk management model. Furthermore, the chapter provides actionable

recommendations for local councils and communities to collaborate more effectively, responding to the challenges posed by climate change and recurring flood events.

Overall, this case study strengthens the thesis's argument for a holistic, culturally informed, and sustainable approach to flood risk management. It demonstrates that integrating indigenous knowledge and fostering community involvement can greatly enhance resilience strategies, ensuring they are both effective and relevant to the diverse needs of local populations. The chapter would benefit from further detail on how these recommendations could be implemented at the policy level, particularly in relation to current governance frameworks.

## Chapter 9

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Preserving Community Resilience: Embracing Tradition  
and Innovation in Disaster Preparedness

**Chapter 10 Notes:**

This paper is prepared for a conference. Its purpose is to illustrate how efforts and planning made during the aftermath of a disaster can be forgotten over time. Some of the data that came out has been submits and accepted to be presented at CIB conference 2025.

For examiners' review, please follow the guidelines of Massey University Thesis with Publication.

This chapter will answer the following research questions:

<b>Research Question:</b> <b>How do intergenerational knowledge gaps impact community flood preparedness, and what strategies can bridge these gaps to enhance disaster resilience?</b>	
<b>Research Objective A:</b> <b>To investigate the mechanisms contributing to the intergenerational attenuation of disaster preparedness knowledge.</b>	
<b>Research Objective B:</b> <b>To identify and assess the impact of traditional and modern disaster preparedness strategies on flood resilience.</b>	
<b>Research Objective C:</b> <b>To propose actionable recommendations for integrating ancestral knowledge with contemporary approaches to sustain flood preparedness across generations.</b>	
<b>Sub Question i</b>	What are the key factors leading to the erosion of disaster preparedness knowledge across generations?
<b>Sub Question ii</b>	How do flood experiences influence preparedness behaviours among affected and unaffected community members?
<b>Sub Question iii</b>	What role does traditional ecological knowledge play in modern flood preparedness efforts?
<b>Sub Question iv</b>	How can educational initiatives and community spaces like libraries facilitate cross-generational learning in disaster preparedness?

**Abstract**

Addressing the challenge of sustaining disaster resilience across generations, this paper examines the phenomenon of intergenerational attenuation and its impact on communities' preparedness efforts. Utilizing qualitative case studies from the Northland region in New Zealand, we explore how communities initially prioritise disaster preparedness following catastrophic events, yet experience a decline in readiness over time as memories fade—a phenomenon termed 'intergenerational knowledge gap.' Through structured analysis, we identify underlying mechanisms contributing to this decline and interventions necessary to address it. Our findings underscore the urgency of combating the erosion of preparedness efforts and regulatory structures as memories of past disasters diminish. Moreover, we highlight the importance of integrating ancestral knowledge, conveyed through oral traditions, music, and narratives, with contemporary strategies for disaster resilience. This fusion involves leveraging technological innovations, fostering community engagement, and promoting educational initiatives for resilience continuity across generations. By nurturing cross-generational learning and preserving cultural heritage, we encourage preparedness for future generations to face recurrent floods and other calamities. Furthermore, this research contributes not only to Sustainable Development Goal (SDG) 11: Sustainable Cities and Communities by highlighting the importance of

integrating ancestral wisdom with modern innovations to address broader SDG 11 objectives but also aligns with SDG 4, which aims to ensure inclusive and equitable quality education for all by promoting educational initiatives for resilience continuity across generations. The insights derived from this study offer actionable recommendations for policymakers, practitioners, and communities striving to mitigate disaster impacts through sustained preparedness efforts and close gaps in disaster resilience research.

Keywords: Community Preparedness, Disaster Resilience, Intergenerational Knowledge Gap

### 9.1 Introduction

Flooding is among the most pervasive natural hazards, affecting millions globally and causing widespread social, economic, and environmental disruption. While communities often mobilize disaster preparedness efforts following catastrophic events, these efforts frequently wane over time as memories fade. This phenomenon, termed the "intergenerational knowledge gap," poses significant challenges for sustaining long-term flood resilience (Cutter et al., 2012; Morrow, 1999). The gap reflects a decline in the transmission of disaster-related knowledge and practices from older generations to younger ones, exacerbating vulnerabilities and weakening community preparedness over time.

Existing research on flood resilience highlights the importance of proactive preparedness measures, such as infrastructure adaptations, land-use planning, and community engagement (Parker et al., 2007; Pelling, 2012). However, a growing body of evidence suggests that these efforts are insufficient without robust mechanisms for preserving and transmitting flood-related knowledge across generations (Kellens et al., 2013; Ronan & Johnston, 2005). Studies in various regions, including Bangladesh, the Philippines, and New Zealand, underscore the transformative role of traditional ecological knowledge in enhancing community-based disaster risk reduction (Berkes et al., 2000; Harmsworth & Awatere, 2013; Shaw et al., 2008). Yet, these knowledge systems are increasingly under threat due to modernization, urbanisation, and migration.

In the Northland region of New Zealand, flooding poses a recurrent threat exacerbated by climate change. Communities in this region exhibit a mix of proactive preparedness behaviours and concerning trends of declining engagement, particularly among younger generations who lack direct flood experience. This research investigates the impact of intergenerational knowledge gaps on flood preparedness in Northland, emphasising the integration of ancestral knowledge with contemporary disaster management strategies. Specifically, it addresses how the erosion of traditional practices and institutional memory affects community resilience and identifies strategies to foster cross-generational learning.

Using a mixed-methods approach, the study collected data from surveys and interviews involving flood-affected and unaffected residents, government agencies, and community organizations. Key findings reveal significant differences in preparedness behaviours between generations, with flood-experienced respondents more proactive and engaged. The study also underscores the critical role of collective responsibility and the need for targeted educational initiatives to bridge knowledge gaps. These findings contribute to the broader discourse on disaster resilience, offering insights into sustainable approaches to disaster preparedness that combine ancestral wisdom and modern innovations.

By addressing the interplay between intergenerational knowledge, cultural heritage, and contemporary strategies, this research aims to advance the understanding of how communities can sustain resilience in the face of climate-induced flooding. The results hold implications for policymakers, educators, and practitioners seeking to mitigate disaster impacts and promote long-term flood resilience.

### 9.2 Literature review

Flooding is a global hazard with profound implications for social, economic, and environmental systems. Building resilience against flooding involves a multifaceted approach, combining individual preparedness, institutional action, and community-based strategies (Cutter et al., 2012; Pelling, 2012). However, sustaining preparedness over time presents a significant challenge, particularly due to the phenomenon of intergenerational knowledge gaps (Morrow, 1999). These gaps, characterized by the diminishing transmission of flood-related knowledge and practices across generations, exacerbate vulnerabilities and weaken community resilience.

#### 9.2.1 *Flood Resilience and Preparedness*

Flood resilience, defined as a community's ability to anticipate, respond to, and recover from flooding, is a cornerstone of disaster risk reduction (Berkes et al., 2000). Research highlights that effective flood preparedness includes a range of measures, from property modifications and evacuation plans to infrastructure development and community-based education (Parker et al., 2007; UN, 2015). For these efforts to be effective, they must be sustained over time and adapted to evolving risks, such as those posed by climate change (Garg et al., 2008).

Studies also emphasize the importance of integrating individual and institutional efforts in flood risk management. Governments and local councils play a critical role in creating policies and infrastructure that support resilience, while communities must engage proactively to implement these measures (Alexander, 2013; Shaw et al., 2008). Despite this, communities often struggle to maintain preparedness, especially in the absence of recent flood events—a lapse exacerbated by intergenerational knowledge gaps.

#### 9.2.2 *Intergenerational Knowledge Gap and Disaster Preparedness*

The concept of intergenerational knowledge transfer has been extensively studied in the context of cultural heritage and education (Berkes et al., 2000). In disaster preparedness, it refers to the mechanisms through which experiential knowledge about risks and mitigation strategies is passed down from older to younger generations. However, several factors, including urbanisation, migration, and changing lifestyles, hinder this transmission, leading to gaps in preparedness behaviours (Kellens et al., 2013; Morrow, 1999).

In New Zealand, indigenous Māori communities traditionally relied on oral traditions and environmental knowledge to predict and manage flooding. These practices, deeply rooted in ancestral wisdom, highlight the importance of community-based strategies for disaster risk reduction (Harmsworth, 2002; King et al., 2007). However, the shift toward modern urban living and the dominance of scientific frameworks have contributed to a decline in these traditional practices (Zivkovic & Heikell, 2022). Similar trends have been observed globally, with studies from Bangladesh

and the Philippines linking the erosion of traditional disaster knowledge to reduced community preparedness (Shaw et al., 2008).

### ***9.2.3 Role of Ancestral Knowledge in Modern Disaster Management***

Integrating ancestral knowledge with modern disaster management strategies offers a promising pathway to enhance resilience. Traditional ecological knowledge (TEK) provides insights into sustainable land use, water management, and risk reduction practices that are often tailored to local contexts (Berkes et al., 2000; King et al., 2007). For example, Māori environmental practices in New Zealand include using natural indicators for flood prediction, a method that could complement contemporary tools like GIS-based mapping and early warning systems (Zivkovic & Heikell, 2022).

Recent studies advocate for hybrid approaches that value indigenous knowledge alongside technological advancements. This integration not only strengthens resilience but also fosters community empowerment by acknowledging the cultural and historical significance of traditional practices (Auliagisni et al., 2022b). For instance, educational programs that combine oral storytelling with interactive digital tools can bridge generational divides while promoting sustainable disaster preparedness behaviours.

### ***9.2.4 Education and Community Engagement in Resilience Building***

Education plays a pivotal role in sustaining disaster preparedness across generations. Targeted programs focusing on disaster risk reduction (DRR) and climate adaptation are essential for addressing knowledge gaps and fostering a culture of resilience (UN, 2015). Community-based initiatives, particularly in rural and flood-prone areas, have demonstrated the effectiveness of participatory education in enhancing disaster awareness and preparedness (Dufty, 2008; Ronan & Johnston, 2005).

In Northland, libraries and community centres serve as critical hubs for delivering disaster preparedness education. These spaces facilitate cross-generational learning and the integration of local knowledge with modern disaster management practices. However, for such initiatives to be effective, they must be inclusive, addressing the unique needs and perspectives of different demographic groups (Ronan & Johnston, 2005).

### ***9.2.5 Knowledge Gaps in Flood Resilience Research***

While the existing literature provides a solid foundation on the importance of disaster preparedness and knowledge transfer, there are notable gaps in understanding how intergenerational knowledge gaps specifically affect flood resilience in the long term. Most studies have focused on immediate post-disaster responses or the role of government and infrastructure in resilience-building (Garg et al., 2008). Less attention has been paid to the nuanced ways in which generational shifts influence preparedness behaviour, particularly in contexts where communities face recurrent or evolving risks such as those exacerbated by climate change (Pelling, 2012).

Further research is needed to explore how to sustain flood resilience across generations, particularly in communities where direct flood experiences may be limited, and where traditional knowledge is under threat from modernization and climate change. Understanding these dynamics is

essential for designing effective, long-term flood management strategies that integrate the wisdom of past generations with innovative approaches to risk reduction.

### 9.3 Methods

This study employed a mixed-methods approach, combining surveys and interviews to explore the impact of intergenerational knowledge gaps on flood preparedness in Northland, New Zealand.

**Study Area and Participants:** The research focused on Northland, an area vulnerable to flooding. Participants included residents of flood-prone communities, government officials, and local organizations involved in disaster management. The observation to the larger areas follows the location of the available libraries illustrated in the Figure 19. Figure 1

**Data Collection Methods:**

- i. **Online Survey.** An online survey was distributed to community members in vulnerable areas, gathering data on flood experiences, risk perceptions, and preparedness behaviours. However, limited internet access in rural areas resulted in a low response rate.
- ii. **In-Person Survey Booths.** To address this, survey booths were set up at libraries and community centres (Figure 43). Out of 30 identified areas, 12 libraries were unavailable for participation. Survey booths were held in the remaining 18 locations, where 185 responses were collected. This method allowed engagement with individuals who lacked online access. A list of the visited and unavailable libraries is provided in the Table 5.



Figure 43 Survey booth for online survey and interview at Whangarei (left) and Paihia (right).

- iii. **Semi-Structured Interviews.** Interviews were conducted with government agency representatives and local organizations to gain insights into flood management policies and community engagement. These interviews helped contextualize the survey findings.

**Data Analysis:** Quantitative data from the surveys were analysed using descriptive statistics, comparing responses from flood-affected and unaffected respondents. Qualitative interview data

were analysed using thematic analysis to identify key themes on flood risk management and generational knowledge gaps.

Research Limitations: Limitations included a low response rate to the online survey and potential biases in the sample due to the focus on areas with accessible libraries. Further research could address these gaps by engaging more isolated communities.

### 9.4 Findings and Discussion

#### 9.4.1 *Community Concerns about Flood Risk and Management*

Respondents expressed significant concern about flood risks and their community's preparedness levels. For example, participants in Whangārei emphasized how overwhelmed stormwater systems during heavy rainfall have repeatedly caused localized flooding in urban areas. This finding reflects the broader literature emphasising risk awareness as a crucial factor in disaster resilience (Cutter et al., 2012; Pelling, 2012). Additionally, frustrations over delays in government-led mitigation projects were common, with residents in Kerikeri expressing scepticism about the timeliness of proposed infrastructure upgrades. These concerns underscore the importance of efficient governance, aligning with Alexander (2013) emphasis on institutional accountability in disaster risk reduction.

#### 9.4.2 *Preferences for Proactive Measures*

A strong preference for proactive flood risk mitigation emerged across both flood-affected and unaffected respondents. In Kaikohe, participants highlighted the need for increased investment in culvert upgrades and vegetation management along rivers, measures deemed critical to reducing flood impacts. Flood-affected respondents, such as those in Moerewa area, cited personal experiences of water intrusion into homes as driving their support for stricter land-use regulations in high-risk zones. This aligns with Parker et al. (2007) advocacy for preventive strategies as the cornerstone of effective disaster management.

By prioritising these community-driven recommendations, this research highlights a proactive approach to flood management. Such measures reflect the literature's findings while emphasising the importance of tailoring interventions to specific regional needs, a nuance often underexplored in prior studies.

#### 9.4.3 *Collective vs. Individual Responsibility for Flood Risk Management*

Both flood-affected and unaffected respondents strongly favoured collective responsibility for managing flood risks, with local councils and central government identified as key actors. For example, participants in Dargaville stressed that large-scale infrastructure projects, such as flood barrier construction, could only be effectively managed through government coordination. However, some respondents in Hikurangi acknowledged the importance of personal responsibility, such as refraining from high-risk development.

This dual recognition of collective and individual responsibilities mirrors findings by Cutter et al. (2012) and Pelling (2012) while introducing a novel insight: the coexistence of these approaches

within the same community. This perspective can inform more balanced disaster risk management strategies that integrate top-down governance with bottom-up community initiatives.

### ***9.4.4 The Influence of Flood Experience on Perceptions and Behaviours***

Flood-affected respondents demonstrated more proactive preparedness behaviours, such as modifying properties and engaging directly with local authorities. For instance, a resident in Kawakawa shared how they elevated their home's foundation and planted native vegetation to stabilise soil after experiencing two severe floods in the past decade. These behaviours align with Ronan and Johnston (2005) findings that disaster experiences often foster heightened awareness and proactive preparedness.

This study adds depth by exploring how non-affected respondents engage less with preparedness. In areas like Kerikeri, residents with no recent flood experiences expressed limited awareness of proactive measures, relying heavily on government alerts rather than self-driven initiatives. This highlights the importance of targeted communication and education efforts to engage diverse groups within communities.

### ***9.4.5 Intergenerational Knowledge Gaps and Preparedness***

A critical finding is the impact of intergenerational knowledge gaps on community resilience. Younger generations, particularly in communities like Kerikeri, exhibited lower engagement with flood preparedness activities and limited familiarity with traditional practices. In contrast, older respondents in Whangārei emphasized the value of oral traditions, such as monitoring environmental cues, to inform preparedness strategies. This gap aligns with Morrow (1999) concept of intergenerational attenuation, where knowledge diminishes over time without direct experiences to reinforce it.

The study further underscores the erosion of traditional knowledge systems in Northland. Māori respondents, for instance, noted that environmental indicators—such as changes in river behaviour—were once integral to community preparedness but are now overshadowed by reliance on modern warning systems. Integrating these practices with contemporary tools, as suggested by Berkes et al. (2000), could enhance preparedness strategies while preserving cultural heritage.

### ***9.4.6 Implications for Policy and Practice***

The findings provide actionable insights for policymakers and practitioners. First, strengthening proactive measures, such as stormwater infrastructure upgrades and land-use restrictions, should be prioritised. These strategies are not only widely supported by the community but also align with best practices in disaster management (Parker et al., 2007). Second, the emphasis on collective responsibility highlights the need for robust local governance structures. Empowering local councils to collaborate with communities can create more inclusive and effective risk management approaches, consistent with Cutter et al. (2012). Lastly, addressing intergenerational knowledge gaps requires innovative educational initiatives that combine ancestral knowledge with modern technologies. By leveraging spaces like libraries and community centres, policymakers can foster cross-generational learning, ensuring vital knowledge is preserved and adapted for contemporary

challenges. This approach, rooted in the principles of Berkes et al. (2000), offers a sustainable pathway for enhancing community resilience.

### 9.5 Conclusion

Northland, New Zealand, and highlighted strategies to enhance community resilience. The findings reveal that flood-affected respondents demonstrate heightened concern and proactive behaviours, driven by personal experiences, while younger generations and those without direct exposure to floods show lower levels of engagement. This intergenerational attenuation, as described by Morrow (1999), threatens the long-term sustainability of resilience efforts unless addressed through deliberate educational and policy interventions.

A significant contribution of this study is its emphasis on integrating ancestral knowledge with modern disaster management practices, a strategy that supports SDG 11: Sustainable Cities and Communities. By combining traditional ecological knowledge (TEK), such as monitoring environmental indicators, with contemporary tools like GIS-based flood mapping, communities can develop more inclusive and effective risk reduction strategies (Berkes et al., 2000). This hybrid approach aligns with SDG 11's goal to enhance urban and rural resilience to disasters by fostering community-driven, sustainable solutions.

Furthermore, the findings underscore the role of libraries and community centres as critical hubs for cross-generational learning, bridging the knowledge gaps between older and younger community members. These spaces provide opportunities for educational programs that integrate storytelling, digital tools, and participatory workshops. This aligns with SDG 4: Quality Education, particularly its emphasis on promoting lifelong learning and inclusive educational initiatives that empower individuals and communities to address complex challenges like climate change and disaster preparedness.

In conclusion, this study highlights the urgent need for proactive measures, robust governance, and inclusive educational initiatives to enhance flood preparedness. By addressing intergenerational knowledge gaps and leveraging both traditional and modern knowledge systems, communities can build sustainable resilience, fulfilling the objectives of SDG 11 and SDG 4 while preparing for future climate-induced challenges.

### 9.6 Authors Comments

The chapter outlines a comprehensive set of strategies to enhance community resilience to floods, with a strong emphasis on educational initiatives, infrastructure investments, community engagement, policy development, and enhanced communication.

Firstly, the proposed educational initiatives are pivotal for bridging the knowledge gap between generations. Developing and funding educational programs that integrate traditional flood knowledge with modern flood management techniques would provide a robust foundation for building resilience. The use of storytelling, alongside digital tools, is an innovative approach to engage younger generations, making the topic more accessible and relatable. This aligns well with the need to address the intergenerational knowledge gap highlighted throughout the research.

In terms of infrastructure investments, prioritizing proactive flood mitigation measures, such as stormwater system upgrades, aligns with the thesis' focus on reducing future flood risks. A strong emphasis on stricter land-use planning in high-risk zones should be a central aspect of Northland's long-term flood resilience strategy, preventing increased vulnerability from future development.

The chapter also effectively highlights community engagement as a cornerstone of resilience. By fostering collective responsibility, involving communities in planning and implementation of flood management strategies will ensure that local knowledge and needs are considered. Creating opportunities for older residents to share their experiences and traditional knowledge with younger community members not only preserves important cultural wisdom but also empowers communities to actively participate in flood risk management. This aspect of the chapter aligns with the thesis' advocacy for bottom-up governance, emphasising community-driven approaches as vital to improving flood preparedness.

The policy development section is essential for establishing a comprehensive framework that integrates traditional ecological knowledge with contemporary flood risk management practices. Implementing policies that recognize both traditional knowledge and modern techniques will ensure that flood management approaches are culturally sensitive, effective, and sustainable. Furthermore, inclusive governance that reflects both community-driven and top-down strategies will help ensure that flood management efforts are equitable and have broad support.

Finally, enhanced communication channels are critical for ensuring that flood preparedness reaches all members of the community, particularly those with limited experience or knowledge about flood risks. Tailoring communication strategies to non-experienced community members will improve individual and collective preparedness, strengthening the overall flood resilience of the region.

Overall, the proposed actions in this chapter directly support the thesis' goals of enhancing flood resilience through integrated, community-driven strategies, proactive flood management measures, and improved governance. However, further elaboration on specific timelines and the integration of these strategies into existing frameworks, such as local government long-term plans (LTPs), would enhance the practical applicability of these suggestions.

## Chapter 10

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### Towards Flood Resilience in the Northland

## 10.1 Integrating the findings chapters

Recurring flood events have long posed a significant challenge to communities in New Zealand, and the Northland region is no exception. Despite growing awareness of flood risks, smaller-scale but frequent floods have not been met with the urgency or proactive measures they require. Unlike catastrophic floods, which capture national attention due to their immediate and dramatic impacts, these smaller recurring floods often fall under the radar. This lack of focus is problematic, as the cumulative effects of frequent, low-to-medium severity floods can cause greater long-term harm than occasional large-scale events.

For instance, repeated damage to infrastructure, property, and local economies steadily erodes community resilience. The storm flood and slip that damaged a vital section of State Highway 1 south of Kaitaia is a clear example. Although the damage closed the road for more than a year (2022–2023), it only gained national attention after yet another storm flood in 2023 disrupted progress. Such cases illustrate how recurrent floods remain largely invisible in policy and practice, leaving communities continually exposed to escalating risks.

This gap in attention to recurring floods forms the central theme of this study, which explores the discrepancies between perceived flood risk, policy frameworks, and actual preparedness. While communities like those in Northland are increasingly aware of flood risks, responses by local government remain predominantly reactive rather than preventive. Five interrelated themes emerged from the research, which are synthesised in this chapter to address the thesis aim of developing community-based strategies for sustainable flood risk management:

1. Community vulnerability and risk awareness – how residents experience and perceive recurring floods.
2. Reactive vs proactive governance – the misalignment between national frameworks and local implementation.
3. Role of land-use planning – the persistence of development in high-risk floodplains.
4. Community-based and indigenous knowledge systems – combining traditional practices with modern technology.
5. Building long-term resilience – integrating recovery, preparedness, and climate adaptation.

The following sections draw on Chapters 4–9 to explore how these themes interconnect. Each chapter contributes a piece of the puzzle, showing how recurring floods are managed—or neglected—within Northland’s governance and community structures.

The concerns expressed by residents about recurring floods underscore their vulnerability to these events, as discussed in Chapter 4: Community Vulnerability to Floods. This chapter examines the challenges faced by communities in flood-prone areas such as Whangārei, Kaikohe, and Kerikeri, where flood risk awareness is widespread but preparedness varies significantly. Many residents reported that smaller flood events are often overlooked by both the government and the public, despite the cumulative damage they cause to homes, infrastructure, and local economies. The frustration voiced by urban residents, especially those affected by overwhelmed stormwater systems, highlights the pressing need to shift flood management strategies to focus more on recurrent floods.

The insufficient attention given to smaller, recurring floods is a key shortcoming in current flood management strategies, as explored in Chapter 5. While existing response and recovery systems are effective for large-scale disasters, they often fail to address the cumulative impacts of less severe flood events. This oversight leaves communities exposed to ongoing damage. Chapter 5 emphasises the need for proactive measures, such as upgrading stormwater systems and implementing stricter land-use policies to prevent development in high-risk areas. Transitioning from reactive approaches to proactive mitigation strategies would significantly enhance resilience in vulnerable areas like Northland.

Proactive strategies, such as community-based flood mapping, can play a vital role in improving flood risk management, as discussed in Chapter 6: Using Community-Based Flood Maps to Explain Flood Hazard in Northland, New Zealand. This chapter demonstrates how flood maps can empower communities to take an active role in flood preparedness and response. By integrating local knowledge with modern flood data, community-based maps not only provide essential hazard information but also foster collaboration between residents and local authorities. This approach leads to more tailored and effective flood management strategies, particularly in regions like Northland.

A balanced and integrated approach to flood risk management (FRM) is essential to address both national and local needs. This has been addressed in Chapter 7: Legal and Governance Frameworks for Flood Resilience – From Policy to Practice. While national legislation provides a strong foundation for disaster management, its effectiveness depends on how well it is translated into local governance structures. As highlighted in this chapter 7, national policies such as the Resource Management Act (RMA) and the Civil Defence Emergency Management Act (CDEM Act) establish the overarching frameworks for resilience and risk reduction. However, the local councils, such as those in Northland, play a critical role in adapting these frameworks to community-specific challenges.

Strengthening the capacity of local councils to manage recurring and smaller-scale flood events is vital for bridging the persistent policy-practice gap. Currently, the disconnect between top-down policies and community-based efforts leaves vulnerable regions like Northland exposed to ongoing flood risks. By enhancing local governance through improved resources, clearer responsibilities, and more inclusive decision-making, councils can implement strategies that better reflect the realities of at-risk communities.

Land-use planning emerges as a central tool for long-term flood risk reduction. Preventing developments in flood-prone areas through stricter building codes and development restrictions is essential for reducing vulnerability. As demonstrated in high-risk areas such as Moerewa and Kawakawa, past floods have caused extensive damage to homes, infrastructure, and local economies—damage that could have been significantly reduced with proactive planning.

The findings emphasise that flood risk management must be fully integrated into urban and regional planning processes, ensuring that growth and development align with resilience objectives. This requires not only stronger regulatory frameworks but also effective community engagement to build public understanding and support. By combining national strategic direction with localised, participatory governance, New Zealand can move toward a more sustainable and adaptive flood management system, ultimately fostering resilient communities and minimising future disaster impacts.

The cumulative impacts of recurring floods also call for improvements in flood response and recovery systems, as discussed in Chapter 8: Improving Flood Response and Recovery in New Zealand. While response frameworks effectively address major disasters, they often prioritise short-term fixes over long-term resilience. The lack of coordination between government agencies and local communities further delays recovery efforts. To address these shortcomings, Chapter 9 advocates for more inclusive systems that integrate local knowledge and actively involve communities, ensuring that recovery processes are timely and sustainable.

