

2015

Investigating Flood and Climate Change Perception in the Hutt Valley



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03/02/2015



WPI



Abstract

Major floods pose a risk to the Hutt Valley due to surrounding geography and increased urbanization. Climate change models suggest flood impacts are likely to increase in the coming decades. Our project investigated public perception of flood risk and climate change in the Hutt Valley. To achieve this goal, we developed and conducted a public survey in collaboration with the Greater Wellington Regional Council. Based on the results of 202 face-to-face interviews with the Hutt Valley public, as well as five in-depth business interviews, we developed a set of awareness and education proposals to support the efforts of the regional council.

Authorship

Team statement: In the creation of this report, Google Documents was used in order to best write cooperatively. The team collaborated in the writing of each section, with each member responsible for the first draft of a significant number of sections. Upon completion, every member read through each section and made appropriate suggestions. Following individual editing, the team read through the paper and accepted said suggestions after discussion. Each person contributed equally and substantially to this report.

Executive Summary

Introduction

According to numerous climate scientists and institutions, including the Intergovernmental Panel on Climate Change (IPCC), climate change is expected to cause more frequent and severe floods worldwide (Arnell & Gosling, 2014; Khan 2012). In New Zealand, the Hutt Valley, located north-east of Wellington with a population of around 130,000 people, has experienced major floods in 1976 and 2004 and is likely to be more vulnerable to climate-induced flooding (Statistics New Zealand, 2013).

To address flooding, The Hutt Valley Flood Management Plan (FMP 2001) was developed in the 1990's by the Greater Wellington Regional Council (GWRC) through a community consultation process, and has relied on river engineering, afforestation, and limited building construction in flood-prone areas (Greater Wellington Regional Council, 2001; Greater Wellington Regional Council, 2013). The FMP is currently being reviewed by the Greater Wellington Regional Council in order to take into account the increased risk of severe flooding associated with climate change.

In order to update the FMP in ways that respond to the views of the local community, the GWRC asked us to investigate public perception of flood risk, climate change, and the effectiveness of flood mitigation measures implemented under the plan. To accomplish this goal, we developed four objectives to guide our project:

- Understand the physical geography and hydrology of the Hutt River
- Understand current government flood management practices and community outreach strategies
- Assess local business perspectives on flood risk, climate change, and flood planning
- Investigate public perception of flood risk and climate change and what factors shape this perception

In order to accomplish the first two objectives, we spent the first couple of weeks touring the area as well as holding meetings with various members of the GWRC and HCC as well as other various key members of the public. We then went on to investigate the public's perception. To do so, our group designed a five to ten minute convenience sample survey. The questions were comprised of both open-ended questions and closed-ended questions that led to a variety of both qualitative and quantitative responses. During our surveying time, we also interviewed five businesses in order to gain their perspective. We asked businesses a more in-depth set of questions which were meant to probe deeper into their views, as well as understand their thoughts on the current planning process. While surveying, we targeted high traffic areas in the Lower Hutt City to maximize our number of respondents, as well as obtain a broad range of demographics from the public. An example of a survey location can be seen in Figure A.



Figure A: Petone Railway Station

In total, we were able to conduct 202 surveys in the Hutt Valley. Upon concluding surveying, we compared the responses between different questions and the demographics of the survey participants in order to find relationships in the data. To do this, we used the chi-squared test for variable independence. To run the chi-squared testing we used a combination of several computer scripts. When a significant pairing was found, the scripts then formatted the data into a human-readable and Excel-compatible spreadsheet. The data in the spreadsheet was used to illustrate relationships between the variables in questions, both textually and graphically via the use of charts.

Findings

Residents of Hutt Valley believe that the area is likely to experience a major flood soon, however blind trust in those responsible has resulted in a disproportional amount of concern. Flooding in the Hutt Valley is viewed as a high frequency, low impact event, confining public perception of flood impacts to transportation and ability to work rather than personal impacts, such as residential damage. Participants underestimate the risks associated with flooding, and the realistic characteristics of a 1 in 440 year flood are foreign to most.

The public had limited knowledge about flood management, despite their concern of the flooding. Few were able to correctly identify the current flood protection manager or provide detail about past flood protection measures. Participants were understandably confused as to who controls flood protection of the Hutt River, as division of responsibility is quite complex. Less than a third of the survey participants were able to correctly name the GWRC as responsible for flood protection, as can be seen in Figure B.



Figure B: Responses for who is responsible for flood management

A respondent’s source of knowledge was found to impact their level of knowledge and understanding of flood protection. Those receiving information from the media were more likely to identify the HCC as responsible for flood protection than those obtaining information from government sources. Additionally, respondents receiving information from government sources were found to be far more likely to believe that the current flood measures have reduced the risk of flooding than those receiving information from the media.

Residents overwhelmingly believe that climate change is happening and needs to be addressed. Of our respondents, a quarter admitted that they knew little or nothing about the issue, but three-quarters knew enough to at least realize its potential impact on flooding, as can be seen in Figure C.

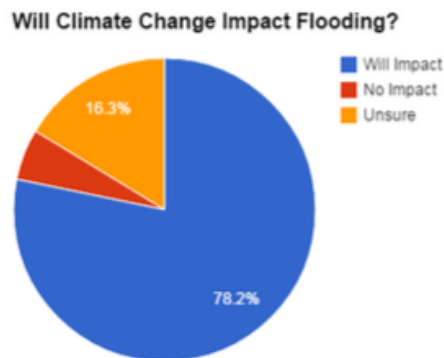


Figure C: Will climate change impact flooding?

However, less than half of the respondents that believe climate change will impact flood risk think that flood risk will increase. This is the opposite of what climate change and flood models predict. The majority of participants did not know any methods to adapt to the impacts of climate change, with most responding with mitigation efforts, such as reducing emissions by taking public transportation or biking to work. Few offered adaptations that could be done on the local level.

Of the five business owners we interviewed, none felt included in the flood planning process. However, not many seemed to want to be involved. The Chamber of Commerce seemed

to be the only one that was concerned, and felt that more businesses should want to get involved. When asked how this could be done, two business owners suggested more public forums, while others suggested business-centered focus groups. Several stated that the Chamber of Commerce would be an excellent source to disseminate information on the issues and how to become more involved.

In meeting with the GWRC, it was found that they rely heavily on government publications in the form of their website, newsletters, and newspaper articles to circulate information regarding upcoming plans. They then hold workshops and open forums that allow stakeholders to express their opinions on plan options. The council incorporates feedback from these meetings into their options. With most of those aged 18-25 unable to identify the GWRC as responsible for flood risk management, as seen in Figure D, it is possible that the information being sent out is not reaching everyone that it needs to.

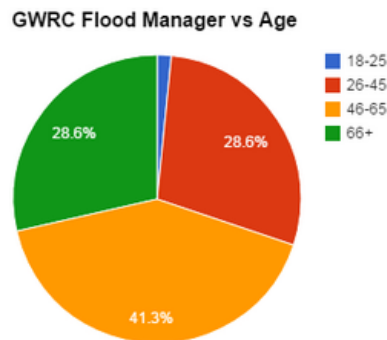


Figure D: Age distribution of those who identified the GWRC as flood risk manager

Recommendations

The GWRC should more clearly communicate flood risk in the Hutt Valley, and stress that the area is always going to be at risk of flooding, despite any and all future flood protection works. This could be done by making the flood risk more personalized, such as reframing the statistic of a “1 in 100 year flood” as “a 26% chance of flooding during a 30-year mortgage”. While these two statistics state the same fact, the latter is more relatable. Another way to do this would be to create an interactive simulation of flooding potential in the Hutt Valley in order to make the problem more relatable to the people affected by it.

Creating a pamphlet going over information on how to be prepared for a flood would allow the public to take individual action. Other individual ways to become involved could be keeping the river clean by not dumping rubbish in it. Signs could be posted along the river that explains how rubbish can clog drains that are supposed to help protect against flooding, as well as the damage to native species. Taking care of your property to keep drains clear is another way the public could become involved.

The GWRC already has multiple resources to distribute information and receive feedback from the public. However, it was found that most of the public does not know where to access this information, and has therefore received none or limited knowledge from reputable sources. The best way to broadcast this information would be through public databases such as the

Wellington library network, the Lower Hutt Chamber of Commerce, or other media outlets such as local newspapers like the well-read *Hutt City News*. The Wellington Library Network has the ability to reach out to over 200,000 members, while the Chamber of Commerce can reach out to 3,500 businesses. An additional method to contact the public could be the use of media outlets, such as their own social media pages, to communicate upcoming events and the importance of the topics being discussed. Any and all methods should promote the online tools the GWRC already has available, as currently only a fraction of the population seems to be familiar with them.

We suggest that the GWRC involve the community sooner in the planning process than is done currently. For businesses, this could be done in collaboration with the Chamber of Commerce, as they can reach a broad member base and have influence in the business community. Additionally, focus groups with several members of the business community could be run earlier in the process to obtain the feedback from this important stakeholder.

Moving forward, we suggest that the GWRC conduct further research in several key areas. During our study we interviewed five businesses, which is not a representation of the business community as a whole. Speaking with a larger number of businesses as well as a wider variety would be useful to gain a better perspective of these key stakeholders, and understand the differences between the different sizes and types of businesses in the area. The influence of major events could also be explored. If a major flooding event were to occur elsewhere in New Zealand, it would be interesting to see if and how that affected the Hutt Valley's view on flood risk. Additionally, researching a respondent's knowledge of flood risk based on whether or not they live in the floodplain could provide additional relationships to compare to the questions.

Acknowledgements

We would like to sincerely thank the Greater Wellington Regional Council for being an amazing sponsor and Worcester Polytechnic Institute for giving us this opportunity. We especially want to thank our contacts at the GWRC, Ross Jackson, Laura McKim, Steve Kamo, and Kristian South for being extremely supportive and helpful throughout this whole project.

We also want to thank the following for their contributions:

- **WPI Advisors:** Mike Elmes & Bob Hersh
- **GWRC Rangers:** Steve Edwards & Grant Timlin
- **Chairperson of the Hutt Valley Flood Management Subcommittee:** Councilor Prue Lamason
- **Lower Hutt City Mayor:** Ray Wallace
- **HCC Contact:** Antonia Wallace
- **Hutt City Chamber of Commerce:** CEO Mark Futter

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Chapter 1. Introduction

According to numerous climate scientists and institutions, including the Intergovernmental Panel on Climate Change (IPCC), climate change is expected to cause more frequent and severe floods worldwide (Arnell & Gosling, 2014; Khan 2012). In New Zealand, the Hutt Valley, located north-east of Wellington with a population of around 130,000 people, is likely to be more vulnerable to climate-induced flooding (Statistics New Zealand, 2013). Since British colonization in the 1840's, collective efforts for local flood control systems have been installed along the Hutt River (Greater Wellington Regional Council, 2001). However, these structures were not designed to deal with the more severe flooding associated with climate change.

The Hutt Valley Flood Management Plan (FMP 2001) was developed by the Greater Wellington Regional Council (GWRC) through a community consultation process. Over the subsequent 15-year period, more than a third of the plan has been implemented. These plans have included techniques such as river straightening, stopbank construction, and afforestation (Greater Wellington Regional Council, 2001; Greater Wellington Regional Council, 2013). A new FMP is currently being developed by the GWRC to account for the increased risk of severe flooding that is expected from climate change.

To help the GWRC develop a plan that is sensitive to public opinion, our project investigated public knowledge of flood risks and climate change in the Hutt Valley region. To understand public perception of flood risk and climate change, we conducted a survey of residents of the Hutt Valley. The findings from the survey will hopefully enable the GWRC to better understand community views on these topics, shape a more informed public discussion, and develop a plan that is supported by Hutt Valley residents.

Chapter 2. Background

This chapter considers the perceptions of flood risk and climate change perceptions in greater depth. First, we explore the history of flooding in the area, the unique conditions that have made the Hutt Valley vulnerable to flooding, mitigation strategies in the Hutt Valley, and the current plans that address flooding. Second, influences on public perception are discussed along with how they affect the public understanding of flood risk. Finally, challenges for effective flood management, including the uncertainty around climate change, the current government structure, as well as stakeholders and the involvement processes are discussed.

2.1 Flooding and Flood Management in the Hutt Valley

Since the initial European settlements in the region, various methods have been used to reduce the flood risk in the Hutt Valley, some of which continue to be used in the most recent flood management plans.

2.1.1 Historical Flooding

The Hutt Valley area, located several kilometers north of Wellington, has long been vulnerable to flooding. In this region, the Hutt River has several major tributaries and a proportionally large catchment area. The location of the region and the map of the Hutt River can be seen in Figures 1 and 2 respectively.



Figure 1: Location of Hutt River catchment (Greater Wellington Regional Council, 2001)



Figure 2: Map of the Hutt River (Greater Wellington Regional Council, 2010)

Flooding is not a new issue for the Hutt Valley, as floods have been recorded back to 1840, when British immigrants first settled the area (Khan, 2012). The Hutt Valley area has had a recorded 141 floods in just a 151 year span, from 1840 to 1990 (Khan, 2012). The largest of these floods was in 1898, when the water levels of the river rose by 990mm in just thirty minutes (Ballinger, Jackson, Reisinger, & Stokes, 2011). At a flow rate of 2000 cubic metres per second, referred to as cumecs in the local vernacular, the 1898 flood filled the valley floor with waters reportedly knee deep in the Lower Hutt township (Greater Wellington Regional Council, 2001; Judy Lawrence, Tegg, Reisinger, & Quade, 2011, October). Figure 3 depicts flood waters during the height of the 1898 flood.



Figure 3: 1898 Hutt Valley Flood (Hutt Valley Flood Management Subcommittee, 2013)

In 1998, two major floods occurred within a week of each other. The floods, topping out at 1305 and 1540 cumecs respectively, caused relatively little damage for their size. Only known trouble spots had major damage, attesting to the quality of the flood prevention system in the Hutt Valley (Greater Wellington Regional Council, 2001). A photo taken during the height of the flood can be seen in Figure 4.



Figure 4: October 1998 Flood downstream from Moonshine Bridge (Greater Wellington Regional Council, 2001)

The last major flood in the Hutt Valley occurred in February 2004. During that flooding event, “heavy rain caused the Waiwhetu Stream to burst its banks and caused major flooding to Riverside Drive, the Hutt Park raceway and the industrial area in Gracefield,” (Greater Wellington Regional Council, 2004). Though the damage was not caused by the Hutt River itself but rather a tributary stream, the flood was notable for exposing communications and warning systems that broke down or were overloaded during the event. Since that time, flood protection measures have been implemented to correct these systems, though there has not been an event large enough to test them (Judy Lawrence, Tegg, Reisinger, & Quade, 2011, October).

2.1.2 Causes and Costs of Flooding

The Hutt Valley area has a high flood risk for a variety of reasons, most of which will be exacerbated due to climate change. Heavy rains, storms, high tides, and sea level rise due to climate change create an area that is highly at risk to flooding (Khan, 2012). Additionally, development in the area has increased over the past 150 years and has “cleared the nearby hill slopes of indigenous vegetation and urbanized the floodplain confining the river to its present path” (Ballinger et al., 2011). Developed areas greatly increase water runoff, which has risen in

the Hutt Valley by 14% since the 1970's. This has caused increased soil erosion along the river, which further increases the impact of the effects of climate change in the Hutt Valley, as the severity and frequency of storms are increasing. This change can be attributed to the increase in the water holding capacity of the atmosphere when the temperature rises (Ballinger et al., 2011). The lack of vegetation in combination with the increase in high tides and sea level rise creates an extremely vulnerable floodplain (McKerchar & Henderson, 2003). Vegetation is an important defense against flood, as their roots hold water and soil (Beattie, 2003). The roots of riverside vegetation are also important in lowering the water level of the river by absorbing runoff.

