Flood Schemes, Flood Hazards, and Awareness in New Zealand

Patrick Walsh,[*1] *Ryan Paulik,*[2] *and Thomas Robertson*[3]
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[1.] Manaaki Whenua – Landcare Research
[2.] NIWA
[3] Consultant
[*]*Contact author*: walshp@landcareresearch.co.nz

Abstract
In the 1990s there was a major shift in New Zealand flood management and flood infrastructure funding, from a centralised approach to Regional Council responsibility. To compensate for the loss of central government funding, flood schemes are now used by many regional councils. There is scant research into these schemes. After extensive data collection, we have national maps of flood hazards, flood schemes, and sea level rise risk. These should be broadly useful in other research and planning. We compare measures of peoples' awareness of flood risk, such as survey data and EQC damage claims, to flood hazard maps, and find that There are several notable areas where they do not align.

Keywords: Flood Management, Sea Level Rise, Flood Policy

1.1 Introduction/Description

Flooding is the most economically damaging natural hazard in New Zealand, with damages projected to continue increasing. There have been over $300 million in insurance claims from flooding just in the four years since 2014.[2] Government planning to avoid and mitigate these damages faces a multitude of social, economic, and environmental barriers, including future sea level rise and other effects of climate change. Government flood management policy has also shifted significantly over the last 50 years, with limited research into the impacts of that change. In the mid to late 1900's, central government was responsible for flood management, with regional catchment boards endowed with significant infrastructure funding and political power, with funding reaching $40 million per year at times (MfE 2008). Recently, however, flood management responsibilities and funding have been transferred to regional and district councils, with scant funding from central government. To bridge this gap in funding, many regional councils use flood schemes, relying on targeted property rates to fund flood management. The research described here explores these flood schemes and associated issues.

[1] https://www.deepsouthchallenge.co.nz/

[2] See the Insurance Council of New Zealand's website for monetary damages of natural hazards: https://www.icnz.org.nz/natural-disasters/cost-of-natural-disasters/

Despite the widespread use of flood schemes, there has only been limited research on them (Smart 2015, Tonkin & Taylor 2017). This research set out to fill that gap and involved a broad data collection effort across regional and district councils, consultants, Crown Research Institutes, and Academic sources. This paper catalogues highlights of the data collected from that effort and previews ongoing analysis of that data. We obtained and/or created comprehensive maps of flood hazards, flood schemes, sea level rise, and insurance claims. These data and their relation to social and economic data are highlighted below.

1.2 Flood Schemes

To obtain data on flood schemes, we engaged a data collection effort from regional and district council websites and contacted regional council representatives. Several regional councils have webpages devoted to large flood schemes, with descriptions and targeted infrastructure.[3] Other Councils maintain data offline, or do not publish scheme maps. Finally, there are three regional councils that do not use flood schemes at all: Auckland, Nelson, and Marlborough. Those regional councils use general tax funds for flood management. In other councils that use schemes, flood management is funded by a blend of flood scheme revenues and general council revenues, with the proportion varying by council and/or scheme.