Finally, traditional knowledge provides a vital foundation for flood resilience, as examined in Chapter 9: Preserving Community Resilience: Embracing Tradition and Innovation in Disaster Preparedness. The chapter highlights the role of intergenerational Māori knowledge in responding to environmental challenges like flooding. However, this knowledge is increasingly at risk of being lost, particularly among younger generations. By integrating traditional practices with modern technologies, such as GIS-based mapping, Northland communities can adopt a more adaptive and effective approach to flood preparedness. This fusion of local wisdom and innovative tools creates opportunities for stronger, more resilient flood management strategies.

Taken together, the findings from these chapters paint a comprehensive picture of the current state of flood management in Northland. They reveal a community that is aware of the risks but often lacks the necessary resources and strategies to effectively prepare for, respond to, and recover from recurrent flood events. The integration of both traditional knowledge and modern disaster management tools is key to addressing this gap and creating a more resilient community.

In conclusion, the research highlights the critical need for a shift in how floods are managed in New Zealand, particularly in regions like Northland. Recurring floods must be given the same level of attention and resources as catastrophic events to ensure that communities are better prepared and more resilient. The integration of proactive flood risk reduction measures, enhanced governance structures, and community-driven strategies will be essential in minimising the adverse impacts of floods and building long-term resilience.

## 10.2 Flood Risk Management and the Relationship Between Findings

The findings from Chapters 4 to 9 weave together to form a comprehensive framework for enhancing flood resilience in Northland. Central to this framework is the integration of proactive flood risk management with community-driven initiatives and local governance. The relationship between findings is shown in Figure 44.

- i. Proactive Measures vs. Reactive Responses: Chapters 4 and 5 emphasise the critical need for proactive flood management strategies, with a focus on infrastructure upgrades, land-use planning, and flood mapping. These measures are essential in addressing recurring floods, which are often overlooked in favour of larger-scale disasters. Chapter 6 reinforces the idea of using local knowledge and resources to complement official risk management efforts, suggesting that a people-centred approach is necessary to fill gaps in governance and legislation (Chapter 7).

- ii. **Building Resilience through Local Governance and Legislation:** Chapter 7 ties in the findings from earlier chapters, pointing to the need for stronger governance structures and better coordination across local councils and communities. By improving legislative frameworks and empowering local authorities, Northland can implement more effective flood risk management strategies tailored to the region's specific needs.
- iii. **Integrating Knowledge Systems for Sustainable Preparedness:** The findings from Chapter 9 provide a unique contribution by highlighting the role of traditional knowledge in building long-term flood resilience. This aligns with Chapter 7's emphasis on land-use planning and Chapter 8's focus on improving recovery efforts, suggesting that community resilience is not just about infrastructure or policy, but also about ensuring cultural and generational knowledge is preserved and integrated into flood preparedness.

Discussing recurring flood problems and their multifaceted impacts requires a comprehensive approach that spans global initiatives, national strategies, regional case studies, and community actions. A robust understanding of disaster risks is the first step towards addressing the risks effectively by framing risk management policies.

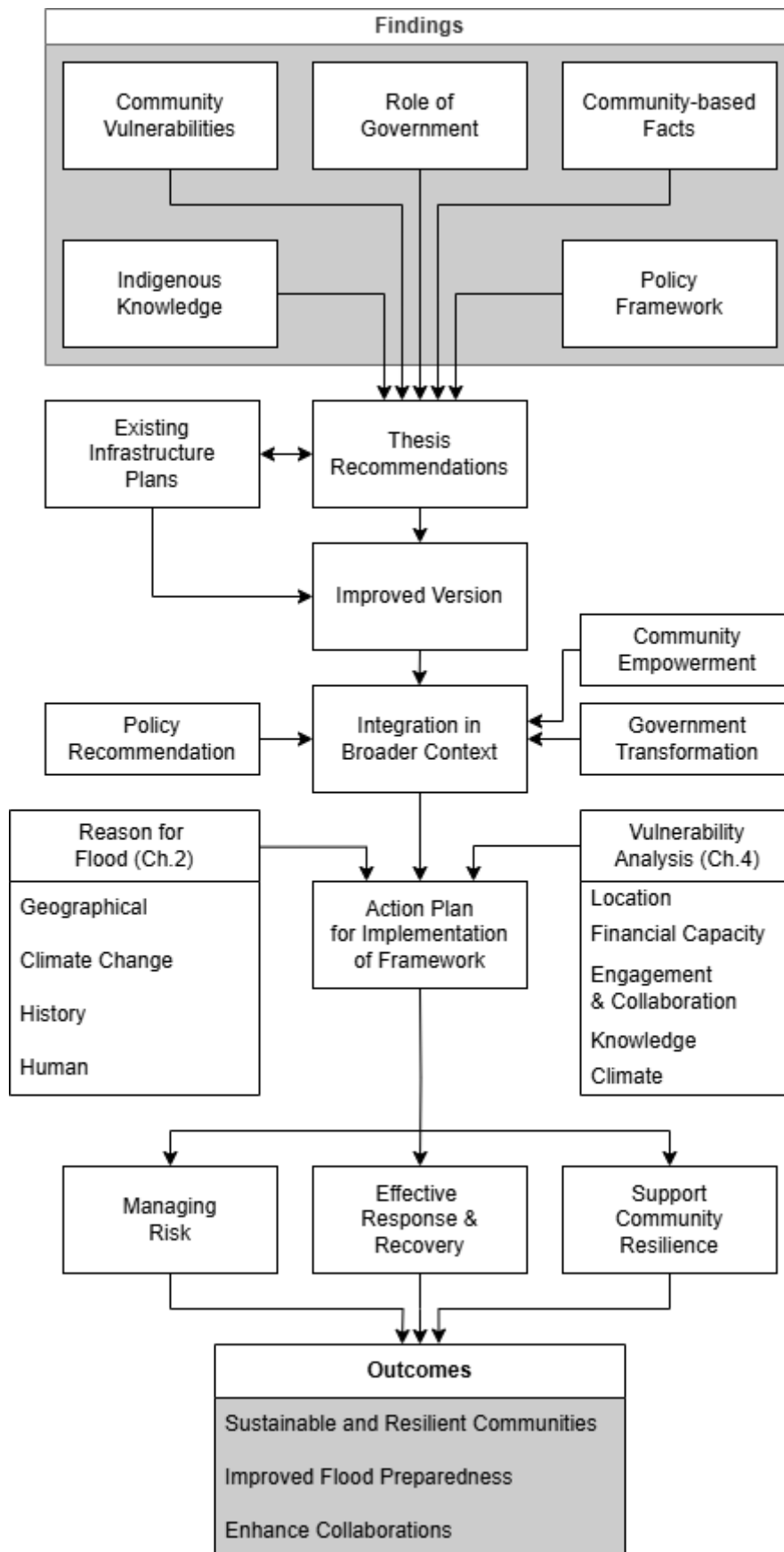


Figure 44 Research findings in a broader context

The relationship between the findings from Chapters 4-9 forms a coherent narrative on flood risk management, emphasising that recurring floods require proactive, locally driven responses. From strengthening local governance to integrating traditional knowledge with modern tools, each chapter contributes to a comprehensive understanding of how to enhance resilience in flood-prone communities like those in Northland. By addressing the gaps in flood management strategies and focusing on long-term, community-centred solutions, Northland can better withstand and recover from future flood events, ensuring sustainable resilience in the face of climate change.

### 10.3 Framework for Improving Flood Risk Management and Enhancing Resilience

This framework emphasises a collaborative, multi-level governance approach, incorporating both top-down and bottom-up strategies to improve flood risk management and build resilience in Northland, New Zealand. It acknowledges the limitations of the existing top-down approach, which has been the primary governance model in the region and suggests that integrating bottom-up strategies—where communities play an active role in decision-making—is crucial for sustainable flood resilience.

#### 10.3.1 Local Government Actions

##### A. Strengthen Proactive Flood Risk Management:

- i. **Infrastructure Upgrades:** Local governments should prioritise upgrades to stormwater systems, riverbanks, culverts, and flood barriers based on comprehensive risk assessments. Investment should also be directed toward vegetation management and improving the drainage capacity of urban and rural areas.
- ii. **Flood Zoning and Land Use Policies:** Enforce stronger land-use regulations to limit development in flood-prone areas. This should involve restricting development in high-risk flood zones and promoting resilient building practices for new constructions.
- iii. **Flood Mapping and Data Sharing:** Promote the creation and use of community-based flood maps, where local knowledge and official data are integrated. Local government should invest in GIS-based flood risk mapping and make the data publicly available, fostering community awareness.
- iv. **Infrastructure Resilience:** Plan for flood-resilient infrastructure that not only mitigates flood impacts but also supports climate adaptation strategies, such as green infrastructure (e.g., rain gardens, permeable surfaces).

##### B. Enhance Flood Response and Recovery Mechanisms:

- i. **Community Involvement in Recovery Plans:** In the event of flooding, involve local communities in post-flood recovery and rebuilding plans. Governments should support community-led efforts to identify priority needs for rebuilding and work with local businesses, schools, and health services to facilitate fast recovery.
- ii. **Early Warning Systems:** Improve the effectiveness of flood warning systems through collaboration with regional and national authorities. Ensure that early warning systems reach

vulnerable communities and are culturally appropriate (e.g., using local languages and traditions for communication).

- iii. **Capacity Building:** Support disaster management training programs for local councils and communities. This should include response simulations, the creation of community emergency plans, and evacuation drills.

### **C. Promote Bottom-Up Governance in Flood Management:**

- i. **Community Empowerment:** Shift some responsibilities of flood risk management to local communities by providing them with the tools and resources to take proactive actions (e.g., neighbourhood flood preparedness workshops, local flood watch groups). Empower communities to engage in decision-making processes related to flood management.
- ii. **Local Flood Committees:** Establish local flood committees that consist of representatives from the local council, emergency services, community groups, and environmental experts. These committees can guide flood management strategies based on local knowledge and community priorities.
- iii. **Collaborative Planning:** Facilitate collaborative flood risk management planning that includes local knowledge and expertise. This may involve conducting community-based consultations and participatory workshops to gather feedback on flood risk perceptions, preparedness needs, and policy preferences.

### **10.3.2 Local Community Actions**

#### **A. Engage in Flood Risk Awareness and Preparedness:**

- i. **Community Education Campaigns:** Local communities should collaborate with the government to educate residents on flood risks, preparedness measures, and personal safety. Educational programs can be conducted in schools, community centres, and online platforms.
- ii. **Personal Flood Preparedness:** Communities should encourage individuals to prepare their homes for flooding by engaging in actions such as elevating homes, clearing gutters, and ensuring emergency supplies (e.g., food, water, first-aid kits) are available.
- iii. **Flood Risk Mapping:** Community members should actively participate in the creation of local flood maps to understand the risks they face. These maps can include not only flood-prone areas but also highlight safe evacuation routes and flood shelters.

#### **B. Strengthen Community Resilience through Local Networks:**

- i. **Community-Based Organizations (CBOs):** Establish and strengthen local CBOs that focus on disaster preparedness and response. These organisations can provide a platform for neighbours to help each other during emergencies, particularly in more isolated areas.
- ii. **Resilience Building through Social Capital:** Foster social networks that improve community cohesion and resilience. Organising events like flood preparedness fairs, resilience workshops,

and community clean-ups can enhance local solidarity and empower people to take collective action in response to flood risks.

### **C. Revive Traditional Knowledge and Practices:**

- i. **Incorporate Māori Knowledge:** Māori communities in Northland have valuable traditional knowledge that can be integrated into modern flood management. Marae-based programs could teach residents how to read environmental cues (e.g., changes in river behaviour) and use indigenous practices to prepare for floods.
- ii. **Cultural Revitalisation:** Communities should collaborate with cultural leaders to revitalize traditional ecological practices, such as sustainable land use and river management, that contribute to long-term flood resilience.

### **D. Build Local Leadership and Capacity:**

- i. **Youth and Volunteer Programs:** Involve young people and volunteers in flood resilience activities. These programs can include training young leaders in disaster management and encouraging them to participate in local governance.
- ii. **Resilience Advocates:** Develop local flood resilience champions who can advocate for change within their communities. These individuals could serve as focal points for flood-related education, volunteer coordination, and disaster response efforts.

### **10.3.3 Transitioning from Top-Down to Bottom-Up Governance**

Historically, flood risk management in Northland has operated under a top-down governance approach, where flood management strategies are typically dictated by central and regional government agencies, with minimal input from local communities. This has led to:

- a) Limited community involvement in decision-making processes regarding flood management.
- b) Misalignment of policies and local needs, as top-down strategies may not fully account for the specific risks and challenges faced by different communities.
- c) Inefficient allocation of resources, as flood management interventions may overlook or underestimate recurring flood risks, which often have greater long-term costs than major catastrophic events.

In transitioning towards more Bottom-Up Governance, the program will focus on community-led flood risk management. Here are some steps to achieve this transition:

### **A. Institutionalise Community Participation:**

- i. **Integrate community representatives into decision-making bodies,** such as local flood committees and advisory boards. Create formal avenues for community input, such as town hall meetings and community consultations.
- ii. **Foster relationships between local government and community leaders** to ensure flood management strategies reflect community priorities and knowledge.

### **B. Promote Local Empowerment:**

- i. Allocate funding for community-led flood mitigation projects, such as improving local drainage or planting vegetation along rivers. Provide communities with the resources and tools to independently assess risks and implement preventive measures.
- ii. Create community disaster preparedness plans that are developed with local input. Ensure that these plans are adaptable and reflect the specific needs and priorities of each community.

### **C. Education and Capacity Building:**

- i. Support programs that provide communities with the knowledge, skills, and resources needed to manage flood risks. This includes training for volunteers, local leaders, and community-based organizations in flood preparedness and response.
- ii. Develop partnerships between local government, community groups, and educational institutions to create a shared platform for flood resilience education.

This shift from top-down governance to a bottom-up approach in flood risk management is essential for enhancing the resilience of Northland's communities. While top-down strategies have their place in flood management, the involvement of local communities through a bottom-up approach ensures that flood resilience is not only sustainable but also tailored to the unique needs and challenges of the region. Local governments can play a crucial role in empowering communities, providing resources, and fostering collaboration, while communities can contribute their knowledge, initiatives, and collective action to flood preparedness and recovery. By integrating these strategies, Northland can develop a more resilient, adaptive, and proactive flood management system that addresses both immediate and long-term flood risks.

## **10.4 Recommendation for Improvement**

This action plan is based on the research findings and aims to enhance flood resilience in Northland, New Zealand, by incorporating bottom-up governance strategies while aligning with national frameworks. The plan compares existing actions with those suggested by this research, highlighting areas for improvement. Based on this study these list below are the implementation plan for the future.

### **10.4.1 Central Government Actions**

#### **A. Current Framework/Plan (New Zealand):**

- i. The National Civil Defence Emergency Management Plan (CDEM) outlines a national framework for managing disaster response and recovery, with an emphasis on preparedness and response.
- ii. The Resource Management Act 1991 (RMA) and the National Policy Statement for Freshwater Management (NPS-FM) guide land use and flood risk management, focusing on high-level regulation and planning.

- iii. The Climate Change Response (Zero Carbon) Amendment Act 2019 establishes a national strategy to combat climate change, including measures to improve resilience to extreme weather events.

### **B. Integrate Bottom-Up Governance into National Flood Risk Management:**

- i. Action: Create a national community involvement framework that supports local flood committees and encourages active participation from community representatives in flood risk management.
- ii. Improvement: While current national frameworks outline flood risk management, they primarily focus on top-down decision-making. This research advocates for a greater role of local communities in shaping flood management policies. This can be achieved through formal representation of community groups in national-level planning.

### **C. Improve Proactive Flood Risk Reduction and Land Use Policies:**

- i. Action: Strengthen the use of flood risk mapping and stormwater infrastructure upgrades as part of national policy initiatives. Incentivize the implementation of green infrastructure (e.g., rain gardens, wetlands).
- ii. Improvement: The current focus is often reactive, with national policies addressing flood management post-event (e.g., recovery efforts). This research emphasises proactive measures, such as prevention, land-use zoning, and investment in climate-resilient infrastructure, to reduce risks before floods occur.

### **D. Improve Flood Recovery and Resilience Planning:**

- i. Action: National guidelines should mandate the creation of local disaster recovery plans that integrate community-based strategies.
- ii. Improvement: While the national CDEM plan provides overarching recovery strategies, the research suggests that recovery plans could be enhanced by emphasising local ownership of recovery, with communities leading recovery efforts based on their unique needs and conditions.

## **10.4.2 Northland Regional Council Actions**

### **A. Current Framework/Plan (Northland):**

- i. Northland's Regional Land and Water Plan addresses flood risk management, focusing on land use, development, and waterway management.
- ii. The Northland Regional Flood Hazard Management Strategy focuses on response, recovery, and mitigating flood risks but is often constrained by limited local government capacity and resources.
- iii. Whangārei District Council's Flood Risk Strategy includes provisions for urban stormwater management and floodplain zoning.

**B. Strengthen Community-Driven Flood Management:**

- i. Action: Empower local communities to contribute to the design and implementation of flood risk management strategies, particularly in flood-prone rural areas.
- ii. Improvement: The regional councils' plans are mainly focused on top-down implementation. The research highlights the need for bottom-up approaches, such as community-led projects, local flood committees, and participatory planning processes, which are less emphasized in current regional policies.

**C. Enhance Local Flood Mapping and Data Access:**

- i. Action: Provide interactive, user-friendly flood risk maps that incorporate local knowledge and make them publicly accessible.
- ii. Improvement: Current flood mapping efforts in the region focus on technical data, often inaccessible to the public. Integrating local knowledge and using community-based flood maps can enhance understanding and preparedness at the community level.

**D. Increase Investment in Proactive Flood Mitigation:**

- i. Action: Prioritise stormwater infrastructure improvements and vegetation management in areas identified as flood risks.
- ii. Improvement: Existing policies and plans focus on reactive responses to floods, with limited proactive measures (e.g., vegetation management, floodplain zoning). Research advocates for a more robust investment in proactive strategies, including upgrading culverts, riverbank stabilization, and stormwater systems before flood events.

**E. Build Local Government Capacity for Flood Risk Management:**

- i. Action: Increase training and capacity-building initiatives for local councils, focusing on integrating community-led initiatives and enhancing communication with the public.
- ii. Improvement: The research underscores the need for greater support for local councils in community engagement and participation in flood risk management. Many regional councils lack the resources to fully implement inclusive flood risk management strategies. Providing additional funding for capacity-building programs would help overcome this barrier.

*10.4.3 Community Representative Actions:*

**A. Current Framework/Plan (Community Level in Northland):**

- i. Communities play a limited role in formal flood risk management planning, and most action occurs reactively after events.
- ii. Local knowledge and traditional practices are not always incorporated into official flood risk management strategies.

**B. Promote Community-Based Flood Resilience:**

- i. **Action:** Establish local flood committees and community resilience hubs in vulnerable areas. These can serve as points for disaster preparedness training, community outreach, and local action.
- ii. **Improvement:** Existing community involvement is often ad-hoc and lacks formal structures. The research recommends establishing formal community flood committees that are involved in planning and decision-making processes. This will help to align bottom-up initiatives with official plans.

### **C. Revive Traditional Knowledge and Integrate It with Modern Practices:**

- i. **Action:** Encourage communities to revive traditional flood management practices such as environmental monitoring and integrate them with modern technologies, like GIS-based mapping and weather forecasting tools.
- ii. **Improvement:** Traditional ecological knowledge is often undervalued in current practices. The research highlights the importance of combining indigenous knowledge with modern flood risk management strategies to enhance resilience in the region.

### **D. Strengthen Community Preparedness and Education:**

- i. **Action:** Launch flood awareness campaigns and preparedness workshops that engage local populations, especially in high-risk areas like Moerewa and Kawakawa.
- ii. **Improvement:** Although some flood education programs exist, they are often not comprehensive or consistent. The research suggests creating more localized and targeted programs that are specific to different communities' needs.

### **10.4.4 Summary of Areas for Improvement:**

- a) **Greater Emphasis on Bottom-Up Governance:** Both central government and regional councils should provide more funding and support for community-driven flood risk management.
- b) **Proactive Risk Management:** While current frameworks focus on flood response and recovery, there is a need for stronger emphasis on proactive measures like land-use zoning, stormwater infrastructure upgrades, and floodplain management.
- c) **Data Accessibility and Local Knowledge Integration:** Making flood maps more accessible and incorporating local knowledge will improve community engagement in flood risk management. A system that integrates both government data and community insights is vital.
- d) **Improved Capacity Building for Local Governments:** Local councils need more resources for training in community engagement and flood resilience, as well as funding for proactive flood mitigation projects.

- e) **Combining Traditional Knowledge with Modern Tools: Strengthening the integration of traditional ecological knowledge with modern flood management tools can provide a more holistic approach to building resilience.**

Table 23 below outlines a comprehensive action plan aimed at improving flood resilience across various stakeholders in Northland. Each action item is designed to facilitate collaboration between the New Zealand Central Government, Northland Regional Council, and community representatives, ensuring a coordinated approach to flood risk management. The table details specific actions to be taken, focusing on transitioning from reactive to proactive flood measures, integrating community participation, strengthening climate resilience in infrastructure, and adopting catchment-based management strategies. Each stakeholder's role is highlighted, emphasising the importance of funding, community engagement, and the implementation of sustainable practices to effectively mitigate flood risks and enhance resilience within the region.

Table 23 provided an Action Plan that outlines the steps that the New Zealand Central Government, Northland Regional Council, and Community Representatives could take to improve flood risk management and enhance resilience, in line with the findings from this research and the suggestions made. The table also compares the existing approaches with areas for improvement. To support the action plan, the checklist also provided to guide the actions of each stakeholder and provide a clear framework to monitor the progress provided in The Central Government Checklist aims to enhance national policies by promoting a cohesive strategy that integrates bottom-up governance. The goal is to adopt a proactive approach to managing flood risks, ensuring that local input and perspectives are incorporated into national decision-making processes. This approach seeks to create more effective and resilient flood management systems.

Table 24.

Following the plan, suggestions for council Long Term Plan updates are shown in Table 22, which outlines strategies and suggested improvements for enhancing flood resilience across various dimensions. It identifies key areas such as flood risk mapping, stormwater infrastructure, flood barriers, land use planning, public awareness, emergency response, intergenerational knowledge sharing, infrastructure design, governance, and funding. Each section describes the current challenges, proposed enhancements, and expected outcomes aimed at reducing flood risks and improving community preparedness and response. The focus is on integrating local insights, fostering community engagement, and promoting sustainable practices in flood management.

Table 26 outlines a structured action plan for enhancing flood resilience over a 10-year period, divided into short-term (0-2 years), medium-term (2-5 years), and long-term (5-10 years) phases. Each phase includes specific actions aimed at community engagement, data collection, infrastructure upgrades, policy review, and capacity building. The focus is on proactive measures, fostering community participation, and implementing sustainable practices to mitigate flood risks. Key components include establishing local resilience committees, conducting workshops, upgrading infrastructure, and creating comprehensive strategies that integrate community input and environmental considerations. The plan emphasises continuous monitoring and adaptation to evolving flood risks and climate challenges.

Table 26. To implement the research findings to real action, the pathway shown in Figure 45.

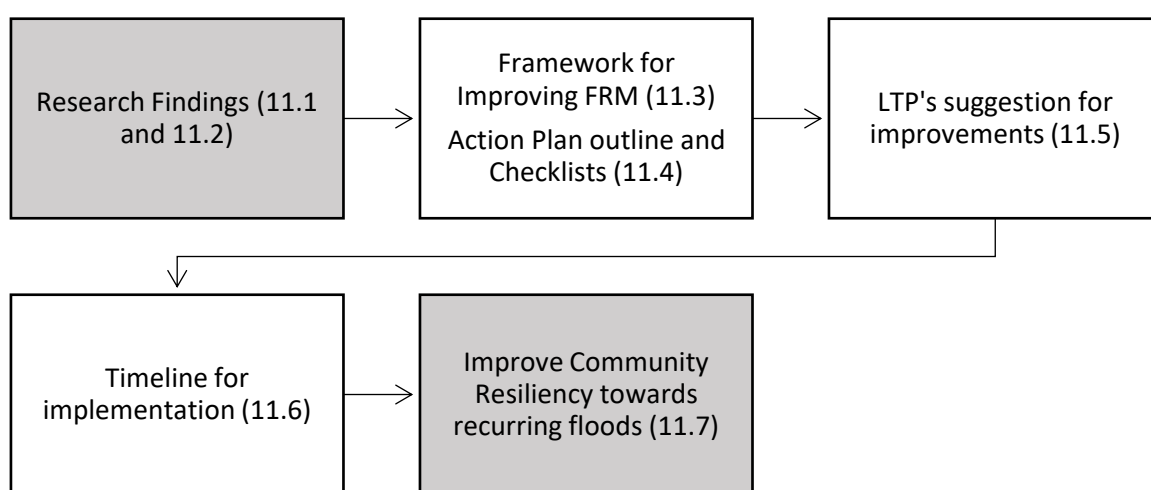


Figure 45 Pathway to implement the research findings

## 10.5 Suggestions on councils LTPs

the 10-Year Long Term Plans (LTPs) in New Zealand present a valuable opportunity to integrate improvements in flood protection strategies and resilience-building measures. These plans are crucial for guiding local governments in the allocation of resources, prioritising infrastructure projects, and shaping long-term policies. Since flood protection is an essential aspect of community resilience, incorporating more proactive, community-based, and sustainable strategies in these plans can significantly improve flood management.

Current LTPs focus primarily on reactive flood management and post-event recovery, with some councils prioritising flood infrastructure upgrades (e.g., flood barriers, stormwater systems) but with insufficient emphasis on climate adaptation and proactive preparedness. After reviewing the Northland Councils Long term plans and comparing them with other regional councils in New Zealand and adding the findings from this research, suggestions on improvements on the Council's LTPs summarised in the Table 22.

## 10.6 Suggestions timeline for implementations

Table 26 outlines a structured action plan for enhancing flood resilience over a 10-year period, divided into short-term (0-2 years), medium-term (2-5 years), and long-term (5-10 years) phases. Each phase includes specific actions aimed at community engagement, data collection, infrastructure upgrades, policy review, and capacity building. The focus is on proactive measures, fostering community participation, and implementing sustainable practices to mitigate flood risks. Key components include establishing local resilience committees, conducting workshops, upgrading infrastructure, and creating comprehensive strategies that integrate community input and environmental considerations. The plan emphasises continuous monitoring and adaptation to evolving flood risks and climate challenges.

Table 26 summarising the suggested timeline for the implementation of flood resilience strategies based on this research findings and recommendations. This timeline can be adjusted depending on available resources and specific community needs, but it provides a broad outline of the steps involved in implementing this flood resilience strategies. Noted that:

- i. Short-term (0-2 years): Focuses on laying the groundwork for flood resilience, including community engagement, data collection, and small-scale proactive actions.
- ii. Medium-term (2-5 years): Expands efforts by implementing larger-scale mitigation projects and integrating governance structures that allow communities to participate actively.
- iii. Long-term (5-10 years): Solidifies flood resilience by ensuring that comprehensive policies, large-scale infrastructure, and sustainable practices are in place, while continuing to assess and adapt strategies.