The main cost of modern flooding is economic, repairing infrastructure such as roads, buildings, and bridges that are washed out. Between 1976 and 2004, the average annual cost for flood maintenance was around \$17 million dollars (NZD) (McSaveney, 2012). The peak year for flood costs was in 1984, where it was estimated that New Zealand paid out over \$110 million dollars (NZD) (Environment, 2004, July). If climate change increases the frequency and magnitude of flooding for Hutt Valley, the cost would rise exponentially due to the increased magnitude in the flood as well as increased population and construction in the area. It is estimated that if a severe flood were to occur in the present day, the tangible damages caused would be around \$1.7 billion (Hutt Valley Flood Management Sub-committee, 2013).

[2.1.3 Past Flood Prevention Efforts](#)

The 1898 flood set flood planning in motion in the Hutt Valley. The design and installation of stopbanks along the Hutt River began in 1901 in response to the 1898 flood. Comprehensive flood plans for the region began to be developed around this time as well. These plans led to Hubert Sladden's "Ultimate Alignment Plan," a large-scale multi-faceted effort which provided the basis of all river control works until 1985 (Easter, 1991). Under this plan, a variety of different flood prevention techniques were employed, with the most notable being river straightening, afforestation, and the aforementioned stopbanks. A full list of definitions for past flood protection measures can be seen in Appendix A.

The 1998 floods proved to be a foundation for a new plan for the region, despite the fairly light amount of damage. The floods showed that the system worked well enough for historical flood levels. The 1998 floods raised the question of whether the system could survive future

floods that were expected to be larger than any previous floods. Options to improve the system began to be explored and eventually lead to the development of the Greater Wellington Regional Council's 2001 Flood Management Plan (FMP 2001), which was the basis for all flood prevention related projects in the region going forward (Greater Wellington Regional Council, 2001).

2.1.4 Current Flood Management Plan

The GWRC's 2001 FMP, developed in response to the 1998 floods and fears of more violent floods, is "a foundation for implementing structural and non-structural measures, and an environmental strategy for enhancing the river environment," (Greater Wellington Regional Council, 2001). The plan was created to address flood prevention techniques, communication between the different involved agencies, and what measures need to be taken in the Hutt Valley to mitigate future flood risk. The plan provided an outline for all flood prevention related projects in the Hutt Valley and was designed to identify key weaknesses where improvements are necessary, determine controversy/opinion of the public and relevant other parties, and recommend an appropriate management structure (Helen, 2012, April; Greater Wellington Regional Council, 2001). The plan provided a guideline for managing and implementing programs that gradually reduced flooding effects (Greater Wellington Regional Council, 2001).

The 2001 FMP called for the design of protection measures able to withstand a flood of 2,300 cumecs, with stopbanks high enough to contain 2,800 cumecs. A flood of 2,300 cumecs was considered a 1 in 440 year flood at the time of development (Greater Wellington Regional Council, 2001). The implementation of the plan is governed by the Hutt Valley Flood Management Subcommittee (HVFMS) who in turn provides recommendations to the Greater Wellington Regional Council (GWRC), Hutt City Council (HCC) and other affected agencies (Hutt Valley Flood Management Subcommittee, 2013). Most of the plan was implemented using rates from the public and GWRC funding following the release of the FMP in 2001. The implementation of the plan consisted of raising stopbank heights and widening the river (Greater Wellington Regional Council, 2001).

In 2013, the 2001 FMP was used to develop a specific plan for the Hutt City portion of the river. As of this writing, the 2013 portion of the plan has yet to be implemented due to a

reconsideration of the effects of climate change. When implemented, the plan calls for upgrading the stopbanks as the 2001 plan suggested, river widening and bridge replacement. Stopbanks breadth will be increased, as will the height. Some narrow portions of the channel (particularly around bridges or city development) will be widened to allow increased water flow. Several bridges do not meet the height requirements for a 2,800 cumec flood and will be replaced when time allows (Hutt Valley Flood Management Subcommittee, 2013).

2.2 Public Understanding of Flood Risk

Studies in risk perception attempt to understand the knowledge and awareness of the public in relation to certain events or hazards. Flood risk perception studies began in the United States in 1945, when Gilbert White published his thesis on how Americans adjusted to flooding (Kellens, 2013). Since that time, flood risk perception studies have been conducted around the world giving key insights into how members of the public perceive flood risk.

2.2.1 Heuristics

Comprehending public strategies of forming opinions and decisions is vital to consider when gathering and understanding the public's perception of flood risk and climate change. The opinions individuals form can be influenced by a preformed set of heuristics, broken down into availability and affect.

The availability heuristic influences public perception of flood risk through falsely perceived statistics and environmentally influenced emotions, subcategorized by: the gamblers fallacy, truncation of frequency, the certainty effect, statistical framing, and emotional influences such as optimism or herd behaviour. The gamblers fallacy states that when a probability is situationally one sided, individuals believe the other probability will occur due to its presence or rather lack thereof. In terms of flooding, if a flood does not occur for a period of time, then a given area is "due" for a flood (Kousky & Shabman, 2015). Truncation underestimates already small probabilities. For example, public perception looking at a 1 in 440 year flood would round the odds to 0, making the risk non-existent (Kousky & Shabman, 2015). The certainty effect relates to the willingness of the public to accept measures based on the certainty of a result rather than the difference. For example, people will be more willing to accept a flood plan that would reduce the risk from 1% to 0% rather than a plan reducing the risk from 2% to 1%, despite being

equal in probability change (Kousky & Shabman, 2015). Statistical framing states that presentation of a question to the public can have influence over the responses. Under this idea, a 1 in 100 year flood would be better understood if framed as “26 percent chance of [a major flood] occurring during the life of a 30-year mortgage,” (Kousky & Shabman, 2015). Optimism describes that positive thoughts of personal safety from a flood causes a belief that the flood risk is less than it currently is (Kousky & Shabman, 2015). Lastly, herd behaviour, also known as cascading, describes the phenomenon of altered individual responses when the group response to a question is known. For example, if most of the general public believes one thing, then an individual is more likely to hold the same belief (Kousky & Shabman, 2015).

The affect heuristic describes the categorization of risks by the public, and that the public uses immediate emotions to judge probabilities. In general, the public tends to overweight small probabilities and underweight large ones. Individuals have a general lack of desire for good aspects to be risky, and likewise, a desire for bad aspects to be uncertain. (Kousky & Shabman, 2015)

[2.2.2 Public Perceptions of Flood Risk and Climate Change](#)

Public perception of flood risk depends on many factors, all of which can be influenced by the heuristics described in the preceding section. A person’s experience can have an impact on their perspective of flood risk, with several studies comparing risk perception of flood victims to non-victims. A Dutch study found that victims of flooding were found to be generally more aware of the risks as they felt more vulnerable to future floods than non-victims. Respondents to a Swiss study informed researchers that recent and frequent floods resulted in higher levels of flood risk perception (Kellens, 2013). In a 2011 study of Hutt Valley residents, “flood-affected respondents had stronger preferences for restricting new buildings or renovations in high-risk areas, modifying or shifting existing buildings away from high-risk areas, deepening river channels, and improving the stormwater network than respondents who were unaffected by flooding,” (Lawrence, 2011). This means that those who have not experienced a flood believe that structural measures are adequate, which is an example of the optimism heuristic. Without flood experience and knowledge of flood prevention measures, people believe they are safe since they have not been affected by flooding (Kousky & Shabman, 2015).

The engineering approach has dominated flood management planning in New Zealand, with a heavy reliance on structural measures such as stopbanks, dredging, and planting vegetation, and with less reliance on building and land use restrictions. These structural solutions, both in the Hutt Valley and all of New Zealand, provide a false sense of security and encourage continued development in an area at a high risk for major flood damage. Successful flood reduction initiatives in some cases have been shown to reduce public awareness of risks as well as a reduction in the amount of personal mitigation taken by citizens (Kellens, 2013). In a Dutch study it was discovered that areas of the Netherlands, vulnerable to severe flood risk, had been so well protected that the public tended to underestimate flood risks due to their lack of personal experience (Terpstra, 2011).

A great deal of Hutt Valley residents believe that the area is “flood free” because of the stopbanks that were put in place to protect against a 1 in 440 year flood (J. Lawrence, Reisinger, Mullan, & Jackson, 2013). In 2011, more than half of Hutt Valley residents were found to be unaware of the level of flood risk they were exposed to (Lawrence, 2011). In order to avoid inappropriate complacency, it is important for the public to know that despite significant efforts, there is no way to completely prevent floods from occurring. The current stopbanks along the Hutt River were designed to protect against a 1 in 440 year flood, but the GWRC is unsure if this standard provides adequate protection due to the uncertainty of the impacts of climate change. Figure 5 depicts the affected area in the event of a major flood, showing that even with the improved flood protection system, there is still a chance for significant flood damage should there be a failure.

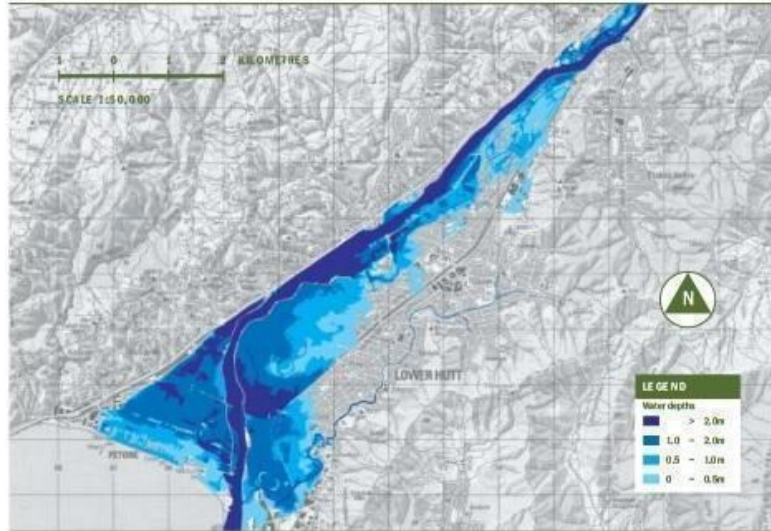


Figure 5: Flood Impact under major flood with system breaches (Greater Wellington Regional Council, 2001)

An underestimation of flood risk poses a problem in the Hutt Valley, especially when accounting for climate change. Flood risk in the area is predicted to increase due to the effects of climate change in the future, which will make the current FMP inadequate. In order to produce effective flood risk and climate change policies, it is necessary to understand the public perception on the issues. In a 2011 study, Hutt Valley residents “saw denying future increases in flood risk [due to climate change] as erroneous,” (Lawrence, 2011). In other words, the public was found to believe that flood risk will be impacted by climate change in the future and action needs to be taken accordingly. Persons who have some knowledge of climate change are more likely to support policies aimed at reducing carbon emissions or climate change mitigation strategies. In a study of undergraduate business/economics majors, 90% of respondents say they support funding research into green energy technologies (Bostrom et al., 2012). A Norway case study found similar results, with 89% of respondents supporting policies that would reduce greenhouse gas emissions. (Lynn D. Rosentrater, 2013). Therefore public awareness of climate change and the threats it poses is key to future planning in the Hutt Valley.

2.3 Challenges to Flood Management

The Greater Wellington Regional Council faces several challenges in terms of managing flood risk. In the following section, the issues of public trust, climate change uncertainty, current government structure, and stakeholders and involvement are explored.

2.3.1 Public Trust

Public perceptions of flood risk and climate change can be directly tied to their views and opinions of the government agency attempting to correct those issues. Studies have shown that there is a strong connection between the public's perception of the risk management agency and their perception of the hazard itself. In other words, "if you cannot evaluate the risk, evaluate the risk manager," (Keller, 2012). In terms of the council, this means that past actions in the flood prevention and climate change fields could adversely affect the public's views on the issues.

During the 1970's, river straightening was attempted in earnest on the Hutt River. While moderately successful on the lower section of the Hutt River, by the 1980's it was deemed unsuccessful on the upper section of the Hutt River. The failure of the upper section of the Hutt River realignment projects was due to the buildup of debris, increasing river flow speeds and eventually returning the river to its original channel. With this failure, according to one researcher, citizens became wary of flood improvement projects involving river straightening (Easter, 1991). During this same time period, afforestation techniques involved the planting of willow trees along the Hutt River, which not only helped to absorb runoff and excess water, but also aided in holding the soil to prevent erosion and landslides. In recent years, residents of the valley have become discontented with the willows as they are a non-native species and would like to see them phased out in favor of native vegetation (Napp, 2002). Lastly, the 2013 Hutt City Central Business District portion of the flood management project was delayed due to reconsideration of the impact of climate change (O'Neil, 2014). This reconsideration has caused a major setback in what was considered an important plan for the public (Hussey, 2014).

2.3.2 Climate Change Uncertainty

Flooding in New Zealand is predicted to be exacerbated by climate change (Khan, 2012). For example, climate change can affect weather patterns and extreme weather events. In the last 30 to 40 years, annual rainfall in the North Island has increased by 8-9%, while runoff has increased at even higher percentage (McKerchar & Henderson, 2003). This means that as climate change intensifies it is likely that floods will increase in both frequency and magnitude (Khan, 2012). New Zealand's National Institute of Water and Atmospheric Research concluded that if the Intergovernmental Panel on Climate Change (IPCC) is correct in its predictions for global

future greenhouse gas emissions, the mean temperature of the country will increase by 2°C by 2080. This is a large increase in that short amount of time, which has the potential to have a substantial impact on the environment. Several examples include an increase in the country's sea level by between 9 and 88 centimeters and an overall increase in rainfall (Mullan & Gentry, 2012). Due to these changes, what was once considered to be a 1 in 440 year flood in the Wellington area is projected to become 1 in 50 year in the next century (Khan, 2012).

[2.3.3 Government Structure](#)

A challenge for New Zealand in combating climate change and its potential impacts is the lack of a unified government response. There are teams in the New Zealand government at the national, regional, and city level that work independently on climate change and flooding policies. As a result, each regional council must individually spend time and effort on planning and research that could instead be done more effectively on a national scale (Helen, 2012, April). These New Zealand government departments are divided in a way that makes it difficult to work together towards the same goal. According to Fensome (2014), “The councils are not working together effectively – this is not a regional problem, but one of a larger scale.” In a 2011 survey, government officials “reported tensions between district, regional, and central government responsibilities,” (Judy Lawrence, Tegg, Reisinger, & Quade, 2011, October). Without a unified plan endorsed by all the councils, the independently created climate change policies often differ in both framing the problem and solutions (Judy Lawrence et al., 2013).

Political control of the river also poses a challenge for flood management in the Hutt Valley. As local officials described to us, the GWRC controls the river and the land up to the banks, while the HCC controls the land along the river. When it comes to the tributaries, responsibility is often split, with some being under the jurisdiction of the HCC and some under the GWRC. Currently, the HCC and the GWRC communicate about flood protection on a monthly basis. Despite the current cooperation, the HCC has the ability to allow development close to the river, increasing potential flood damage, leaving the GWRC to only voice an objection.

2.3.4 Stakeholders and Involvement

Prominent stakeholders of flood management planning are New Zealand government agencies. In New Zealand, flood management responsibility is shared among three levels. First, on the national level, the major organizations are the Ministry for the Environment (MfE) and the Ministry for Civil Defense and Emergency Management (MCDEM). These two groups share the responsibility of setting national policies for flood risk. The MfE is more focused on setting policies while the MCDEM is focused more on the strategy of the Civil Defense and Emergency Act (CDEM), an act established in 2002 to improve the management of hazards through smaller planning groups. The eleven regional councils, as defined in the Local Government Act (2002), are in charge of translating national policies to the regional scale, while local councils are responsible for land use decisions and regulating building in flood prone areas (Helen, 2012, April).

In addition to government officials, other groups have a stake in flood management plans. One of these groups are homeowners, as residential land that is in the impacted areas of flood management plans may need to be sold in order to make way for proper flood prevention (Hutt Valley Flood Management Subcommittee, 2013). This has happened in the past, and creates tension between the landowners and those trying to implement flood protection measures. This tension is common enough that in a 2011 survey of government officials, a national policy statement on the issue of flooding was recommended in order to provide “a consistent direction that could stand up to pressures when they are challenged in the courts by those wishing to develop land,” (Judy Lawrence, Tegg, Reisinger, & Quade, 2011, October).

