Adapting to Rising Sea Levels in Seaview Gracefield, New Zealand

Developing the Seaview Sea-Level "Sea-narios" Climate Game

By:

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greater WELLINGTON REGIONAL COUNCIL

WPI

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Developing the Seaview Sea-Level "Sea-narios" Climate Game

An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
degree of Bachelor of Science

by
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Report Submitted to:

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Greater Wellington Regional Council
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ABSTRACT

Seaview Gracefield is an industrial hub, located in a low-lying coastal area at the confluence of the Waiwhetu stream and the Hutt River near Wellington, New Zealand. Hoping to mitigate the area's flood risk exacerbated by sea-level rise, the Greater Wellington Regional Council plans to develop an adaptive pathways land use plan. We created an informative climate scenario for businesses during interviews. We gathered various perspectives of business leaders to gauge the level of awareness and planning regarding future sea-level rise in the area. We encountered a large spectrum of perspectives. In order to generate community engagement, we developed a serious game called the Seaview Sea-level "Sea-narios" game to communicate climate risks to businesses.

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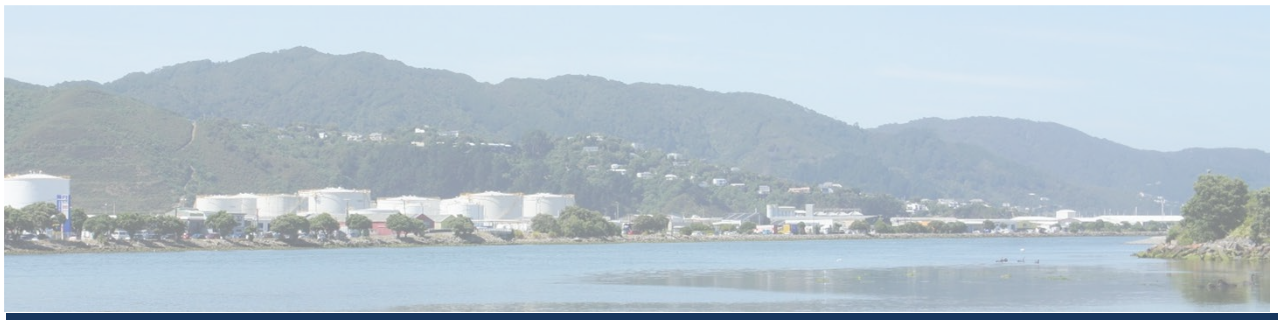
- Jen Houdalakis, Seaview Business Association Coordinator
- Carl Longstaff, Managing Director, Metal Art Ltd.
- The Business Community of Seaview Gracefield
- The Pelorus Trust House



EXECUTIVE SUMMARY

Located near Wellington, New Zealand, Seaview Gracefield is a low-lying coastal area at the confluence of the Waiwhetu stream and the Hutt River. The area is at high risk of flooding, which is set to worsen with climate change-induced sea-level rise. As the industrial hub of the Hutt Valley, it is extremely important to understand business perspectives on long-term flood mitigation strategies, as those viewpoints will be vital to any flood mitigation planning and land use plans in the area. Our sponsor, the Greater Wellington Regional Council, plans to incorporate perspectives of Seaview Gracefield business owners when developing a plan to address the future effects of sea-level rise in the area.

OUR SPONSOR

The Greater Wellington Regional Council (GWRC) is an overarching council representing eight territorial councils within the region (Figure 1). One of those councils is the Hutt City Council. The GWRC handles services and planning, such as natural resource management, flood protection, and provision of regional parks (GWRC, n.d.). They have a significant role in the community response to flood protection by developing staged floodplain management plans in areas with a high threat to flooding. City councils such as the Hutt City Council are responsible for essential community services in Hutt Valley such as road maintenance, land-use, and subdivisions (GWRC, n.d.). The GWRC and Hutt City Council work collaboratively on flood mitigation projects in the area.

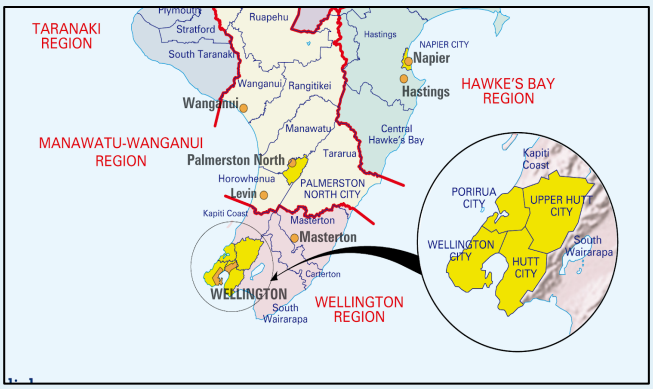


Figure 1: Regional and District Council Boundaries (LGNZ, n.d.)