This action plan helps ensure that flood resilience in Northland progresses steadily, with proactive measures being prioritised over reactive ones. It is a well-rounded approach that considers community involvement, infrastructure improvements, education, and long-term policy alignment.

Table 23 below outlines a comprehensive action plan aimed at improving flood resilience across various stakeholders in Northland. Each action item is designed to facilitate collaboration between the New Zealand Central Government, Northland Regional Council, and community representatives, ensuring a coordinated approach to flood risk management. The table details specific actions to be taken, focusing on transitioning from reactive to proactive flood measures, integrating community participation, strengthening climate resilience in infrastructure, and adopting catchment-based management strategies. Each stakeholder's role is highlighted, emphasising the importance of funding, community engagement, and the implementation of sustainable practices to effectively mitigate flood risks and enhance resilience within the region.

**Table 23 Action Plan for Stakeholders to improve Flood resilience**

<b>Action Plan</b>	<b>New Zealand Central Government</b>	<b>Northland Regional Council</b>	<b>Community Representatives</b>
<b>Action 1: Shift from Reactive to Proactive Measures</b>	Increase funding for long-term flood mitigation projects, such as natural infrastructure and climate adaptation.	Prioritise proactive flood risk reduction measures (e.g., stormwater infrastructure, flood zoning).	Support local councils in advocating for flood preparedness.
	Support local governments in implementing proactive flood resilience measures, with a focus on risk reduction.	Implement climate-resilient flood defences based on future climate scenarios.	Educate community members on the importance of preventive measures.
<b>Action 2: Integrate Community-Based Flood Risk Management</b>	Provide guidance and funding for community-driven flood management initiatives.	Facilitate community consultations on flood risk management strategies.	Engage in local flood risk assessments and planning discussions.
	Develop frameworks for the active involvement of communities in flood risk assessments and decision-making.	Establish partnerships with community groups and integrate their insights into flood resilience plans.	Organise local workshops to raise awareness about flood risk and preparedness.
<b>Action 3: Strengthen Climate Resilience in Infrastructure</b>	Ensure national policies emphasize the integration of climate change projections into all flood protection measures.	Upgrade and retrofit existing flood protection infrastructure to account for climate change impacts.	Advocate for climate-resilient infrastructure in local development plans.

	Fund research into innovative, climate-resilient infrastructure solutions.	Invest in nature-based solutions like wetland restoration, riverbanks reforestation.	Promote awareness of climate risks and encourage sustainable building practices.
<b>Action 4: Adopt Catchment-Based Flood Management</b>	Introduce guidelines and resources for catchment-based flood management approaches at the national level.	Implement catchment management strategies that prioritise flood risk across broader geographical areas.	Participate in catchment management planning.
	Encourage regional cooperation across councils to manage flood risks at the catchment scale.	Coordinate efforts with neighbouring regions and councils.	Support flood protection measures that consider upstream and downstream communities.
<b>Action 5: Integrate Traditional Ecological Knowledge (TEK)</b>	Support research and initiatives to incorporate Māori TEK into flood risk management.	Collaborate with iwi and local communities to integrate traditional knowledge with modern flood resilience strategies.	Contribute traditional knowledge and environmental indicators to local flood risk assessments.
	Develop national policies that encourage the use of local knowledge in environmental management.		Work with local councils to incorporate Māori practices into disaster preparedness.
<b>Action 6: Strengthen Funding for Long-Term Projects</b>	Provide funding incentives for local councils to invest in long-term flood mitigation and adaptation.	Seek funding from central government to support long-term flood mitigation efforts.	Support local fundraising and government grant applications for flood resilience initiatives.
	Allocate emergency funds for flood preparedness initiatives at the national level.	Prioritise long-term flood resilience projects in the regional development plans.	Advocate for more investment in community-driven flood protection measures.
<b>Action 7: Public Education and Awareness Campaigns</b>	Fund and promote national public awareness campaigns on flood risk and climate change impacts.	Create educational campaigns and workshops tailored to local flood risks.	Engage with local schools and community centres to educate residents on flood preparedness.
	Provide educational materials for local governments to use in their communities.	Collaborate with schools, libraries, and community organizations to spread flood awareness.	Organize events and training to empower community members with self-sufficiency in flood-prone areas.

<b>Action 8: Improve Land Use Planning and Zoning</b>	Update national guidelines to incorporate flood risk in land-use planning.	Implement stricter flood risk zoning and restrictions on building in flood-prone areas.	Advocate for zoning policies that prevent high-risk development in flood-prone areas.
	Provide incentives for developers to build flood-resilient infrastructure.	Collaborate with urban planning experts to ensure long-term flood resilience in all developments.	Promote resilient building techniques within communities.
<b>Action 9: Monitor and Evaluate Flood Resilience Strategies</b>	Support research into effective flood resilience measures and their long-term success.	Regularly assess and update flood risk management strategies in consultation with local communities.	Participate in flood resilience assessments and evaluations.
	Monitor and review flood resilience policies regularly to ensure they meet changing needs.	Use feedback from community members to evaluate the success of resilience measures.	Provide feedback to local councils on the effectiveness of flood risk management measures.

The Central Government Checklist aims to enhance national policies by promoting a cohesive strategy that integrates bottom-up governance. The goal is to adopt a proactive approach to managing flood risks, ensuring that local input and perspectives are incorporated into national decision-making processes. This approach seeks to create more effective and resilient flood management systems.

Table 24 Action Plan Checklist

<b>1. Central Government Checklist:</b>	
<b>Goal: Strengthen national policies, integrate bottom-up governance, and ensure a proactive approach to flood risk management.</b>	
<b>Checklist:</b>	
i.	<b>Policy and Governance:</b> <input checked="" type="checkbox"/> Establish a national framework to incorporate bottom-up governance in flood risk management. <input checked="" type="checkbox"/> Ensure national flood management policies integrate local community participation and community-led initiatives. <input checked="" type="checkbox"/> Align national flood management policies with climate change adaptation strategies (e.g., Zero Carbon Act).
ii.	<b>Proactive Risk Management:</b> <input checked="" type="checkbox"/> Strengthen policies to prioritise pre-flood mitigation measures, such as land-use planning and stormwater infrastructure upgrades. <input checked="" type="checkbox"/> Mandate the use of flood risk mapping in all flood-prone areas to guide infrastructure development and emergency planning. <input checked="" type="checkbox"/> Provide incentives for green infrastructure (e.g., wetlands, rain gardens) to reduce flood risks in urban and rural areas.
iii.	<b>Data and Knowledge Sharing:</b> <input checked="" type="checkbox"/> Ensure the accessibility and public availability of flood risk maps and real-time flood data. <input checked="" type="checkbox"/> Establish a national knowledge-sharing platform for flood management, including community input and local knowledge.
iv.	<b>Support for Local Authorities:</b> <input checked="" type="checkbox"/> Provide training programs and financial support for local governments to build capacity for flood risk management. <input checked="" type="checkbox"/> Allocate funding for community-based flood management programs and resilience projects
v.	<b>Monitoring and Evaluation:</b> <input checked="" type="checkbox"/> Develop a national flood resilience monitoring system that includes both national-level data and local community feedback. <input checked="" type="checkbox"/> Regularly evaluate the effectiveness of community-based flood resilience programs and adjust where necessary.
<b>2. Northland Regional Council Checklist:</b>	
<b>Goal: Strengthen regional flood risk management strategies, engage communities, and invest in proactive flood mitigation.</b>	
<b>Checklist:</b>	

<p>i. <b>Community Engagement:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Establish formal local flood committees that represent diverse community interests in flood management.</li> <li><input checked="" type="checkbox"/> Facilitate community consultations on flood management plans, ensuring that local knowledge and concerns are integrated.</li> <li><input checked="" type="checkbox"/> Organise community-based flood risk education programs and workshops, especially in high-risk areas like Moerewa and Kawakawa.</li> </ul> <p>ii. <b>Proactive Flood Management:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Prioritise the implementation of proactive flood mitigation measures such as vegetation management, culvert upgrades, and riverbank stabilisation.</li> <li><input checked="" type="checkbox"/> Integrate flood risk reduction into local development and land-use plans, including zoning and setbacks from flood-prone areas.</li> <li><input checked="" type="checkbox"/> Ensure stormwater infrastructure in urban and rural areas is upgraded and maintained to manage increasing rainfall and flood risks.</li> </ul>
<p>iii. <b>Local Knowledge Integration:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Incorporate community-based flood maps alongside official government flood data for better local understanding.</li> <li><input checked="" type="checkbox"/> Foster partnerships with Māori communities to integrate traditional ecological knowledge (TEK) in flood resilience efforts.</li> </ul>
<p>iv. <b>Building Local Capacity:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Increase staff training for local council personnel on community flood resilience strategies.</li> <li><input checked="" type="checkbox"/> Provide resources to local councils to enhance community outreach, public awareness, and flood preparedness.</li> </ul>
<p>v. <b>Monitoring and Evaluation:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Develop a regional flood resilience dashboard to track progress on proactive measures, community engagement, and infrastructure improvements.</li> <li><input checked="" type="checkbox"/> Conduct annual reviews of flood management strategies, involving community feedback to identify areas for improvement.</li> </ul>
<p><b>3. Community Representatives Checklist:</b>  <b>Goal: Foster local ownership and leadership in flood resilience efforts, support preparedness, and integrate traditional knowledge.</b></p>
<p><b>Checklist:</b></p>
<p>i. <b>Community-Based Planning:</b></p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Establish local flood committees to represent the community in decision-making processes.</li> <li><input checked="" type="checkbox"/> Engage in community-led flood risk mapping to identify key flood-prone areas and vulnerable locations.</li> <li><input checked="" type="checkbox"/> Encourage participation in local consultation meetings and workshops to influence flood risk management policies.</li> </ul>
<p>ii. <b>Flood Preparedness and Education:</b></p>

	<ul style="list-style-type: none"><li>☑ Organise flood preparedness workshops to educate residents on flood risk reduction, evacuation plans, and emergency response.</li><li>☑ Distribute flood preparedness kits and ensure early warning systems are accessible to all residents.</li><li>☑ Promote neighbourhood-level initiatives, such as flood resilience plans for households and local businesses.</li></ul>
iii.	<b>Traditional Knowledge Integration:</b> <ul style="list-style-type: none"><li>☑ Revive and document traditional ecological knowledge (e.g., environmental monitoring) to integrate with modern flood management tools.</li><li>☑ Collaborate with local Māori groups to share knowledge about historical flooding patterns and traditional resilience practices.</li></ul>
iv.	<b>Community Leadership:</b> <ul style="list-style-type: none"><li>☑ Identify and train local flood resilience champions who can lead efforts to prepare for and respond to flood events.</li><li>☑ Encourage youth involvement in flood resilience activities to bridge the generational knowledge gap and ensure long-term community engagement.</li></ul>
v.	<b>Monitoring and Advocacy:</b> <ul style="list-style-type: none"><li>☑ Collect community feedback on flood risk management efforts and share this information with local councils and regional authorities.</li><li>☑ Advocate for improvements in local flood infrastructure, such as better drainage systems, flood barriers, and zoning policies.</li></ul>

Table 22 outlines strategies and suggested improvements for enhancing flood resilience across various dimensions. It identifies key areas such as flood risk mapping, stormwater infrastructure, flood barriers, land use planning, public awareness, emergency response, intergenerational knowledge sharing, infrastructure design, governance, and funding. Each section describes the current challenges, proposed enhancements, and expected outcomes aimed at reducing flood risks and improving community preparedness and response. The focus is on integrating local insights, fostering community engagement, and promoting sustainable practices in flood management.

**Table 25 Improving flood protection within Northland Regional Long-Term Plan**

Items	Current State	Suggested Improvements	Expected Outcomes
<b>Flood Risk Mapping and Data Collection</b>	Basic flood risk data, with limited community-based flood maps.	- Update flood risk data regularly.	- More accurate identification of flood-prone areas.
		- Create detailed, community-based flood hazard maps incorporating local insights.	- Better planning and preparedness based on localized risks.
<b>Stormwater and Drainage Infrastructure</b>	Outdated stormwater systems, particularly in urban areas.	- Prioritise stormwater upgrades.	- Reduced flooding during heavy rainfall.
		- Invest in sustainable drainage solutions like permeable surfaces, green infrastructure.	- Enhanced flood resilience in urban areas.
<b>Flood Barriers and Protection Infrastructure</b>	Limited flood barriers or ineffective flood protection structures.	- Increase investment in flood barriers in high-risk areas.	- Increased protection against flooding in critical infrastructure and communities.
		- Implement natural barriers such as wetlands and dunes.	- Reduced damage from floods.
<b>Land Use Planning and Zoning Regulations</b>	Some zoning laws exist but may not be strict enough for flood-prone areas.	- Strengthen land use planning to avoid construction in flood-prone areas.	- Reduced exposure to flood risk through controlled development in high-risk areas.
		- Enforce stricter zoning regulations for new developments.	

<b>Public Awareness and Education</b>	Limited community engagement on flood preparedness.	- Increase public awareness campaigns on flood risks and preparedness.	- Improved community understanding of flood risks.
		- Promote community workshops and flood education programs.	- Increased flood preparedness actions by individuals and businesses.
<b>Emergency Response and Recovery Plans</b>	Existing plans may not be fully tailored to local needs.	- Develop more localized and community-specific emergency response plans.	- Faster response times in case of flood events.
		- Ensure quick recovery mechanisms are in place.	- More effective and efficient recovery from flood events.
<b>Intergenerational Knowledge Sharing</b>	Loss of traditional flood knowledge, especially among younger generations.	- Create programs for cross-generational knowledge sharing.	- Increased community preparedness through shared knowledge.
		- Integrate traditional environmental knowledge with modern flood management tools.	- Stronger resilience and adaptive strategies.
<b>Resilience in Infrastructure Design</b>	Infrastructure often designed with a focus on short-term needs.	- Promote flood-resilient infrastructure designs, such as elevated buildings, floodproofing measures, and green spaces.	- More flood-resilient infrastructure.
			- Reduced damage to critical facilities during flood events.
<b>Local Governance and Community Involvement</b>	Top-down governance with limited community input.	- Implement a bottom-up governance model for flood resilience.	- Enhanced community ownership of flood management strategies.
		- Foster greater community participation in flood risk management.	- More inclusive and responsive flood resilience planning.

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<b>Funding and Investment in Flood Protection</b>	Flood protection funding may be insufficient or slow to allocate.	- Increase funding dedicated to flood protection.  - Secure government and private sector partnerships for infrastructure projects.	- More consistent and timely investment in flood resilience measures.  - Strengthened flood protection infrastructure.
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Table 26 outlines a structured action plan for enhancing flood resilience over a 10-year period, divided into short-term (0-2 years), medium-term (2-5 years), and long-term (5-10 years) phases. Each phase includes specific actions aimed at community engagement, data collection, infrastructure upgrades, policy review, and capacity building. The focus is on proactive measures, fostering community participation, and implementing sustainable practices to mitigate flood risks. Key components include establishing local resilience committees, conducting workshops, upgrading infrastructure, and creating comprehensive strategies that integrate community input and environmental considerations. The plan emphasises continuous monitoring and adaptation to evolving flood risks and climate challenges.

Table 26 Suggested timeline for implementation

Action Plan Area	Specific Actions	Timeline
<b>Short-Term (0-2 years): Initial Planning and Assessment</b>		
<b>Community Engagement &amp; Awareness</b>	- Establish community flood resilience committees and begin consultations across key flood-prone areas (Moerewa, Kawakawa, Kerikeri).	<b>0-2 years</b>
	- Conduct community workshops on flood risks and gather feedback.	
	- Develop educational programs focusing on flood preparedness and traditional knowledge integration.	
<b>Data and Risk Mapping</b>	- Begin mapping local flood risks, integrating community knowledge with existing flood data (e.g., GIS-based mapping).	<b>0-2 years</b>
	- Develop and pilot a community-led flood mapping initiative.	
	- Assess stormwater infrastructure and flood-prone areas to identify immediate upgrade needs.	

<b>Policy Review &amp; Early Reforms</b>	- Review national and regional flood management policies, identifying gaps in proactive measures.	<b>0-2 years</b>
	- Advocate for the inclusion of bottom-up governance in policy frameworks.	
<b>Short-Term Proactive Actions</b>	- Begin small-scale pilot projects in flood-prone areas (e.g., stormwater upgrades, vegetation management along rivers/culverts).	<b>0-2 years</b>
	- Test community-led preparedness strategies in small-scale, non-catastrophic flood events.	
<b>Medium-Term (2-5 years): Implementation of Proactive Flood Management Strategies</b>		
<b>Infrastructure Upgrades &amp; Proactive Flood Mitigation</b>	- Begin implementing proactive flood mitigation projects identified in the short-term phase (e.g., stormwater upgrades, riverbank stabilization).	<b>2-5 years</b>
	- Prioritise green infrastructure projects (e.g., wetlands, rain gardens, native vegetation restoration).	
<b>Strengthening Bottom-Up Governance</b>	- Formalize community participation in local flood management decisions. - Establish regular feedback loops between local councils, central government, and communities.	<b>2-5 years</b>
<b>Education &amp; Capacity Building</b>	- Expand training programs for community leaders and local government officials on flood resilience and climate adaptation.	<b>2-5 years</b>

	- Strengthen the role of libraries/community centres as hubs for flood preparedness education.	
<b>Monitoring &amp; Evaluation</b>	- Set up a monitoring system to assess the effectiveness of implemented measures.	<b>2-5 years</b>
	- Include community-driven monitoring to assess the impact of resilience strategies.	
<b>Long-Term (5-10 years): Full Implementation and Sustained Action</b>		
<b>Comprehensive Flood Resilience Strategy</b>	- Develop a region-wide flood resilience strategy incorporating climate adaptation and sustainable land-use planning.	<b>5-10 years</b>
	- Integrate flood risk reduction into urban/rural development plans to ensure future growth is resilient to floods.	
<b>Major Infrastructure Projects</b>	- Complete large-scale infrastructure projects such as flood barriers, reinforced levees, and stormwater upgrades.	<b>5-10 years</b>
	- Invest in regional resilience hubs and ongoing collaboration among councils, communities, and national authorities.	
<b>Sustained Community Leadership</b>	- Ensure local leadership is engaged in long-term flood risk management.	<b>5-10 years</b>
	- Provide support for community-driven flood resilience initiatives, engaging younger generations.	

<b>Policy Integration and National Alignment</b>	<ul style="list-style-type: none"> <li>- Fully integrate proactive flood risk management policies at both national and regional levels.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>- Establish national flood resilience targets in alignment with New Zealand's climate change goals.</li> </ul>	<b>5-10 years</b>
<b>Continuous Review &amp; Adaptation</b>	<ul style="list-style-type: none"> <li>- Review flood resilience strategies every 3-5 years to ensure relevance based on new flood risk data and changing climate conditions.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>- Evaluate the success of bottom-up governance and scale up strategies across New Zealand.</li> </ul>	<b>5-10 years</b>
<b>Focus on Long-Term Proactive Measures Over Reactive Measures</b>	<ul style="list-style-type: none"> <li>- Implement floodproofing infrastructure (e.g., retrofitting properties, upgrading stormwater systems).</li> </ul> <hr/> <ul style="list-style-type: none"> <li>- Limit development in flood-prone areas through effective land-use planning.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>- Increase community awareness and proactive preparedness behaviours.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>- Restore natural flood management systems like wetlands and floodplains.</li> </ul>	<b>Ongoing (from 0-10 years)</b>

## 10.7 Summary of flood resilience plan for Northland

For Northland, specific suggestions to enhance flood resilience should focus on the region's unique challenges and opportunities. These could include strengthening community involvement, incorporating local knowledge, and adapting to the changing climate. Below is the summary of plan for improving Northland's resilience to flooding, addressing gaps identified in this research and considering the region's needs:

### 1. Strengthening Local Governance and Community Involvement

- i. **Empower Local Communities:** Create platforms where community members—especially those in flood-prone areas—can actively participate in flood risk assessments, floodplain zoning, and mitigation strategies. This can be done through workshops, community meetings, and advisory groups, involving local iwi (Māori tribal groups) to ensure culturally relevant input.
- ii. **Encourage Bottom-Up Governance:** While the current system in Northland follows a top-down governance model, adopting a bottom-up approach will be crucial. This would mean ensuring communities are not only informed but also have decision-making power regarding flood protection efforts. Consider the creation of community flood resilience committees that work closely with local councils to ensure the community's needs are met.
- iii. **Enhance Flood Risk Literacy:** Use local venues, such as libraries and community centres, to distribute educational materials and host flood resilience workshops. Promoting awareness of both modern flood prediction tools and traditional ecological knowledge (TEK) can help integrate both contemporary and ancestral methods of flood forecasting.

### 2. Flood Risk Management with a Focus on Proactive Measures

- i. **Implement Floodplain Zoning and Land Use Controls:** Northland needs to strengthen land-use planning policies, particularly for high-risk flood areas. This includes restricting new developments in flood-prone areas and ensuring that existing properties are built with adequate flood protection measures. The Northland Regional Council should take the lead in mapping vulnerable areas and enacting local policies that reflect these risks.
- ii. **Natural Infrastructure Solutions:** Invest in nature-based solutions such as the restoration of wetlands, riparian planting, and floodplain reconnection to act as natural buffers against floods. These measures can help reduce the severity of flooding while also providing ecological and cultural benefits.
- iii. **Improved Stormwater Management:** Given Northland's small urban centres and rural areas, stormwater management needs to be improved, especially in areas like Whangārei where overwhelmed stormwater systems have caused localized flooding. Focus should be on upgrading existing stormwater infrastructure, incorporating flood storage, and enhancing drainage systems to cope with extreme rainfall events.

### 3. Climate Change Adaptation and Futureproofing

- i. **Climate Resilient Infrastructure Investments:** Northland's flood protection infrastructure needs to adapt to the changing climate. This includes upgrading levees, stormwater systems, and coastal defences to handle both existing flood risks and future climate scenarios. Moreover, climate adaptation should be integrated into all new developments and infrastructure projects, prioritizing resilience.
- ii. **Adopt Future-Proofing Measures for Coastal Areas:** Many parts of Northland are vulnerable to coastal flooding due to rising sea levels. The Regional Council should prioritise coastal zone management, including flood-resistant infrastructure and retreat strategies in areas vulnerable to sea-level rise.

### 4. Involving Māori and Traditional Ecological Knowledge (TEK)

- i. **Integrate TEK into Flood Management:** As indicated in the findings, Māori communities possess valuable environmental knowledge that could be used to strengthen flood resilience in the region. Traditional knowledge, such as monitoring natural indicators (e.g., river behaviour, bird migrations), could provide supplementary tools for modern flood forecasting. Local iwi should be directly involved in developing flood management plans, ensuring the inclusion of culturally important practices.
- ii. **Respect and Restore Traditional Landscapes:** Engage in the restoration of traditional Māori flood resilience techniques, such as mahinga kai (food-gathering areas), which can also help with flood mitigation. Restoring traditional wetland areas can act as natural flood buffers and provide significant ecological value.

### 5. Enhancing Local Response and Recovery Capacity

- i. **Increase Local Response Capacity:** Ensure Northland's emergency services are well-equipped to handle frequent but lower-impact flood events. Train local emergency services personnel in flood response, ensuring rapid response teams can act quickly during flood events. Additionally, enhance early warning systems for both communities and emergency services.
- ii. **Disaster Recovery Planning:** While Northland's communities are highly concerned about flood risks, the region would benefit from developing a comprehensive flood recovery plan that includes resources for both immediate relief and long-term recovery. Community-based recovery strategies, such as local volunteer networks and crowdsourced funding, can speed up post-event support.

### 6. Public Education and Capacity Building

- i. **Develop a Resilience Education Program:** Public education is a vital tool for building long-term resilience. The Northland Regional Council should collaborate with schools, community groups, and local media to raise awareness of flood risks, preparedness measures, and community responsibilities. This can include both traditional and digital tools to reach different segments of the population.
- ii. **Interactive Flood Mapping and Awareness Tools:** Leverage technologies like GIS-based flood maps and online flood risk platforms to make flood data easily accessible to the community.

Residents could engage with interactive maps that show flood-prone areas, evacuation routes, and flood preparedness plans. Regularly update these tools to account for changes in land use and climate data.

### 7. Long-Term Investment in Proactive Flood Resilience

- i. **10-Year Long-Term Flood Resilience Plans:** Following New Zealand's practice of 10-year Long-Term Plans (LTP) for local governance, Northland's flood protection and resilience plan should include explicit measures for flood prevention, climate adaptation, and resilient community engagement. This could involve allocating more funds towards proactive flood mitigation rather than predominantly focusing on post-event recovery.
- ii. **Multi-Stakeholder Collaboration:** Strengthen collaboration between the central government, Northland Regional Council, local iwi, community groups, and private sector partners (e.g., infrastructure providers). Regular cross-sectoral workshops can ensure that diverse stakeholders are aligned and invested in flood resilience actions.

### 8. Monitoring, Evaluation, and Adaptation

- i. **Flood Resilience Feedback Loop:** Regularly assess the effectiveness of flood resilience strategies and adapt them to emerging risks. Northland should implement a monitoring system that tracks flood events, responses, and recovery efforts. This can be paired with community feedback mechanisms to ensure strategies remain responsive to local needs and changing flood dynamics.

To enhance flood resilience in Northland, the region needs to transition from a reactive flood management approach to a proactive, integrated strategy that empowers local communities, incorporates traditional ecological knowledge, and adapts to climate change. The suggested action plan focuses on community engagement, proactive flood management, climate adaptation, and resilient infrastructure to ensure Northland is better prepared for future flood risks.

Incorporating these elements into Northland's flood resilience framework will align with New Zealand's long-term sustainability goals and disaster risk reduction objectives, ensuring that the region's communities, ecosystems, and infrastructure are more resilient to the impacts of recurring floods.

# Chapter 11

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## Conclusion

## 11.1 Addressing the Research Questions

This thesis set out to develop community-based strategies for effective and sustainable flood risk management (FRM) in the Northland region of New Zealand, with a particular focus on addressing recurring floods that often receive less attention than catastrophic flood events. Through a comprehensive analysis of governance frameworks, land-use planning policies, and community resilience practices, this research has addressed the overarching aim by providing actionable recommendations that bridge the gap between national policies and local realities.

The study demonstrates that while New Zealand's national flood management frameworks, including the Resource Management Act (RMA), Civil Defence Emergency Management (CDEM) Act, and National Disaster Resilience Strategy (NDRS), provide a strong strategic foundation, their translation into local contexts remains inconsistent. In Northland, this has resulted in a policy-practice gap, particularly visible in the management of smaller, recurring floods. These floods, though less dramatic than major disasters, have cumulative impacts that disrupt infrastructure, livelihoods, and ecosystems, as shown by repeated closures of critical transport routes such as State Highway 1.

For clarity, this research has addressed the objectives and research questions in chapters 4-9. While Chapter 10 provided the integrations of these findings to the overall thesis aims, below is the summary of how the study addresses the main questions asked in Chapter 1.