The flood management plan intends to promote economic growth through making more land available for commercial development, as well as providing infrastructure upgrades (Hutt Valley Flood Management Subcommittee, 2013). Because of this plan and its potential effects, local businesses are another stakeholder, as they can be severely affected by flooding. Larger chains with many locations are able to withstand the potential loss of a single location and thus are willing to locate into a flood prone area to make a profit. If a small business is destroyed/damaged in a flood, they may not have the resources to recover and thus have much to lose (Kousky & Shabman, 2015). In 2004, the Waiwhetu stream, a tributary to the Hutt River, “burst its banks and caused major flooding to Riverside Drive, the Hutt Park raceway, and the

industrial area in Gracefield,” (Greater Wellington Regional Council, 2004). The flood caused an estimated 200 million dollars in damage to local businesses and residents (Stewart, 2012). In order to implement the flood management plan in the Hutt Valley, some commercial land may need to be acquired by the council. Some local businesses are concerned about the closure of car parks and streets that may occur during and after the implementation of the flood management plan, making it more difficult for customers to reach their stores (Hutt Valley Flood Management Subcommittee, 2013).

The Greater Wellington Regional Council has several measures in place in attempt to better communicate with and involve local stakeholders. As described by members of the GWRC, community and online forums, as well as public workshops are held on a case to case basis to achieve this goal. They announce workshops and open forums to gather input from the public and relevant stakeholders. These are generally used to inform members of stakeholder groups, such as businesses, affected residents, and government officials about the issues at hand. Workshops are comprised of select stakeholders, informed via email or mail with a requirement to RSVP. Members of the GWRC stated that they selected stakeholders based on the policy being discussed. Community meetings, which opposed to workshops, are open to all members of the community and are held on occasion to obtain direct input from members of the public. The GWRC also seeks input from the community directly on their website, where the public can send comments and feedback through forums. When the discussion period ends, the council reviews the plan and incorporates the appropriate suggestions. At that point, the final plan is selected and it is ready for implementation. For flood protection and the flood management plan, the GWRC attempts to include the public as often as possible, however the political sensitivities of many of these plans are often left out of the public spectrum until the plan has been refined down.

Chapter 3. Methodology

The goal of our project was to understand the scope of public knowledge and opinion on climate change and flooding in the Hutt Valley region. The GWRC will use this information to better understand public perception, as well as increase awareness of these risks going forward. Increased awareness will allow the council to create more effective policies that have the support of the public going forward. In order to achieve this goal, we developed the following research objectives:

- Understand the physical geography and hydrology of the Hutt River
- Understand current government flood management practices and community outreach strategies
- Assess local business perspectives on flood risk, climate change, and flood planning.
- Investigate public knowledge of flood risk and climate change and what factors shape this perception.

3.1 Understand the Hutt River's Geography and Hydrology

During our first week in New Zealand, we met with several members of our sponsor organization to tour the area in order to gain a better comprehension of the physical layout of the river. The GWRC organized a few trips with Grant Timlin, a Hutt river ranger from the GWRC, and Steve Edwards, a park ranger from Kaitoke Regional Park, who were familiar with the area and could help us better understand the region. The tours also helped us to identify ideal survey areas with high traffic and a broad range of the population. Some potential locations we brought back to our sponsor included the Petone railway station and the Westfield Queensgate Mall

3.2 Understand current government flood management practices and approaches to community outreach.

Shortly after our arrival in Wellington, we conducted a series of discussions with representatives from various organizations to better understand their viewpoints, influences, and concerns about the flood risk in the Hutt Valley, as well as the direction of our project. The meetings were set up by our liaison to the GWRC, Ross Jackson. These included representatives from our sponsor the GWRC as well as representatives from the local Hutt City government.

3.2.1 Key Members of the GWRC

In our first meeting with our sponsoring members of the GWRC, we worked to clarify our visions of the project and to identify appropriate deliverables. We met with Ross Jackson, Flood Protection Advisor, Kristian South, Senior Communications Advisor, Steve Kamo, Flood Protection Engineer, and Laura McKim, Policy Advisor. We hoped to gain an understanding of how the council views the issue of flooding and climate change, as well as the politics involved regarding residents and the GWRC's plans and policies. We discussed potentially controversial topics that could pose problems during surveying, such as potential plans to purchase private property for new flood protection measures, or confidentiality agreements made with the council in talking with the media. Additionally, we discussed what they wanted from our project, specifically if they desired any tangible results, such as media campaign designs or a website mock-up. Another point of clarification was the emphasis on climate change vs. flooding in terms of knowledge, priority, and impact. Finally, we wanted to understand the views of the GWRC itself on flood protection and climate change. We understood that they considered it an issue, but to what extent? Was it a top priority issue or one that would be fixed as needed?

3.2.2 Hutt City Council and Mayor

Shortly after our arrival in Wellington, our sponsor set up a meeting between our team, the mayor of Lower Hutt City, Ray Wallace, and selected members of the Hutt City Council (HCC) such as Antonia Wallace, Senior Communications and Marketing Advisor. Another key person in attendance was Judy Lawrence, Adjunct Research Associate at the New Zealand Climate Change Research Institute. In the meeting, we not only wanted to introduce ourselves, but also gain a valuable perspective on the issue of flood prevention. To that point, we had learned of the politics surrounding the flood protection on a regional scale; however we wanted to view it on a more local level. The officials we were meeting with had jurisdiction in the Lower Hutt City and the uses of the land in that area. (The GWRC has rights over the uses of the water/riverways). Our discussion, which lasted approximately 30 minutes, focused on the following questions:

- What were the areas of agreement and disagreement between the local and regional government in terms of flood protection?
- How were the roles and responsibilities of local vs regional council understood?

- How did the local government understand the severity of the flood risk?

3.3 Assess local business perspectives on flood risk, climate change, and flood planning

During our time in the Hutt Valley, we wanted to gain insight into the perspective of local businesses as they have a large impact on the community, creating jobs and paying property taxes to support local services. We wanted to know how businesses were affected by flooding and flood management plans. To understand this, our sponsor set up interviews with several local business owners. These included Mark Futter, the CEO of Lower Hutt Chamber of Commerce, Chris Mackay of MacKay’s Financial Planning, Cameron Tooley of PackProd, and Harvey Reid of Managing Director of Diesel Gas International Limited. While surveying, we also came across the owner of Craftwood Souvenirs who had heard of our surveying work and wanted to speak with us on the issue.

While interviewing business owners, we discussed their thoughts on flooding and climate change. The interviews were conversational in tone to allow the interviewee to talk freely and for us to ask follow-up questions to any topic they brought up. We began by talking about their broad ideas about flood risk and climate change, asking questions such as, “How would a major flood affect your business?” From there we narrowed our focus into flood protection, asking if they had felt included in the management process or were even aware of it.

3.4 Investigate public knowledge on flood risk and climate change and what factors affect this

To investigate public knowledge, we conducted 202 surveys of those who work or live in the Hutt Valley. We worked with the GWRC on developing a semi-structured survey with a convenience sampling plan and reviewed it with members of several departments, including Flood Protection and Communications. The survey aimed to address the following research themes:

- How concerned is the public about flood risk?
- How much knowledge does the public have regarding flood risk?
- What views does the public hold regarding climate change?

Our survey was based on previously conducted surveys given to us by the GWRC such as a 2011 study conducted by Judy Lawrence in the Hutt Valley, as well as other successful Worcester Polytechnic Institute (WPI) interactive qualifying projects (IQP) in the area. We tested our draft survey on several employees of the GWRC, who gave us feedback on the flow of the survey and clarity of the questions. We then revised the surveys, and tested on eleven more employees. After this test run, we made further revisions to question phrasing, order, and overall flow of the survey. We considered the survey finalized at this point, and began surveying in the Hutt Valley.

We used a convenience sample, meaning the only requirements for the participants were that they live, work, or regularly visit the Hutt Valley and that they were over the required age of eighteen years. The participants were asked about their understanding of the potential flood and climate change risks for the area, with their opinions on both matters being transcribed. We conducted face-to-face interviews in teams of two in several pre-determined locations. One team member surveyed the participant, while the other recorded their responses. As quantity of survey participants became an issue, our team divided into individuals. The survey locations were high profile, highly trafficked areas including the Lower Hutt Central Business District, Melling and Petone Railway Stations, and the Petone Esplanade. These types of locations gave us the best chance to interact with a broad range of individuals who live and work in the Hutt Valley, and were determined by both the GWRC and ourselves. As surveying commenced, we split into smaller groups and were able to cover several of these locations simultaneously. Dividing allowed us to maximize survey participants, especially at high volume times such as around lunch. Pictures of the survey locations can be seen in Figure 6 and 7 below.



Figure 6: Petone Railway Station



Figure 7: Area near Westfield Queensgate Mall, Lower Hutt

Conducting in-person interviews allowed us to ask questions in a particular order and prevented the wording of later questions from affecting the responses of earlier questions. The interviews lasted no longer than ten to fifteen minutes, and on average ran between five to ten minutes, depending on the knowledge of the participant. We interviewed members of the public over a period of two weeks. Our schedule for surveying and other tasks can be found in Appendix B.

The main purpose of the survey was to understand how the public perceives flood and climate change risks, as well as their knowledge of flood protection. The survey questions were mostly open-ended, but some took the form of multiple choice, Likert scale, and yes or no response questions. When conducting the surveys, we provided the survey participants the option to follow along with a copy of the survey, to increase the overall clarity of the questions being asked. If necessary, we also clarified questions as needed. If multiple participants in the same location wished to take the survey at the same time, we gave both participants a copy of the survey to fill out on their own, so that auditory answers would not influence each other. At the end of the survey, we collected information regarding the participants' demographics. Participants were reminded that they could choose not to answer any questions that they did not feel comfortable answering. Information such as age, household income, ethnicity, location of residence, and relation of career field to flooding or climate change was recorded to help us understand how perception of flood risk and climate change may vary along socio-economic dimensions. General awareness of flood prevention and flood risk was collected to determine the current public knowledge of the issue. We then discussed the potential impacts of climate change

in the region in order to gain an understanding of the public's opinion of the topic. Several survey questions that were used are:

- On a scale of 1-5, how likely do you think it is that the Hutt Valley will experience a major flood in the next 30 years, similar to the flood in 2004?
- What can be done in the Hutt Valley to adapt to the effects of climate change?
- What has been done to reduce the risk of flooding in the Hutt Valley?

The complete survey can be found in Appendix C.

The process of analyzing the data began simultaneously with the survey. Coding methods were used to identify themes from open-ended responses. We generated codes based on participants' responses. For example, the question "How would a flood impact your daily life?" was coded into responses such as transportation, work, essentials (food and water), etc. The development of codes allowed us to group similar responses together in an attempt to more easily find common themes in the data. A sample coding list can be found in Appendix D.

During the analysis of the survey, we looked for relationships between responses and participants' demographic information. For example, we might find that age affects knowledge based upon past experiences as is suggested in the literature (Kellens, 2013). We also analyzed relationships between belief of increasing flood risk versus belief in climate change. Comparing different responses between questions and demographics allowed us to discover themes and relationships.

In order to analyze the data, we created computer scripts to organize and compare various responses and demographics from our surveys. Then we used a variable independence chi-square test to see if any factors could be related. This required creating a matrix of data for each possible combination (153 total) of responses from the 18 questions referenced (out of 23 total on the survey). Using this form of non-parametric test, the mathematics required can be simplified as follows:

$$Expected = (sum\ of\ category1 * sum\ of\ category2) \div Total\ responses$$

$$\chi^2 = \sum\{(Obs - Exp)^2 \div Exp\}\ for\ all\ entries$$

$$degrees\ of\ freedom = (columns - 1) * (rows - 1)$$

$$p - value = cdf(\chi^2, degrees\ of\ freedom)$$

If the end p-value is less than .05, then there is an acceptable chance (>95%) that the variable in the table is related and we can reject the null hypothesis that the variables are unrelated. The meaning of the p-value is the percent probability that we are wrong in assuming the variables are related, so for example, if the p-value is .03, there is a 3% chance that we are incorrect in stating there is a relationship between the two variables in the test. After the dependence is determined to be within acceptable bounds (for our purposes, 95% confidence that there is a potential relation or $p < .05$), the scripts output the relevant data in an Excel-friendly format for use in analysis and graphic aids. See Appendix E for a sample of the code used in data analysis and statistical calculations.

The following is an example calculation to determine the p-value for the related factors of “Experienced a flood” and “Age.” To determine these values, we first calculated the expected values of data based on our observed values, as seen in Figure 8.

Observed values:

	18-25	26-45	46-65	66	NA	TOTAL
No	26	33	17	12	4	92
Yes	16	30	40	21	2	109
TOTAL	42	63	57	33	6	201

Expected values:

	18-25	26-45	46-65	66	NA	TOTAL
No	$92 * 42/201$ $= 19.2$	$92 * 63/201$ $= 28.8$	$92 * 57/201$ $= 26.1$	$92 * 33/201$ $= 15.1$	$92 * 6/201$ $= 2.7$	92
Yes	22.8	34.2	30.9	17.9	3.3	109
TOTAL	42	63	57	33	6	201

Figure 8: Expected values from observed values

From the observed and expected values, we calculated the chi-squared statistic (χ^2). To calculate χ^2 , we used the formula, $\chi^2 = (Observed - Expected)^2/Expected$. Figure 9 shows this calculation using the data from Figure 8.

$$\chi^2 = (26 - 19.22)^2/19.22 + (33 - 28.8)^2/28.8 + (17 - 26.1)^2/26.1 + \dots = 13.712$$

Figure 9: Sample χ^2 calculation

With χ^2 , we needed to calculate the degrees of freedom for the relation by simply using the formula *degrees of freedom* = (columns - 1) * (rows - 1). With degrees of freedom in hand, the p-value could be calculated using the equation $p - value = cdf(\chi^2, degrees\ of\ freedom)$, with cdf representing the cumulative distribution function. In this case, the result of the p-value was 0.00827. Since 0.00827 is less than the decided acceptable error of 0.05, we can determine that there is a strong likelihood that “Experienced a flood” and “Age” are related.

The remaining five questions from our survey were open-response, meaning they had no categorical or numerical basis on which expected values could be calculated. These were not analyzed statistically, but rather on a word-frequency basis. The results to these questions were categorized in the fashion mentioned earlier. The script we created was able to identify the

frequency of our coded responses. This allowed us to report knowledge of non-quantitative topics, such as what can be done about climate change, based on common responses.

After the survey responses were analyzed, we presented our findings to a joint meeting of the GWRC and the HCC. These findings highlighted public knowledge and perception of the current flood risk, climate change, and how flood risk can be affected by climate change. We also discussed how these perceptions vary to give the GWRC the insight it needs about which areas and people to target in order to increase overall knowledge on flood risk (Greater Wellington Regional Council, 2001).

Chapter 4. Findings

This chapter will present our findings organized by our objectives listed in the beginning of Chapter 3.

- Understand the physical geography and hydrology of the Hutt River
- Understand current government flood management practices and community outreach strategies
- Assess local business perspectives on flood risk, climate change, and flood planning.
- Investigate public perception of flood risk and climate change and what factors shape this perception.

4.1 Geographical and Hydrological Findings

On our tours with the rangers, Steve Edwards and Grant Timlin, they showed and explained the unique geography of the region that makes the river so vulnerable to flooding. They discussed the relationship between the geography of the area, the hydrology of the river, and the infrastructure along the river. We explored areas that are prone to flooding and erosion, as well as the human and natural causes that shape the geography of the river.