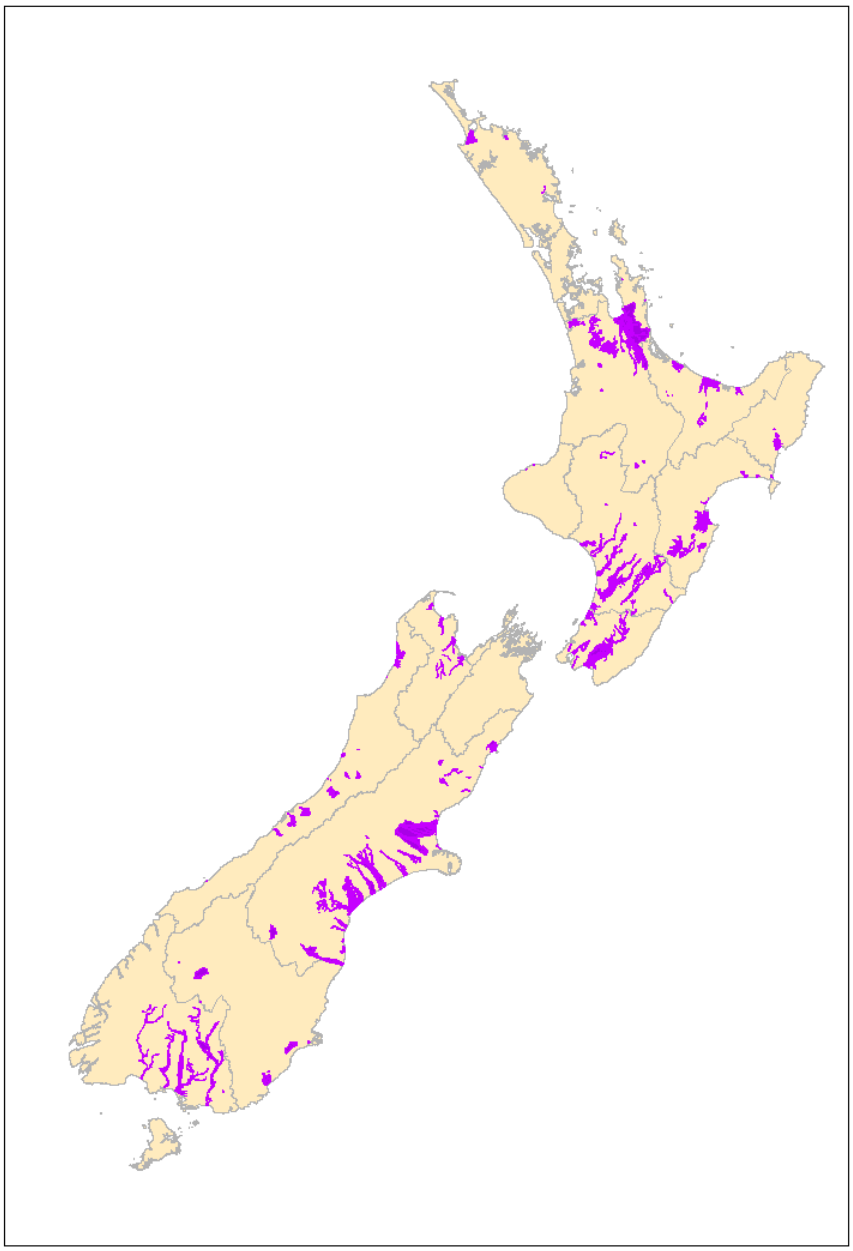
We also contacted several other entities concerned with flooding in the private and academic sectors, including other flooding researchers funded through the Deep South National Science Challenge.[4] Through that effort we were able to obtain data from Tonkin & Taylor from previous research on scheme locations funded through the River Managers' Special Interest Group (Tonkin & Taylor 2017).

Through those data sources, we were able to obtain a comprehensive overview of New Zealand's flood schemes. Figure 1 contains a map of the flood schemes identified by Tonkin & Taylor, shaded in grey. In some areas, those data were a subset of the data obtained from regional and district councils, while in other areas they were more expansive. The map shows the use of flood schemes is spread across the country.

[3] For instance, see Canterbury's catalogue of information about flood and river management schemes: https://www.ecan.govt.nz/your-region/your-environment/river-and-drain-management/flood-protection/