### **Q1: How can Northland improve its flood management strategies to effectively prepare for, respond to, and recover from recurrent flood events?**

This thesis identifies several key strategies that Northland can adopt to improve its flood management efforts, particularly in response to recurrent flooding events. The findings highlight that current flood management in Northland is largely reactive, with more emphasis placed on response and recovery than on prevention and preparedness. This research advocates for a more proactive and integrated approach to flood risk management, where flood preparedness and resilience become central priorities.

The thesis suggests that enhancing local flood resilience can be achieved by:

- i. **Community Involvement:** Strengthening bottom-up governance by establishing community flood resilience committees and fostering consultations across flood-prone areas. This would involve residents more actively in flood planning and decision-making processes.
- ii. **Infrastructure Improvements:** Implementing flood mitigation projects, such as upgrading stormwater infrastructure, creating green infrastructure (e.g., wetlands, rain gardens), and stabilizing riverbanks.
- iii. **Education and Capacity Building:** Developing programs to raise community awareness about flood risks, alongside training local government officials and community leaders in effective flood risk management.
- iv. **Policy Reform:** Reviewing and revising flood management policies to prioritise proactive measures, such as flood risk reduction and preparedness, alongside response and recovery measures.

Through these actions, Northland can shift from reactive responses to a more forward-thinking approach, better preparing for and managing flood risks in the long term.

### **Q2: What are the key factors influencing community resilience to floods in Northland, and how can these factors be optimised to minimise flood impacts and enhance disaster management processes?**

This thesis identifies several critical factors influencing community resilience to floods in Northland, focusing on both individual and collective capacities to cope with flood risks. Key findings include:

- i. **Community Knowledge and Engagement:** A significant gap in intergenerational knowledge about flood preparedness and risk management was identified. Strengthening the role of local communities in understanding flood risks, through both modern education and traditional knowledge, is crucial. The thesis recommends increasing community involvement in flood management decisions through bottom-up governance approaches, ensuring that local needs and concerns are addressed.
- ii. **Local Leadership and Social Capital:** Strong community leadership and networks (such as local libraries and community centres) play a vital role in fostering resilience. Building social capital, through partnerships between councils, government agencies, and communities, ensures collective action and shared responsibility.
- iii. **Infrastructure and Environmental Management:** The thesis emphasises the importance of sustainable flood risk management practices, which include restoring natural flood management systems (e.g., wetlands, floodplains) and ensuring that infrastructure investments are resilient to climate change impacts. This includes designing flood protection systems that not only manage the risk but also enhance community resilience by restoring and protecting natural resources.
- iv. **Education and Awareness Programs:** Empowering communities through ongoing education about flood risks and resilience strategies is another critical factor. The thesis advocates for community-driven educational programs and flood resilience workshops to enhance preparedness and encourage proactive behaviour.

## **11.2 Focus on long term proactive measures over reactive measures**

While short-term reactive measures (such as emergency response plans and flood relief efforts) are necessary to address immediate flood impacts, the key to improving long-term resilience in Northland lies in prioritizing proactive measures. These actions ensure that the region is better prepared for future flood events, reduces the costs and damages associated with flooding, and builds a resilient community capable of managing flood risks.

The long-term approach focuses on:

- i. Floodproofing infrastructure, including retrofitting properties and upgrading stormwater systems.

- ii. Land-use planning that limits development in flood-prone areas, which can help mitigate the severity of floods and avoid the need for costly recovery measures.
- iii. Community education programs to increase awareness and encourage proactive preparedness behaviours.
- iv. Restoration of natural flood management systems, such as wetlands and river floodplains, which help reduce the speed and intensity of floodwaters.

Focusing on these proactive strategies helps reduce future flood impacts and supports a more sustainable, resilient approach to flood management over time.

### 11.3 Thesis contribution to the current flood events issue in New Zealand

This research, while focused on long-term strategies for flood resilience in Northland, can significantly contribute to addressing current flood events in New Zealand. Although the study emphasises proactive, long-term measures, the lessons learned from this research can be directly applied to the ongoing flood challenges in the country. Moreover, it offers insights into how to ensure that the lessons from these current floods are integrated into future resilience-building efforts, particularly by avoiding the intergenerational knowledge gap once flood events are no longer the immediate focus.

#### 1. Applying Long-Term Flood Resilience Lessons to Current Flood Events

While the research centres on long-term flood resilience planning, the findings can offer crucial insights for immediate and short-term flood response in New Zealand. For example:

- i. **Community Participation and Bottom-Up Approaches:** The research emphasises the need for bottom-up governance and the integration of local knowledge in flood management strategies. This lesson is especially relevant to current flood events, as local communities are often the first to respond and can provide valuable insights into flood risks that may not be captured in broader assessments. Engaging local communities in the response and recovery phases can enhance the effectiveness of existing efforts, as they can provide real-time knowledge and recommendations for immediate flood mitigation.
- ii. **Proactive Flood Management:** The study calls for proactive flood mitigation measures, such as stormwater infrastructure upgrades and floodplain zoning, which are relevant to managing ongoing flooding. The importance of these proactive steps can be communicated to policymakers and local authorities involved in the current flood events, encouraging them to prioritise long-term strategies that reduce vulnerability over time, even in the face of immediate pressures.

By connecting long-term resilience goals to current events, the research offers practical actions that can be taken to enhance flood preparedness and response in real-time. Risk reduction and infrastructure investment, such as improving flood barriers and drainage systems, can be reinforced

in the immediate aftermath of a flood event, ensuring that recovery efforts align with broader, long-term resilience plans.

### 2. Building on Lessons from Recent Flood Events

The recent flooding in New Zealand has underscored the need for improved flood resilience, particularly in the face of climate change. The lessons from recent flood events—including the Canterbury floods (2010-2011), the Auckland floods (2023), and the Hawke’s Bay floods (2023)—can inform future preparedness efforts. Some of the key lessons that resonate with the findings of this research include:

- i. **The Need for Proactive Measures Over Reactive Ones:** Recent floods have shown how reactive flood management systems often fall short when it comes to minimising damage and protecting communities. The research emphasises the importance of addressing flood risks before they escalate. Incorporating flood risk assessments, early warning systems, and climate adaptation strategies into long-term planning can help New Zealand avoid the worst outcomes of future floods, particularly in flood-prone areas.
- ii. **Intergenerational Knowledge Transfer:** One of the critical contributions of this research is the focus on bridging the intergenerational knowledge gap. In the wake of major flood events, it is common for the urgency of response to overshadow long-term knowledge-sharing practices. The research suggests incorporating local, traditional knowledge alongside modern tools, such as GIS-based flood mapping. During the recovery phase of current flood events, it would be beneficial to tap into the knowledge and experience of older generations to avoid losing valuable lessons once flood events are no longer a “hot topic” in the media. Community-led initiatives, including workshops and storytelling, could be incorporated into the recovery process to foster intergenerational exchanges of flood preparedness knowledge.

### 3. Avoiding the Intergenerational Knowledge Gap Post-Flood

A significant challenge identified in this research is the intergenerational knowledge gap that emerges when flood events become less frequent and no longer dominate public discourse. After major floods, public attention and government focus often shift away from long-term flood resilience, resulting in a loss of knowledge among younger generations who may not experience a flood event directly. This research suggests several strategies to prevent the erosion of this vital knowledge:

- i. **Institutionalising Knowledge Preservation:** The research highlights the importance of preserving traditional knowledge systems, such as observing environmental cues, and integrating them with modern technologies. By establishing formal mechanisms within government agencies and community organisations, this knowledge can be maintained and passed on. For instance, local governments can institutionalise knowledge-sharing programs that involve elders, local environmental experts, and climate scientists in the process of flood preparedness education. These programs could take place in public forums, libraries, and schools, ensuring that younger generations receive continuous exposure to flood resilience knowledge.
- ii. **Incorporating Knowledge into Educational Systems:** One way to ensure the longevity of flood resilience knowledge is by embedding it into the national education system. School curricula

could include modules on disaster preparedness and flood risk management, integrating both modern scientific understanding and traditional knowledge. This would help younger generations stay engaged with the issue, regardless of the recency of flood events, and prepare them for future challenges.

- iii. **Leveraging Technology for Knowledge Sharing:** As part of long-term planning, the research suggests leveraging technology to bridge the knowledge gap. Digital platforms, mobile applications, and interactive websites could be developed to share real-time flood information, document local experiences, and ensure that historical flood data is readily accessible. These tools can become repositories of knowledge that connect community members across generations and help sustain the flow of important information even after the flood event has passed.

#### **4. Long-Term Focus on Proactive Measures**

Finally, the research advocates for a long-term, proactive approach to flood resilience, which includes not only response and recovery but also risk reduction and preparedness. To ensure that this approach is maintained, the research emphasises that flood management strategies must be integrated into local government's 10-year long-term plans (LTPs). These plans should be continually reviewed and updated based on new flood risk assessments, incorporating feedback from local communities. Suggestions for improvement are provided in Section 10.5. By doing so, the flood resilience effort remains a constant priority, regardless of the ebb and flow of media attention and government focus.

Incorporating proactive measures into the planning stages of flood management—such as land-use zoning, infrastructure investment, and climate adaptation—will help avoid the risk of oversights and missed opportunities, which often occur when focus shifts away from flood events.

### **11.4 Thesis Contributions to broader context**

This PhD research contributed to the body of knowledge and practicality, especially in the context of Northland, New Zealand, where the issue of recurring small floods often gets overlooked compared to large-scale catastrophic events. By focusing on the community's resilience and offering long-term, proactive measures, this work could make a significant difference in addressing the local flood challenges. While it may seem like a narrow focus, the solutions this research has proposed have the potential to not only reduce flood risks but also strengthen community preparedness, response, and recovery in a region that is often underrepresented in broader flood risk management discussions. This research could also contribute to filling the gap in addressing smaller, recurring floods, which can often cause substantial cumulative damage and disruption.

**Addressing an Overlooked Issue:** Most flood management efforts and research tend to focus on large-scale, catastrophic floods because they generate immediate attention due to the magnitude of their damage. However, the recurring smaller floods, especially in regions like Northland, are often ignored. These floods might not seem as dramatic in the moment, but they cause significant cumulative damage, disrupt lives, and affect the local economy. By focusing on these small but frequent floods, this research addresses a persistent issue that affects the daily lives of many in Northland, ensuring that this often-overlooked aspect of flood risk management gets the attention it deserves.

**Empowering Local Communities:** This research introduces the idea of a bottom-up approach to flood risk management, which is highly valuable. In New Zealand, and globally, top-down governance often results in slower responses, and communities feel disconnected from the decision-making process. The emphasis on a more inclusive, community-based approach to flood resilience promotes local ownership, enabling communities to take proactive steps in disaster preparedness and response. This helps communities not only to reduce their vulnerability but also to build long-term resilience.

**Proactive Flood Management:** By focusing on long-term, proactive flood resilience measures, this research is advocating for a shift in flood management strategy that prioritises prevention over reaction. While many current strategies focus on post-flood recovery, this work emphasises the need to mitigate risks and improve preparedness before a flood happens. This shift is critical for reducing the ongoing costs of flooding and minimising future damage. The findings and proposed action plans highlight how communities can plan and make the most of their resources.

**Sustainability and Intergenerational Knowledge:** The research addresses the issue of intergenerational knowledge gaps, an often-overlooked barrier to building long-term resilience. This is especially relevant in a world where older traditions and local knowledge can be lost or overshadowed by technological advances. By suggesting ways to combine modern flood management tools with traditional knowledge, the research proposes a strategy that respects cultural heritage while adapting to the challenges of the modern world. This integration of both forms of knowledge can lead to more effective, sustainable flood risk management in the long term.

**Impacting National and Global Flood Resilience:** While this research is focused on Northland, New Zealand, the lessons learned from the findings can have global applicability. Many regions face similar challenges with recurring, smaller floods, and this research provides valuable insights into how communities can better prepare for these events. Furthermore, this work aligns with global sustainability goals, such as SDG 11 (Sustainable Cities and Communities) and SDG 4 (Quality Education), by promoting inclusive disaster management and resilience-building through community-centred approaches.

**Filling a Knowledge Gap in Flood Risk Management:** As stated earlier, most existing research tends to focus on catastrophic events or larger-scale flood risk management measures. This work fills an important gap by addressing community resilience to recurring floods, emphasising the need for better understanding of local dynamics, preparedness, and response. The findings can provide much-needed guidance for local governments and practitioners working to improve flood risk management strategies in similar regions worldwide.

Therefore, this research contributed by addressing an often-neglected issue in flood risk management, prioritising long-term solutions and promoting community-led action. This research not only offers solutions to flooding but also lays the foundation for a sustainable, resilient future for Northland. By pushing for more inclusive, proactive flood management strategies and bridging knowledge gaps, the research is contributing to creating stronger, more resilient communities, not just in New Zealand but potentially in other regions facing similar challenges.

## 11.5 Future research

As this research can only focus on the objectives of developing community resilience to recurring floods, it comes with limitations on depth and topic to cover. In continuation of this topic of community resiliency to floods, further research below suggested to evaluate the action plan suggested on the research findings:

- i. **Exploring the Role of Indigenous Knowledge in Flood Resilience:** Further research could investigate how indigenous knowledge systems can be better integrated with modern disaster management practices. Focusing on the Māori perspective, particularly in relation to traditional ecological knowledge (TEK) and its role in flood preparedness, could offer valuable insights into community-based approaches to resilience.
- ii. **Evaluating the Effectiveness of Bottom-Up Governance in Flood Risk Management:** Additional research could assess the practical application of bottom-up governance in flood risk management across different New Zealand regions. Studies could focus on community-driven flood risk management projects and evaluate how well they complement and enhance top-down approaches. This could include evaluating the effectiveness of local participation in decision-making and the impact of community involvement on flood risk reduction outcomes.
- iii. **Community Health and Psychological Resilience in Flood-affected Areas:** Future studies could explore the mental health and psychological resilience of communities that experience frequent floods. Understanding how repeated flood events affect mental well-being and how to address these impacts can enhance holistic resilience strategies, integrating both physical infrastructure and psychological preparedness.
- iv. **Long-Term Social and Economic Impacts of Flood Events:** Research should focus on the long-term social and economic consequences of recurring floods, particularly in rural and vulnerable communities. Investigating how ongoing flood risks affect livelihoods, housing, and local economies can provide critical information for developing more resilient communities.

This thesis has highlighted key challenges and strategies for enhancing flood resilience in Northland, New Zealand, and offers valuable insights that contribute to flood risk management and community preparedness. Despite widespread awareness of flood risks in the region, recurring flood events continue to pose a persistent challenge, with current management strategies primarily focused on response and recovery rather than proactive measures. Through the integration of findings from various chapters, this study demonstrates the importance of bottom-up governance, community participation, and intergenerational knowledge exchange in strengthening resilience to floods.

The research shows that community-driven solutions are essential for improving flood risk management in Northland. Particularly, it highlights the value of local knowledge, which, when combined with modern disaster management tools, can enhance flood preparedness and response. However, a significant gap exists in addressing the long-term aspects of flood resilience, particularly the intergenerational knowledge gap, which can undermine efforts to build sustainable, adaptive communities. The findings indicate that traditional knowledge has been eroded over time and

integrating it with contemporary flood management practices offers a pathway toward more inclusive and sustainable resilience.

Moreover, while the existing top-down governance approach in New Zealand has contributed to flood management, this study suggests a shift towards a bottom-up approach—one that involves local communities more actively in decision-making, knowledge-sharing, and preparedness activities. This shift can ensure that the needs and perspectives of communities are better represented, and flood resilience is more deeply embedded in everyday practices.

## Appendices and References

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Lists of appendices and references

## Appendices

Appendices will be uploaded separately as supplementary to this thesis

Appendix	Title
A	Historical Flood Database
B	Survey and Interview Questions and Ethics
C	Community Meeting Minutes
D	Managing The Risk in NZ
E	Ethics Notification and materials

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Year	Event	Date (from)	Date (to)	Flood Frequency	What Happened? (Caused, Mitigation, and Preparedness)	Impacts	Value of damages	Responses
2022	Northland Flooding	21/03/2022 24 July 2022	23/03/2022 26 July 2022	1:100 1:250	<p>Rainfall in March was particularly dry other than 3 days of thunderstorm activity which saw storm intensity's that exceeded 100-year events in several areas</p> <p>Rainfall in March was limited except for three days of heavy thunderstorms between 21 – 23 March, most falls across Northland averaged 30-40mm an hour on the 22nd and 23rd, however on the morning of the 21st several sites experienced intense rainfall over 1 – 2 hours, resulting in some flooding. The maximum rainfall intensity on the 21st was 112 mm, in 1 hour, which was recorded at the Brynderwyn rain gauge, this event exceeded the threshold for a 1 in 250-year event (HIRDS V4, 0.4% chance of happening in any one year).</p>	<p>Emergency services are at the scene of State Highway 11, near Lemon's Hill, after a slip led to the closure of the road in both directions, police said.</p> <p>Surface flooding and rising tides have also severely affected several roads and bridges, including on State Highway 10; Kaeo and Oromahoe; State Highway 1 Whakapara; areas of Horeke; Moerewa; and State Highway 12 Taheke.</p> <p>It comes after heavy downpours and severe northeast gusts led to power outages to 2000 homes across Waitangi and Paihia on Monday morning.</p> <p>Civil Defence Northland said on Facebook that heavy rainfall and the impending high tide on Monday afternoon may lead to surface flooding and the closure of one or both lanes of multiple state highways, including: SH1 at Whakapara, north of Whangārei; SH10 near Kaeo; Puketona and Waimate North; and SH12 at West Taheke.</p> <p>Meanwhile, the Whangārei District Council said Ngunguru Road is closed in both directions due a slip, which is expected to be cleared on Tuesday. In addition, Cove Road, Waipu Gorge Road and Cullen Road are down to single lanes due to slips and landslides.</p>		
2021	Northland flood	12-Jul	13-Jul		Surface flooding, rapid river rise, as 'significant' rainfall hits Northland	<ol style="list-style-type: none"> <li>Whangarei</li> <li>Kaeo</li> <li>Kerikeri</li> <li>A minor slip, approximately five cubic metres in size, had already fallen on State Highway 11 between Opuā and Kawakawa.</li> </ol>		
2020	Northland Storm Flooding	17-Jul	18-Jul	0.2% (1:500 year)	<p><b>1. Heavy Rain Resulted in Flooding</b> After months of near-crippling drought more than 200mm of rain fell over 10 hours from Friday (17 July 2020) night. Northland Civil Defence Emergency Management group manager, Graeme MacDonald said the flooding was similar to 2014 except the deluge came in a much shorter period.</p> <p><b>2. Mitigation</b> Whangarei detention dam prevent major flooding in the Whangarei CBD, however, the floods still impacted the central city. A 113m-long flood wall was built near Raumanga Stream to increase flood protection in Whangarei CBD. The project started in 2009 and finish in the end of 2019.</p>	<p>1. Far North District a. Infrastructure - Around the Far North 165 locations have been damaged by recent floods and earlier flood events where slips have never fully been corrected. State Highway 1, at the Mangamuka Gorge just south of Kaitiāia, has a number of slips. Damage to roads caused by slips to date is expected to cost \$5.9 million, excluding the slips in Mangamuka George, the New Zealand Transport Agency said. b. Property - The Waiharakeke Stream near Kaikohe has been bursting its banks and flowing into the small town of Moerewa. Council teams have visited 100 homes in Moerewa and found houses and septic tanks have been flooded. c. Paddocks under water - Many Northland farmers who've been struggling as a result of the drought now find their paddocks completely under water. Especially in a vast plain between Whangārei and Kawakawa, and north of Moerewa. d. Paihia area - debris and silt in the Waitangi River damaged water intakes and a submersible pump, cutting water supplies to the Paihia e. Russel area - Some sewage had spilled out to sea</p> <p>2. Whangarei District a. Waterplant - Floods closed some of the region's water treatment plants, residents need to conserve water for a couple days. b. Farmland - paddocks completely under water c. Infrastructure - Flooding, slips, and landslide in some area mainly at south Whangarei and caused at least \$8 million in damage to the District's infrastructure (WDC, 19 Aug 2020)</p>	<p>1. Far North District Areas damaged by floodwater : 165 Road damages caused by slips : \$5.9 m -nzta House affected at Moerewa : 100</p> <p>2. Whangarei District Infrastructure damages : \$8 million</p> <p>insurance council NZ total insurance covers for home, vehicles, and damages : \$37 m</p>	<p>1. <b>Welfare support / collaboration</b> Civil defence, the Ministry of Social Development, and the Ministry of Primary Industries were all on ground to provide welfare support as well as the Rural Support Trust</p> <p>2. <b>Government</b> the Government had put \$30,000 towards a Mayoral Relief Funding to support the Northland community. More than \$26 million has been pledged by the Government to strengthen Northland roads and protect the region from future floods.</p> <p>3. <b>Far North District</b> a. <b>Moerewa</b> - the council got the tanks cleaned out to enable people to stay in their homes. Council inspected 109 properties in Moerewa [assessing sanitary matters]; Council staff were out in force supporting residents and other agencies to assess property damage and welfare needs. b. <b>Paihia</b> - Infrastructure and Asset Management Team and alliance partner, Far North Waters, did temporary repairs while the Communications Team raised awareness of the problem in the Paihia community.</p> <p>4. <b>Whangarei</b> a. <b>Evacuation by CDEM</b> - Some people relocated to the two Civil Defence welfare centres set up in the Kamo Scout Hall and Onerahi Community Hall. b. <b>Whangarei District Council</b> - Council has around 730 roading repair jobs from the 17 July storm</p>
2019								
2018	Northland-Bay of Plenty flooding (Ex-cyclone Gita)	14-Jul	15-Jul	mid-latitude cyclone category 3	<p>MetService forecaster Cameron Coutts said up to 80mm had fallen over the past 24 hours in the Far North, most of that was between 9pm and 10am. The heaviest deluge was 29mm, between 7am and 8am near the Mangamuka Ranges. Another 50mm to 80mm occurred by 6pm, mostly on the western side of Northland. Warning posted in the Northland Weather Updates facebook community pages</p> <p>Whangarei District Hopua te Nihotetea dam lessening the severity of major flooding from the Raumanaga Stream in the city's CBD and parts of Morningside and Raumanga.</p>	<p>School closure Flooding and road closures have led to the closure of Kaeo Creative Minds ECE and Hukerenui Playcentre, as are Kokopu School, Otaika Valley School, Whananaki School, Hukerenui School and Whangaruru School.</p> <p>Far North District Property - Power is out to 67 customers after a tree brought down power lines north of Te Ngaere Bay. Properties on Mahinepua Rd, Tauranga Bay Rd, Thompson Rd, Thompsons Access Rd and Wainui Rd are affected.</p> <p>Kaipara District Property - Flooding in Kaipara Flats, near Warkworth. Paddocks are flooded</p> <p>Whangarei District Infrastructure - floodwaters blocking SH1 at Whakapara area (between Whangarei and Kawakawa) Hikurangi swamp - The banks of the Hikurangi Swamp had breached. Ruakaka river - McCathie Rd was closed as the Ruakaka River has burst its banks and is over the road. Several roads were not passable either because of the trees falling and blocking the roads, potholes, or high water covering.</p>	<p>Insurance Claim - on property: \$ 3.7 m Property - 16 schools in Northland and one early childhood centre had closed (Ministry of Education, 2018) Power outages in Kamo, Parua Bay and Tangowahine caused by trees falling. cars: A pothole on SH1 near View Rd, Hikurangi, has damaged about five cars and another one between Kaiwaka and Te Hana had caused trouble for southbound motorists. One car suffered a punctured tyre and a damaged front driver's wheel rim. Three other vehicles had also pulled over with punctures</p>	<p><b>During the event</b> - Workers were clearing a massive slip blocking State Highway 11 at Lemons Hill, between Kawakawa and Paihia, using a digger to break up several large trees so they can be moved off the highway. An engineer assessed the stability of the slip face in the highway.</p> <p>Police: the police opened alternative access due to inaccessible road in SH1. Diversion are in place along Jordan Valley Rd and Hukerenui Rd and police advise drivers to avoid the area.</p>
2017	Northland Flooding / Far North flood	22-Jun	23-Jun	0.2% (1:500 year)	<p>Flooding caused by heavy rain in Northland overnight has left roads like rivers, trapping some people in a dairy and closing a number of schools.</p> <p>Hopua te Nihotetea scheme Scheme has performed in accordance with design, during minor storm events in 2017.</p> <p>Kāeo-Whangaroa flood scheme Kāeo township is still exposed to flooding from the Waikare Creek as well as from backwater from the Kāeo River.</p>	<p>Far North District Power cuts - homes without power in Fairburn, Kaitiāia and Honeymoon Valley. Infrastructure - Turntable Hill near Moerewa flooded. The nearby settlement of Peria was cut off when access roads from both directions were flooded. Flooding at SH12 in Matakōhe, SH1 in Mangamuka and SH11 in Paihia. State Highway 1 was flooded at the usual trouble spot near Rangiahua Bridge when the Waihou River breached its banks around noon, as well as south of Kawakawa. Omaunu Rd, which connects Kaeo township with Whangaroa Hospital and homes on the far side of the valley, was submerged early in the day but was still passable to four-wheel-drives.</p> <p>Farmland - some dairy farm were flooded</p>	<p>properties : damaged house components bause of flooding going inside the house utilities : power cut because of stong wind and heavy rain. lifestyle : schools and local shps closed due to inacissible and flooded school</p>	<p><b>School closed</b> - Nine schools closed for the day in Kaeo, Mangamuka, Matauri Bay, Pawarenga, Peria, Umawera and Waikare because buses were unable to run. Taipa Area School closed because buses were cancelled and its grounds were flooded, while Motatau and Pampurua schools were closed because of power cuts.</p> <p><b>Communities</b> - going to work as usual since the road still accesible by car. Power repair crew restored the power Fairburn, south of Kaitiāia soon after the falling trees was cleaned up, and in Honeymoon Valley after the road accessible</p>