On our tour with Grant, we visited the central business district of Lower Hutt specifically mentioned in the 2013 City Scoping Report, as well as sites in the upper Hutt Valley that are also at risk to flooding. These locations involved flood-prone structures such as the Melling Bridge and an exposed sewage pipe located in the suburb of Silverstream. River straightening of the Hutt River has led to increased river velocity, especially during flooding events. This increased velocity has led to higher erosion rates, and in turn more pronounced erosion damage, both along the banks and the bed of the river. Erosion has been particularly bad at a Silverstream sewage pipe, located approximately 500 meters downstream from the Silverstream bridge. When constructed, the pipe was buried five meters below the river bed. Now, the pipe is completely exposed at the surface. As erosion wears down the bed of the river, it places strains on infrastructure located in the river, such as sewage pipes. These pipes were not designed to protect against the flow of a river, as they were expected to have sediment above them to protect them. This can cause the pipes to rust or form cracks during prolonged exposure to the high river flow. In this particular case, the exposed sewage pipe leads to increased potential for pollution due to

pipe leaks. The river pouring over the sewage pipe at Silverstream appears as a man-made water fall, shown below in Figure 10.



Figure 10: Erosion at Silverstream Sewage Pipe

In addition to the vulnerable infrastructure, through Grant we discovered that continued development of the Hutt Valley remains an ongoing problem. Development in the floodplain proceeds despite the increasing flood risk due to climate change. Traveling upstream, we were able to see construction of new residential buildings in areas close to the river that are considered to be at high risk for flooding. The area is still a hotbed for industry and there are a large amount of employment opportunities creating the need for housing. Due to the preexisting industry and infrastructure in the Hutt, the area draws the attention of many local business owners, despite the risk of flooding. The settlement of larger corporations may influence smaller local businesses, leading them to believe the area to be profitable and safer than it is. This can be seen as an example of herd mentality or cascading, one of the influencing heuristics described in Chapter 2.

Steve, Grant, and several members of the GWRC shared their view that new developments should be focused away from the floodplain, though that is not as easy as it sounds, due to the fact that GWRC's management responsibility is limited to the physical river. The surrounding land being used for development is managed by the HCC. While the HCC does

have some restrictions on development close to the river in its 2004 district plan, the restrictions vary depending on the proximity of the building to the river and are decided upon on a case by case basis (Greater Wellington Regional Council, 2010). Steve and Grant did not feel that these restrictions were adequate in the long term, due to the high rate of urbanization still occurring in the floodplain. They felt that more needed to be done to deter future development close to the river.

To understand how terrain contributes to flood risk, we travelled through the catchment to the headwaters of the Hutt River, located in Kaitoke Regional Park and seen in Figure 11.

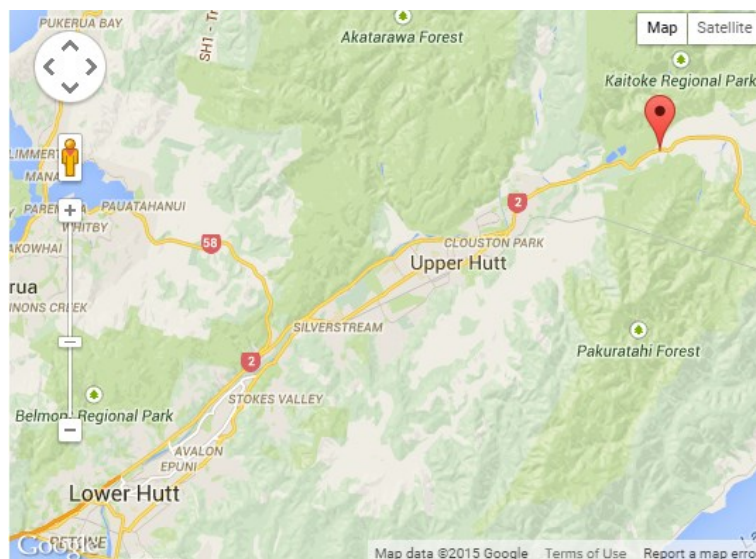


Figure 11: Headwater location of Hutt River (Google Maps 2015)

The catchment area of the Hutt River consists of multiple tributaries and covers an area of 655 km² (Greater Wellington Regional Council, 2010). In Kaitoke Regional Park, the river is located in a narrow canyon that winds along the bottom of steep hills, before entering the more open floodplain downstream. When rain falls over the catchment, water flows down the hills and is constricted to the Hutt River and its tributaries: the Pakuratahi, Mangaroa, Akatarawa, Whakatikei, and the Wainui Rivers. As the Hutt River progresses, each of these tributaries join it adding to the overall volume. A map showing the location of the catchment of the Hutt River can be seen in Figure 12 below.

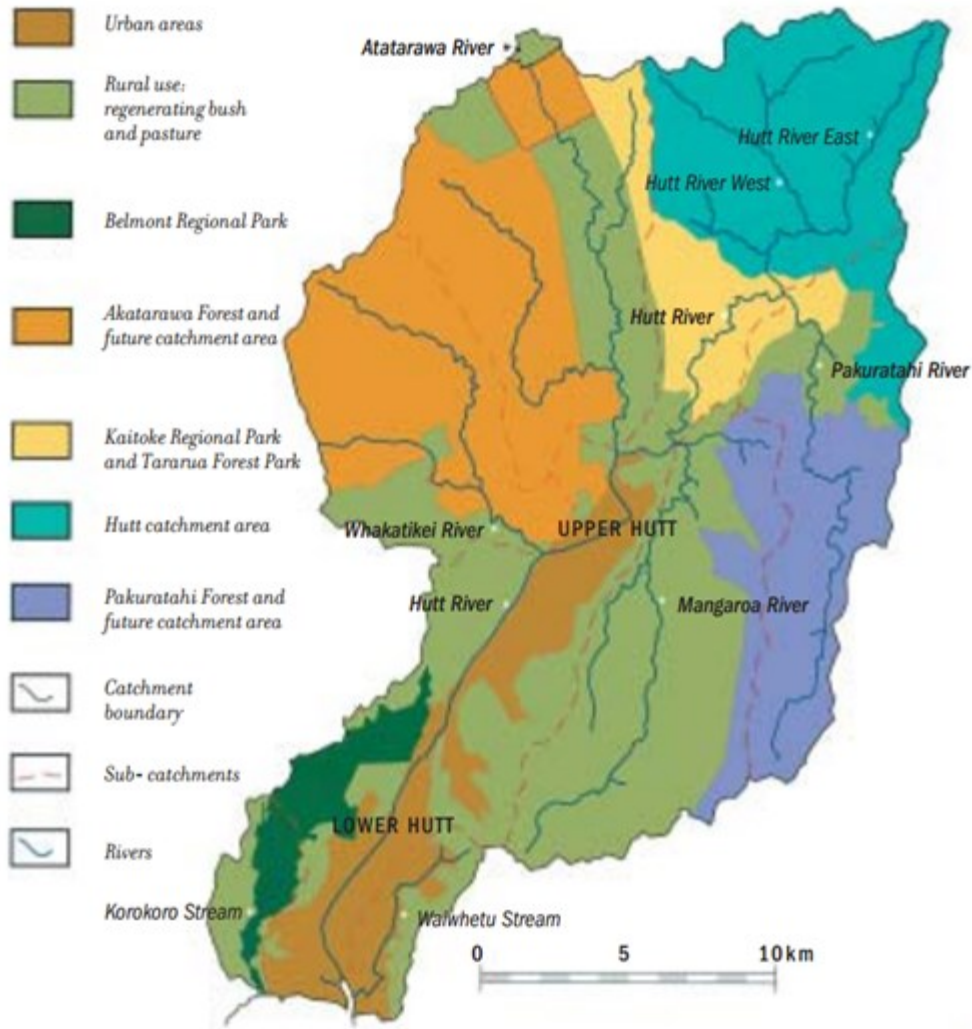


Figure 12: Tributaries and catchment area of Hutt River (Greater Wellington Regional Council, 2001)

In Kaitoke Regional Park we observed a high vegetation line along the river, giving visual insight not only of the power of the river, but also of the typical flood height. River bank vegetation struggles to survive below the high point of river flow, resulting in a natural high-water mark. A photo from Kaitoke Regional Park seen in Figure 13 below shows this high vegetation line of the Hutt River.



Figure 13: Hutt River in Kaitoke Regional Park

The rangers also discussed the importance of the Hutt River to the general public due to its use for a wide variety of recreational activities: walking, jogging, bicycling, horseback riding, riding motor vehicles or driving all-terrain vehicles, fishing, and swimming. As the GWRC continued to provide more land to be used as parks, it in turn created an increase in public use both along and in the river. Due to this, there is often tension between implementing new flood protection measures and providing land use for recreational entertainment value. Since many flood prevention techniques close off sections of the river temporarily or require land, it can be disruptive to those traveling on or along the river.

Being able to see the effects of erosion and the proximity of development to the Hutt River on a personal level gave us a first person perspective of the challenges our sponsor and the region face. Observing specific physical locations of the flooding allowed us to better connect with and understand the survey participants when discussing their past personal experiences with flooding. For example, we became familiar with small flood-prone areas such as Block Road or the Melling car park and were able to discuss these in more detail with our survey respondents. This familiarity helped us discuss the extent of past floods, how floods at those locations affected the area, as well as current views of flood risk. We were also better able to understand answers that talked about sedimentation or effects of erosion. These were brought up multiple times by residents, so we were able to understand what exactly they were referring to and its potential impacts because of these tours.

4.2 Government flood management practices, challenges and approaches to community outreach.

During our study we spoke with two different levels of government, the HCC and the GWRC. We present our findings from these interviews by key question.

4.2.1 How important of an issue is flooding to the government?

We discovered that flood mitigation strategies in the Hutt Valley are seen as possible models throughout the country. Hutt Valley flood protection plans and their development strategies for estimating flood risk, incorporating climate change, and involving local stakeholders could be the blueprint for other local and regional councils.

Due to this nationwide significance, the council understands the importance of successful flood prevention. Many have experienced flooding themselves and understand this significance on a personal level. Council members also recognized that climate change may change flood risk in the coming years, though were unsure to what extent. Officials stated they would rather prepare for the worst predictions and have the actual impacts be less than be underprepared and have the impacts be more severe. During our interviews, councilors referred to the devastating flood of 1976, showing that flooding has long been on the minds of these regional councilors. We heard several anecdotes describing the damage caused during that time, including bridge washouts and impassable roadways. Officials expressed a similar desire to ensure flooding of this accord would never occur again.

4.2.2 How closely do the views of the HCC match the GWRC on the issue of flooding?

Overall, the Hutt City Councilors showed support for the works of the GWRC. Contrary to much of the flood management literature which talks about turf battles between different levels of government, the GWRC and HCC appeared to discuss and collaborate effectively (Judy Lawrence, Tegg, Reisinger, & Quade, 2011, October). However, multiple officials expressed frustration with not having enough support regarding flood risk and climate change from the central government. Council members understood the potential severity of a major flood in the Hutt Valley area and wanted to see the risk mitigated through community action as well as council policies. They also understood that for council policies to be enacted, the GRWC must have the support of the public. We found that channels of communication between the HCC and

GWRC were effective, aided by monthly meetings and a good rapport between members of the two councils.

4.2.3 How has past community involvement been conducted?

Community involvement can be an important way to gain support for government flood management plans, such as the Otaki Floodplain Management plan where the community became “fully involved and now has a stake in it,” (Greater Wellington Regional Council, 1998). However, in some cases they can actually infuse the community with a sense of opposition. A study from Canada in 2002 on the topic of community involvement in flood planning found that when residents were consulted after the flood planning options were narrowed down to one option by public officials, they did not believe that their input truly mattered and that everything was a foregone conclusion (Sinclair, Morris-Oswald, Olczyk, 2003). Community involvement needs to be done in a delicate way in order to be useful. If you involve the community too late, they do not feel as if their input mattered, and the same goes for only presenting the community with a limited number of options. Through our meeting with key members of the GWRC, we learned about the flood planning process. This process involves months of research on both the processes and implications of each of the proposed plans, due to the complexities of flood protection and climate change. Due to the high uncertainty of success of flood planning, the council waits until the plans have been narrowed down to few, realistic options rather than a variety of options that may or may not work. During this potentially lengthy process, the public may feel as though they are excluded, when it simply may be an inappropriate time to include them.

While discussing past community involvement, a 2014 survey conducted by the GWRC as part of the development of the Greater Wellington Regional Council Long Term Plan 2015-25 was brought up. This survey claimed that residents of the different districts of the Greater Wellington Region indicated that they would much prefer to be consulted about major council decisions through the use of online tools, such as forums or surveys (Greater Wellington Regional Council, 2014). The GWRC already utilizes online tools for public feedback, so perhaps the public is unaware that what they want already exists. With the various options the GWRC uses to involve the public in planning processes, they believe they are sending the message out to the public in an effective way. With the public seemingly unaware of the online

tools they have available to them and becoming involved after some of the planning has already been done, the community may believe that they are not fully involved in the flood planning process.

4.3 Assess local business perspectives on flood risk, climate change, and flood planning

We conducted in depth interviews with five businesses as well as the CEO of the Lower Hutt Chamber of Commerce. We wanted to get a different stakeholder viewpoint in the flood planning process. As flood management plans aim to promote economic growth, businesses are regularly consulted by the GWRC (Hutt Valley Flood Management Subcommittee, 2013). This section will present the information regarding business viewpoints concerning involvement with the flood prevention planning for the Hutt Valley.

4.3.1 How concerned are businesses about the impacts of flooding and climate change?

While the businesses we interviewed were concerned about flood risk, saying they considered it potentially severe, they saw it more as a long-term problem. They largely believed the stopbank work and dredging to be adequate, with one owner describing that the system, “should have a significant effect in reducing floods in the future.” Confidence in the stopbanks can be attributed to the role they have played holding back high flood waters. Interviewees identified specific problem locations, such as the flood-prone car park located near the Melling Bridge. Chamber of Commerce CEO Mark Futter stated that at least once a year at the Melling car park, “The businesses guys are running out and moving their cars... [If] you left your car there, you’ve got an insurance claim.” He emphasized the importance of flood protection, as a flood is a “crippling concern” for the region, with 18,000 people commuting from the hills to work, without considering those in the valley or those visiting. He believes people are not concerned enough with flooding and need to be made more aware of the risk. Although the GWRC has information highlighting the flood risk in the area, Mark’s comments about the need for increased awareness suggests that this outreach effort is not reaching businesses and the community.

Several business owners told us that they were not particularly well informed on the issues of flooding and climate change. Because of this, none of the businesses we had spoken to had taken action to prepare themselves for a flood; only the Chamber of Commerce mentioned that emergency supplies and safety plans for employees would be of benefit. Businesses did not specifically mention being affected by the 2004 flood, with two of them stating that they were either away from the floodplain or high enough in their office building that flooding would not affect them. This implies the perception that flooding is not an immediate concern, overridden by the other challenges and duties of running a business or perhaps from a belief that flood planning measures are effective. One owner did admit that flooding is an issue their business should take more seriously.

[4.3.2 What threats do businesses face in regard to flooding?](#)

The CEO of the Chamber of Commerce in the Hutt, Mark Futter, emphasized the potential damage of a major flood, putting the projected tangible damage at about \$2 billion (NZD), which is approximately the same as the GWRC's estimate of \$1.7 billion, mentioned previously in Chapter 2. Mark stated during our interview that 97.2% of the businesses in the area are considered small and medium enterprise, composed of twenty employees or less, and they simply do not have the resources to rebuild after such a catastrophic event. With larger businesses, the loss of one store may not bankrupt the company and they can base themselves in profitable locations despite the risks. Smaller businesses usually do not have the resources to fully understand the risks and hope that larger businesses have done more thorough research on the area (Kousky & Shabman, 2015). When large businesses began to move into the Hutt Valley, small businesses followed suit not fully comprehending the risks at hand.