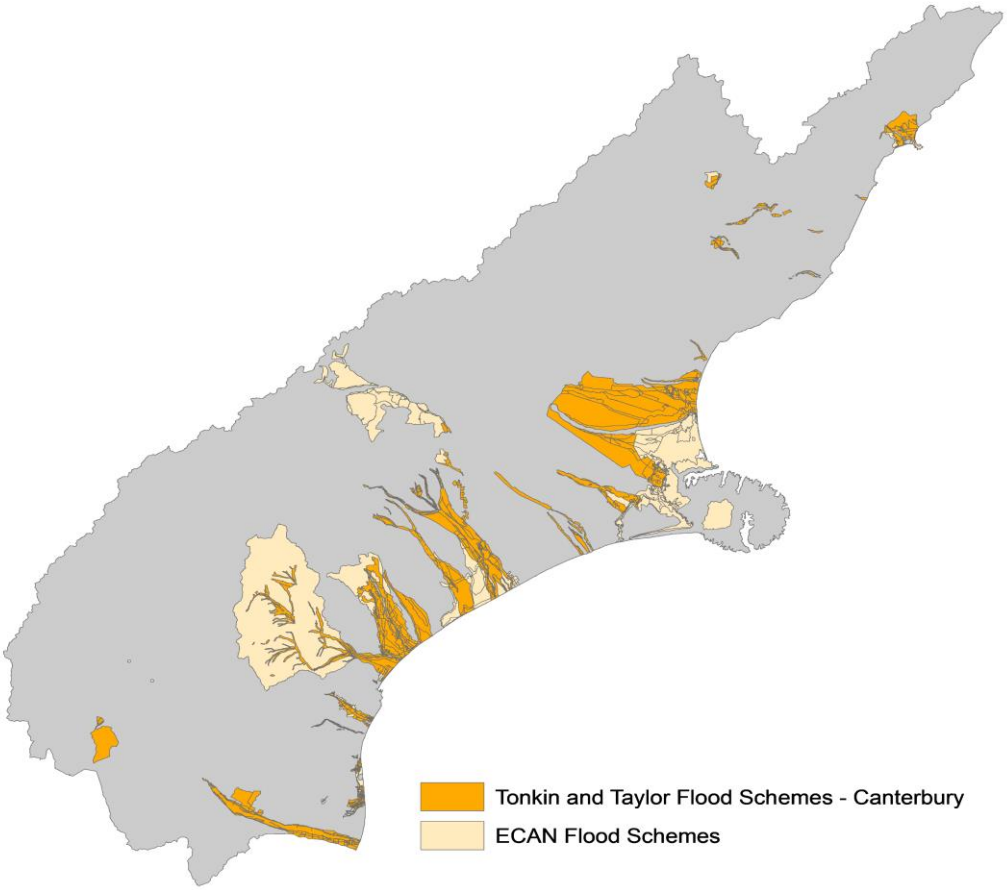
[4] Descriptions of these related projects can be found at: https://www.deepsouthchallenge.co.nz/programmes/impacts-and-implications

Figure 1: Flood Schemes Identified



As an example of differences between the Tonkin & Taylor data and regional council data, Figure 2 shows data from Environment Canterbury in light orange and Tonkin & Taylor data in dark orange. Some of the differences in the data come from dates harvested. The Tonkin & Taylor data were collected several years earlier, so do not reflect newer schemes, or those under development. There were also some schemes that were not as relevant to flooding that were excluded, such as drainage schemes for farming and other purposes that the Council provided together with the flood scheme maps. Overall, in identifying flood schemes, the Tonkin and Taylor Data were quite accurate.

Figure 2: Different Data Types



1.3 Flood Hazards

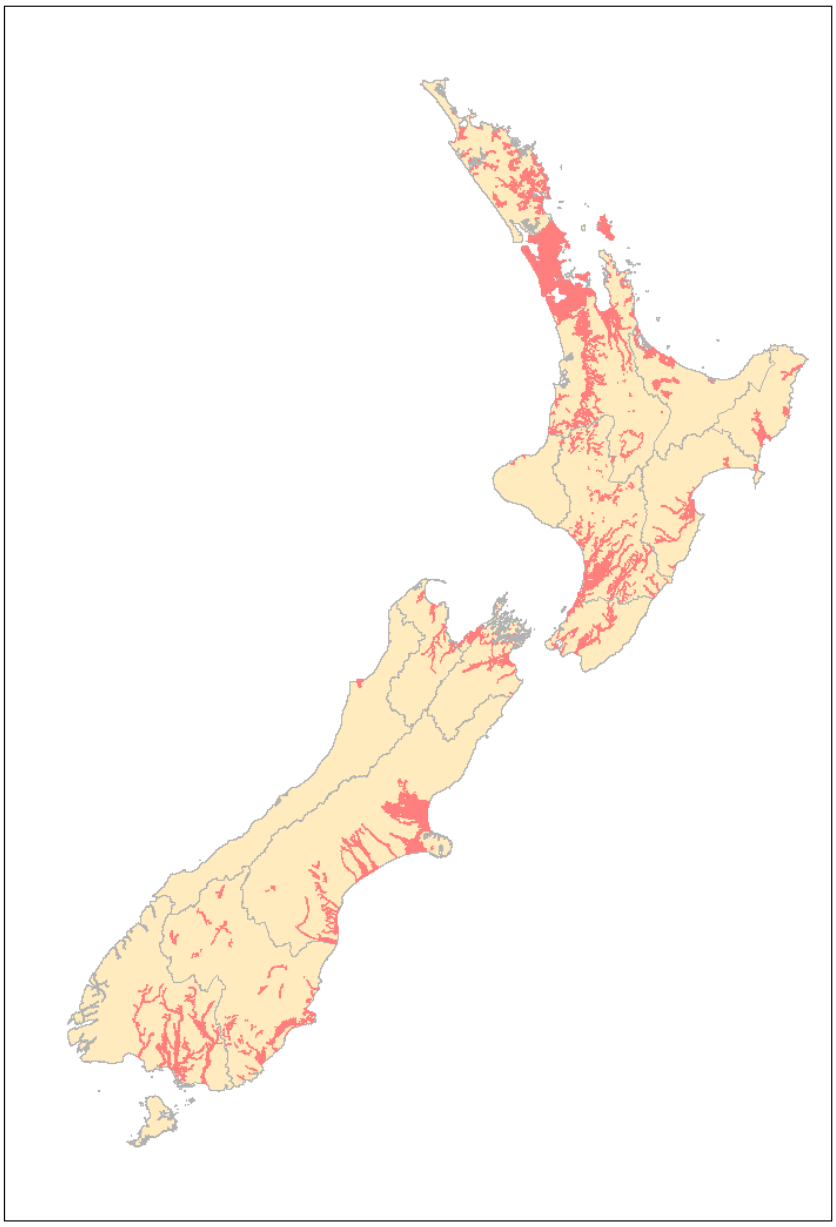
We engaged in a similar data collection campaign for data on flood hazards. Since flood management is handled locally, flood maps are also the responsibility of regional, unitary and territorial authorities. Additionally, the maps provided by those authorities are frequently measured by different flood return intervals, such as a 1 in 100 year flood risk versus a 1 in 500 year flood risk. Fortunately, public access to these types of maps has improved considerably over the past few years with access to web map portals like ESRI Arc GIS and IntraMaps. In late 2018, an online search indicated that 13 out of 16 regional councils or unitary authorities have some form of flood map online.