2017	North Island Heavy Rain and Flooding	7-Mar	13-Mar	1:100 year	<p>Very heavy rain fell over many areas of the North Island during the period 7-13 March, which resulted in severe flooding. A slow-moving depression remained in the North Tasman Sea for most of this period. Fronts on the eastern edge of the depression brought the rain.</p> <p>Since Kaeo Township was built on the flood plain of the Kaeo River, flooding in 2017 was adding the vulnerabilities and was destructive to the area.</p>	<p>Powercut - 1200 people in Northland were without power on 11 March. Ground water - Groundwater systems have begun to increase in response to the wet conditions and soil moisture is above the mean for this time of year at all sites</p> <p>Far North District Infrastructure - There was flooding on State Highways 1, 10, and 11, South of Kerikeri on 11 March. Property - Residential 35 km south of Kerikeri covered by floodwaters. (A family was trapped in their house) Kawakawa - Far North Civil Defence spokesperson Bill Hutchinson said a family was reportedly trapped by floodwaters up the flood-prone Waiomio Valley, just south of Kawakawa, but emergency services were unable to reach them. Some residents in the area had self-evacuated to Mohinui Marae. Kaeo - Kaeo River began flooding State Highway 10 just before 6pm. power cut - The weather has also taken its toll on the Far North's power network. This morning 600 households were without power, mainly in Oue, Waimamaku and Horeke in South Hokianga. Power was restored to all but 60 households by 4pm.</p>	Power cuts : 1200 people	<p>Roadworks conducted to prevent the slips The community clean up directed by the local authorities in Kerikeri</p> <p>The Northland Civil Defence Emergency Management Group is advising of possible localised flooding later this afternoon (Thursday 9 March) around Kaeo and Ngunguru Road to the Tutukaka Coast in particular, and is recommending residents make their travel plans ahead of high tide around 6pm.</p> <p>some residents have to self-evacuate because of the access</p> <p>The Kawakawa Fire Brigade brought in an inflatable boat in case they had to mount a rescue overnight</p> <p>River and stream levels in the region are being monitored closely, with special attention being paid to the Kaeo, Waitangi, Whakapara and Mangakahia rivers. There are risks of flash flooding in some areas caused by heavy, localised thunderstorms.</p> <p>Civil Defence was also warning farmers to move stock to higher ground if they have any concerns.</p>
2016	Northland flood	10-Aug			<p>MetService warns things are not looking up anytime soon with another 90mm expected to fall until 9pm. Motorists were advised to drive with extreme care and with lights on and watch for slips and flooding. Farmers were advised to stay away from flood waters and not to cross flooded highways or tracks.</p> <p><b>preparedness</b> CDEM : ask public to participate in civil defence activities (decision making, exercises, volunteer rescue, welfare teams)</p> <p><b>reduction</b> CDEM do the effective building controls and/or planning (e.g. floor height above likely flood levels); redundancy in critical infrastructure; careful and secure location of critical services and infrastructure</p>	<p>Whangarei Scores of roads around Warkworth and Wellsford are closed, sections of State Highway 1 between Warkworth and Whangarei are under threat. farmland is starting to disappear under a murky pool of water At least four rural primary schools in the rain-affected region have closed their doors early as more than 50mm of heavy rain has fallen across the region since 6pm. Some people trapped in the floodwater.</p> <p>The car was stuck in waters on a road that was located near a stream. school - Ahuroa School near Pohui has been forced to shut because of the floodwaters.</p> <p>Infrastructure - Deep flooding on State Highway 16 at West Coast Rd between Kaukapakapa and Wellsford had made the road impassable. Flooding has closed six roads around the Rodney District and others are passable but flooded. A slip has closed Matakana Valley Rd and two slips were partially blocking lanes on Pakiri Rd. Floodwaters were also affecting State Highway 1 at Dome Valley and Purewa, south of Whangarei.</p>	5 people rescued after trapped in a car flooded with water	<p><b>Firefighter</b> - Firefighters were called to save two people caught out by rapidly rising floodwaters. One stranded Wellsford resident could not get out of their Whangapiro Valley Rd property because of the height of the water. Firefighters sandbagged the lower level of the inundated home and moved valuables to the second storey before the person was safely helped out of the waterlogged property.</p> <p><b>emergency services</b> - A motorist called emergency services after being trapped by rising floodwaters on Waiteitei Rd, north of Wellsford. When fire crews arrived they found three abandoned vehicles on the submerged road.</p> <p><b>CDEM</b> - a high level of cooperation and information sharing between responding agencies; a clear understanding of respective roles and responsibilities in an emergency.</p>
2015		March		low	Cyclone Pam Remain			
2014	Upper North Island Storm/ Northland - Coromandel Storms	8-Jul	12-Jul	less than a 1:10 year	<p>From 8-12 July there was a very strong moist northeasterly flow over the north of the North Island. This brought severe gales, which blew down trees, blew roofs off houses and cut power to thousands of households. There was also prolonged heavy rain which caused flooding in some areas. Northland was worst affected, resulting with many damages.</p> <p>Kāeo-Whangaroa flood scheme Scheme has performed in accordance with design during July 2014 flood</p>	<p><b>Property</b> - More than 13,000 homes across Northland were without power, with the rural areas around Kaipara and Whangarei worst hit. <b>Agriculture</b> - Some avocado orchards in the Far North and Whangarei district were hit hard, especially those in exposed eastern areas. The cost of the storm to that industry was estimated at \$13.5 million, with a 30% loss of crop. <b>Farmland</b> - DairyNZ estimated that 5000 hectares of grass on dairy farms in the region was expected to remain under water for 10 days, and would take three months to become productive again. The cost of regrassing was conservatively estimated at \$660 per hectare, while other costs would include fencing, repairing fences and the loss of calves. <b>Infrastructure</b> - State Highway 1, south of Kawakawa, was closed when a 70m section of road collapsed. Mangakahia Road became the only direct route to the Far North after the State Highway 1 closure. Mangakahia Road was also damaged by the storm. <b>Wairua and Haruru Falls</b> - The area was extensively flooded, and there were strong currents across paddocks leading into the Waitangi River.</p>		<p>The Ministry of Social Development had received more than 130 requests for food, clothing and fuel, mostly as the result of power outages, in the Kaitiaki, Kawakawa and Kaikohe areas. A welfare centre was set up at the Haruru Bledisloe Hall for residents affected by flooding</p>
2014	New Zealand Storm	9-Jun	11-Jun	0.2% (1:500 year)	<p>A complex low pressure system extended from the mid-Tasman Sea to the northwest of the North Island, bringing a moist northeasterly flow over NZ. This resulted in severe gales in many northern North Island areas, with Auckland being particularly hard hit.</p>	<p>Far North District <b>Infrastructure</b> - More than 40 rural roads were closed or described as passable with caution due to flooding. The Rangiahua bridge on State Highway 1 at Horeke was closed due to flooding.</p> <p>Whangarei District <b>Infrastructure</b> - Several roads were closed due to flooding.</p>		
2013	New Zealand Storm	4-May	4-May	1:100 year	<p>A deep low pressure system crossed New Zealand during the period 4-6 May, bringing stormy weather to many areas. Heavy downpours caused chaos around the country with power cut to hundreds of homes, buildings flooded and some flights suspended.</p>	<p>Much of Northland was hit by thunderstorms and heavy rain on May 4. There was flooding in the Kaipara district.</p>		
2012	North Island Storm	18-Mar	20-Mar	1:50	<p>A deep low, from the sub-tropics, became slow-moving to the north of the North Island and brought heavy rain over areas from Gisborne to Northland. It was also accompanied by southeast gales.</p>	<p>Infrastructure - Some sections of the state highway were closed by surface flooding, and strong winds brought down trees. Property - Power was cut to hundreds of homes. Some schools were closed due to the flooding Far North District Kaeo - Water levels in the main street of Kaeo were about 1 metre high on 19 March. State Highway 10 near Kaeo was closed overnight on 19/20 March. Kaipara District Infrastructure - State Highway 12 was closed overnight on 19/20 March due to the flooding. Whangarei District Otaika - Flooding at Otaika, a 61 year old woman was rescued after her vehicle was swept away by floodwaters (about 11:30 am on 19 March). The Whangarei District Council is reporting flooding this morning on Ngunguru Rd, SH1 Whakapara, Whananaki North Rd, Matipo Pl, Marua Rd, Otonga Rd, Kokopu Rd and Russell Rd, and trees down or slips on Russell Rd, Peach Orchard Rd, Kaiatea Rd, and Springs Flat. Whananaki - Due to the flooding, a woman had to abandon her car after it was caught in floodwaters (8:30 am on 19 March). Mokau - A man had to abandon his car after it was caught in rising water (7:30 am on 19 March). Whakapara - Six cars were stranded on the north side of SH1 about 1:30 pm on 19 March due to the high flooding. Ngunguru - The fire brigade rescued a couple and their three year-old child from their home after 1.5m floodwaters threatened to engulf their property.</p>		

2011	Upper North Island Storm (Ex-tropical Cyclone Wilma)	28-Jan	29-Jan	category 4	<p>Ex-tropical Cyclone Wilma Ex-tropical cyclone Wilma moved rapidly across the northeastern North Island on January 28 and 29, bringing very heavy rainfall and causing severe flooding and slips. About 280mm of torrential rain fell in the eastern hill country of Northland on January 28. This caused substantial damage to the region's road network and some water and sewage treatment plants.</p> <p>(In May 2011, high downpour hit Kaeo area and overflow rivers creates floods in some areas)</p> <p>Mitigation Northland Regional Council on its Annual Plan 2011-2012 under the River Management Activity: Continuing to manage rivers to reduce flood hazard risk. Stage one flood reduction works undertaken in 2011/2012: works focused on channel maintenance within the CBD</p>	<p><u>Far North District</u> <b>Property</b> - rising floodwater at Kawakawa, 70 people evacuated from their homes. <b>Water plant</b> - Paihia's water treatment plant was damaged and residents were asked to conserve water. <b>Infrastructure</b> - Roads were washed out in Moerewa, Kawakawa, Haruru Falls, Paihia, Opuia and Kaeo with extensive slips across Northland.</p> <p><u>Whangarei District</u> Flooding at Pipiwai area</p>		<p><b>Evacuation</b> - Temporary welfare shelters were set up in Northland to house about 70 people, after tropical cyclone Wilma battered the area on the night of January 28. People from Kaeo through to Kawakawa were evacuated from their homes due to rising floodwaters.</p> <p><b>Whangarei</b> - In Pipiwai, firefighters used a boat to rescue a man and woman who were stuck up trees for more than three hours, due to the rising flood waters.</p>
2009	Upper North Island Storm February and March	5-Mar	5-Mar		<p>March 5 A large trough of low pressure over the Tasman Sea on the 5th joined with a new low from the subtropics. A slow-moving trough sat across the North Island on the 6th.</p> <p>February 27 A storm affected most places in the North Island, with heavy rain, flooding, high winds and heavy seas. Rivers in the Far North were running high and fast on the morning of the 28th.</p>	<p><u>Far North District</u> Road access - During 27th Feb flooding, Kaeo was cut off by flooding on roads north of the intersection of State Highway 10 and Whangaroa Rd overnight. The town was only accessible by four wheel drives and trucks until the water began to subside around 9am. Flooding at Kaeo - The Kaeo River peaked at 3 m at about 5:30pm on the 5th March. Flooding at Waikare - At Waikare Valley, a river threatened to burst its banks on the afternoon of the 5th, but did not. Flooding at Kerikeri - The Kerikeri River peaked at about 3am on the 27th, reaching a few metres away from the Kemp House. It was much lower than the flood of July 2007, when less rain had fallen, as this time the bridge was not there to collect debris.</p> <p><u>Whangarei District</u> flooding - Firefighters helped a resident on Silverstream Road clear a flooded trench at about 10pm on the 5th. Whangarei Harbour - Sewage spilled into Whangarei Harbour on the 5th and 6th March, after the Okara pumping station overflowed from 8.30pm on the 5th and the Hatea system overflowed two hours later. Swimming was banned for one week and shellfish gathering for one month in the harbour, from the Town Basin to Waikaraka. Whangarei city - Heavy rain in Whangarei caused a sewage overflow at the Okara Park Pumping Station between 3am and 6am on the 28th February. People were warned not to swim or gather shellfish in the harbour. 1400 cubic metres of sewage was spilled into the harbour, but only a small amount of it was raw. An accident occurred on Reotahi Rd at Whangarei Heads just after 3pm, in which two cars collided. One person was reported to have chest and facial injuries. Ruakaka coastal - water had to be pumped out from 33 boats moored at the marina that were in danger of sinking, and one boat did sink. Car accident in Waipu - Two cars collided when one spun out on State Highway 1 near the summit of the Brynderwyns Hills near Waipu, at about 1.34pm on the 28th. Two Swedish people were killed, a male driver and female front passenger of one car, both in their early 20s.</p>	<p>Power cuts : 8 homes in Far North in march events and more in February event. Three people died in Northland in car accidents on wet roads in February storm. Police attended at least 12 minor traffic accidents on the 27th and 28th that were attributed to the wet conditions.</p>	
2008	North Island Weather Bomb and Storm	26-Jul	29-Jul		<p>North Island The first storm of three in a one-week period. A deep low brought high winds, seas and rainfall to the upper North Island, causing widespread power cuts along with flooding and damage to trees and buildings. Three people were drowned in the Bay of Plenty.</p> <p>Northland The storm made landfall in Northland on the morning of the 26th. Winds gusts (130km/hr) brought down trees and power lines throughout Northland. Northland had up to 140 mm (14 cm) of rain during the storm. In the eastern hills from Kaeo to Whangarei Heads, up to 115 mm (11.5 cm) of rain was recorded from midnight to 2.30pm on the 26th. Several days later, fallen trees, slips and flooding blocked many roads in Northland on the 30th. All highways in Northland were affected by fallen trees, surface flooding, pot holes or slips. The biggest slip was on SH11 at Lemon's Hill, between Kawakawa and Opuia, which was closed for most of the 30th. On the morning of the 30th Northland was cut off from the south due to a huge slip on SH1 north of Warkworth and overnight flooding on the SH16 alternative route.</p>	<p><u>Far North District</u> Property - homes were damaged in Kaikohe, Kerikeri, Mangonui and Russell. Surface flooding - Towai Road at Maromaku, SH12 at Ngawha, and SH1at Rangiahua Bridge was closed by flooding. SH1 closed by a slip at Mangamuka Gorge and traffic was held up for some four hours. SH12 at Taheke in the Far North was affected by flooding on the 26th. Cars were trapped in the floodwaters near Rakauwhia Road. Mill Rd at Kawakawa was closed after heavy flooding earlier in the afternoon on the 30th. There was surface flooding in two places between Bulls Gorge and Cottle Hill on SH10 at Kerikeri on the 30th and a slip at Hayes Hill. <b>Infrastructure</b> Kaeo - SH10, the main road through Kaeo, was closed due to flooding on the 27th. Kaeo was submerged on the 26th, but the damage was nowhere as bad as the 2007 floods. The river knocked fences over and they were piled up with logs. There was some flooding around low-lying Dip and Omanu Roads, with about 1 m of water. on the 29th, Kaeo escaped serious flooding overnight. There were many flooded paddocks and some minor roads were unpassable to smaller cars. Panguru - Some 35 people sought shelter at Panguru's Waipuna Marae as a precaution, although the river did not burst its banks. Some roads in Panguru were still flooded on the 29th, limiting access to the coast. Moerewa - The Otiria Stream flooded at Moerewa, making access limited on SH1 where the bridge was flooding at the base of Turntable Hill. Traffic banked up at Moerewa.</p> <p>Lake Owhareiti - on 24 August, a month after July flooding events, overflow from Lake Owhareiti near Pakaraka was eroding a valley through farmland, which was about six metres wide and 50 metres long, and flooding a private road to Lakeland subdivision, off Ludbrook Rd. The Northland Regional Council needed about \$50,000 to lay pipes for a water outlet at the lake.</p>	<p><u>Northland Region Overall</u> School closed early in Northland: 27 Highway road damages (26th-27th July and 29th July-1st August events) : \$10 million Highway network damages (29th July event): between \$1 million and \$2 million</p> <p><u>Far North District</u> Road damages : around \$6 million. House without power: 400</p> <p><u>Whangarei District</u> Damages to the area: bout \$2 million ( About \$2.5 million, including government subsidies, was diverted for storm repairs, leaving the Whangarei District Council short of cash for regular maintenance.) House without power: 500</p>	<p>Surface flooding - Several northland's schools closed early Landslide at Dargaville - Fulton Hogan workers had been clearing a small slip there on the 30th when the rest of the bank gave way, closing the road.</p>
2008	North Island and West Coast Flooding	29-Apr	1-May		<p>Storm On the 29th, a deep low pressure system and associated trough approached New Zealand from the west. A warm front moved onto the Far North in the evening, while a larger cold front moved in from the west overnight. The combination of the systems resulted in thunderstorms in the north of the North Island, with some heavy downpours. The hills and coastal areas north-east of Whangarei and parts of central Northland took most of the heavy bursts of rain on the 29th. Rain was especially heavy in the eastern hills of Northland.</p>	<p><u>Whangarei District</u> Overall Northland - large pools of water were visible on some farms Flooding at Helena Bay, Otonga, and Russell</p>		<p><b>Evacuation</b> - Northland firefighters attended flood calls every four minutes between 11pm and 12am, as well as attending slips, motorists stranded in flood waters and numerous houses and garages filled with water.</p>

2007	Northland Floods	28-Mar	29-Mar	July : 1% (1:100 year) March: 1:50 year to 1:150 year (Similar like flood in 1981)	<p>1. Storm The storm caused by a depression moving southeast from the north Tasman Sea towards the North Island coast and encountering a blocking high pressure system to the east of the country. In 2007, the storm was happened in March 28-29 and July 9-10. The storm damaging the northland specially in the Kaeo township area.</p> <p>2. Mitigation and Preparedness In March 2007 flooding event, weather forecasting models did not foresee the intensity of rainfall that occurred. Many residents were caught unawares and serious losses occurred. These losses were mainly due to the landslides and overwhelming of low-level flood protection schemes designed for 1/5 year to 1/20 year events. Such low level protection schemes create a false sense of security.</p> <p>3. Whangarei District Emergency -Whangarei coastal storm CDEM declared state of emergency for 3 days after the storm (10-13 July 2007)</p> <p>4. Far North District There is a flood avoidance and mitigation plan for this area but it does not appear to have been adopted by the local community. a. Kaeo flood management - Kaeo township has a flood protection scheme designed to give ~1/20 year protection. However, Kaeo flood scheme was overwhelmed by floodwaters. b. The Maungapareua River - experienced the second highest flood in 40 years of record. Prediction of accurate levels is difficult because the Kerikeri Basin bridge acts as a flood restriction. Low vent at high tide levels. Fortunately the water level did not reach the bridge.</p>	<p>1. Whangarei District a. Hikurangi Swamp area - 5000 ha of farmland was inundated, many farmers' flood reserve' pastures were also inundated. b. Whangarei city area - Evacuation was conducted by the Whangarei CD before the Whangarei Valley Dam was filling with floodwater and avoid gridlocked cars when the floods coming to the city. c. Waipu -</p> <p>2. Far North District a. Landslide - unstable hill slopes and inundation caused serious damages to the area. Many of the recent hill slope failures were re-initiated old slips. Slope failure on the houses that being built "on the edge" of steep slopes because of the views. b. Properties at Watangirau - Several households in the Matangirau area (Matangirau School Road) have been displaced because of flooding from the Touwai Stream (local community did not appear to follow the flood mitigation plan). c. Kerikeri - In South of Kerikeri, the floods inundated the Lily Pond Farm Park at Puketona and the Haruru Falls Resort (The eventual water level reached sink bench level in the house). d. Kaeo Township - The resulting floods inundated dwellings and commercial buildings, particularly in the township, including the school, and downstream along SH10, Dip Road and the Waikoura flats. The township was inundated both by fast flowing water from the Waikara Creek which runs under SH10, then by much deeper flood water from the Kaeo river. The flood depth on SH10 through Kaeo was approximately a metre deep.</p>	<p>1. Far North District <b>Kaeo township</b> Major Affected Areas: Kaeo, Kerikeri, haruru falls, Waitangi, Paihia, Russell, Opuia, and Kawakawa. Road Damages: \$20m Power cuts: 8,000 homes People stranded by slips and flooding: 264 Properties Affected by flooding: 228 Fire service callouts : 80 Emergency welfare centre: 62 people Water height in Kaeo chemist, High Street, Kaeo: 40 cm School closed at Kaeo (3days) : 1</p> <p><b>Bay of Island area</b> Insurance losses in the BOI: \$ 10m Heritage bypass construction: \$8.5m Kemp House &amp; Stone Store repairment (incl. damages from 1981 flood): \$1 m Vehicles trapped on SH10 towards Paihia: 200 Power cuts in Kerikeri and Opuia : 200 and 24 respectively Fire service callouts: 200 (Paihia) School Closed in Kerikeri: 5</p> <p>2. Whangarei District Lost Production to Hikurangi Swamp flood Scheme: \$20m Road Damages: \$4m Sewage flowed into Whangarei Harbour: 10,000 cubic metres Power cuts: 3,745 homes Young stock &amp; dairy cows lost on one farm: 170</p>	<p>1. <b>Collaboration : Central Government Support</b> In November 2008, following the March and July 2007 floods, Central Government offered to provide funding support for the most vulnerable flood affected properties in Kaeo, contingent on the following: a. Assistance for Kaeo in the long term flood risk mitigation plan by the Northland Regional Council. b. The cost of relocating or raising vulnerable houses should be split four ways between the Northland Regional Council, Far North District Council, the home owners and the government. c. The government's one quarter share towards these costs would be capped at \$500,000 (GST exclusive)</p> <p>2. <b>Northland Regional Council</b> a. NRC had commenced work towards the development of a flood risk reduction strategy for Kaeo. b. Maintenance of the river channel and floodplain and development of a hydrometric network and hydraulic model from which to assess the flood hazard, risk and components of a flood risk reduction strategy (in Far North District (Kaeo Area), Kaipara District (Kaihu river), and Whangarei District.</p> <p>3. <b>Far North District</b> <b>Kaeo</b> - local rugby clubrooms received support from the whole country as it raised funds to lift the clubrooms off the ground to minimise the risk of damage from further flooding</p> <p>4. <b>Whangarei District</b> <b>Hikurangi Swamp</b> - NIWA on their reports stated that future damage could be</p>
2006	Northland Floods	April	May		Northland experienced a very wet April, with rainfall amounts well above average. Rain fell, on average, over 22 days during April, with heavy rain recorded early, mid and late April. Typically river flows were significantly above their normal April flows.	Serious flooding resulted at Rangiahua where flood waters crossed SH1. Kaeo Township was also affected by flood waters from the Kaeo River extending over SH10 at Kaeo. Flood warnings were issued for the Mangakahia, Wairua and Northern Wairoa River catchments.	River flood protection and spillway need some works	From 27 April to 2 May the MetService issued a series of severe weather watches and warnings for Northland (including the greater part of the North Island). These warnings were issued as a result of a large, deep depression which had remained relatively stationary in the mid Tasman Sea. A series of fronts accompanied with moist, warm air was expected to generate intense thunderstorm activity as this depression moved across New Zealand. These events were closely monitored while each front moved over Northland.
2005								
2004					Ex-tropical Cyclone Ivy brought high rainfall, flooding and high winds to much of the North Island.	Some surface flooding happened in Kaikohe. Significant flooding occurred in Northland due to Ex-tropical Cyclone Ivy. Kaitiaki were highly affected.		
2003	Northland floods	27-Mar-03	28-Mar-03		Heavy rain brought flooding to parts of Northland. People were evacuated in Kaitiaki. One man was killed after being electrocuted by a fallen powerline and another man got hypothermia after he was swept away by flood waters.	<p>Far North District At Kaitiaki, about 60 people were evacuated from 26 homes on Rongopai Place and Bank Street on the 28th, after the Awanui River overflowed.</p> <p>There was a lot of surface flooding in Kaeo. Flood waters covered the main road through the town and closed the schools.</p> <p>Whangarei district Raw sewage spilt into an alleyway in central Whangarei on the 28th after heavy rain overloaded the sewerage system. There were flood waters across Loop Road on the 28th at Otaika.</p>	More than \$250,000 (\$295,000 2008 dollars) of damage was done to roads.	
2002	Upper North Island Weather Bomb	18-Jun-02	21-Jun-02	1:150 years	A weather bomb brought heavy rain, flooding and high winds and high seas to much of the upper North Island.			
2001	Northland flooding and Ex-tropical Cyclone Sose	1-Dec-01	2-Dec-01		High rainfall occurred throughout Northland on the 1st and 2nd. The heaviest falls were over the Waimea, Tutamoe and Mangamuka Ranges and in Kerikeri and Kaeo.	Three state highways - SH12, SH1 and SH10 - were closed in different places on the night of the 2nd. Numerous smaller roads throughout the Far North were closed or under water. A back road between Whangarei and Kaikohe had surface flooding.		
2000	Northland flooding	3-Nov	5-Nov		<p>Rainfalls Awanui: 205mm/24hrs (return period 150 years)</p> <p>Convection was again the main culprit when a downpour struck Awanui, just north of Kaitiaki.</p>	<p>Far North District Homes were evacuated, schools and roads closed, and a bridge washed away.</p> <p>Whangarei District State Highway 1 at Whakapara was flooded when the Whakapara River overflowed on the night of the 4th. The road was closed overnight on the 4th and one lane reopened at about 9am on the 5th. 26 people had to be rescued after 13 vehicles became trapped by the flood waters at about 10pm. 24 people spent the night at the Hikurangi Fire Station. An elderly woman and her daughter were taken to hospital with moderate injuries after a van began to sink in flood waters on SH1 at Whakapara. The van appeared to have floated into the deepest water, and sunk out of sight. The water was about 2 m deep over the road. Farmland on the southbound side on the highway was flooded after the flood waters became trapped between a railway line embankment parallel to the northbound lane. The flood waters were well over fences on the 5th. A farmer who had lived in the area all his life said the flooding was some of the worst he had seen.</p>		
1999	Northland Far North District Flood/ HOKIANGA AREA DEVASTATED	21-Jan	22-Jan		<p>Rainfalls Panguru: 100mm/3hrs (return period over 150 years) Bayly's Beach: 90mm/2hrs (return period over 150 years) Omapere: 120mm/5hrs (return period over 150years)</p> <p>State of Emergency: 22 Jan 1999 to 10 Feb 1999 Declared at 0858; DRC appointed.</p>	Homes were washed away in the small towns of Pawaranga, Panguru and Omapere after walls of water and logs swept down the valleys. Impact in Hokianga area: 4 communities severely affected; 270 people evacuated; 80 in emergency accommodation; 96 sections damaged; 75 houses damaged; 3 houses destroyed. Est. cost impact \$4.3m		