Mark stated that if a flood were to hit, the entire Wellington region could be brought to a standstill, as the Hutt is not only the industrial center of the area, but also a home to a great number of schools, hospitals, scientific research laboratories, and other regionally critical facilities. Some 3,500 businesses of various sizes are part of the Hutt Valley Chamber of Commerce, and Mark estimates that these businesses do not have appropriate natural disaster emergency plans in place. He discussed emergency planning corporations such as Survivor, an emergency management business located in Grenada North. "They are putting all of these plans and bits and pieces in place for large businesses" However as stated earlier, the majority of

businesses are small or medium, potentially leaving the majority of businesses without external planning aid.

Flooding of the Hutt Valley is covered for businesses under their normal insurance policy, but for many this may not be enough, especially for those without emergency planning. These businesses that have not planned for a flood would rely solely on their insurance for protection and helping them recover after a flooding event. Flooding is not emphasized by insurance companies in the Hutt Valley; therefore there is no extra concern on the part of businesses regarding the potential impacts of a flood. Without emphasis, what exactly is covered under insurance in a flooding event is unclear to many. Even Mark, the CEO of the Chamber of Commerce, was unaware of how exactly flood insurance is covered in the region. Upon contacting an insurance broker from August Insurance, it was clarified that there is no specific flood insurance policies offered in the Hutt Valley. Instead, flood damage would be covered under a homeowner's or businesses regular insurance policy. Whether this coverage would be adequate is unclear. Unfortunately, we only had a very brief discussion with the insurance broker and they were only able to clarify that there is no separate flooding insurance. For businesses, it would be crucial to understand how they would be covered in the case of a flood, so they can take proper precautions.

[4.3.3 How have businesses been involved in flood planning and how would they like to be involved?](#)

Most business owners we spoke with that had heard of the GWRC's City Centre Scoping Report from 2013 felt they were not included in the planning process. As described in Chapter 2, the planning process for businesses consists of the GWRC inviting key stakeholders to workshops, taking input, and then incorporating that input into their flood management plan. Mark said that few businesses or community members were consulted when formulating the report, and questioned whether the correct members of the community, business or otherwise, were consulted. In order to make informed decisions in the community, Mark believes there should be more commercial and public involvement in the flood planning process.

Mark was able to provide several ways he believed that businesses could become more involved. He offered to distribute flood risk information to the Chamber's member base of 3,500

businesses. Additionally, Mark suggested that in order to increase participation from businesses, they could be presented with maps and images demonstrating how a major flood would impact the Central Business District. Maps or images would make a flooding event seem real, and hopefully motivate businesses to become more involved in the planning process. Currently, the GWRC does try to involve businesses, but can be selective about which ones they consult in workshops. Persuading businesses to attend these workshops has been another challenge altogether. The Chamber of Commerce was only able to attend one of three workshops, due to other commitments, held regarding the 2013 report. Many businesses are unmotivated to attend with one owner describing the sentiment, “they will sit on their hands and stick their head in the sand; it’s always someone else’s problem.”

Other businesses’ perspectives differed from Mark’s, as they seemed to be less concerned about the flood risk. One business claimed he did not even know of the report’s existence, but stated that he trusted the council was doing their best work and he would be protected. Another business owner preferred to be left out of the process saying, “I’m not sure I’m qualified to do it... it’s not an area of expertise that I have and I would like to think that we can employ people that are pragmatic and open-minded and well-schooled so they can do it for us.” As some of these businesses would be affected by future flood plans, we previously hypothesized that they would be more concerned about the planning process and would want to become more involved for personal interests. This suggests that some in the business community assume the GWRC has the capability and resolve to create effective plans for the whole community without their input.

4.4 Public perception of flood risk and climate change

Throughout the analysis of our data, we explored three major themes: flood risk concern, flood knowledge, and climate change perception. We explore these in the following sections by answering three main questions.

- How concerned is the public about flood risk?
- How much knowledge does the public have regarding flood risk?
- What views does the public hold regarding climate change?

We answered these questions by conducting 202 surveys in the Lower Hutt region. Appendix F contains raw survey data and additional tables and diagrams from our survey.

Findings from our studying closely match previous studies in the Hutt Valley area, specifically the Judy Lawrence study from 2011, mentioned in Chapter 2. According to the latest census data, New Zealanders of European descent makes up 67.2% of the Hutt City population while those of Maori descent make up 16.2% (Profile.id, 2013). Of those that took our survey, 71.8% identified as being of European descent while 7.9% identified as Maori.

4.4.1 How concerned is the public about flood risk?

Participants expressed moderate concern over the flood risk in the Hutt Valley. Numerous residents believe that a major flood is likely to occur within the next thirty years, which is similar to the finding about the likelihood of major flooding in the Lawrence study, which found that 76.5% of people believed a flood would happen in their lifetimes, compared to our finding of 75.2% (Lawrence, 2011). With the two studies taking place approximately four years apart, the results suggest the flood risks remain a public concern. This finding is also supported by the risk literature, described in Chapter 2. According to what risk researchers call the availability heuristic, people who can readily recall past floods believe that the likelihood of another event is higher than those have not had the experience (Kousky & Shabman, 2015). 54% of our survey participants responded that they had directly experienced a flood, as seen in Figure 14.

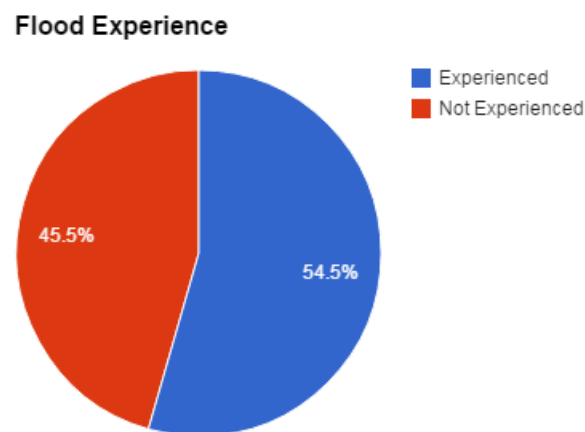


Figure 14: Participants' flood experience

When the public was asked how a major flood would affect their day-to-day lives, the majority of people only mentioned flooding impact on transportation, either around town or to and from work. Comparatively, few mentioned residential effects of flooding such as property

damage or loss of personal items, or family such as separation or loss of life. The majority of participants (88%) showed little concern over basic essentials, such as food and water, stating that they would have enough provisions to last a few days to a week on their own, as can be seen in Figure 15.

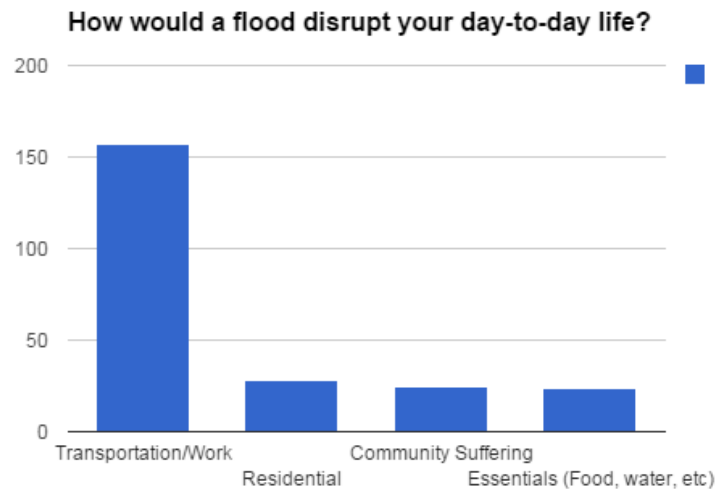


Figure 15: Top results for “How would a flood disrupt your day-to-day life?”

The public appears to underestimate the impacts from a major flood, claiming it would be an inconvenience, simply disrupting transportation. They are not as concerned that their homes could be damaged by a flood or that they may not have the proper supplies in the event they are isolated from stores. This can be seen as an example of the optimism heuristic. Although the public believes that a flood is likely to happen, there is an overarching trend that the impacts of the flood will not affect them personally (Kousky & Shabman, 2015).

Despite the majority of participants believing that there will be a major flood in the next thirty years, the average response rated the risk of a flood being no higher than other natural disasters for the area, as seen in Figure 16.

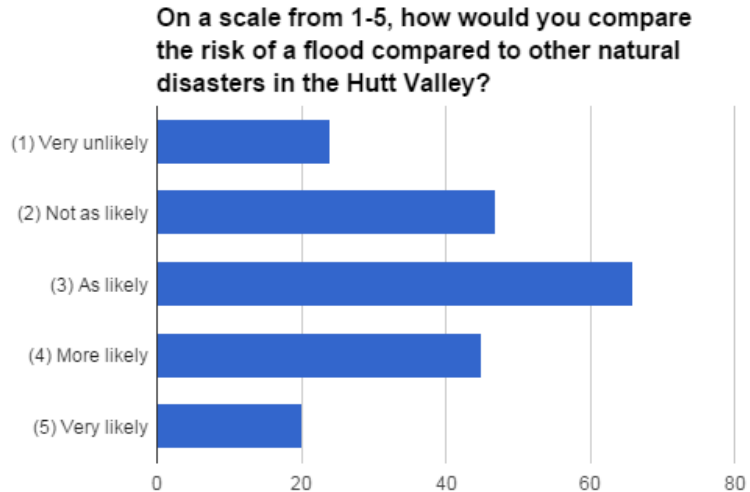
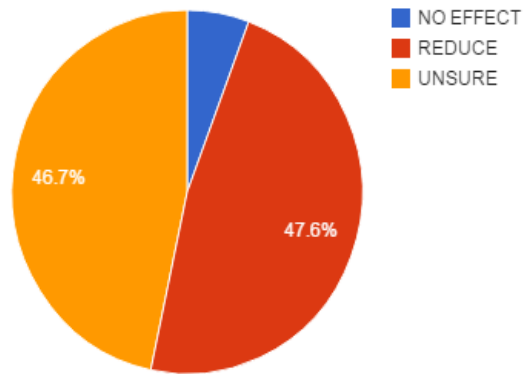


Figure 16: Comparison of flood to other natural disasters

Those that rated the flood likelihood as a 3 are saying that they think the flood risk is equal to the risk of an earthquake or tsunami. The most common comparison made was to the earthquake risk, with 34% mentioning some level of concern. This frequent comparison to earthquakes may partly be caused by the 2011 earthquake in Christchurch, leaving the concept fresh in the minds of the public. A number of participants stated that the area was very likely to experience flooding and an earthquake, with one response stating, “we haven’t had either for a while, so we’re due to have both of them.” This is a prime example of the Gambler’s Fallacy discussed in Chapter 2. Since the Hutt Valley has not seen a major flood in a long period of time, many members of the public believe that a flood will occur (Kousky & Shabman, 2015).

Concern about flood risk was found to parallel flood experience, which supported findings from Judy Lawrence’s 2011 survey that found those that had experienced flooding demonstrated more concern (Lawrence, 2011). Age was also found to be tied with concern about flood risk. Younger respondents have not experienced as much flooding in their lifetimes, and thus are unsure whether the current flood measures are adequate because they have never truly been tested in their lifetime. Older respondents on the other hand have experienced more flooding, with ten participants bringing up the devastating 1976 flood that Ray Wallace, the Hutt City Mayor, experienced. Older respondents were found to have increased confidence in the flood protection measures, and thus less concern as shown in Figure 17.

Flood Measure Effect For Age Below 45



Flood Measure Effect For Age Above 45

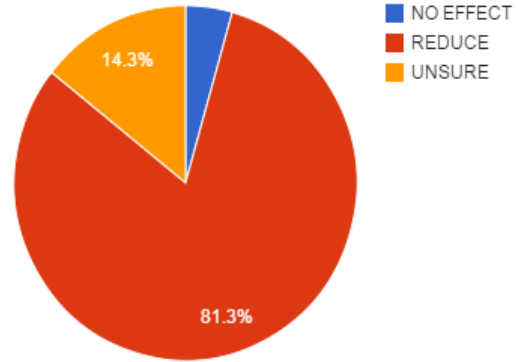


Figure 17: Age vs thoughts on flood measure effect on flood risk

Increased confidence can be appropriate in the short term, as it shows public trust for flood prevention measures. Respondents thought that the likelihood of a flood was high, as seen in Figure 18, yet believe that the current flood protection measures have reduced the flood risk, as seen in Figure 19.

Major Flood Likelihood in the Next 30 Years

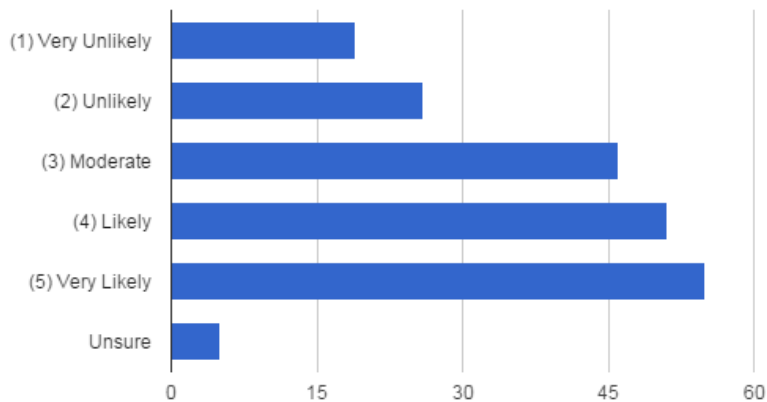


Figure 18: Major flood likelihood in the next thirty years

Have flood measures reduced the flood risk?

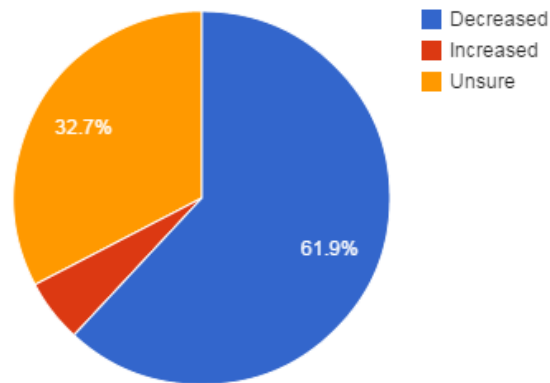


Figure 19: Have flood measures reduced the flood risk?

With the lack of flooding in the Hutt Valley since 2004 and increased flood protection measures put in place in the time since, the public does not think that a flood will affect them severely (Judy Lawrence, Tegg, Reisinger, & Quade, 2011, October). Studies have shown that people living in a flood prone area, such as the Hutt Valley, can doubt the severity of the current flood risk, especially after not experiencing a significant flood for a prolonged period of time (Kousky & Shabman, 2015). With a complacent view of flood risk, it can be challenging to convince people they are in danger even with proper flood risk information readily available.

4.4.2 How informed is the public about flood risk and flood risk management?

Survey participants were asked an open answer question about what factors contribute to flooding of the Hutt River. This question enabled the survey participant to list as many factors as they could identify. As shown in Figure 20 below, more than half of all respondents mentioned rainfall as the leading cause of flooding.

Flooding factors

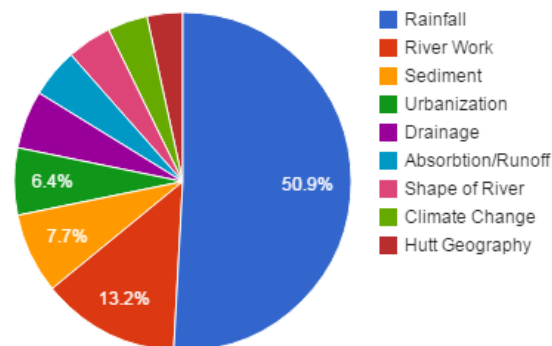


Figure 20: Flooding factors in the Hutt Valley

However, other responses to the question were much less frequent. Only 13.2% of participants mentioned some form of river work, and less than 10% of all survey participants listed sediment build up, urbanization, or drainage issues. This data shows that a large number of our participants were not fully aware of the multitude of flooding causes for the Hutt Valley. As described in Chapter 2, there are a variety of factors that make the Hutt Valley so vulnerable to flooding.