Through online searches and contacts at councils, we were able to obtain broad coverage of flood hazard maps. These maps were created using several different modelling or mapping methods, such as LIDAR, aerial photographic, historic data, and computer modelling, among others. The resulting combined dataset therefore has varying levels of accuracy, adding to the difficulty of making comparisons across councils. Nonetheless, it represents a holistic dataset of potential threats. The constructed map appears in Figure 3.

Some differences across councils are easily seen in the Auckland area. Much of the land in the Auckland Regional Council area is classified by some level of hazard, whereas adjoining areas immediately above and below appear to be much less affected. The differences are likely due to differences in methods of data collection and analysis, as opposed to actual risk.

There are some notable differences in the flood hazards identified in Figure 3 and the flood scheme areas in Figure 1. For instance, Auckland, Nelson, and Marlborough contain flood hazards, but no schemes. Other areas, such as the Manawatu-Wanganui region, contain both widespread flood risk and flood schemes.

Figure 3: Flood Hazard Zones



1.4 Survey and Insurance Data

The flood scheme and hazard mapping indicated that there is not a consensus on what areas face flood risk. There are certainly some places that face chronic flooding, which is obvious to local residents. On the other hand, there are likely other areas that only periodically flood, but face large damages during those times. We were interested in local awareness of flooding issues, and how that compares to actual flood risk. As part of this research, two new questions were added to the 2017 Survey of Rural Decision Makers (SRDM) (Brown 2017). The SRDM is a national survey of thousands of farmers which is conducted approximately every two years and is now in its fourth iteration.[5] Asking farmers about their flood hazard and involvement in flood schemes gives a unique view of local awareness.

The first question survey respondents were asked was "historically, has flooding been a concern" in your area? The second question was "do you participate in a flood mitigation scheme?" The results are summarised in Table 1. There were 4,566 responses to each of these questions. For flood hazards, 1,754 indicated that flooding had been a historical concern in their area, while 2,670 said it was not. For the flood schemes, 432 said that they participated in one.