1997	HOUSES, SHOPS FLOODED IN KERIKERI AND KAEO	30-Jun	30-Jun	<p><u>Rainfalls</u>  Brynderwyn Hills: 310mm/24 hrs (return period over 150 years)  incl 96mm/1hr (return period over 150 years)  and 165mm/2hrs (return period well over 150 years)  Maungaturoto: 268mm/24hrs (return period over 150 years)  Purerua: 131mm/7hrs to 4pm (return period 80 years)  Convection flared up on a front as it moved southwards over Northland.</p>	<p>Flooding in Kerikeri and Kaeo, many roads, including State Highway 1, were closed by slips.  Deaths: Two  Evacuations: Hundreds</p>		
1988	CYCLONE BOLA (North Kaipara)	10-Mar	13-Mar		<p>2 deaths. Northland insurance losses were \$3.72m (1991) excluding EQC</p>		
1981	Kerikeri Flashflood / KEMP HOUSE FLOODED	19-Mar	20-Mar	<p><u>Rainfalls</u>  F. Hunt: 448mm/9.5hrs (return period well over 150 years)  incl 174mm/2.5 hrs (return period well over 150 years)</p>	<p>(1 death). Insurance claims (excluding EQC) were \$5m (1994)  A massive flood struck the Kerikeri area, and New Zealand's oldest house, Kemp House, was inundated to ground floor window-sill level. The Waipapa Flats were completely covered with water, and in the Waipapa Landing area a house was completely washed away. Fifty boats were torn from their moorings. Most of the river valleys at the northern end of Kerikeri were scoured, and the vegetation along their banks totally cleaned out.  Destroying the flood recorder in Whangarei  Damaged historical properties: Stone Store (1819), Kerikeri mission house (1822)</p>		
1975	LOCALISED STORM SOUTHEAST OF WHANGAREI	30-May	30-May	<p><u>Rainfalls</u>  Ngunguru: 145.5mm/8hrs to 3pm 30th. (return period 30 years)  Matapouri: 277mm/24hrs (return period over 150 years)</p>	<p><u>Total Damage</u>  Damage: \$150,000.  2012 Dollars: 1.4 million  <u>Property</u>  The most severe damage was restricted to an area of only 60 sq km, although considerable damage was caused over an area of 230 sq km. Two houses were demolished by slips, and six houses were flooded. There were also some stock losses.</p>		
1974	KAEO – OKAIHAU STORM	22-Feb	23-Feb	<p>The two-hour rainfall recorded at Paitu (near Kaeo) between 9am and 11am was a huge 134.3mm. Total rainfall for the two-day duration of the event exceeded 350mm.</p>	<p>One bridge was lost, rivers overflowed their banks, and many fences were flattened</p>		
1973	Whangarei Hikurangi flooding	16-Jul	16-Jul		<p>Whangarei and Hikurangi flooding</p>		
1971	SEVERE ELECTRICALSTORMS AFFECT TAIPUHA AND WHANGAREI HEADS	18-Apr	19-Apr	<p>The maximum rainfall within Taipuha area was estimated at 250mm, and this fell in the two and a half hours to 10pm 18th. This is 2.59 times the 150- year return period rainfall, and would place this storm at number three in the hierarchy (see Appendix 1).  The rainfall at Whangarei Heads was estimated at 230mm in the five and a half hours to 2.30am on the 19th. This is also a well over 150-year return period rainfall.</p>	<p>Major slipping occurred on hillsides, with roads damaged. Buildings were damaged and paddocks flooded.</p>		
1968	Ex tropical cyclone giselle	9-Apr		<p><u>Caused</u>  Ex-tropical Cyclone Giselle reached Cape Reinga early on the morning of the 9th.</p>	<p><u>Infrastructure</u>  Three main highways were closed on the 9th. All roads to the Far North were affected by slips, subsidence or flooding.  The Whangarei-Kaeo highway (State Highways 1 and 10) and the Whangarei-Kaikohu highway (State Highways 1 and 12) were flooded on the 9th.  <u>Property</u>  heavy rain and strong winds caused damage to many homes, buildings and farms. Thousands of hectares of farmland were flooded. Hundreds of stock were drowned.  The Awanui River at the School Cut reached a gauge height of 8.108 m on the 10th. Three pleasure launches and one barge were thrown ashore and destroyed in the Bay of Islands.  <u>Far North District</u>  <b>Cape Reinga</b> : property damaged because of the strong winds  <b>kaitaia</b>: Homes in Kaitaia were surrounded by flood waters. Floodwaters caused sewers to overflow gully traps. Kaitaia was cut off by slips and flooded roads. A farmer was killed after being blown off a haystack in Kaitaia.  <b>Mangamuka Gorge</b> : State Highway 1 through Mangamuka Gorge was covered by flood waters in two places. Mangamuka Gorge was blocked by 30 landslips.  <b>ninety-mile beach</b>: Two busloads of tourists were left stranded on Ninety Mile Beach  <b>Selwyn flat</b>: The Selwyn Swamp at Big Flat Road reached a gauge height of 0.863 m on the 10th.  <b>Te Kao</b>: Houses were inundated at Te Kao.  <u>Kaipara District</u>  <b>Dargaville</b>: A large garage housing a tractor, a truck and car disintegrated at the height of the storm.</p>	<p><u>The damage in Kaitaia and Dargaville</u>: was estimated at \$150,000 (\$2,260,000 2008 dollars).  <u>Road</u> : The Ministry of Works believed that road damage in Northland would total \$150,000 (\$2,260,000 2008 dollars).  Casualties : 1 (kaitaia)</p>	<p>1. disaster waste management in actions to identify and removing the flooding waste like mud, sands, trees, garbages, building materias, and other waste.</p>
1948	Northland and Auckland Storm	19-Jul	19-Jul		<p><u>Far North District</u>  <b>Infrastructure</b> - Serious floods occurred in parts of the Far North. Slips blocked the highway in the Mangamuka Gorge.  <b>Property</b> - The business and central residential area of Russell was flooded. More than 1000 acres (4.05 km*2) were flooded.  <u>Kaipara District</u>  <b>Infrastructure</b> - The Dargaville-Opononi road was flooded  <u>Whangarei District</u>  <b>Infrastructure</b> - All main roads north of Whangarei were blocked by slips and flooding (Little damage was done to roads). Minor slips occurred on the main road south of Whangarei.  Riponui Road - flooded up to 18 in (46 cm) deep in some places.  Purua district - The floods in the Purua district were the heaviest residents could remember.  Marua Road - covered with water in several places.  <b>Low-lying parts</b> - in the northern end of Whangarei became miniature reservoirs. A large area of the Hikurangi swamp was flooded, with hundreds of acres under water.</p>		

1936	THE '36 CYCLONE	1-Feb	2-Feb	<p><u>Rainfalls</u> Northland: Whangarei 290mm/24hrs (return period over 150 years) Russell 301mm/24hrs (return period over 150 years) Warkworth 275mm/24hrs (return period 120 years)</p> <p>An ex-tropical cyclone caused widespread devastation across a large part of the country. The centre passed just west of Northland and Auckland, then veered southeast to cross the central North Island, emerging near Napier.</p>	<p>In parts of Auckland there were floods of record proportions, and Whangarei was flooded to depths of up to a metre. Napier was isolated by floodwaters. There was also extensive flooding in Whanganui, Manawatu and Wairarapa.</p> <p><b>Kaitaia</b> - The Mangakahia River in Northland rose 19 metres at Titoki. Kaitaia main-street was flooded a metre deep</p> <p><b>Whangerei</b> (almost 300 mm of rain fell in 24 hours) - Floodwater ran through the business district tearing up footpaths and entering buildings.</p> <p><b>Whakapara</b> - The railway bridge at Whakapara 25 kilometres north of Whangerei was destroyed, stopping rail traffic for days.</p> <p><b>The Wanganui River</b> - inundated thousands of acres of farmland, entered a number of houses, and carried away two spans of the Shell Oil Company's wharf. The Okehu water pipeline was cut leaving the city with only one days supply.</p> <p>In one valley north of <b>Kaukapakapa</b> floodwater was so deep a house was inundated so that only its chimneys were visible. The public works settlement at <b>Tangowahine</b> was flooded.</p>		<p><b>Whangerei</b> - Gellignite was used in an unsuccessful attempt to clear driftwood piled up against Victoria Bridge, which carried the road to Whangerei Heads, where several cottages were blown down.</p>
1917	PROLONGED PERIOD OF WET WEATHER	26-Jan	6-Feb	<p><u>Rainfalls</u> Taheke: 231mm/24hr (return period over 150 years)</p> <p>A 10-day period of wet weather included the large 24-hour rainfall of 231mm in 24 hours at Taheke on the 2nd February.</p>	<p>Most bridges in Northland were swept away.</p> <p>A blocking high near the Chatham Islands maintained a long period of moist northeasterlies over the northern North Island, culminating in the passage of a front.</p>		

Summary	1917,1920, 1934,1981	<p><u>storm</u> Decadal-scale variations in El Niño Southern Oscillation patterns suggest that in Northland the period 1978-1999 may have been relatively quiescent and that the post-1999 years may be experiencing severe weather and floods that are more similar to patterns experienced in 1947-1977.</p> <p><u>river flooding</u> River flooding caused by localised heavy rain/thunderstorms provides the highest risk to the Northland region, closely followed by storm with widespread heavy rain and wind. The region's road network has proven particularly vulnerable to damage in many recent events, with full recovery from the more significant events taking months to years.</p> <p><u>Urbanisation in floodplain area</u> the increment of dwellings on the floodplains area creates inundation. This could be caused of this following reasons: 1. Settlements originally developed alongside rivers which provided transport access 2. Roads tended to be built along the river valleys and people built near the road. 3. Building costs are lower on flatter sites. 4. General population drift has shifted more people northwards. 5. Maori have been moving back to their ancestral lands. Maori originally used the floodplains for gardens and lived on the hills. Now the only land they can claim connection to (e.g. for security against a loan) is what was their part of the communal garden.</p> <p>Properties - the floods have had more enduring effects for the owners of flood affected property, especially in terms of loss in property value, difficulty of selling property, and in some cases obtaining insurance cover. Even where properties have been raised, potential issues remain given anticipated loss of access to dwellings, and ground level damage, in times of flood.</p> <p>risk perception - since communities rely on the council informations, the engagement depends on the exposure of the certain community to such informations, the engagement oalso depends on how well the council reach each communities. different perceptions creates different actions during the disaster.</p> <p>1. the damages cause of flooding more predictable in the recent years. 2. insurance cover most of the properties in the flood risk areas 3. the typical damages can be predicted in the certain locations. For example, hokurangi swamps - if riverbanks bursts the main issue will be how to recover the soil and the cultivations. and in kaoo will be property that get flooded then the action more into streghthening the structure of the houses and availability to the fresh water.</p> <p>overall immediate action plan will be executed by the local council (CDEM ), the scope of the responsibility will be as written in the Acts. For the major events CDEM lead the action on structure however for the minor events, local community leader might go into the actions (clean up after the flood, road cleanup, trash pick-ups) insurances company will work into the scenario for the affected community to claim. for community without insurance, options might follow.</p>					
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Recovery	Legislatives	Links and References	Comments	Summary	Theme
<p><b>Flood mitigation project</b> - Court said there was now impetus to make the flood mitigation project in place before the next severe rain event.</p> <p><b>Collaboration</b> - The Insurance Council of New Zealand (ICNZ) and the Earthquake Commission (EQC) are working together to assist Northlanders in recovery efforts following severe weather and flooding last July.</p> <p><b>Far North District</b></p> <p><b>Moerewa</b> - Council had a major stormwater project ready to be built which would have helped reduce flooding in the Moerewa as the worst hit area.</p> <p>Kawakawa: NZTA SH1/SH11 Kawakawa intersection improvements, roadworks for \$6m</p>	<p>1. National Civil Defence Emergency Management Plan 2006 : If a major flood damages critical flood defence infrastructure, then central government will also meet up to 60 percent of the asset's repair cost, once damages reach a certain threshold</p> <p>2. Long Term Plan 2018-2048: application for flood protection and control works infrastructure as required under the Local Government Act 2002, section 101B</p>		<p>1. Infrastructure damages was the accumulation of the current flood hazard and the previous damages.</p> <p>2. Whangerei detention dam (Hopua te Nihotetea dam) plays significant role by rapidly capturing 400,000 cubic metres of floodwaters from the Raumanga Stream that otherwise would have swept through the city's CBD and parts of Morningside and Raumanga.</p> <p>3. In June, Awanui flood scheme improvements turned Far North paddock into vital new spillway. The works were just completed in July 1st, and working as flood spillway during the mid July storm.</p>	<p>1. The floods caused by the overflowing water from the riverbanks and happened after months of drought. Because dry, compacted soils mean that rainfall is less easily absorbed into the ground, it increasing the likelihood of flooding in the area if the sudden heavy rain/ storms happen</p> <p>2. Area affected were in Far North District and Whangerei district. The scenario at Whangerei had prevented the flood to come to the city even though the dam has reach its full capacity and not prepared for 500yr type of storm. however, the nearby land of raumanga river (farmlands) covered by water and the high flow of water hitting some roads.</p> <p>3. Flood damaged the waterplant</p>	<p>Drought to flood</p> <p>Overcapacity of flood prevention plan</p> <p>fresh water after flood</p>
<p>Taipa brigdes built because since 2017 the school has been close for more than 6 times due to flood. the flood water also always contaminate the pipe and the waterplant</p>					
<p><b>July 2018</b> - Northland Regional Council introduced a new regional Flood Infrastructure Rate, following public consultation on the Long Term Plan</p> <p><b>Awanui River</b> - Eight-year project is designed to boost flood protection significantly in and around Kaitiāia. Along with significant repairs, the scheme will be upgraded to handle bigger floods, enabling it to protect urban Kaitiāia in a 'once in a century' type flood and its surrounding areas in a 'one in 20-year flood'. \$15 million Awanui flood scheme upgrade. Flood risks will be mitigated via combination of improvements to stabilise stopbanks in the area, plus diversion of flow and works to mitigate the effect of the large, slow-moving Bell's Hill slip falling into the nearby Awanui River and causing flooding.</p> <p><b>The Panguru work</b> would involve building stopbanks and widening a stream channel to increase its capacity during floods.</p> <p><b>community</b> - flood donation events by the community</p>	<p>1. <b>Long Term Plan 2018-2048</b>, Infrastructure Strategy : Flood protection and control – Rautaki Hanganga</p> <p>Published in 26 June 2018, this strategy outlines how the regional council intends to manage its flood protection and control assets, and what the most likely scenario is for the management of these assets.</p> <p>2. <b>Northland Regional Council Long Term Plan 2018-2028</b> for Awanui flood scheme major programme of repairs and upgrades.(Refer to 1900, 1958, 2015)</p>	<p><a href="https://www.nrc.govt.nz/media/lvkh0hvo/infrastructure-strategy-2018-2048-flood-protection-and-control-rautaki-hanganga.pdf">https://www.nrc.govt.nz/media/lvkh0hvo/infrastructure-strategy-2018-2048-flood-protection-and-control-rautaki-hanganga.pdf</a></p> <p><a href="https://www.newstalkzb.co.nz/news/national/heavy-rain-shuts-highway-and-causes-flooding-in-northland/">https://www.newstalkzb.co.nz/news/national/heavy-rain-shuts-highway-and-causes-flooding-in-northland/</a></p>	<p>1. Hopua te Nihotetea dam worked well</p> <p>2. caused by climate change</p>	<p>1. overcapacity riverbanks Ruakaka river, and hikurangi swamp banks</p> <p>2. Slips and erosion happened in the highway between kaikataia and paihia</p>	<p>Soil erosion</p> <p>Infrastructure</p> <p>overcapacity riverbanks</p> <p>climate change</p>
<p><b>Kaero-Whangaroa flood scheme</b></p> <p>Western section of the main stopbank number two was topped up as settlement had been identified from a monitoring survey. (expected to exceed the 30-year timeframe before renewal is required)</p> <p><b>Whangerei District Council</b></p> <p>More than 100-metre long flood wall built in Woods Rd</p>	<p>1. preparation of 2018 LTP</p>	<p><a href="https://www.nzherald.co.nz/northern-advocate/news/article.cfm?c_id=1503450&amp;objectid=11880712">https://www.nzherald.co.nz/northern-advocate/news/article.cfm?c_id=1503450&amp;objectid=11880712</a></p>	<p>high wind- trees hitting the power source distributor</p>	<p>1. Kaero built in the flood plain and heavy rain in the area caused the flood every year.</p> <p>2. it is slow flood but the damage is recurring.</p> <p>3. damage to the dairy land- livestocks may be safe but the tools might rusty the wealthyness increase vunerability</p>	<p>flood plain flooding</p> <p>cutting the access</p> <p>affecting the productivity of kids but not parents</p>

<ol style="list-style-type: none"> <li>1. cleanup</li> <li>2. roadworks</li> <li>3. insurance claim</li> <li>4. community donations</li> </ol>	<p><b>1. River Management Guidelines ( 18 May 2017)</b> - These guidelines set out the river management responsibilities of landowners and Northland Regional Council.</p>	<p><a href="https://www.nrc.govt.nz/media/etij5pl5/river-managementguidelines.pdf">https://www.nrc.govt.nz/media/etij5pl5/river-managementguidelines.pdf</a></p>	<p>Insurance Claim - totalled \$ 61.7 m</p>	<p>Periods of heavy rainfall between 7 and 12 March bought an end to the drought conditions experienced throughout Northland from January. Due to this rain event, most areas in the region experienced rain in excess of 150% of the long-term median for March, with areas such as Aupouri Peninsula and Maungaturoto receiving over 400% of the long-term median. Groundwater systems have begun to increase in response to the wet conditions and soil moisture is above the mean for this time of year at all sites. creates surface flooding because the excessive groundwater when heavy rain occurred.</p>	<p>access problem - trapped family have to self evacuate effective warning but low risk awareness of some people</p>
<p><b>collaboration</b> CDEM plan to increased awareness of the risks of infrastructure failure may help to encourage businesses to have their own backups and become more resilient to these failures. In particular, the road network has suffered significant damage in past storm events and is vulnerable both in terms of land instability (slips) and flooding. Road access is critical for emergency services and other response agencies to carry out their functions and the resilience of the road network is a key issue for Northland. CDEM make an Integrated planning by all agencies with a role to play in recovering from emergencies</p>	<p>1. Northland Civil Defence Emergency Management Plan 2016 - 2021</p>	<p><a href="https://www.nzherald.co.nz/nz/flooding-as-big-wet-sets-in-around-northland/WOJ3QHVTWHIGS2KVTEOWLOEVRE/">https://www.nzherald.co.nz/nz/flooding-as-big-wet-sets-in-around-northland/WOJ3QHVTWHIGS2KVTEOWLOEVRE/</a></p>	<ol style="list-style-type: none"> <li>1. fast responses of firefighter</li> <li>2. reliable informations</li> <li>3. but low information for self-evacuation on the road for travellers</li> </ol>		<p>Slips flooded paddocks information about evacuation during travel</p>
<p>Whangarei District Council Improvement works to free up flows beneath a Rust Ave bridge Awanui flood maps development</p>	<ol style="list-style-type: none"> <li>1.</li> <li>2.</li> <li>3.</li> </ol>	<p>Headline: The Northland floods of July 2014. <a href="http://blog.metservice.com/2014/07/the-northland-floods-of-july-2014/">http://blog.metservice.com/2014/07/the-northland-floods-of-july-2014/</a></p>	<p>Insurance Claim - totalled \$ 18.8 m</p>		
<p><b>Whangarei detention dam (Hopua te Nihotetea dam)</b> - Constructed in 2014/15 to detain water for up to the 1:100 year flood with an allowance for climate change and freeboard.</p>	<ol style="list-style-type: none"> <li>1.</li> <li>2.</li> <li>3.</li> </ol>	<p>Headline: Rainfall swamps Northland. <a href="http://www.nzherald.co.nz">www.nzherald.co.nz</a>, 11 June 2014.</p>	<p>Insurance claims for the storm total \$29.8 million. (all NZ)</p>	<ol style="list-style-type: none"> <li>1. Both climatic and non-climatic factors have the potential to affect future flood losses.</li> <li>2. Detailed flood hazard maps and depth-damage curves can reduce the non-climatic factors.</li> </ol>	
<ol style="list-style-type: none"> <li>1.</li> <li>2.</li> <li>3.</li> </ol>	<ol style="list-style-type: none"> <li>1.</li> <li>2.</li> <li>3.</li> </ol>				
<p><b>Kāeo-Whangaroa flood scheme</b> - The Kāeo Stage One works were constructed in 2013/15</p>	<ol style="list-style-type: none"> <li>1. 2012 - 2022 Long term plan for Hikurangi Swamp</li> <li>2.</li> <li>3.</li> </ol>	<p>Headline: Water levels rising in Far North <a href="http://www.nzherald.co.nz">www.nzherald.co.nz</a>, 19 March 2012.</p>	<p>North Island: One major rural insurance company has received claims for about \$1 million.</p>		

	1. 2. 3.	Headline: Welfare shelters set up in Northland www.nzherald.co.nz, 29 January 2011	Insurance Claim - \$ 19.8 m (Northland and bay of plenty)		
	1. 2. 3.	1. Headline: Northland escapes the worst. www.northernadvocate.co.nz, 7 March 2009 2. Headline: Flood-prone Kaeo escapes serious damage. www.radionz.co.nz, 6 March 2009, 7:33am. 3. Headline: Northland residents on flood alert. www.stuff.co.nz, Source: NZPA, 5 March 2009, 10:42pm. 4. Headline: Storm brings flooding to Northland town. www.newstalkzb.co.nz, 28 February 2009, 8:08am. 5. Headline: Far North cleanup. www.newstalkzb.co.nz, 28 February 2009, 3:16pm. 6. Headline: Driver dies near Waipu. www.northernadvocate.co.nz, 28 February 2009. 7. Headline: Storm causes flap in tent town. www.northernadvocate.co.nz, 2 March 2009. 8. Headline: Plenty of water but few problems as storm hits Northland. www.nzherald.co.nz, Source: NZPA and weatherwatch.co.nz, 28 February 2009, 11:30am.	First flood on 27 February caused road slips causing casualties		
	1. 2. 3.				
	1. 2. 3.				

<p><b>Flood Risk Reduction Development</b></p> <p>The flood had fundamentally shifted the assessed flood risk for Kaeo area and East coast of Northland generally.</p> <ol style="list-style-type: none"> <li>Improved understanding and management of flood risk in terms of community and stakeholder engagement</li> <li>Reduce risk from smaller floods through the remedial of river works. These works have focused on maintaining the efficiency of the floodplain and river channel to convey floodwaters, and primarily involve the removal of accumulated sediment from the river channel and removal of flow obstructions from the floodplain.</li> <li>Informed decision-making for identify and assess risk</li> <li>Reduce risk from all floods, manage residual risk through flood warning and community response plan</li> <li>Reduce risk long term by protection works for highest risk dwellings located on the flood plain and developing the flood scheme works.</li> <li>Avoid creating future/ additional risk by developing Risk management policy</li> </ol>	<p><u>1. Interim Kaihu River Management Plan ( 2 July 2007) - recovery plan after flood in March 2007- Guidelines for managing the Kaihu River and its floodplain by landowners, residents and Northland councils.</u></p> <p><u>2. Utilising the principles of NZS9401:2008 'Managing Flood Risk - A Process Standard', a flood risk reduction strategy was developed for Kaeo. Development of the strategy was underpinned by the following key components:</u></p> <ol style="list-style-type: none"> <li>Community and stakeholder consultation and engagement through the strategy development process.</li> <li>Flood hazard assessment, undertaken through hydraulic modeling.</li> <li>Flood risk assessment, based on an assessment of the depth and velocity of flood water and the potential for damage to property and loss of life.</li> <li>Multi criteria analysis of flood risk reduction options, based on social, environmental, economic, cultural, technical criteria and degree of flood risk reduction, including scenario modeling of options where appropriate.</li> </ol>	<ol style="list-style-type: none"> <li>NIWA 2007 flood report</li> <li>City Design Ltd (1999), Auckland City Flood Hazard Mapping, Technical Specification</li> <li>Ministry of Environment (2008), the likely effects of projected climate change</li> <li>NRC (2005), Kaeo River Flood Management Plan</li> <li>FNDC (2007), Kaeo Storm Water Catchment Management Plan</li> <li>Westmount School (2007), Northland's devastating deluge</li> </ol>	<ol style="list-style-type: none"> <li>The response and recovery actions focus in the most affected area, Kaeo township. This devastation events creates a major movement in providing long term plan for flood management in Northland.</li> <li>The flood scheme works proposed for Kaeo are designed to reduce the depth and velocity of flood waters in the Kaeo Township, protect the schools, improve access to Kaeo during flood events and provides a defended site that enables for future development/relocation of dwellings and businesses.</li> <li>The area below Haruru Falls has had severe flooding in the past (1930s and 1950s) and minor flooding in 1981. In the March 2007 floods the Haruru Falls Resort suffered severe damages on two fronts. It was inundated by the river on its lower side and partially demolished by landslips on its uphill side. Some protection to this facility could be offered by retaining walls, flood walls and a flood warning system.</li> <li>There are some assesment for Awanui flood management scheme's performance during the flood and referred for the future improvement works.</li> <li>In Whangarei, The reservoir is not lowered in anticipation of floods because of previous false alarms and water shortages. This situation is not satisfactory and measures should be implemented to prevent a future disaster.</li> </ol>	<ol style="list-style-type: none"> <li>The rainfall intensities were more than double the forecast amounts and warnings did not prepare people for what eventuated.</li> <li>There is a pervasive distrust of the reliability of heavy rain forecasts in Northland. Many residents were caught unawares and serious losses occurred.</li> <li>Many landslides took place in locations where previous hillside failures had occurred. All floods took place in locations where previous floods had occurred.</li> <li>Whangarei City was saved from serious flooding by its water supply reservoir which was, by chance, partially full at the onset of the storm.</li> <li>Situation update and review should be conducted in all of the flood management plan that affected by the floods. Measures should be implemented to prevent a future disaster. The flood protection measures could either be structural flood defence works, provision of sufficient flood detention storage based on more reliable forecasting systems, or a combination of these.</li> <li>Maungaparuru River/ Kerikeri river flood protection finds it difficult to predict the actual water level in the kerikeri level because of the kerikeri basin bridge. Debris collect on the bridge and restrict its capacity to an unpredictable degree. Removal or raising of this bridge would help safeguard Kemp House and make flood levels more predictable. Flood detention basins could help reduce the flood peak levels.</li> <li>Research effort should be focussed on better warning systems, provision of realistic inundation and landslide hazard maps and incorporation of these into regional development plans.</li> </ol>	<p>Collaboration between agencies for responding to the flood</p>
<ol style="list-style-type: none"> <li></li> <li></li> <li></li> </ol>	<ol style="list-style-type: none"> <li></li> <li></li> <li></li> </ol>	<p><a href="https://www.nrc.govt.nz/media/x4cczoyc/hydrologv2.pdf">https://www.nrc.govt.nz/media/x4cczoyc/hydrologv2.pdf</a></p>			
		<p><a href="https://hwe.niwa.co.nz/event/February-March_2004_North_Island_Extropical_Cyclone_Ivy">https://hwe.niwa.co.nz/event/February-March_2004_North_Island_Extropical_Cyclone_Ivy</a></p>			
		<p><a href="https://hwe.niwa.co.nz/event/March_2003_Northland_Flooding">https://hwe.niwa.co.nz/event/March_2003_Northland_Flooding</a></p>			
		<p><a href="https://hwe.niwa.co.nz/event/June_2002_Upper_North_Island_Weather_Bomb">https://hwe.niwa.co.nz/event/June_2002_Upper_North_Island_Weather_Bomb</a></p>			
		<p><a href="https://hwe.niwa.co.nz/event/December_2001_Northland_Flooding">https://hwe.niwa.co.nz/event/December_2001_Northland_Flooding</a></p>			
<ol style="list-style-type: none"> <li></li> <li></li> <li></li> </ol>	<ol style="list-style-type: none"> <li></li> <li></li> <li></li> </ol>	<p><a href="https://hwe.niwa.co.nz/event/November_2000_Northland_and_Waikato_Flooding">https://hwe.niwa.co.nz/event/November_2000_Northland_and_Waikato_Flooding</a></p>			
<ol style="list-style-type: none"> <li></li> <li></li> <li></li> </ol>	<ol style="list-style-type: none"> <li></li> <li></li> <li></li> </ol>				

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			1. the events of cyclone giselle focus more into Wahine events. The ava		

	1. 2. 3.				
	1. 2. 3.				