In regards to flood risk and protection, participants had little familiarity with flood prevention measures. Most respondents were unable to list any flood reduction measures apart from stopbanks. This open-ended question asked participants to list flood protection measures. We predict that stopbanks were mentioned frequently due to their visibility in the Lower Hutt and at our surveying locations. The next most frequent response was some form of “river works,” which included all forms of river shaping (straightening, widening) as well as the maintenance of the banks of the river, as seen in Figure 21.

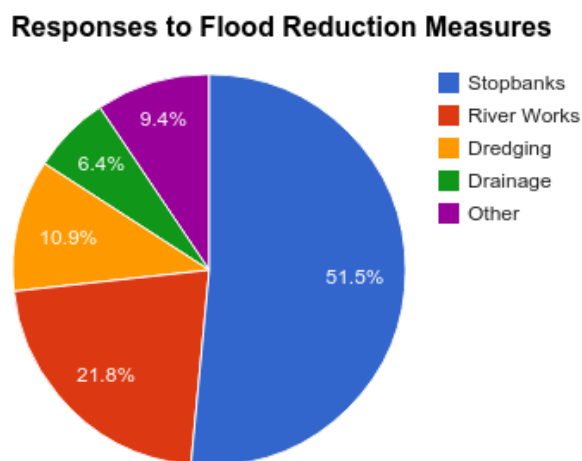


Figure 21: Responses to, “What has been done to reduce the risk of flooding in the Hutt Valley?”

This suggests that the public is largely unaware of the past actions taken to reduce flood risk, which includes other measures such as dredging, river straightening, river widening, afforestation, etc. The next top answer was the coded category of river works. This category was composed of answers given by respondents who had seen work being done on the river or riverbanks, but were unable to identify what the work had specifically entailed. The public’s limited knowledge of flood protection measures may suggest that the outreach efforts by the GWRC may need to be improved.

Respondents also had difficulties correctly identifying who was responsible for flood risk protection in the Hutt River. More people believed that the Hutt City Council (32.7%) was responsible than the Greater Wellington Regional Council (31.2%) and an even greater number (36.1%) named a different organization. These survey responses can be seen below in Figure 22

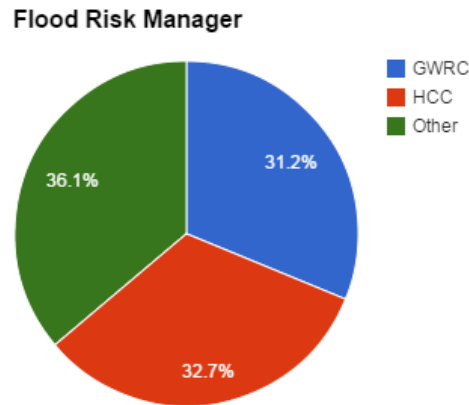


Figure 22: Flood risk manager of the Hutt River

By correctly identifying the responsibilities of different levels of government, the public will be able to more effectively determine where to look for different emergency planning resources. With the structure of government in flood protection in the Hutt Valley, it is understandable that participants were not fully aware of who does what. As we discovered from the GWRC, flood management in the Hutt Valley is not straightforward to understand, with different organizations responsible for different aspects of the river, as previously specified in Chapter 2.

The perceived organization responsible for managing the flood risk for the Hutt River was found to be related to the source of the participants flood knowledge. Participants who believed that the HCC was responsible for flood management were more likely to receive their flooding information from media sources, including, but not limited to, television and newspapers. Those who identified the GWRC as responsible were more likely to receive their information from a government source, such as GWRC newsletters or the GWRC website. Although the amount is relatively low (41.9%) it is found to be significant in comparison with the frequency of other responses, as seen in Figure 23.

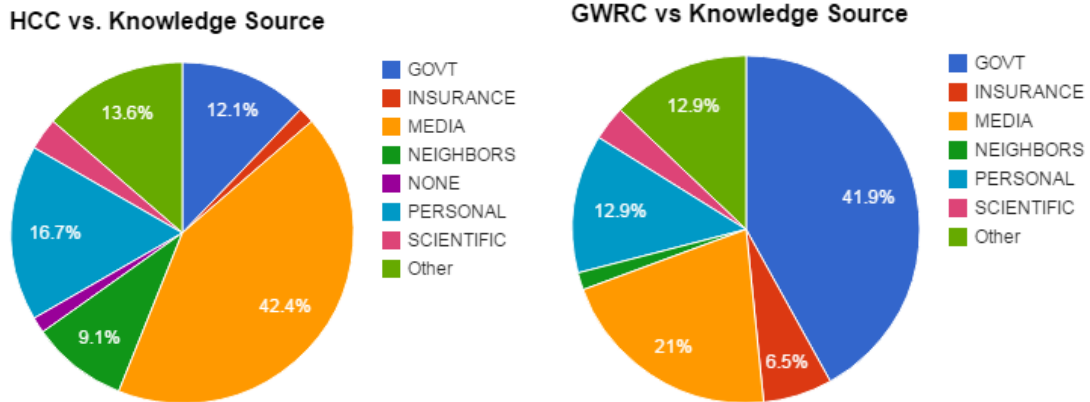


Figure 23: Comparing Information Source to Identification of Responsible Agency

Younger people typically obtain their knowledge from the internet, versus newsletters and newspapers for older people. During our study, almost no participants below the age of 25 were able to identify the GWRC, while the majority of those over 46 were able to correctly make this identification, as seen in Figure 24.

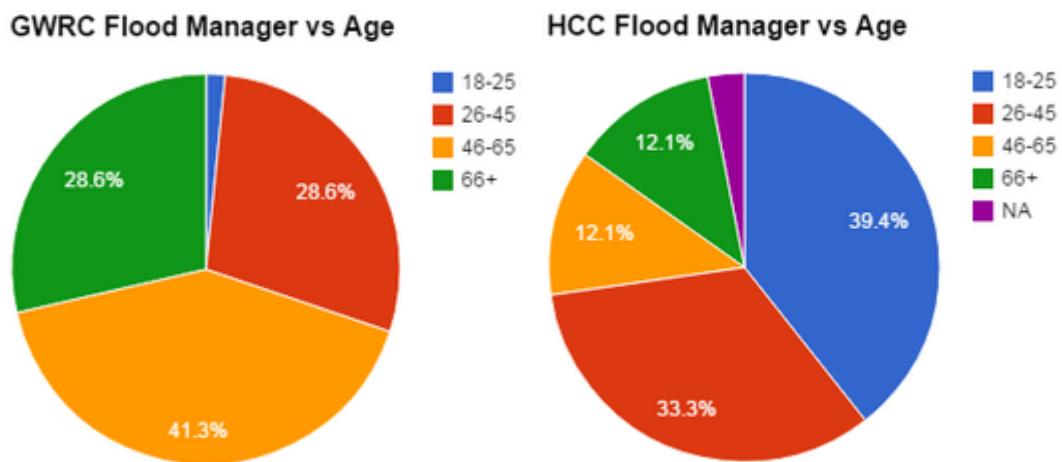


Figure 24: Age compared to Hutt Valley flood manager

The GWRC primarily uses newsletters to direct the public to the information they want them to see. With younger audiences not being able to identify the GWRC as the flood manager for the Hutt Valley, GWRC information may not be reaching younger audiences or younger audiences may not be interested enough about the issue to seek out information independently.

Those who identified the GWRC as the agency responsible for flood protection strongly believed that the protection measures in place reduced the flood risk. Participants identifying the HCC had more uncertainty over this, with some believing the measures had no effect, as seen below in Figure 25.

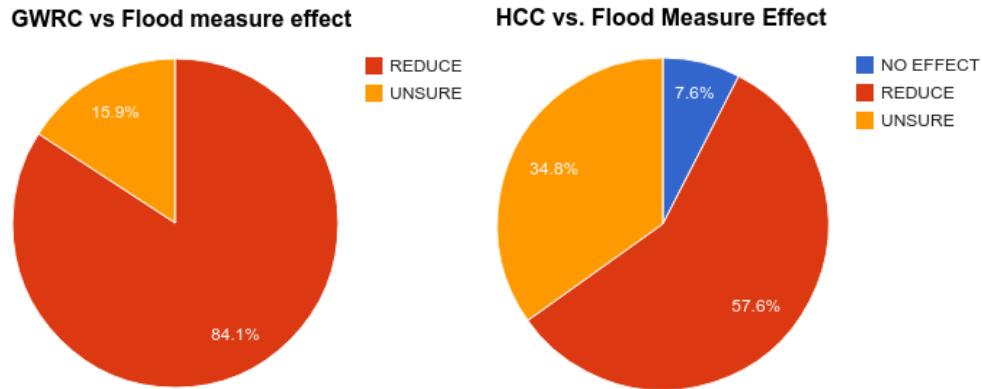


Figure 25: Flood measure effect compared to who is responsible

With a large portion of GWRC identifiers receiving their information from the government, this trend starts to make sense. When flood management plans are initiated, the government advertises that the plan will reduce the risk. People obtaining information from this source would then be more likely to believe this. Therefore, those people will be satisfied with the work done, and hence be less inclined to see the urgency of increased flooding due to climate change. On the contrary, those who received their information from media sources were mostly unsure of what the effect on flood risk was and in some cases showed skepticism towards the efforts of the GWRC, as seen in Figure 26.

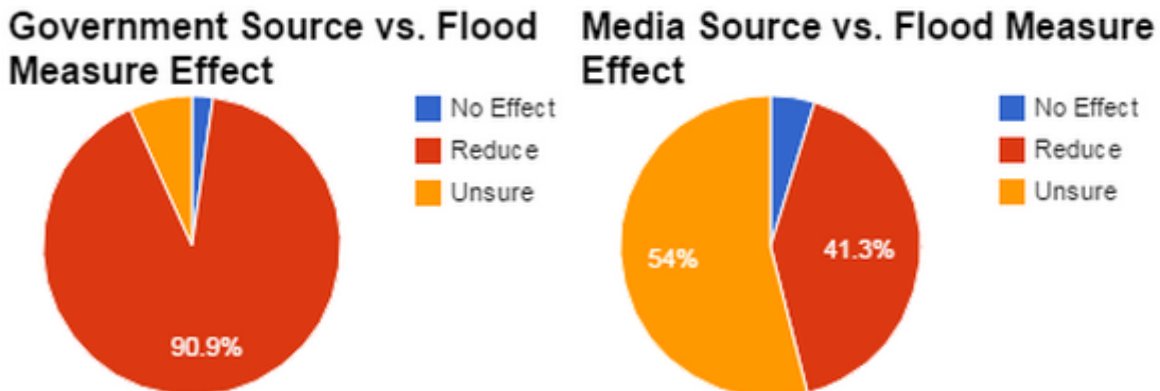


Figure 26: Knowledge source compared to flood measure effect

Those receiving their information from the media are more likely to be wary of the current flood protection plans, while those that say they obtain their information from the government are not. This again highlights the effect that public awareness and involvement with the government has on the overall trust in the actions taken.

4.4.3 What views does the public hold regarding climate change?

The majority of survey participants believe that climate change is a real and ongoing process. These respondents believe that climate change is happening, however more than a quarter admitted they did not know much about the subject, giving responses such as “little” or “nothing” to the question “What do you know about climate change?” Of those that did provide information to the open ended question, most talked about changing weather patterns, or that there would be more extreme weather events in the future, as seen in Figure 27.

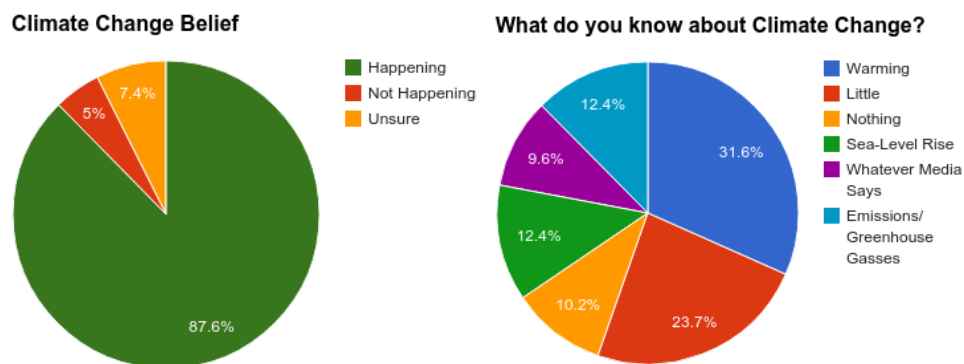


Figure 27: Belief and knowledge in climate change

This question was meant to gauge the respondent’s views of climate change, and to see if they could come up with information about the factors that contribute to climate change or the consequences of it such as sea level rise, ozone depletion, increased carbon emissions, etc.

When asked if enough was being done to adapt to the effects of climate change in the Hutt Valley, 44.1% of participants felt that more could be done. When posed with the question of what could be done, the majority of responses focused more on the topic of mitigation efforts, such as reducing emissions or pollution, instead of flood adaptation measures, as can be seen on Table 1.

Reduce Emissions (Carpool, public transportation, etc.)	15.8%
Flood Planning (River Straightening, dredging, etc.)	8.9%
Stopbank Improvement	7.9%
Urban Planning (Homes away from river, better zoning laws, etc.)	6.9%
Reduce Pollution (river, general human pollution, etc.)	4.4%
Nothing Can Be Done	8.9%

Table 1: Top answers to, “What can be done in the Hutt Valley to adapt to the effects of climate change?”

Numerous respondents framed the question as a local matter, such as improving public transportation, increasing carpooling, walking to work as not to drive, etc. A significant number of people believed nothing could be done. These people largely held either the belief that climate change was already too advanced to adapt to or mitigate, or were thinking globally and did not believe that the Hutt Valley had a significant impact on the larger scale. These results show that the public has a general idea that climate change is occurring, but little about the specific causes and effects of the issue. They seem to have knowledge, to a certain extent, of what is causing climate change, what its potential impacts are, and what needs to be done to reduce its potential effects.

The majority of those who believed in climate change also believed that it will have a direct impact on flooding, as seen in Figure 28.

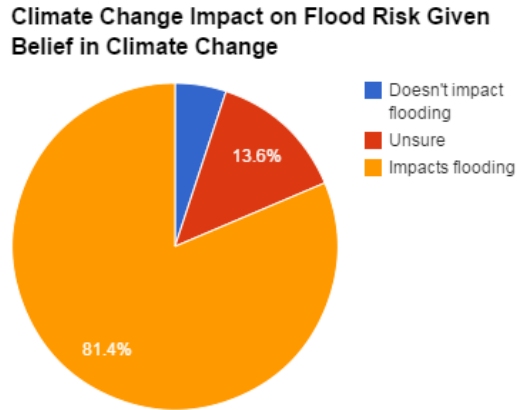


Figure 28: Impact of climate change on flooding

This is supported by Judy Lawrence’s 2011 study that found that residents of the Hutt Valley believe that climate change will have an impact on flooding and flood risk in the future (Lawrence, 2011) Interestingly enough, not all of those who tied climate change to increased flooding thought this impact would increase flood risk, as shown in Figure 29 below.

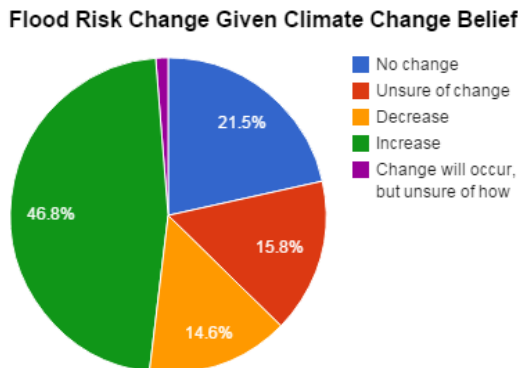


Figure 29: Thoughts on flood risk change over time given belief in climate change

Just over half of respondents who believed in climate change did not believe that the flood risk would increase in the coming years. Potentially, this falls back to the public’s trust of the government and the effectiveness of the flood prevention measures put in place. The public may believe that the measures already in place are sufficient to deal with future flooding, or may believe that future floods will be no worse than what has occurred in the past. Those that did respond in favor of increasing flood risk mainly gave climate change as the reason for the increase, mentioning factors like extreme weather events and a wetter climate, as shown in Figure 30.