Table 1: SRDM Results

	Historical Flood Hazard	Flood Scheme
Yes	1,754	432
No	2,670	3,747
Unsure	142	387

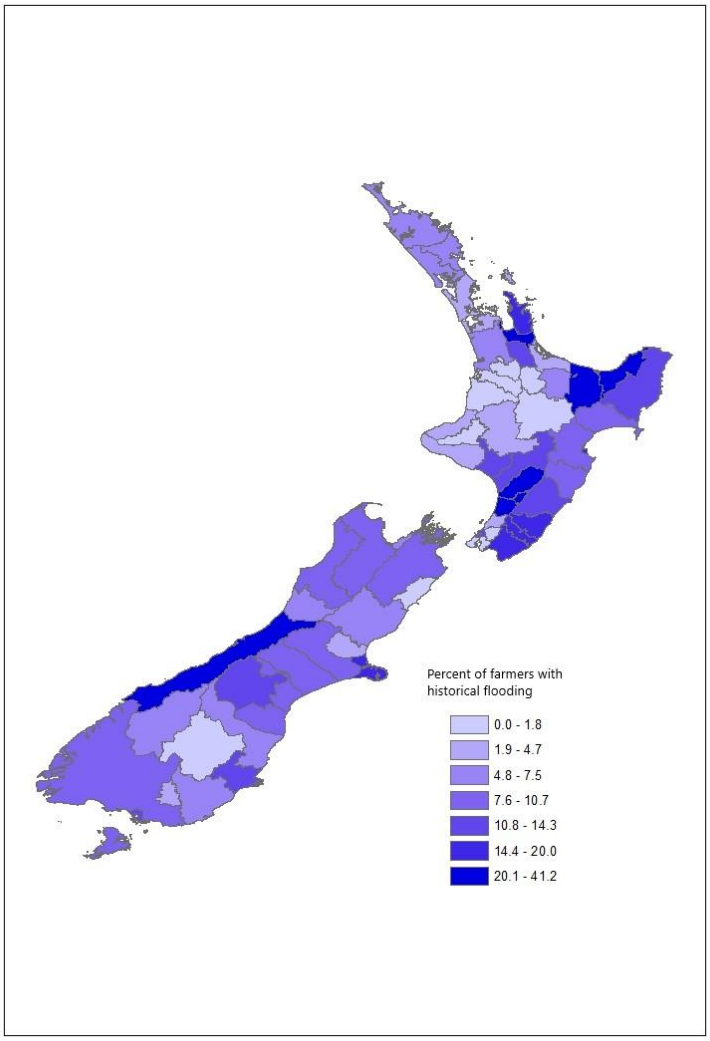
Figure 4 shows the results of the historical flooding question, with results aggregated at the territorial authority (TA) level. Although there are many areas that overlap with Figure 3, there are several notable areas where farmers said they faced flooding concerns, but where flood risk maps don't show a risk. For instance, on the eastern side of the Bay of Plenty, Figure 3 does not show many areas of flood risk. However, the average SRDM response in that area is one of the highest in the country. Farmers there have significant concerns about historical flooding, yet official maps might not appropriately reflect that. Conversely, Figure 1 shows that there are several flood schemes in that area of the Bay of Plenty.

A similar conflict can be seen in the West Coast TAs, where farmers express significant concern, yet the flood maps we could obtain did not reflect those concerns. This

[5] For more information about the SRDM, see https://www.landcareresearch.co.nz/science/portfolios/enhancing-policy-effectiveness/srdm/srdm2017

may be a function of publicly available data or maps; local authorities may be aware of flood risks, but do not fully share them publicly.

Figure 4: Aggregated SRDM Flood Hazard Responses



Another measure of local flood awareness can be obtained from the Earthquake Commission (EQC). For homes that have private insurance coverage (and hence pay fees to the EQC), the EQC will cover some of the flooding damage to their land (but not the structure).[6] A high occurrence of flood damages should correlate with more EQC claims, which should translate into more local awareness. If householders in an area are constantly facing flood damage, it should be clear that there is a flood risk. We obtained data from EQC

[6] Another Deep South-funded research project explores EQC claims in more detail: https://www.deepsouthchallenge.co.nz/projects/extreme-weather-climate-change-eqc

on flood-related claims locations and merged them with New Zealand meshblocks (the smallest NZ Census area). Figure 5 depicts those data, where meshblocks with a higher number of claims (irrespective of the value of the claims) are shaded darker. The figure shows that the Bay of Plenty has several areas where meshblocks have higher counts of EQC claims. Those areas correspond to the SRDM responses and flood scheme maps, but are partially at odds with the flood hazard maps.