Higher population densities mean that more people are now living in hazardous locations. Research effort should be focussed on better warning systems, provision and publicising of realistic inundation and landslide hazard maps and incorporation of these into regional development plans.

there are developments in the legislatives, but mainly the acts structurised based on the hieararchy of responsibility.

Overall, the responses can ve divided into two periode, fighting the flood and living with the flood ( how to be more resilience to the flood).



## Information Page

### Q1.1. Questionnaire survey: Using maps to explain flood hazard and climate change impacts

#### Project Information

Maps can be useful tools to empower communities towards informed decision-making as part of an overall flood risk management strategy. However, simply providing information to the public is not enough. At present, we do not know if the existed flood maps serve their purpose and how the availability of flood maps influences community decisions towards better flood protection.

This project is funded by Massey University. The project will identify the community understanding of flood management programs, flood maps, and flood protection measures based on existing hazard risk information.

#### Survey invitation

You are invited to participate in this questionnaire survey on using flood maps to communicate flood hazards and climate change impacts.

#### Survey procedure

The questionnaire is structured into four main sections related to your background, understanding, benefits and concerns about using maps as hazard risk communication tools.

#### Ethics Notification

This project has been evaluated by peer review and considered to be low risk. Consequently, it has not been reviewed by the University's Human Ethics Committees. The researcher named below is responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researchers, please contact Prof Craig Johnson, Director, Research Ethics, telephone (06)356 9099 x 85271, email: [humanethics@massey.ac.nz](mailto:humanethics@massey.ac.nz)

### Q1.2. Statement of Consent

This is an anonymous questionnaire that has been designed to ensure that individual participants are not identifiable. Your participation is entirely voluntary. You may decline to answer any questions. By choosing the consent below, you have given consent to participate in this study and the subsequent reports and publications. All the collected data from this questionnaire will be stored securely in the Massey University data repository and can only be accessed by the relevant researchers.

If you have any questions, please contact:

Researcher: Widi Auliagisni, PhD student

School of Built Environment

Email: [WAuliagisni@massey.ac.nz](mailto:WAuliagisni@massey.ac.nz)

Phone: +64 [REDACTED]

Supervisor 1: Prof Suzanne Wilkinson

School of Built Environment

Email: [S.Wilkinson@massey.ac.nz](mailto:SWilkinson@massey.ac.nz)

Supervisor 2: Dr Mohamed ElkhARBoutly

School of Built Environment

Email: [MElkhARBoutly@massey.ac.nz](mailto:MElkhARBoutly@massey.ac.nz)

- I have read the information sheet and consent to participate the study
- I do not consent, I do not wish to participate

## Demographic

### Q2. Demographic and household information

*Note: The information you provide us will be kept confidential. We will only look at correlations between demographic information and people's views on flood risk issues. Information about individual households will not be released to anybody outside this research project.*

Q2.1. In which district do you currently live?

- Whāngārei District (Please specify, e.g. Whāngārei CBD)
- Kaipara District (Please specify, e.g. Dargaville)
- Far North (Please specify, e.g. Kaitāia)

Q2.2. What is your profession?

- Please specify (e.g. student, teacher, farmer, engineer, etc.)
- I prefer not to answer

Q2.3. How well do your household speak Te Reo?

- Native Speaker / Proficient
- Advanced
- Intermediate
- Beginner
- Not applicable

Q2.4. How well do your household speak English?

- Native Speaker / Proficient
- Advanced
- Intermediate
- Beginner
- Not applicable

## Flood Impacts

Q3. **Overall Flood Impacts**

*This section asks about flood events that have occurred in Northland from 2010 onwards, and the impacts those events have (or haven't) had on you.*

Q3.1.

When was the biggest past flood event that you are aware of that directly affected your property? (Please give details)

- Approximate date: (e.g. July 2019, June 2020 flood)
- I do not know of any events that have affected my property

Q3.2. Has anyone in your household suffered an ongoing injury or illness due to past flood events?

- No
- Yes - please give details including which flood:

Q3.3. What best describes your property affected by a flood incident? (Select all that apply)

- House
- Farm
- Workshop
- Equipment
- Others

Q3.4. Has the flood damaged property been repaired?

- Ongoing
- Not yet repaired
- Repaired

Q3.5. Did the flood affect the property price?

- Yes, price increased
- Yes, price decreased
- No, stayed the same
- Do not know

## Flood Insurance

### Q4. Flood Insurance

*We want to know about your experience regarding flood insurance*

Q4.1.

Do you have flood insurance?

- Yes
- No
- Do not know

Q4.2. With regard to insurance, which of the following statements are correct in your case? (Select all that apply)

- My insurance did not cover the losses I expected it to

- EQC (Earthquake Commission) has settled my claim
- My insurance company has settled my claim
- My insurance excess has gone up since the event because of increased flood risk
- I have found it difficult to get insurance cover since the event
- I cannot afford insurance cover

## Community view on flood risk management measures

### Q5. Community effects of flood events and flood risk management measures

*Community participation is significant in flood risk management. We want to know about your community responses to the recent flood events*

Q5.1.

Did you find the community response to the previous flood incident satisfactory?

- Agree – why?
- Disagree – why?

Q5.2. Have flood risk management measures (such as works to strengthen stop banks) been implemented in your flood risk area?

- Yes – which one?
- No – why?
- Do not know

Q5.3. What level of flood risk is your property exposed to?

- High (10 year Flood Extent)
- Intermediate (50 year Flood Extent)
- Low (100 year Flood Extent)
- Do not know

## Flood Maps Knowledge

### Q6. Flood maps

*Flood maps are exists to increase community preparedness. We want to know if the flood maps are useful to inform the flood risks.*

Q6.1.

Have you (within the last year) checked the location of your property on a flood hazard map?

- Yes
- Yes, but longer than a year ago
- No

Q6.2. Where would you access flood maps? (Select all that apply)

- Northland Regional Council Website
- Community Group Platform
- District Council Websites
- School
- Insurance company
- Property showroom
- Other (Please specify)

Q6.3. How useful do you think flood hazard maps are to inform you about flood risk?

- Very useful
- Somewhat useful
- Not at all useful

## Experience

### Q7. Experience in Using flood maps

*Flood maps are accessible for the public, however, we want to know about your experience when using flood maps*

Q7.1. Have you ever use flood maps?

- Yes
- No

Q7.2. What is your experience when you used the flood maps?

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
The maps are easy to access (Website, News, Community Board posters)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The maps are easy to follow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The language is understandable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The features in the flood maps are easy to understand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The design of the flood maps is easy to understand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In the flood maps, I can easily locate my property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The risk to my property of flood hazards after using the maps became obvious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q7.3. After you used flood maps, did you change behaviour?

	Extremely unlikely	Somewhat unlikely	Neither likely nor unlikely	Somewhat likely	Extremely likely
I bought/ considered buying the insurance after knowing my property was prone to flood	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I protected the property by waterproofing, elevated the floor, or repaired the structure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was thinking of moving to another place with less/no risk of flood	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I educated myself about flood preparedness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I got ready and knew what to do if my property got flooded	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I informed others (e.g. family, relatives, or friends) if I knew their property was at risk of flood	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Point Forward**

Q8.

## Actions for the future flood

*Councils are providing measures and action plans to reduce the impacts of future floods. We want to know your opinion.*

Q8.1.

Do you know what the council has planned to reduce flood risk?

- Yes  
 No

Q8.2. Which of the following do you agree are best options?  
(Select all that apply)

- Raising stop banks  
 Deepening river channels (e.g. digging)  
 Improving the stormwater network  
 Relocating houses away from high-risk areas  
 Increasing buffers like natural areas and ponds  
 Give earlier warnings and improve evacuation plans  
 Modify buildings (e.g. raise floor levels and utility services)  
 Restrict new buildings or renovations in areas with high flood risk  
 Nothing needs to be done; I don't believe that flood risk will increase sufficiently to present any cause for concern

Q8.3. Please indicate whose responsibility you believe it is to reduce flood risk.

- Central government  
 Northland Regional Council  
 District Council  
 Community Groups  
 Individual household  
 Nobody; I do not believe that flood risk will increase

## Community preparedness

Q9. **Community participation and preparedness towards future flood**

*We want to know your opinion about community participation in flood protection measures.*

Q9.1. Please scale the extent to which you agree or disagree with each of the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Floods are too destructive to bother preparing for	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A serious flood is unlikely to occur during my lifetime	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is difficult to prepare for floods	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preparing for floods will significantly reduce damage to my home when a flood occur	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preparing for floods will improve my living conditions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preparing for floods will improve the value of my house/property	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q9.2. Thinking about how you participate in life in your community, please scale how often you undertake each of the following:

	Never	Sometimes	About half the time	Most of the time	Always
I have worked with others on something to improve community life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I participate in local activities or events (e.g., festivals, fetes, fairs)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have contributed money, food or clothing to local causes, charities, or to others in my community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have attended a public meeting on a community issue	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have been involved in volunteer activities intended to benefit my community (e.g., fundraising, clean-up days, local groups, Scouts/Brownies).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Gift cards**

Q10.1. Enter your email to win one of ten \$20 supermarket gift cards (winner emailed by 1 July 2021)

Q10.2. Do you want to participate for further flood research

Yes (please provide phone/email if have not stated in the Q10.1)

No

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Day	Location	Time	
Monday, 7 June	Albany - Whangarei via Waipu - Ruakaka	8:00 am	11:00 am
	<i>Lunch</i>	<i>11:00 am</i>	
	<i>Whangarei Library</i>	<i>1:00 am</i>	<i>5:00 am</i>
Tuesday, 8 June	NRC meeting	9:00 am	10:00 am
	WDC Meeting	10:00 am	11:00 am
	Ngunguru - Tutukaka - Matapouri	1:00 pm	6:00 pm
	<b>Accommodation in Whangarei</b>	<b>7:00 pm</b>	
Wednesday, 9 June	Whangarei - Kawakawa - Paihia	8:00 am	9:00 am
	Kawakawa library	9:00 am	12:00 am
	Paihia library	1:00 pm	5:00 pm
	<b>Paihia/ kerikeri hotel</b>	<b>6:00 pm</b>	
Thursday, 10 June	Kerikeri library / FNDC	<i>8:30 am</i>	<i>12:00 pm</i>
	Kerikeri - kaeo	<i>12:00 pm</i>	1:00 pm
	Kaeo Library	1:00 pm	4:00 pm
	Kaeo - Mangonui - Kaitaia	4:00 pm	6:00 pm
	<b>Kaitaia hotel</b>	<b>7:00 pm</b>	
	Friday, 11 June	Kaitaia Library	8:00 am
Kaitaia - Dargaville		5:00 pm	8:00 pm
<b>Dargaville hotel</b>		<b>8:00 pm</b>	
Saturday, 12 June	Dargaville library	9:30 am	12:30 pm
	Ruawai community	12:30 pm	5:00 pm
	<b>Dargaville hotel</b>	<b>6:00 pm</b>	
Sunday, 13 June	Dargaville - Managwhai	9:00 am	11:00 am
	Mangawhai Library	11:00 am	3:00 pm
	Mangawhai - Albany	3:00 pm	4:30 pm
	Albany	5:00 pm	

<b>Activities</b>
Travel time Intercity (1 hr 45 min)
<i>lunch</i>
Survey/Interview community
Meeting / Interview
Meeting / Interview
Travel time (30 min), observation
<b>Accomodation</b>
Travel time (1 hr), observation
Meeting / Interview
Survey/Interview community
<b>Accomodation</b>
Survey/Interview community
Travel time (30 min), observation
Survey/Interview community
Travel time (1 hr 20 min), observation
<b>Accomodation</b>
Survey/Interview community
Travel time (3 hr)
<b>Accomodation</b>
Survey/Interview community
Observation
<b>Accomodation</b>
Travel time (1 hr 30 min)
Survey/Interview community
Travel time (1 hr 30 min)

**Taumarere Flood Management Working  
Group**  
**Friday 6 August 2021 at 10.00am**

**AGENDA**

**Kaihū River Working Group**  
**Friday 13 August 2021 at 10am-12pm**

# **AGENDA**

**Kerikeri-Waipapa River Working Group**  
**Friday 15 October 2021 at 10.00am**

# **AGENDA**

The Objectives	Key Action	What has been done	Finding during the flood / how does it work during the flood
<p>• Identify and understand risk scenarios (including the components of hazard, exposure, vulnerability, and capacity), and use this knowledge to inform decision-making.</p> <p><b>Readiness</b></p>	<p>How: identify the risk/ understand the component of risk</p> <p>Goals: Informed decision making</p>	<p>The regional council referred to the central government guidelines.</p> <p>Developing Community Solution Plan</p>	<p>Risk communication is not reaching to all element of society.</p> <p>There are two things happened during flood readiness - a vertical and horizontal point of communication.</p> <p>1. A community representative get some news from the government or media - then contact other community leaders</p> <p>2. These community leaders then inform their community via phone, knocking on doors, community meeting, and Facebook group.</p> <p>Issues: Not many mentioned about the communication line from government that goes directly to the individual. Only some part of community were included on the meeting - majority has good educational/ expertise background Indirect communication - missed in translation/ different understanding from what the government intention.</p>
<p>Build risk awareness, risk literacy, and risk management capability, including the <b>ability to assess risk</b></p> <p><b>Readiness</b></p>	<p>Goals - community can assess the risk and manage capability to protect</p>	<p>Ability to asses the risk, mainly by provide the relevant information on the website. Some information provided during the community flood meeting.</p>	<p>This is still limited to the user benefited from the tools provided by the government. when the community asked on how do they know if they are safe from the flood, the answer is because it never flooded. However, in July 2020, the area suddenly flooded and the community are not prepared.</p>

<p>Understand the economic impact of disaster and disruption, and the need for investment in resilience; identify and develop financial mechanisms that support resilience activities</p>	<p>Economic impact of disaster, investment in resilience, financial mechanism</p>	<p>Flood rate</p>	<p>Majority not have flood insurance - struggle to recover</p>
<p><b>Readiness - for Recovery</b></p>	<p>Goal - steady economy to support resilience</p>	<p>Infrastructure funding for flood protection</p> <p>Insurance</p> <p>Aids scheme from central govt</p>	<p>Aids cannot covers - leaving in the unsuitable condition</p> <p>Sending discussed on the community meeting</p>

<ul style="list-style-type: none"> <li>Put in place organisational structures and identify necessary processes – including being informed by community perspectives – to understand and act on reducing risks</li> </ul> <p><b>Reduction</b></p>	<p>How: identify necessary processes – including being informed by community perspectives</p> <p>Goals: understand and act on reducing risks</p>	<p>Understand and act on reducing risk (informed by community perspective)</p> <p>Efforts to have catchment meetings involve community representatives, experts, and organisation representatives.</p> <p>This helps the government to understand different perspectives and different issues faced by the different elements of the community.</p>	<p>We found that not wide range of community involved on the flood meeting. In one of the meeting, community that lived very close to the where the meeting held they have no idea of what's going on.</p> <p>The community still strongly follow the leader over the government organisation, therefore it is necessary to make the leader and the government on the same page and be part of reduction plan.</p>
<p>Address gaps in risk reduction policy (particularly in the light of climate change adaptation)</p> <p><b>Reduction</b></p>	<p>How: assessing the current policy and compare to the situation</p> <p>Goal: address the gaps for risk reduction</p>	<p>The regional council refer to the standard guidelines xxx, the strategic plan, and the infrastructure plan.</p>	<p>Floodplain policy on the landuse plan are not widely discussed. It was found that many discussion gravitate towards protecting the houses/ property from flood by protecting the building - but not yet necesarilly on the large scale such as area base, where to develop and where not. Although the house protection is good and useful, it is dangeoruse if people take it as a long term activities as this is a recurring flood and based on the prediction ithe intensity and tyhe frequency is highere.</p>
<ul style="list-style-type: none"> <li>Ensure development and investment practices, particularly in the built and natural environments, are risk-aware, taking care not to create any unnecessary or unacceptable new risk.</li> </ul>	<p>How: development practise are risk aware</p>	<p>Strategic Plan that covers, lessons learned for improvement. However, this often too general.</p> <p>Flood recorded, data available to those who need - to what extend?</p>	<p>There are flood record but not easily accesses by the public, this one served case by case. There are HWE catalog record the wheather event impact (including flood) but this is not recent</p>

**Reduction - recovery  
(mitigate/prevention)**  
(The lessening or minimising of  
the adverse impacts of a  
hazardous event)

Goal: Not to create new risk

needed, but this is not recent.

What different/better/ How this research contribute	Recommendation Way forward
<p>Literature review on the flood risk scenario and point the gap and the regional vulnerability. Key point to address and to discuss further.</p>	<p>Conduct an annual survey of public perceptions of risk, resilience and preparedness.</p> <p>Direct line of communication source or if the information going from the representative, make sure that the representative present on the same line and include both parties of agree/ not agree. Get feedback and provide the representative from the government in the community meeting as well to provide explanation if required.</p> <p>Long term goal: communications on risk more relevant and easily accessible.</p>
<p>on our research talking communicating risk through maps discusses on what are the gaps for this to be effectively applied. It is found that many local community are still not included o the flood meeting therefore the information are not well distributes. This linked to the objective above as well.</p> <p>This flood meeting largely involve adult, however, we also need to build awareness on the younger generation - that they can bring home and applied</p>	<p>Provide the training/workshop or create events specifically for this, engage young people at school. Working with organisation like NZ redcross to spread awareness and facilitate volunteer / training.</p> <p>Often promote on the town / posters</p>

	More research encourage and facilitated on the Northland
Understanding on how community recover from flood - this can be lessons learned for preparation.	Encourage people to have insurance
Understand on infrastructure protection strategies	Encourage to protect the property
Way on decision to be more transparent - regarding investment on infrastructure.	Provide materials/ workshop on how the individual can protect their property  Transparency on budget - can be trough local news etc so people knows where their money goes.

<p>Comparing the government plan and what community experienced by investigation and site observation.</p> <p>This comparison resulted on the gap on:</p> <p>Information distribution</p> <p>Inclusion of wider community representative</p> <p>Point on different information intention - what government intention vs what community perceived</p>	<p>Community have a clear who is the community representative and who is the government rep for their community.</p>
<p>The issue was raised on the paper: why still build on floodplain? Highlighting the gap in policy and the 10 recommendation on how we can start developing a healthy floodplain and discourage people from building on it.</p> <p>And the overview of flood risk management policy in NZ provide the suggestion on the decision line</p>	<p>What is acceptable action to what degree need to be determined and regulated. Assess the 10 recommendation on how to stop building on floodplain.</p>
<p>We have identify the historical flood from 18xx to the flood caused by cyclone Gabrielle 2023.</p>	<p>Measurement tool, regional record update is necessary. Knowing where historical flood happen, current flood on flood maps, and prediction, and anomaly flood location are to be recorded as water flow will tell us</p>

referred to water. Now will refer to something.

## Widi Auliagisni

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**From:** widi auliagisni <widi.aulia@hotmail.com>  
**Sent:** Wednesday, 10 September 2025 9:25 pm  
**To:** Widi Auliagisni  
**Subject:** Fw: Human Ethics Notification - 4000024164

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**From:** humanethics@massey.ac.nz <humanethics@massey.ac.nz>  
**Sent:** Tuesday, March 30, 2021 10:33 AM  
**To:** WidiAuliagisni.Auliagisni.1@uni.massey.ac.nz <WidiAuliagisni.Auliagisni.1@uni.massey.ac.nz>; M.Elkhaboutly@massey.ac.nz <M.Elkhaboutly@massey.ac.nz>; S.Wilkinson@massey.ac.nz <S.Wilkinson@massey.ac.nz>  
**Cc:** humanethics@massey.ac.nz <humanethics@massey.ac.nz>  
**Subject:** Human Ethics Notification - 4000024164

HoU Review Group

Ethics Notification Number: 4000024164  
Title: Using maps to explain flood hazards and climate change impacts

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director (Research Ethics), email humanethics@massey.ac.nz. "

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish require evidence of committee approval (with an approval number), you will have to complete the application form again answering yes to the publication question to provide more information to go before one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

You are reminded that staff researchers and supervisors are fully responsible for ensuring that the information in the low risk notification has met the requirements and guidelines for submission of a low risk notification.

If you wish to print an official copy of this letter, please login to the RIMS system, and under the Reporting section, View Reports you will find a link to run the LR Report.

Yours sincerely

Professor Craig Johnson  
Chair, Human Ethics Chairs' Committee and  
Director (Research Ethics)

## DOCTORAL THESIS WITH PUBLICATIONS GUIDELINES

### THE DIFFERENCES BETWEEN A DOCTORATE WITH PUBLICATIONS AND A TRADITIONAL THESIS OR DOCTORATE BY MONOGRAPH

The “Doctorate with Publications” is an alternative to the traditional “Doctorate by Monograph” approach to writing the doctoral dissertation.

In a traditional Doctoral thesis by Monograph, the doctoral student writes up their research in a comprehensive thesis or book form, with typically discrete chapters that cover for example, an introduction, literature review, conceptual development or methods, results and analyses, discussion, and conclusions. The monograph approach demonstrates both depth and breadth of knowledge in the student’s discipline within a single tome. Often only once the doctoral thesis is completed is an attempt made to publish one or more research articles arising from the work, which are then submitted to academic journals or other appropriate peer-reviewed literature.

In a Doctoral thesis with Publications, the doctoral student authors or co-authors multiple articles on their research during their doctoral programme. These articles are then collated and linked together to constitute the doctoral thesis. Each article will be structured in a way that is appropriate for the field and specific publication, often typically comprising an abstract, introduction with literature context, conceptual development or methods, results, analyses, discussion, and conclusions. This may lead to some repetition in a thesis of this nature, which is not in this context seen as a flaw. It is important to recognise that a thesis with publications is not composed exclusively of publications (see structure below). A doctoral thesis with publications must still demonstrate sufficient breadth and depth of knowledge in the discipline but does so using an appropriate number of discrete published articles as chapters (see below).

### GUIDELINES FOR PREPARING A THESIS WITH PUBLICATIONS (TwP)

Candidates considering presenting their thesis with published work should consult with their supervisors early in their candidature to determine whether the thesis with publication format is appropriate. If a candidate is considering this format, it is expected that this be identified as part of the ‘confirmation of registration’ candidature milestone process.

A Doctorate with Publications requires a candidate to present a thesis comprising typically between two and six research papers/publications. The exact number of publications included in the thesis may vary by discipline. Students may write a monograph thesis and publish just one paper. The publications may be various stages of publication at the time of thesis submission for examination.

The expectation is that the doctoral candidate should target mainstream journals in their discipline for publication of their work. Wherever possible aim for international and highly ranked journals, or a journal with a robust peer review process.

Publications contributing to the doctoral thesis must have been written during the period of candidature enrolment and supervision in the doctorate, and candidates cannot present material which was published prior to their doctoral enrolment as part of the thesis.

Published material may be submitted for examination once only and by one doctoral candidate, so where team research is involved, it is important to clarify roles at an early stage. In special circumstances, different parts of the same publication may be submitted for examination by different candidates (e.g. where experiments and modelling have been done by different people). This will need to be clarified in a statement of contribution that is required to accompany each chapter comprising a publication (see below).

Where work has been published, the journal/publisher may need to give copyright permission for the material to be included in a thesis which will be placed in the Library’s electronic repository. Candidates should gain copyright clearance as early as possible if this is the case. It should however be noted that thesis chapters comprising discrete articles/publications must be formatted according to a consistent style within the body of the thesis and not according to publication formats. Usually journals permit reproduction of pre-print versions of articles that are not in final publication format.

Candidates can change their decision to present their thesis in the thesis with publication format and revert to a monograph format during their candidature (for example, if results do not go as expected and are not deemed publishable), as long as the decision does not impact on the time to completion and the thesis submission is within the doctoral guidelines.

## STRUCTURE OF THESIS WITH PUBLICATIONS

Thesis structure will vary depending on the number of research papers to be included. A thesis with publications may consist of a combination of published and non-published chapters. The thesis may therefore include papers that:

- Are in the (final) process of being prepared for publication in a peer-reviewed journal (in prep.)
- Have been submitted for publication in a peer-reviewed journal but not yet accepted (in review, including in revision after reviewers' comments)
- Have been accepted for publication in a peer-reviewed journal but not yet published (in press)
- That are published in a peer-review journal, edited book chapter, or equivalent.
- That are in exhibitions, site specific installations, film, video, scores (with exegesis)

Some chapters may include work that is not publishable, but which nevertheless contributes to the subject body of knowledge and is thus admissible for doctoral research. A doctoral thesis with publications may therefore partly or (nearly) entirely comprise research papers.

Notwithstanding the previous paragraph, the thesis must have an overall introductory chapter which outlines the topic, justifies the research, identifies research objectives and outlines the thesis structure, indicating those chapters that have been written as papers for peer-reviewed publication.

Before the start of each chapter which represents a research paper or publication, the candidate must complete and include a DRC 16 'Statement of Contribution – Doctorate with Publications/Manuscripts'. The DRC 16 outlines the student contribution, authorship, intended target journal and the status of the publication.

The research paper/manuscript should be presented in the same form as they were presented, or intend to be presented, for the target journal, with exception that the referencing and text formatting should be standardised throughout the thesis and must be in the body of the chapter.

The candidate should outline the links between the chapters/research papers. A chapter comprising an article will necessarily include an opening paragraph linking with the preceding chapter and/or a closing paragraph linking to the next chapter, in which the overall fit of the article is set clearly within the body of research that is the doctoral thesis.

The candidate must ensure that all methods used in the body of research for the thesis are clearly described in the thesis. These are usually contained within the method sections of the corresponding papers. However, appendices should also be used to outline or expand upon methods that may have been abbreviated for publication. Any data and discussion that was also abbreviated to conform to the strictures of the publication process, including information published as supplementary material should also be included in appendices to the thesis. If appropriate, it is also acceptable to have unpublished chapters that may focus on a methodology, or set of results, but also the methodology chapter (or parts thereof) may be published. Unpublished chapters are entirely admissible in a thesis with publications. The thesis introduction should clarify what chapters are published and they should be referenced accordingly.

The thesis should conclude with a final chapter providing a synthesis of the work as a whole presented in the body of the thesis. It is important that discrete published chapters are brought together in this coherent synthesis to demonstrate the overall contribution to knowledge provided by the body of research within the thesis. Final overall conclusions revisiting the research objectives draw the thesis to a close at the end of the synthesis, or as a short, discrete chapter according to preference and disciplinary practice.

Formatting of the final thesis may be a challenge as the thesis should be a whole, presented in the same font and format, so figures and tables have to be renumbered and references consistently formatted.

The thesis with publications must still work as an integrated whole, address a significant research question or questions, and present a clearly identified original contribution to knowledge of the subject with which it deals.