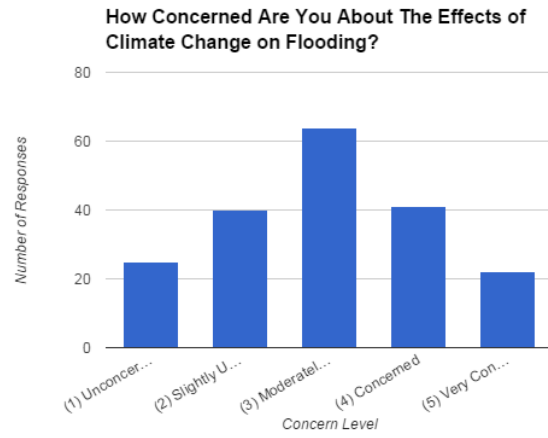


Figure 30: Concern over effects of climate change on flooding

Chapter 5. Recommendations and Conclusions

From our findings and analysis, we developed the following recommendations for the Greater Wellington Regional Council (GWRC).

5.1 Informing the public about flood risks and flood management

The media, including television sources and the Hutt News, is where many of our interviewees identified that they obtain information about flood risk. Accordingly, the GWRC should have a larger media presence on topics including flood risk management and flood mitigation techniques. That said, it is not an easy task for the GWRC. The public currently believes that they are safe and protected by the GWRC from future flood risk, when that may not be the case. Flooding is a statistically probable event that is predicted through flood risk models, however, these models make assumptions and therefore the true flood risk is often uncertain. This uncertainty is exacerbated when climate change is thrown into the equation. The framing of the information provided by the GWRC needs to communicate this uncertainty to the public in order to make them aware of the true risks they are exposed to, and further explain that the GWRC cannot protect them from uncertain extremes in the future. Communicating the potential risks and solutions is important as members of the public do not seem to be currently aware of the limitations of existing flood mitigation measures.

Making flood risk more personal may cause people to have a stronger response to flood protection. This could effectively be done by framing the risk in a different, more relatable light. An example would be, “there is a 26% chance of a flood during the life of a 30-year mortgage,” (Kousky & Shabman, 2015). This differs from the 1 in 100 year flood statistic, but says the same fact in a potentially more meaningful and personalized format for the public and has been proven to be more effective at raising awareness (Kousky & Shabman, 2015). Framing the statistic this way makes the issue more personable, as people start to realize that there is a strong likelihood of a flood in the longer term. It also makes people start thinking about how a flood would affect them monetarily. This action would correct two heuristics in one, by reframing the statistic for the public and removing the ability to truncate the low probability to non-existent.

An increase in knowledge of both the flood risk and effects of climate change does not necessarily correlate to increased action, however. For example, the GWRC has previously marked high water marks from past floods on buildings in the Hutt City. According to various members of the GWRC, this proved ineffective. Simply providing knowledge does not guarantee people will be analytical about it. In order to nudge people to act, the underlying values of the community must be explored in order to find effective ways to motivate people to act.

While models are not perfect, an interactive simulation could be developed to illustrate the potential impacts of various levels of flooding as influenced by a number of factors. These factors could include sea level rise and other climate change effects, stopbank resistance, amount of rainfall in the ranges, as well as human effects on the river like rubbish disposal and dredging. The University of Iowa created a model for their area to promote knowledge of hydrological systems, flood risk, and how it is influenced by climate change. The Iowa model was framed as a game, allowing the user to use real time data to better understand the concept of flooding (Demir, 2014). The Tasman District Council has created a similar flood model to present to the public the potential risks of climate change (Lawrence et al., 2013). Something similar to this could be created for the same use. People need to know the uncertainties of climate change and its effects, but this is an important first step in acclimating people to acting on uncertainty. At the same time, the public needs to understand the potential hardships of dealing with climate change, though be reassured by the GWRC that it is an issue that can and should be addressed. It is better to act and overestimate the impacts, than wait until the impacts are too much to do anything about.

Personalizing the flood risk may cause the public to want to take individual action, so it would be important for the GWRC to encourage community members to take this type of action or find out more information so they can be properly prepared for a major flooding event. Information about individual preparedness could be distributed in the form of a pamphlet that could list actions similar to earthquake disaster planning: securing valuables, creating an emergency supplies kit, writing down emergency contact numbers, etc., and could be placed on the GWRC website or in various places around the Hutt Valley. The public could also be encouraged to stop dumping trash near the river, as we found during our tours with the GWRC rangers that trash can cause drainage issues which exacerbate flood problems. Placing signs

along the river or information in a pamphlet warning residents of the effects of dumping rubbish on the drains, as well as the hazards this provides to native species would be a way to raise awareness on this issue. Other acts that could be taken include taking care of one's own property. By clearing debris and keeping drainage pipes clean, individuals can help keep the drainage system working properly.

To get flood information out to the public, we suggest building on existing resources. One approach would be working with the Wellington Library System or the Lower Hutt Chamber of Commerce to utilize their databases. The Wellington Library System has the ability to reach out to over 200,000 members of the public and the Lower Hutt Chamber of Commerce works with over 3,000 businesses in the impacted area. Using these database-like organizations to send out information on flood risk and climate change impact could be the first step in involving the general public into the flood management process.

Instead of using a database resource for spreading public awareness, the Greater Wellington Regional Council could also use the local newspapers, or target specific areas themselves. There are several local newspapers that are distributed in the Hutt Valley, all of which have a decent reader base that could be utilized by the GWRC. By placing an ad, story, or informational column in the papers, the council could both spread information and start conversation. If the council were to create their own deliverable such as a flyer or bulletin, they could post them around areas both at risk of flood and of high public traffic. An area suggested to us by the Chamber of Commerce was the Melling Carpark. The park is used by a large quantity of Hutt Valley employees, all of which are affected yearly when the car park floods from the river. Social media would also be a valuable area to target, in the attempt to reach the 18-25 demographic that could not identify the GWRC as the flood risk manager for the Hutt River.

5.2 Increase public and stakeholder involvement

The community, both residents and businesses, want to be kept informed and wish to be involved in this process. Through our survey and interviews, at least 37.1% of people we spoke to mentioned the desire to learn more information on both flood risk and climate change. As we discovered through the study conducted by the GWRC, discussed in Section 4.2.3, Hutt Valley residents largely preferred to be involved using online tools like discussion forums, surveys, and

even the GWRC website. In speaking with members of the GWRC, these types of initiatives already take place. However, the public may not be aware that the GWRC already uses these online tools. The tools are mainly publicized using government publications, so in order to have the public utilize them they should be advertised using more methods such as television programs or newspaper articles.

Based off on the flood planning literature, and our understanding of the current involvement patterns in New Zealand, we recommend that the public and businesses are involved earlier in the process than they are currently. As it stands, the GWRC creates several plans, chooses what they believe to be the best one, and then goes to the community for comment on it before implementation. Instead, the community could be involved in the decision making process with workshops, focus groups, and forums held before the planning process is narrowed down into one option. These events could be open to everyone, potentially with one set of events for the general public and one set for local businesses. (Local businesses could be consulted in a focus group versus an online set-up for the general public for example). These events should also be highly publicized so people are aware and able to attend if they so choose. Although we are not in the position from the GWRC to determine whether or not this suggestion would be possible or appropriate for the council, we recommend these actions based on the public feedback from our surveys, feedback from our business interviews, and our own research on the subject. The village of South Holland, Illinois is an example of early feedback working well in the community. In the 1990's after a series of floods, residents were angry that not enough was being done to protect them and that they were not involved in the flood planning process. Village officials "formed a Flood Liaison Committee so residents and staff would work together," (Jamieson, 1999). After over a year of working with the public, holding meetings and workshops to keep the community involved, the village created a flood management plan for their area. South Holland has received numerous awards for community involvement for this effort and the community continues to be actively involved in the flood planning process.

5.3 Conclusions

As New Zealand has numerous coastal and waterfront towns, research investigating public perception of flood risk and climate change is important in planning for the future. This is especially true in the Hutt Valley, whose geography makes it particularly at risk to flooding.

Further research following this study would be beneficial to both the GWRC and the Hutt City community. Areas of focus could include a more robust exploration into the views of businesses in regards to flood risk and climate change. Different sectors of businesses should be looked at, such as retail, manufacturing, shipping, etc. and how what they do affects their perception. The differences in views between corporations, chains, and small businesses could be explored as well. Corporations might already have policies regarding both subjects, while chains might not be concerned as they think the rest of their stores will make up for losses in those damaged or destroyed by flooding. Small businesses might not have the resources or knowledge to do anything and thus could be more cautious towards flooding.

Additionally, if a major flood occurred elsewhere in New Zealand, it would be interesting to ask the question “On a scale from 1-5, how would you compare the risk of a flood compared to other natural disasters in the Hutt Valley?” During our survey, people still seemed to have the earthquake in Christchurch fresh on their minds. Perhaps this influenced how they perceived their own risk to an earthquake, and therefore lessened their view on the flood risk. If a major flood occurred, this question could be asked again and the results could be compared to our results to see how much a major event influences people's perception.

As current events stand, further surveying is recommended, but not necessarily at regular intervals. It will be important to monitor the public's knowledge and awareness on these issues, but should only be necessary at strategic times, for example after a media campaign or a major flooding event elsewhere in New Zealand. Due to the variability of flooding in relation to climate change, the best course of action is to involve and inform the most amount of community members and businesses as possible.

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Appendices

Appendix A: Flood Prevention Technique Descriptions and Uses

River Straightening

River straightening is the realignment of the central channel of a river by either digging a new channel or removing excess debris in the original channel (Easther, 1991). River straightening reduces flood risk by preventing build-up of sediment, allowing a larger volume of water to flow faster. This is often used to route rivers away from immovable settlements. However, this method can cause greater risk of flooding downstream due to the increased water velocity (BBC, 2014). River straightening occurred in earnest on the Hutt River in the 1950's. While moderately successful on the Lower Hutt River, by the 1980's it was deemed unsuccessful on the Upper Hutt River. The failure of the Upper Hutt River realignment projects was due to the buildup of debris, increasing river flow speeds and eventually returning the river to its original channel. With this failure, citizens became wary of flood improvement projects involving river straightening (Easther, 1991).

Afforestation

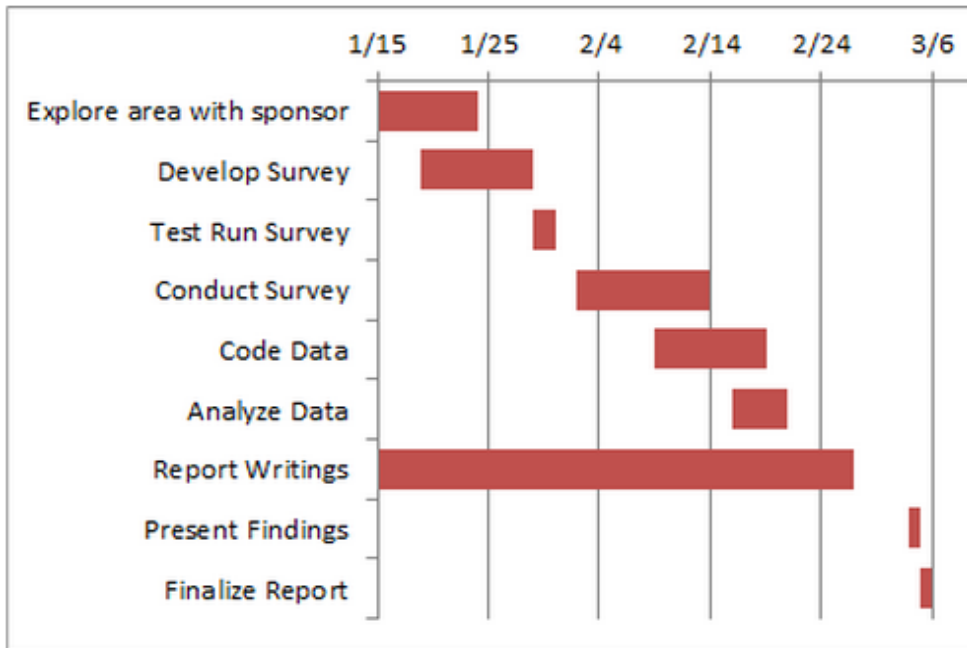
Another major procedure is afforestation. This is the practice of planting greenery around riverbanks that are prone to flooding. The roots will spread out and help absorb excess rainwater and lower river discharge (BBC, 2014). This is a very cost-effective solution for a low-stake flood zone. Depending on the climate and local population, finding adequate native plants to absorb water may be a concern. As part of Hubert Sladden's "Ultimate Alignment Plan," which provided the basis of all river control works until 1985, greenery (specifically willow groves) were planted alongside the Hutt River (Easther, 1991). In recent years, residents of the valley have become disenfranchised by the willows as they are a non-native species to New Zealand and would like to see them phased out in favor of native vegetation (Napp, 2002).

Stopbanks

One of the most well-known methods of flood prevention in the Hutt Valley is a levee, which is defined by the United States Army Corp of Engineers as "an embankment or shaped mound for flood control or hurricane protection" (US EPA, 2014). Referred to as a stopbank in New Zealand, they are typically built around particularly low or critical portions of the river. Under this method, even if the river floods, the waters will not spill over the banks and into the surrounding area. This is due to the increased height provided by the berm. The design and installation of stopbanks along the Hutt River began in 1901 in response to the 1898 flood. They



are continually being upgraded to meet the changing needs of society and the environment (Easter, 1991). A specific example of stopbank use in New Zealand is in the Jim Cooke Park. The stopbank was created in 1957, and it lasted until a new design was suggested in 2014. The previous design held without any faults for over 50 years; the new design simply improves on the older model to resist a more severe flood (Greater Wellington Regional Council, 2014).