Figure 5: EQC Flood claims and meshblocks

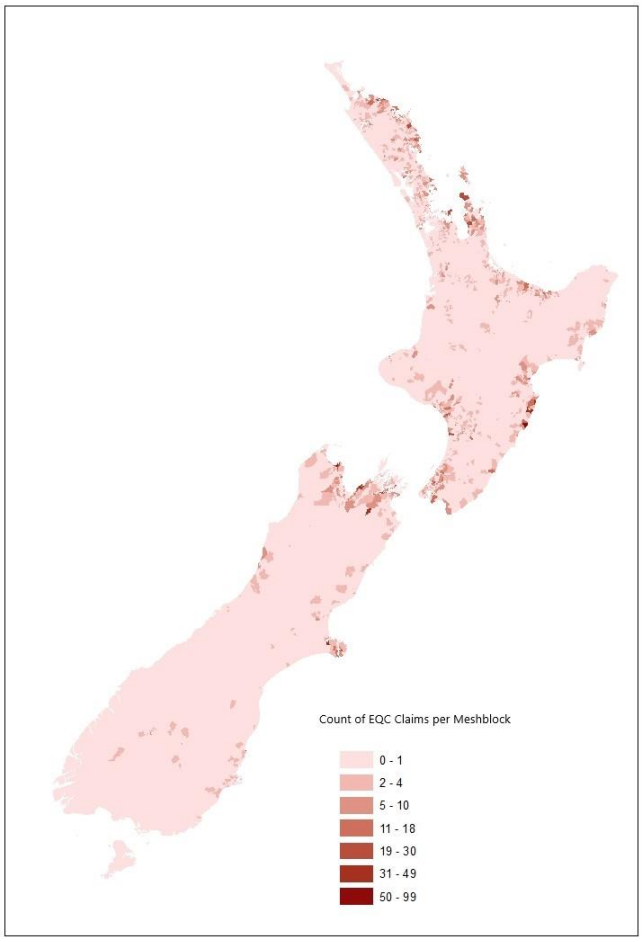
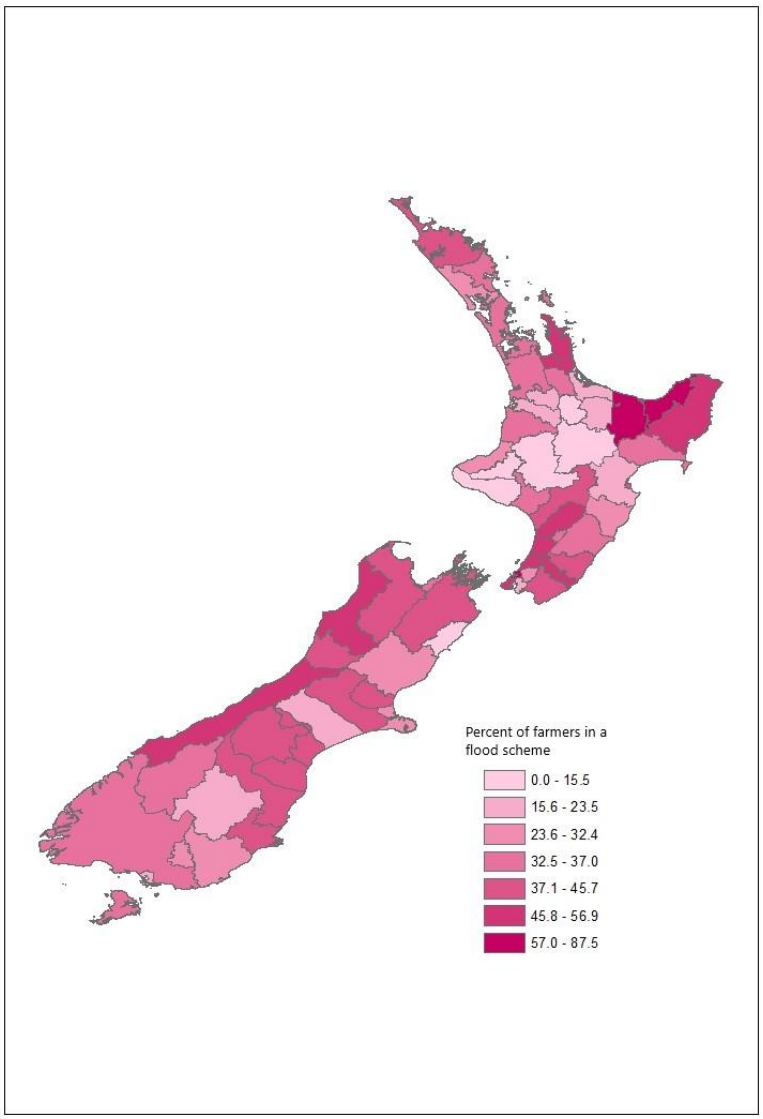