## AUTHORSHIP OF THE PUBLICATIONS

The authorship of publications is determined based on the APA authorship guidelines, which also highlight that the supervisors are NOT automatically the authors on all publications arising from the candidate's research for the doctorate. Only supervisors who have contributed sufficient intellectual knowledge to an academic paper that is part of a doctorate with publications should be included as co-authors of that academic paper. Authorship of publications is decided by discussion and agreement between the supervisors and candidate.

In some cases, the candidate may be the sole author of a publication(s). Where the candidate is a joint author with supervisor(s) and/or others, the contribution by the candidate is normally expected to be in the capacity of first/primary author. Multi-authored papers in a thesis must have a *substantial* and *significant* contribution by the candidate. The principal supervisor signs the 'Statement of Contribution: Doctorate with Publications/Manuscripts (DRC 16)' specifying the candidate's contribution. To protect the interest of candidates, it is important that authorship is discussed at an early stage of candidacy, ideally with the involvement of an independent party, such as the unit postgraduate coordinator, with an ideal context being the confirmation process.

Candidates are advised to fully reference previous publication of their own sole-authored work, including graphs, tables and images that they themselves have generated. Any other intellectual content must be fully and appropriately referenced to the person(s) that supplied them. They are then able to sign a statement that the thesis is their own work.

## EXAMINATION

The candidate is expected to have a working knowledge of all parts of the thesis, and to be able to answer questions about the thesis as a whole in the oral examination.

The University sets the standard by which theses are examined, and acceptance of any part by a publisher does not necessarily mean that it meets examination standards. Examiners will be instructed to examine all parts of the thesis with equal rigour and may request major or minor changes to any part of the thesis regardless of whether it has been published or not. Material included in a thesis with publications is clearly of publishable quality, but the candidate's understanding of their body of work in its constituent parts, as well as the whole, must be examined.

Whether a candidate submits their thesis in traditional monograph form or with publications, examiners will still be asked to examine the thesis following the same guidelines:

- That the candidate shows familiarity with, and understanding of the relevant literature
- The thesis provides a sufficiently comprehensive study of the topic
- The research questions have been identified
- The methods adopted are appropriate to the subject matter and properly applied
- The research findings are documented and explained coherently
- The thesis as a whole makes an original contribution to the knowledge of the subject with which it deals, and the candidate understands the relationship of the thesis to the wider context of the knowledge in which it belongs.

It is advisable for supervisors to select examiners who are familiar with the *Doctorate with Publications* format if at all possible.

## FREQUENTLY ASKED QUESTIONS

*Which is of more value? A TwP or a monograph?*

- For the examination process there is no difference. Some candidates may find it beneficial to have published papers in their thesis for subsequent job opportunities or for applications for a post-doctoral research position. An examiner will not see a monograph of lesser value if it meets all the criteria for doctoral studies.

*How do you structure a TwP?*

- It is similar to a monograph. Introduction chapter; followed by the literature review (which may or may not be published), then one can have a methodology chapter, but it is not required; and then the chapters which may or may not have been published already (in prep/review/press/published). The last chapter is the discussion or synthesis where the whole thesis and research must be discussed and the novel contribution covered.
- Chapters may require additional introductions and conclusions to ensure clarity of relationship with broader thesis.

*Each published article typically describes literature, methods etc. So how do you avoid repetitive writing across the thesis chapters?*

- This cannot be prevented, but the candidate should try to minimise where possible. Although a paper may have been published, it will still be 'examined' as part of the overall thesis, and repetition will be taken into account by the examiners.

*How does a New Zealand TwP measure up against a doctorate (usually by monograph) in the U.S.?*

- There is no difference. The same academic principles (e.g., original contribution to knowledge etc) apply to both versions. The required word limit still applies.
- Even if much of the content has been published in peer-review outlets the thesis must still pass as a doctorate (an original, coherent contribution as a body of knowledge to the discipline).

*Is different work involved in a TwP compared to a monograph?*

- Yes. One has to plan the chapters as papers, start writing earlier in the doctorate and while writing the thesis, submit and revise previous chapters/ papers as per the reviewer's comments. Once a paper is submitted, control is in the hands of the journal editors.

*Is there anything to prevent you from publishing while presenting your thesis in a monograph form?*

- No not at all.

*Is there a minimum or maximum number of publications per thesis?*

- No. It can vary, often only one chapter is actually published, others maybe under review, and some submitted. Generally, it is expected that there are between two and six chapters which are in published format (in prep/review/press/published).

*Is it more challenging to produce a TwP when conducting research from a mixed method or humanities approach?*

- Potentially. This option is most likely to be useful in cases where a student has already some experience in producing articles or reports and therefore seeks to pursue a TwP given familiarity with this genre. However, it may be more difficult to ensure a coherence of work around an overarching research question in these fields.

*What are the rules around authorship? Does the doctoral candidate always have to be the lead author? What if the journal doesn't use a first author system, and instead lists them alphabetically?*

- It is expected that the candidate is the lead author. In Humanities and Social Sciences, the usual practice is to rank authors alphabetically unless one author is a clear lead author, in which case the position of names can at times be determined by contribution. Massey expectation is that authorship is determined based on the APA authorship guidelines.

*Does qualitative research (that is done from a science discipline) sit well with publications?*

- There is no reason why not. It will be important to select journals carefully and choose the most appropriate publication outlet for the work.

*If your supervisor is new to TwPs, who else can a student go to for advice (for both the student and the supervisor)?*

- GRS, and they can refer the student to staff whose students regularly do TwP.
- Postgraduate Coordinators in the academic units.

*How are ethics managed and integrated into the TwP process?*

- There is no difference. If a researcher is working with people or animals, the ethics process needs to be addressed and discussed in the papers/ chapters.
- There are ethical considerations with regards to co-publishing that need to be considered (i.e. ensuring student work is appropriately recognised in publications).

*Monograph vs. TwP - Is this a personal decision or does it have to be justified in another way?*

- The student and supervisory panel should discuss the format of the thesis in the provisional year. Supervisors and students should both agree that TwP is the best avenue.

*When do you decide which journal to submit to? How do you make that decision? How do you make sure that you stay productive in that process?*

- The journal should be discussed with the supervisors. Once one paper is submitted the candidate should start the next one or work on the literature review.
- Ensure good quality publication outlets (well known, well ranked) to ensure strong reviews and to maximise student benefit.

*What are some of the challenges associated with TwP? And what tips/advice is there for overcoming those challenges?*

- Staying within a time frame and not extending the Doctorate while waiting for papers and reviews. Keep productive while waiting for an Editor's reply.
- Dealing with reviewer's comments can be challenging, but your supervisors should provide support, and this provides good preparation for examiners comments.
- Formatting of the final thesis may be a challenge as the thesis should be a whole, presented in the same font and format. So, figures and tables have to be renumbered and references consistently formatted because the thesis is a publication in its own right and as such should be a cohesive document.
- Ensuring the student retains a birds-eye view of the thesis as an overarching project that, with all parts working together, makes an original contribution to the field.

*When you decide to do a TwP, is there a formal process for that, or is it simply an agreement that you make with your supervisor(s)?*

- There is no formal process. Just an agreement between the student and supervisor(s). However, there are forms that need to be completed as part of the submission of the thesis which attributes the contribution of the candidate and other authors for those chapters in the thesis that are publications or in the process of publication (in prep/review/press).

*If in doubt, please contact your supervisor.*

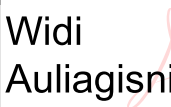
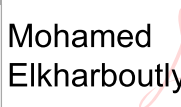
Ref	Reviewer Comment	Planned/Made Change	Response/Explanation
1	Include a list of abbreviations after the list of tables. Some abbreviations are used without being introduced (e.g. UNDRR, IPCC).	Add a new 'List of Abbreviations' section after the Table of Tables. Ensure all abbreviations are spelled out at first mention.	Agreed. A list of abbreviations has been added for clarity and consistency. All abbreviations are now introduced before first use.
2	Abstract lacks specificity on data collection and theoretical contributions.	Revise abstract to include number of interviews, surveys, and key contributions (e.g. bottom-up governance, resilience framework).	Revised to clearly specify methods, contributions, and novelty in the abstract.
3	Multiple aim statements and unclear context in Section 1.1.	Reframe and unify the thesis aim in Section 1.1. Align wording with thesis title and research objectives.	Revised Section 1.1 to clearly state the central aim and scope of the study. Redundant phrases were removed for clarity.
4	Section 1.2 title suggestion: Change to "Addressing Recurring Flood Challenges in Multi-Level in New Zealand".	Update section title accordingly.	Title changed as suggested for precision and clarity.
5	Add in-text citations to support claims in Section 1.2.	Add supporting references for flood impacts and recent events in New Zealand.	References from NIWA (2021), NEMA (2022), and IPCC (2021) added.
6	Chapter 2 Section 2.3.5 lacks in-text citations.	Add multiple recent and relevant academic references to support the listed lessons.	Citations from relevant peer-reviewed studies have been added to strengthen the section.
7	Inconsistent use of 'natural disaster' vs 'natural hazard'.	Standardise terminology across all chapters to use 'natural hazard' unless quoting specific sources.	Terminology revised throughout the thesis for consistency with the argument presented in Section 2.2. Note that the use of hazards is recommended if it is talking specifically to "natural" hazards. Referring to Flood as a disaster is correct, only not flood as natural disaster but flood disaster is part of natural hazard phenomena
8	Theoretical foundations of resilience, strategy development, and capability building are underdeveloped.	Expand Chapter 2 to include in-depth discussion of theoretical frameworks with citations.	Theoretical underpinnings of key concepts now explicitly discussed and cited to meet PhD-level expectations.
9	Figure 9 and 14 lack source citation.	Add source citations for all figures where applicable.	Citations have been added for Figure 9 and Figure 14 to acknowledge original sources.
10	Justification of research methods and generalisability is insufficient.	Revise Chapter 3 to include rationale for chosen methods, sample size, and triangulation process.	Added detailed justification of methods, sampling strategy, and addressed generalisability and bias.
11	Chapter 3: Discrepancy between research questions/objectives in Section 3.5.2 and Table 1.	Align all research questions and objectives across Chapter 1, 3, and 12.	Revised to ensure consistent research questions/objectives throughout thesis.
12	Insufficient detail on data collection (interviews, surveys, booths, timelines).	Add a table summarising all data collection stages, sample sizes, and timing.	Table with detailed data collection stages, sample size, and timelines added.
13	Statistical analysis methods for quantitative data not specified.	Describe statistical analysis tools/methods used (e.g., SPSS, descriptive stats).	Statistical methods for survey analysis clarified in methods section.
14	Chapter 4: Research questions and objectives are misaligned.	Revise research question to reflect actual study focus and align with sub-questions.	Main research question revised to reflect the Northland-specific scope.
15	Sources missing for statistics and claims in Section 4.2.3.	Add in-text citations for all statistical claims and data sources.	Citations from Nature and relevant urbanisation/flood risk literature added.
16	Clarify terms like 'near' and 'close' in Table 6; explain soil condition assessments.	Define spatial terms and briefly describe soil condition assessment method.	Clarified proximity terms and added observational criteria for soil evaluation.
17	Chapter 5: Figure 25 lacks source, Figure 26 text hard to read.	Add citation for Figure 25 and replace Figure 26 with a higher-resolution version.	Sources added; low-quality figures updated for legibility.
18	Chapter 6: Font inconsistency and formatting issues.	Standardise font across section 6.1 and correct spacing in headings.	Formatting and font issues corrected throughout Chapter 6.
19	Chapter 7: Table 13 and 14 missing sources.	Add citations for Tables 13 and 14 from local law documents.	Local legal sources cited for both tables.
20	Chapter 12 (now chapter 11): No acknowledgement of limitations; unclear theoretical contribution.	Add section discussing limitations and clarify theoretical framework contributions.	New paragraph added to address research limitations and theoretical implications.

Thesis Section
Preliminary pages (after list of tables)
Abstract
Chapter 1, Section 1.1
Chapter 1, Section 1.2
Chapter 1, Section 1.2
Chapter 2, Section 2.3.5
Chapters 2, 4, and elsewhere
Chapter 2
Chapter 2, Figures
Chapter 3
Chapters 1, 3, and 12
Chapter 3
Chapter 3
Chapter 4
Chapter 4, Section 4.2.3
Chapter 4, Table 6
Chapter 5, Figures
Chapter 6
Chapter 7, Tables 13 and 14
Chapter 11

Ref	Reviewer Comment	Planned/Made Change	Response/Explanation	Thesis Section
1	Chapters 4, 7, 8, and 10 (conference papers) do not meet the standard for standalone core research outputs.	Integrate key content from these chapters into background or literature review sections.	Agreed for chapters 7 and 8. The content from these chapters has been integrated and reframed to strengthen the thesis's core narrative as a new Chapter 7. Been discussed and agreed that Chapters 4 and 10 are believed to be more valuable as standalone chapters.	Chapters 7
2	Chapter 5 is underdeveloped, particularly in its methodology and connection between data and findings.	Revise Chapter 5 to clarify methods, sampling details, and enhance data-analysis connection.	Chapter 5 has been substantially revised to clarify methodology and strengthen analytical linkages.	Chapter 5
3	Section 2.3 lacks analytical insights from historical examples.	Add analytical commentary and lessons learned from international resilience cases.	Section 2.3 revised to include deeper analysis and practical lessons from comparative resilience examples.	Chapter 2, Section 2.3
4	Include more recent risk management standards, such as AS/NZS ISO 31000.	Expand discussion to include current risk standards and tools (e.g., consequence-probability matrices).	Recent standards and frameworks (AS/NZS ISO 31000) incorporated to broaden conceptual base.	Chapter 2
5	Lacks reference to Ministry for the Environment's 2020 National Climate Change Risk Assessment.	Include and cite the 2020 NCCRA and align its key findings with thesis discussions.	NCCRA 2020 now included to provide national policy context for flood-related risks.	Chapter 2
6	Seven research questions outlined initially are reduced to two in the conclusion without explanation.	Ensure consistency of research questions throughout and explain any refinement in the conclusion.	Research questions aligned across all chapters; conclusion now explains synthesis and narrowing.	Chapters 1, 3, 12
7	Methodology across chapters lacks an overarching framework; rationale for varied methods unclear.	Introduce a unifying methodological framework in Chapter 3 and explain variation across chapters.	A consistent framework has been established; variations across chapters now explicitly justified.	Chapter 3
8	Chapter 5: Survey distribution, key informants, and workshop data unclear.	Clarify sampling methods, distribution strategy, and roles of respondents in Chapter 5.	Clarified survey and workshop details; Table 9 updated for transparency.	Chapter 5
9	Figures are low quality or lack clarity; unclear citations (e.g., Figure 1).	Replace low-resolution figures with high-quality versions and add citations.	All figures updated for clarity and proper citations included in captions and text.	Multiple chapters
10	Conclusion lacks clear articulation of original insights and their implications.	Revise conclusion to explicitly state novel contributions and practical implications.	Conclusion rewritten to clearly articulate original insights and their relevance to theory and practice.	Chapter 12

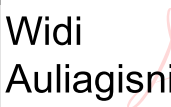
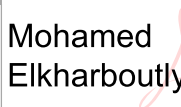
Chapter	Issue	Comment Summary	Action in Thesis	Reviewer(s)
Chapter 1: Introduction	Research Aim not clearly stated	Make aim explicit in layout and font	Clarify and bold the aim in Section 1.8; consider centering for emphasis	MJ
Chapter 1: Introduction	Multiple messages in 1.1 about study purpose	Confusing context	Streamline section 1.1 to clearly and consistently define the study's main goal	AL
Chapter 1: Introduction	Missing in-text citations in background	Weak support for claims	Add relevant sources to support statements about NZ flood trends and recent events	AL
Chapter 2: Literature Review	Lacks theoretical depth	Community resilience theory not well covered	Expand literature on community resilience frameworks and include more in-text citations	AL, PVS
Chapter 2: Literature Review	Superficial historical analysis	Section 2.3.5 too general	Deepen analysis and link global historical examples to NZ context	PVS
Chapter 2: Literature Review	Use of outdated standards	Only NZS 9401 used	Incorporate AS/NZS 31000 and 2020 Climate Change Risk Assessment	PVS
Chapter 3: Methodology	Methodological justification unclear	No rationale for approach changes	Clarify why different methods are used per chapter; add overarching framework	PVS, AL
Chapter 3: Methodology	Bias and validity not discussed	No mitigation steps explained	Discuss researcher bias, triangulation, and include reflexivity notes	AL
Chapter 3: Methodology	Insufficient detail on sampling and instruments	Unclear data collection process	Add tables summarizing number of participants, timing, tools used, and locations	AL, PVS
Ch. 4-8: Findings (New Ch 4-7)	Findings reaffirm known issues	Limited novelty	Clarify how findings led to new insights or applied solutions (e.g., resilience plan)	PVS
Ch. 4-8: Findings (New Ch 4-7)	Lack of analytic depth	Findings too descriptive	Use stronger analytical framing and clearly tie data to claims	AL, PVS
Ch. 5: Case Study	Weak connection between data and conclusions	Unclear how data supports claims	Re-express links between survey/interview results and conclusions; improve structure	PVS
Chapter 11-12: Synthesis (New Ch 10 - 11)	Original contribution unclear	Reinforces known ideas	Explicitly define what's new: practical tools, theory application in NZ context	PVS
Chapter 11-12: Synthesis (New Ch 10 - 11)	No link between research questions and conclusion	Streamlined questions unexplained	Explain why the 7 questions were reduced and how synthesis still answers them	PVS
General	Low-res figures, inconsistent terminology	Presentation issues	Improve figure resolution, ensure consistent use of terms like 'hazard/disaster'	AL, PVS
General	Conference papers not clearly integrated	Disconnected narrative	Add linking text and rationale for inclusion of conference-based chapters	PVS

## STATEMENT OF CONTRIBUTION DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the student and the student's main supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the student's contribution as indicated below in the Statement of Originality.			
Student name:	Widi Auliagisni		
Name and title of main supervisor:	Mohamed ElkhARBOUTLY		
In which chapter is the manuscript/published work?	Chapter 5		
Describe the contribution that the student and members of the supervisory team have made to the manuscript/published work: <sup>1</sup>			
Widi Auliagisni - Conceptualisation, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, Resources, Validation, Visualisation			
Suzanne Wilkinson - Supervision, Validation, Writing - review & editing			
Mohamed ElkhARBOUTLY - Methodology, Supervision, Validation, Writing - review & editing			
Please select one of the following three options:			
<input checked="" type="radio"/>	<b>The manuscript/published work is published or in press</b> Please provide the full reference of the research output: "Flood Risk Management in New Zealand: A Case Study of Northland Urban Community" was presented at CIB World Building Congress 2022 and the manuscript has been published in the open access journal Earth and Environmental Science, Volume 1101, Future Proof City in 2022		
<input type="radio"/>	<b>The manuscript is currently under review for publication</b> Please provide the name of the journal:		
<input type="radio"/>	<b>It is intended that the manuscript will be published, but it has not yet been submitted to a journal</b>		
Student's signature:	 <b>Widi Auliagisni</b>	Digitally signed by Widi Auliagisni Date: 2025.02.25 22:06:11 +13'00'	Main supervisor's signature:
			 <b>Mohamed ElkhARBOUTLY</b>
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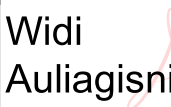
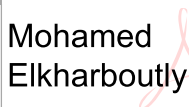
<sup>1</sup> Refer to the Massey University Publishing and Authorship guidelines ([OneMassey for staff](#), [Stream for students](#)) and/or [Contributor Roles Taxonomy \(CRediT\) guidelines](#) for guidance.

## STATEMENT OF CONTRIBUTION DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

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Name and title of main supervisor:	Mohamed ElkhARBOUTLY		
In which chapter is the manuscript/published work?	Chapter 6		
Describe the contribution that the student and members of the supervisory team have made to the manuscript/published work: <sup>1</sup>			
Widi Auliagisni - Conceptualisation, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, Resources, Validation, Visualisation			
Suzanne Wilkinson - Supervision, Validation, Writing - review & editing			
Mohamed ElkhARBOUTLY - Methodology, Supervision, Writing - review & editing			
Please select one of the following three options:			
<input checked="" type="radio"/>	<b>The manuscript/published work is published or in press</b> Please provide the full reference of the research output: Auliagisni, W., Wilkinson, S., & ElkhARBOUTLY, M. (2022). Using community-based flood maps to explain flood hazards in Northland, New Zealand. Progress in Disaster Science, 14, 100229. <a href="https://doi.org/https://doi.org/10.1016/j.pdisas.2022.100229">https://doi.org/https://doi.org/10.1016/j.pdisas.2022.100229</a>		
<input type="radio"/>	<b>The manuscript is currently under review for publication</b> Please provide the name of the journal:		
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Student's signature:	 <b>Widi Auliagisni</b>	Digitally signed by Widi Auliagisni Date: 2025.02.25 22:10:07 +13'00'	Main supervisor's signature:
			 <b>Mohamed ElkhARBOUTLY</b>
			Digitally signed by Mohamed ElkhARBOUTLY Date: 2025.02.26 16:26:38 +13'00'
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Student name:	Widi Auliagisni		
Name and title of main supervisor:	Mohamed ElkhARBOUTLY		
In which chapter is the manuscript/published work?	Chapter 7		
Describe the contribution that the student and members of the supervisory team have made to the manuscript/published work: <sup>1</sup>			
Widi Auliagisni - Conceptualisation, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, Resources, Validation, Visualisation			
Suzanne Wilkinson - Supervision, Validation, Writing - review & editing			
Mohamed ElkhARBOUTLY - Methodology, Supervision, Writing - review & editing			
Please select one of the following three options:			
<input checked="" type="radio"/>	<b>The manuscript/published work is published or in press</b> Please provide the full reference of the research output: "Overview of New Zealand Legislation for Flood Resilience" published in the proceeding titled 45th AUBEA Conference 2022: Global Challenges in a Disrupted World: Smart, Sustainable and Resilient Approaches in the Built Environment, Australia.		
<input type="radio"/>	<b>The manuscript is currently under review for publication</b> Please provide the name of the journal:		
<input type="radio"/>	<b>It is intended that the manuscript will be published, but it has not yet been submitted to a journal</b>		
Student's signature:	 <b>Widi Auliagisni</b>	Digitally signed by Widi Auliagisni Date: 2025.02.25 22:15:56 +13'00'	Main supervisor's signature:
			 <b>Mohamed ElkhARBOUTLY</b>
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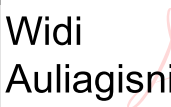
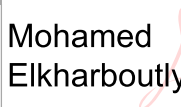
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Student name:	Widi Auliagisni		
Name and title of main supervisor:	Mohamed ElkhARBOUTLY		
In which chapter is the manuscript/published work?	Chapter 7		
Describe the contribution that the student and members of the supervisory team have made to the manuscript/published work: <sup>1</sup>			
Widi Auliagisni - Conceptualisation, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, Resources, Validation, Visualisation			
Suzanne Wilkinson - Supervision, Validation, Writing - review & editing			
Mohamed ElkhARBOUTLY - Methodology, Supervision, Validation, Writing - review & editing			
Please select one of the following three options:			
<input type="radio"/>	<p><b>The manuscript/published work is published or in press</b></p> <p>Please provide the full reference of the research output: "Enhancing Flood Resilience through Effective land - use Planning Policies in New Zealand" published under Springer Nature Proceeding. <a href="https://link.springer.com/book/9789819611805">https://link.springer.com/book/9789819611805</a></p>		
<input type="radio"/>	<p><b>The manuscript is currently under review for publication</b></p> <p>Please provide the name of the journal:  The full manuscript will also be published in International Journal of Disaster Resilience in Built Environment</p>		
<input checked="" type="radio"/>	<p><b>It is intended that the manuscript will be published, but it has not yet been submitted to a journal</b></p>		
Student's signature:	<p><b>Widi Auliagisni</b></p> <p>Digitally signed by Widi Auliagisni Date: 2025.02.25 22:21:37 +13'00'</p>	Main supervisor's signature:	<p><b>Mohamed ElkhARBOUTLY</b></p> <p>Digitally signed by Mohamed ElkhARBOUTLY Date: 2025.02.26 16:34:26 +13'00'</p>
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Student name:	Widi Auliagisni		
Name and title of main supervisor:	Mohamed ElkhARBoutly		
In which chapter is the manuscript/published work?	Chapter 8		
Describe the contribution that the student and members of the supervisory team have made to the manuscript/published work: <sup>1</sup>			
Widi Auliagisni - Conceptualisation, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, Resources, Validation, Visualisation			
Suzanne Wilkinson - Supervision, Validation, Writing - review & editing			
Mohamed ElkhARBoutly - Methodology, Supervision, Validation, Writing - review & editing			
Please select one of the following three options:			
<input checked="" type="radio"/>	<b>The manuscript/published work is published or in press</b> Please provide the full reference of the research output: "Learning from floods – How a community develops future resilience" was published in the MDPI Open Access Water Journal 2022 <a href="https://www.mdpi.com/2073-4441/14/20/3238">https://www.mdpi.com/2073-4441/14/20/3238</a>		
<input type="radio"/>	<b>The manuscript is currently under review for publication</b> Please provide the name of the journal:		
<input type="radio"/>	<b>It is intended that the manuscript will be published, but it has not yet been submitted to a journal</b>		
Student's signature:	 <b>Widi Auliagisni</b> <small>Digitally signed by Widi Auliagisni Date: 2025.02.25 22:25:10 +13'00'</small>	Main supervisor's signature:	 <b>Mohamed ElkhARBoutly</b> <small>Digitally signed by Mohamed ElkhARBoutly Date: 2025.02.26 16:34:51 +13'00'</small>
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Student name:	Widi Auliagisni		
Name and title of main supervisor:	Mohamed ElkhARBOUTLY		
In which chapter is the manuscript/published work?	Chapter 9		
Describe the contribution that the student and members of the supervisory team have made to the manuscript/published work: <sup>1</sup>			
Widi Auliagisni - Conceptualisation, Data Curation, Formal Analysis, Investigation, Methodology, Writing - original draft, Resources, Validation, Visualisation			
Suzanne Wilkinson - Supervision, Validation, Writing - review & editing			
Mohamed ElkhARBOUTLY - Methodology, Supervision, Validation, Writing - review & editing			
Please select one of the following three options:			
<input type="radio"/>	<b>The manuscript/published work is published or in press</b> Please provide the full reference of the research output:		
<input type="radio"/>	<b>The manuscript is currently under review for publication</b> Please provide the name of the journal:		
<input checked="" type="radio"/>	<b>It is intended that the manuscript will be published, but it has not yet been submitted to a journal</b>		
Student's signature:	<b>Widi Auliagisni</b> Digitally signed by Widi Auliagisni Date: 2025.02.25 22:31:39 +13'00'	Main supervisor's signature:	<b>Mohamed ElkhARBOUTLY</b> Digitally signed by Mohamed ElkhARBOUTLY Date: 2025.02.26 16:35:13 +13'00'
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