Appendix B: Team Schedule





Appendix C: Survey Versions 1-3




Version 1

 WPI	 greater WELLINGTON REGIONAL COUNCIL Te Pahi Matua Taiao										
<p>Flood Risk:</p> <p>Have you experienced a major flood in the Hutt Valley?</p> <p>If yes, please describe your experience</p> <p>On a scale of 1-10, how likely do you think it is that the Hutt Valley will experience a major flood, similar to the flood in 2004?</p> <p>1 2 3 4 5 6 7 8 9 10</p> <p>Where have you obtained your knowledge about flood risk? (Select all that apply)</p> <ul style="list-style-type: none"><input type="checkbox"/> Personal experience<input type="checkbox"/> Neighbors/other community members,<input type="checkbox"/> Media<input type="checkbox"/> Local/regional government,<input type="checkbox"/> Scientific publications,<input type="checkbox"/> Other: please describe <p>In what ways would a major flood disrupt your day-to-day life? How would it affect your community?</p> <p>Do you live in the floodplain?</p> <p>What causes flooding of the Hutt River?</p> <p>How worried are you about the risk of a flood compared to other natural disasters in the Hutt Valley? (Earthquake, Flood, Tsunami, etc.)</p> <p>Do you believe the flood risk will change in the coming years? If so, how much and why?</p> <p>Flood Protection:</p> <p>Who is responsible for flood protection of the Hutt River?</p> <p>What has been done to reduce the risk of flooding in the area?</p> <p>What effect have these measures had on the flood risk?</p>	<p>Climate Change:</p> <p>What are your views regarding climate change?</p> <p>Do you think climate change will have an impact in the Hutt Valley?</p> <p>On a scale from 1-5, how concerned are you about these potential impacts? 1 2 3 4 5</p> <p>What can be done in the Hutt Valley to adapt to the effects of climate change?</p> <p>Do you think that enough is being done? (Why?)</p> <p>Demographics:</p> <p>In which age bracket do you fall?</p> <table border="0"><tr><td><input type="checkbox"/> 18-25yrs</td><td><input type="checkbox"/> 46-50yrs</td></tr><tr><td><input type="checkbox"/> 26-30yrs</td><td><input type="checkbox"/> 51-55yrs</td></tr><tr><td><input type="checkbox"/> 31-35yrs</td><td><input type="checkbox"/> 56-60yrs</td></tr><tr><td><input type="checkbox"/> 36-40yrs</td><td><input type="checkbox"/> 61-65yrs</td></tr><tr><td><input type="checkbox"/> 41-45yrs</td><td><input type="checkbox"/> 65yrs+</td></tr></table> <p>What ethnicity do you identify as?</p> <ul style="list-style-type: none"><input type="checkbox"/> New Zealander (European)<input type="checkbox"/> New Zealander (Kiwi)<input type="checkbox"/> Maori<input type="checkbox"/> Samoan<input type="checkbox"/> Cook Island Maori<input type="checkbox"/> Tongan<input type="checkbox"/> Niuean<input type="checkbox"/> Chinese<input type="checkbox"/> Indian<input type="checkbox"/> Other (e.g., Dutch, Japanese) (Please specify): <p>What is your household income category?</p> <ul style="list-style-type: none"><input type="checkbox"/> Prefer not to answer<input type="checkbox"/> Less than \$20,000<input type="checkbox"/> \$20,001-\$30,000<input type="checkbox"/> \$30,001-\$50,000<input type="checkbox"/> \$50,001-\$70,000<input type="checkbox"/> \$70,001-\$90,000<input type="checkbox"/> \$90,001-\$100,000<input type="checkbox"/> \$100,000+ <p>Is your occupation directly related to flood risk or climate change?</p> <ul style="list-style-type: none"><input type="checkbox"/> Yes<input type="checkbox"/> No <p>Is there anything else you'd like to add?</p> <p>Would you like to know more about flood risk and climate change?</p>	<input type="checkbox"/> 18-25yrs	<input type="checkbox"/> 46-50yrs	<input type="checkbox"/> 26-30yrs	<input type="checkbox"/> 51-55yrs	<input type="checkbox"/> 31-35yrs	<input type="checkbox"/> 56-60yrs	<input type="checkbox"/> 36-40yrs	<input type="checkbox"/> 61-65yrs	<input type="checkbox"/> 41-45yrs	<input type="checkbox"/> 65yrs+
<input type="checkbox"/> 18-25yrs	<input type="checkbox"/> 46-50yrs										
<input type="checkbox"/> 26-30yrs	<input type="checkbox"/> 51-55yrs										
<input type="checkbox"/> 31-35yrs	<input type="checkbox"/> 56-60yrs										
<input type="checkbox"/> 36-40yrs	<input type="checkbox"/> 61-65yrs										
<input type="checkbox"/> 41-45yrs	<input type="checkbox"/> 65yrs+										

Version 2

 WPI	 greater WELLINGTON REGIONAL COUNCIL Te Pahi Matua Taiao
<p>Flood Risk: Have you experienced any flooding in the Hutt Valley? If yes, when? Please describe your experience</p> <p>On a scale of 1-5, how likely do you think it is that the Hutt Valley will experience a major flood, similar to the flood in 2004? Not likely 1 2 3 4 5 Very likely</p> <p>Where have you obtained your knowledge about flood risk? (Select all that apply)</p> <ul style="list-style-type: none"><input type="checkbox"/> Personal experience<input type="checkbox"/> Neighbors/other community members<input type="checkbox"/> Media<input type="checkbox"/> Local/regional government<input type="checkbox"/> Scientific publications<input type="checkbox"/> Insurance<input type="checkbox"/> Other: please describe <p>In what ways would a major flood disrupt your day-to-day life? How would it affect your community?</p> <p>Do you live in the river floodplain? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>What factors contribute to the flooding of the Hutt River?</p> <p>On a scale from 1-5, how would you compare the risk of a flood compared to other natural disasters in the Hutt Valley? (Earthquake, Tsunami, etc.) Not as likely 1 2 3 4 5 More likely Why?</p> <p>Do you believe the flood risk will change in the coming years? If so, how will it change and why?</p>	<p>Climate Change: What do you know about climate change?</p> <p>Do you think climate change will have an impact on flood frequency and intensity?</p> <p>On a scale from 1-5, how concerned are you about these potential impacts? Unconcerned 1 2 3 4 5 Very Concerned</p> <p>What can be done in the Hutt Valley to adapt to the effects of climate change?</p> <p>Do you think that enough is being done? (Why?)</p>
<p>Flood Protection: Who do you think manages flood risk for the Hutt River?</p> <p>What has been done to reduce the risk of flooding in the Hutt Valley?</p> <p>What effect have these measures had on the flood risk?</p>	<p>Demographics: In which age bracket do you fall? <input type="checkbox"/> 18-25yrs <input type="checkbox"/> 25-45yrs <input type="checkbox"/> 45-65yrs <input type="checkbox"/> 65+ yrs</p> <p>What ethnicity do you identify as? <input type="checkbox"/> New Zealander (European) <input type="checkbox"/> Chinese <input type="checkbox"/> New Zealander (Maori) <input type="checkbox"/> Indian <input type="checkbox"/> Pacific Islander <input type="checkbox"/> Other (Please specify):</p> <p>What is your household income category? <input type="checkbox"/> Prefer not to answer <input type="checkbox"/> Less than \$20,000 <input type="checkbox"/> \$20,001-\$70,000 <input type="checkbox"/> \$70,001-\$140,000 <input type="checkbox"/> \$140,001+</p> <p>Is your occupation directly related to flood risk or climate change? <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>Is there anything else you'd like to add?</p> <p>Would you like to know more about flood risk and climate change?</p>

Version 3 (Final Version)

 WPI	 HUTT CITY TE AWA KAIRANGI	 greater WELLINGTON REGIONAL COUNCIL Te Pane Matua Taiao
<p>Do you live or work in the Hutt Valley? What suburb? If not, how often do you visit the Hutt Valley?</p>	Climate Change: What do you know about climate change?	
Flood Risk: Have you experienced any flooding in the Hutt Valley? If yes, when? Please describe your experience	Do you think climate change will have an impact on flood frequency and intensity?	
Do you live in the Hutt River floodplain? <input type="checkbox"/> Yes <input type="checkbox"/> No Or Unknown:	On a scale from 1-5, how concerned are you about these potential impacts? Unconcerned 1 2 3 4 5 Very Concerned	
On a scale of 1-5, how likely do you think it is that the Hutt Valley will experience a major flood in the next 30 years, similar to the flood in 2004? Not likely 1 2 3 4 5 Very likely	What can be done in the Hutt Valley to adapt to the effects of climate change?	
Where have you obtained your knowledge about flood risk? (Select all that apply) <input type="checkbox"/> Personal experience <input type="checkbox"/> Neighbors/other community members <input type="checkbox"/> Media <input type="checkbox"/> Local/regional government <input type="checkbox"/> Scientific publications <input type="checkbox"/> Insurance <input type="checkbox"/> Other: please describe	Do you think that enough is being done? Why or why not? By whom?	
In what ways would a major flood disrupt your day-to-day life? How would it affect your community?	Demographics: In which age bracket do you fall?	
What factors contribute to the flooding of the Hutt River?	<input type="checkbox"/> 18-25yrs <input type="checkbox"/> 26-45yrs <input type="checkbox"/> 46-65yrs <input type="checkbox"/> 66+ yrs	
On a scale from 1-5, how would you compare the risk of a flood compared to other natural disasters in the Hutt Valley? (Earthquake, Tsunami, etc.) Not as likely 1 2 3 4 5 More likely Why?	What ethnicity do you identify as? <input type="checkbox"/> New Zealander (European) <input type="checkbox"/> Chinese <input type="checkbox"/> New Zealander (Maori) <input type="checkbox"/> Indian <input type="checkbox"/> Pacific Islander <input type="checkbox"/> Other (Please specify):	
Do you believe the flood risk will change in the coming years? If so, how will it change and why?	What is your household income category? <input type="checkbox"/> Prefer not to answer <input type="checkbox"/> Less than \$20,000 <input type="checkbox"/> \$20,001-\$70,000 <input type="checkbox"/> \$70,001-\$140,000 <input type="checkbox"/> \$140,001+	
Flood Protection: Who do you think manages flood risk for the Hutt River?	Is your occupation directly related to flood risk or climate change? <input type="checkbox"/> Yes <input type="checkbox"/> No	
What has been done to reduce the risk of flooding in the Hutt Valley?	Is there anything else you'd like to add?	
What effect have these measures had on the flood risk?	Would you like to know more about flood risk and climate change? <input type="checkbox"/> Yes <input type="checkbox"/> No	

Appendix D: Sample Coding

What can be done in the Hutt Valley to adapt to the effects of climate change?

Emissions

Public Transportation

Fewer cars

biking to work

walking more

less industry

Flood Planning

continue river works projects

infrastructure (bridges)

stopbanks

Urban Planning

zoning

house stilts

Stopbank Improvement

build up stopbanks

continue working on stopbanks

Pollution

reduce carbon emissions

clean up river

deal with river algae

waste management

recycling

Nothing

nothing can be done

going to happen no matter what

Appendix E: Sample Computer Code Used to Analyze Data

csv.sh - Amalgamation shell script

```
#!/bin/bash

# Transpose rows and columns of data

python Dropbox/python/csv_col_to_row.py tab tab data.tsv data2.tsv

cd Dropbox/perl/

# Survey data analysis - this file is omitted here due to length (660 lines)

perl csv_survey.pl ~/data2.tsv

cd corrs

# Calculate row/column totals for use in chi squared test

python sum_tables.py

cd new

# Conduct chi square test and output tsvs where p<.05

python chi_square.py

mv *.csv csv/

cd csv/

# Replace commas with semicolons to allow conversion from tsv to csv

sed -i 's/,;/g' *

sed -i 's/\\t/,/g' *
```

csv_col_to_row.py - transpose a matrix

```
#!/usr/bin/python

import csv

import sys

from itertools import izip

if len(sys.argv) > 4:

    delim = sys.argv[1]

    delim2 = sys.argv[2]

    f = sys.argv[3]
```

```
    of = sys.argv[4]
else:
    delim = raw_input("In delimiter: ")
    delim2 = raw_input("Out delimiter: ")
    f = raw_input("Data file: ")
    of = raw_input("Output file: ")

if delim == "tab":
    delim = '\t'
if delim2 == "tab":
    delim2 = '\t'

a = izip(*csv.reader(open(f), delimiter=delim))
csv.writer(open(of, "w"), delimiter=delim2).writerows(a)
```

Appendix F: Survey Response Data

Do you live or work in Hutt Valley? What suburb?

Residents	139	68.8%
Workers	27	13.4%
Visitors	15	7.4%
Live and work	21	10.4%

Have you experienced any flooding in the Hutt Valley?

Experienced	110	54.5%
Not Experienced	92	45.5%

On a scale of 1-5, how likely do you think it is that the Hutt Valley will experience a major flood in the next 30 years?

(1) Very Unlikely	19	9.4%
(2) Unlikely	26	12.9%
(3) Moderate	46	22.8%
(4) Likely	51	25.2%
(5) Very Likely	55	27.2%
Unsure	5	2.5%

Where have you obtained your knowledge about flood risk?

Media	111	29.8%
Personal Experience	113	30.3%

Local/Regional Government	62	16.6%
Neighbors/Other Community Members	31	8.3%
Scientific Publications	17	4.6%
Insurance	11	2.9%
Other	28	7.5%

In what ways would a major flood disrupt your day-to-day life? How would it affect your community?

Top Answers

Transportation/Work	157	77.7%
Residential	28	13.8%
Community Suffering	25	12.4%
Essentials (Food, water, etc.)	24	11.8%
Minor	22	10.9%
Access	14	6.9%

What factors contribute to the flooding of the Hutt River?

Top Answers

Rain	119	58.9%
River Work	31	15.4%
Sediment	18	8.9%

On a scale from 1-5, how would you compare the risk of a flood compared to other natural disasters in the Hutt Valley?

(1) Very unlikely	24	11.9%
-------------------	----	-------

(2) Not as likely	47	23.3%
(3) As likely	66	32.7%
(4) More likely	45	22.2%
(5) Much more likely	20	9.9%

Do you believe the flood risk will change in the coming years? If so, how will it change and why?

Will change	120	59.4%
Will not change	47	23.3%
Unsure	35	17.3%

[If previous answer “Will change”]:

		(X/120)	(X/202)
Will Increase	81	67.5%	40.1%
Will Decrease	37	30.8%	18.3%
Unsure Which Direction	2	1.7%	1.0%

Who do you think manages flood risk for the Hutt River?

GWRC	63	31.2%
HCC	66	32.7%
Other	73	36.1%

[If previous answer “Other”]:

Combination of 2 or more	33	45.2%
--------------------------	----	-------

Civil Defense	9	12.3%
Council	12	16.4%
Unsure	13	17.8%
Misc.	6	8.2%

What has been done to reduce the risk of flooding in the Hutt Valley?

Stopbanks	104	51.4%
River Works	44	21.7%
Dredging	22	10.8%
Drainage	13	6.4%
Other	19	9.7%

What effect have these measures had on the flood risk?

Decreased	125	61.9%
Increased	11	5.4%
Unsure	66	32.7%

What do you know about climate change?

Happening	177	87.6%
Not Happening	10	5.0%
Unsure	15	7.4%

Do you think climate change will have an impact on flood frequency and intensity?

Will Impact	158	78.2%
-------------	-----	-------

No Impact	11	5.5%
Unsure	33	16.3%

[If previous answer: “Will Impact”]

Will Increase	81	67.5%
Will Decrease	37	30.8%
Unsure Which Direction	2	1.7%

On a scale from 1-5, how concerned are you about these potential impacts?

(1) Unconcerned	25	13.0%
(2) Slightly Unconcerned	40	20.8%
(3) Moderately Concerned	64	33.3%
(4) Concerned	41	21.4%
(5) Very Concerned	22	11.5%

What can be done in the Hutt Valley to adapt to the effects of climate change?

Top Answers

Emissions	32	15.8%
Flood Planning	18	8.9%
Urban Planning	14	6.9%
Stopbank Improvement	16	7.9%
Pollution	9	4.4%
Nothing	18	8.9%

Do you think that enough is being done to adapt to the effects of climate change? Why or why not? By whom?

Yes	67	33.2%
No	83	41.1%
Unsure	52	25.7%

In which age bracket do you fall?

18-25	42	20.8%
26-45	63	31.2%
46-65	57	28.2%
66+	34	16.8%
NA	6	3%

What ethnicity do you identify as?

NZ (Euro)	145	71.8%
NZ (Maori)	16	7.9%
Pacific Islander	12	5.9%
Other	18	10.9%
NA	7	3.5%

What is your household income category?

<20,000	25	12.4%
20,000-70,000	51	25.2%
70,000-140,000	52	25.7%

140,000+	21	10.4%
Prefer Not to Answer	53	26.2%

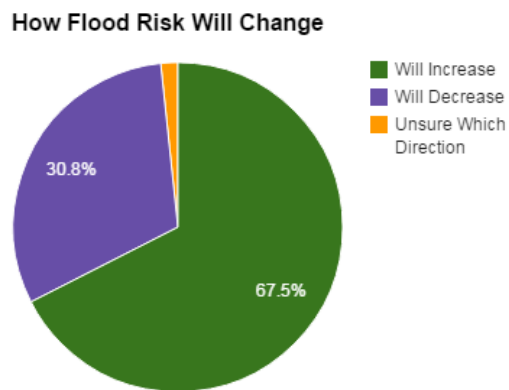
Is your occupation directly related to flood risk or climate change?

Y	30	14.9%
N	172	85.1%

Would you like to know more about flood risk and climate change?

Y	75	37.1%
N	127	62.9%

Breakdown of those that responded with “will change” to the question “Do you believe the flood risk will change in the coming years?”



Breakdown of respondents that responses that were not HCC or GWRC to the question “Who manages flood risk for the Hutt River?”