Figure 6 contains the result of the SRDM question about flood schemes. These results are roughly representative of the flood scheme maps in Figure 1, with a few minor differences. First, there were 29 survey respondents in Auckland who said that they participated in flood schemes. Nelson and Marlborough also had a handful of people that said yes to the flood scheme question. Since none of those regional councils use flood schemes, there might be other local flood mitigation groups or efforts that they are thinking of. These responses could be due to uncertainty in the question they are asked. Since flood schemes were not fully defined, the question may have confused people in areas where they are not used.

Figure 6: Aggregated SRDM Flood Scheme Responses



1.5 Threat of Sea Level Rise

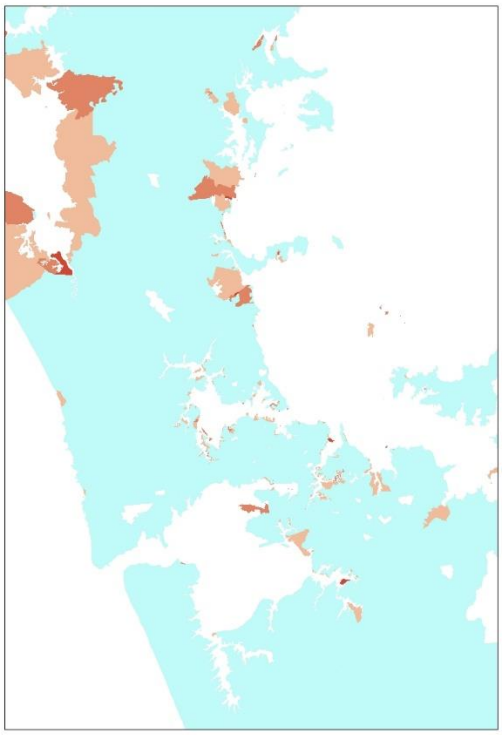
With its long coastline, New Zealand faces substantial threats from future sea level rise (SLR), with official estimates suggesting New Zealand will see 5-10% more than the world average.[7] In coordination with the Intergovernmental Panel on Climate Change, several

[7] https://www.niwa.co.nz/natural-hazards/hazards/sea-levels-and-sea-level-rise

potential time paths for sea level were developed, as contained in Bell et al (2017). There are several alternative ways to assess the threat of SLR, as it relates to local economic and social data. In a 2015 report prepared for the Parliamentary commissioner for the environment, NIWA presented several measures of SLR risk.[8] Their analysis used digital elevation maps nationally, and LiDAR maps where available to assess SLR risk.[9]

We were interested in linking a national elevation map to meshblocks to produce a consistent map that could be linked to a range of other factors. As a first step, we used 8m elevation maps to identify areas most at risk for SLR. Flood damages in those areas would be expected to increase significantly over the next century. For example, Figure 7 is a map of threatened areas in Auckland, mapped at the meshblock level. Darker red areas indicate higher proportions of the meshblock under 0-1 m. The map indicates that there are significant areas under threat in Auckland at just the 0-1 m level.

Figure 7: Auckland SLR Threats

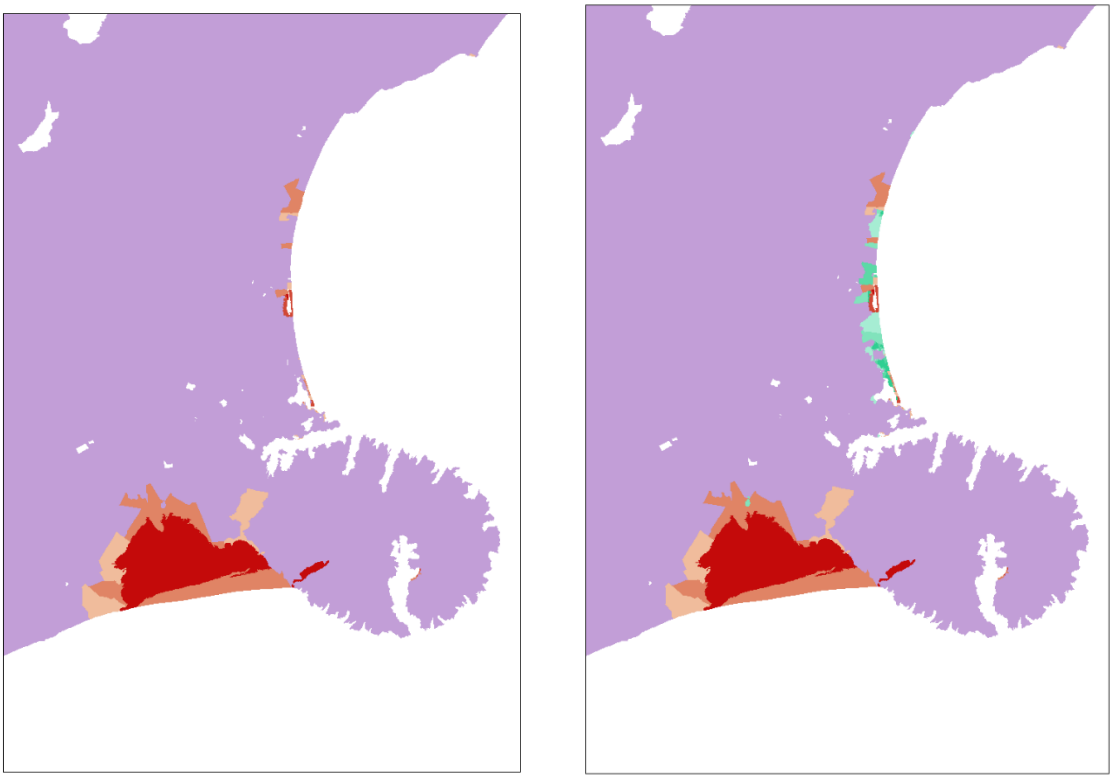


[8] A wealth of NZ-specific information and assest at risk can be found at: https://www.pce.parliament.nz/media/1384/national-and-regional-risk-exposure-in-low-lying-coastal-areas-niwa-2015.pdf.

[9] LiDAR maps are typically available in urban areas. Many of the LiDAR maps for NZ can be found at: https://data.linz.govt.nz/group/national-elevation/data/category/elevation/

Figure 8 contains similar maps of SLR threats for the Christchurch area. The main coastal urban area of the city appears in the middle of the map along the curved vertical coast. The left side of the figure shows meshblocks with SLR risk at the 0-1m level. The map on the right side of the figure also contains 1-2m risk in green, where a darker green indicates higher risk. These maps are available from the authors upon request. They should hopefully provide the research community a nationally consistent measure of SLR threat that is easily linked with many other datasets.

Figure 8: Christchurch SLR Threats



1.6 Discussion

To help fill information gaps in flood risk and awareness, this project conducted an extensive data collection effort with government, academic, and private parties. We focussed on flood schemes as a way of financing flood management and find that they are widely used across the country, although there is heterogeneity across regional councils. Mirroring past findings (Storey, Noy et al. 2017), we find that there is still a significant need for centralised methods, maps, and data on flood hazards and mitigation. Although several regional councils provide exemplary public flood hazard information, others are inhibited by lack of funding, analysis, and publicly available resources.

Based on national survey questions and data from the EQC, we also find that there may be differences between public awareness of flood hazards and official flood maps. To properly plan future flood policy and ensure responsible decisions by citizens, it is important

that public awareness of flood risk matches actual hazards. A major insurance company recently announced that their home insurance policies will be priced differently depending on natural hazard risk.[10] This could have substantial implications for future home sales and risk assessments. If insurance premiums increase to match other developed countries, some homes might become unaffordable for their current tenants. It will therefore be critical that homeowners are properly informed of their actual flood risk, particularly before purchasing a home.

This brief paper provided an overview of several databases collected under this research project. There are also several extensions of this research under development. First, we are running statistical models that explore the determinants of flood scheme locations. Due to their design, which uses property taxes, flood schemes may be more likely to be deployed in higher income areas. We investigate this possibility in a companion paper. Second, we also use statistical models to identify the impact of flood schemes on EQC claims data. Initial results suggest that schemes significantly reduce the number of EQC claims, as well as claimed damages. Finally, ongoing research at NIWA is using soils data to better identify areas of historical flooding to complement existing flood hazard maps.

1.7 References

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[10] https://www.nzherald.co.nz/personal-finance/news/article.cfm?c_id=12&objectid=12226077