SEAVIEW GRACEFIELD'S VULNERABILITY

In a 2019 GWRC report, Seaview Gracefield was considered the most vulnerable area to flooding in the Hutt City district. Seaview Gracefield is vulnerable for two main reasons: because of its topography, and its industrial composition. The area is part of a catchment, so when heavy rainfall overflows any of the connected tributaries, the extra water is directed to the Hutt river, causing it to flood. This, combined with the fact that Seaview Gracefield is in a low-lying coastal area, makes it prone to flooding. Seaview Gracefield's industrial composition also makes it vulnerable. As the industrial hub of Hutt Valley, it contains more than 700 businesses (Hutt City Council, 2018a). It is zoned as a Special Business Activity Area, which allows for hazardous facilities. This zoning is not common in the Wellington area, making it difficult for businesses who rely on it to relocate. Hazardous facilities are potentially dangerous in the event of a major disaster (Hutt City Council, 2017). Sea-level rise will exacerbate these vulnerabilities. Flooding from storm surges will worsen as the sea temperature increases. Also, as sea-levels rise, so will the water table. This worsens the phenomenon of groundwater inundation, which in addition to worsening flooding, will also create a number of other negative effects. This includes increased liquefaction risk, spread of contaminants, and mixing of storm and wastewater (Wellington Water, n.d.; Plane et. all, 2019).

DYNAMIC ADAPTIVE PATHWAY PLANNING (DAPP)

While fortification (hard engineering solutions) and retreat (strategic buyout of land in order to convert its use) are the most common solutions to flood management, there is another emerging strategy to deal with flood risk: Dynamic Adaptive Pathway Planning (DAPP). Dynamic Adaptive Pathway Plans are flexible and involve a series of actions over time (Lawrence, 2018). DAPP incorporates long-term planning into short-term decisions determined by events called trigger points. Trigger points are times where the course can change, while still staying on track for achieving the end goal (Lawrence, 2018).

GOALS & OBJECTIVES

The goal of this project is to catalyze the development of an adaptive pathways land use plan for the Greater Wellington Regional Council in response to rising sea levels in the Seaview Gracefield area. To accomplish this goal, we developed the following research objectives:

1. Establish a climate scenario to help educate business leaders about the future effects of sea-level rise.

2. Based on known and emerging trigger points, assess current business continuity planning and knowledge regarding climate change.

3. Develop and test a facilitated climate game, and offer recommendations for further community engagement.

METHODS

Establish a Climate Scenario to Help Educate Business Leaders About the Future Effects of Sea-Level Rise

In order to inform business leaders of the ways sea-level rise is expected to affect them, we created a climate scenario in the form of an infographic to use during interviews. The final infographic included basic sea-level rise projections over the next 50 years from the GWRC online tool, flood maps from the Wellington Region Flood Hazards map tool, and information on how sea-level rise and increased flooding could affect insurance and urban infrastructure.

Based on Known and Emerging Trigger Points, Assess Current Business Continuity Planning and Knowledge Regarding Climate Change

We developed an understanding of business perspectives and discovered potential trigger points through semi-structured interviews with officials from the Hutt City Council and the Hutt City Chamber of Commerce. We conducted 20 semi-structured interviews with business leaders in Seaview Gracefield. The most successful strategy was a walk-in method. This means we walked in, introduced ourselves, and asked for a short 15-30 minute interview with the owner or manager. We also utilized contacts from the Hutt City Council and other business leaders to find willing interviewees. Our interviews focused on gaining insight into six main topics:

- General information about the business
- Knowledge of climate change & sea-level rise
- Experiences with flooding
- Continuity planning regarding sea-level rise & flooding
- Changes in insurance
- Interest in workshops/future education

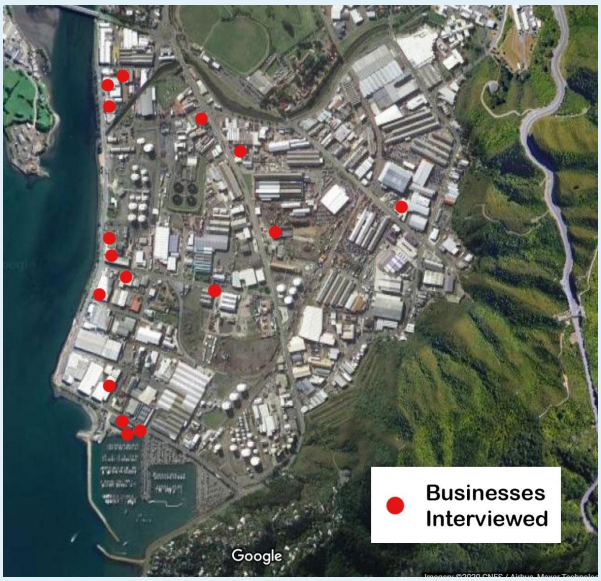


Figure 2: Map of interviewed businesses who agreed to be identified (four wished to be unidentified).

Develop and Test a Facilitated Climate Game, and Offer Recommendations for Further Community Engagement

We created an excel file where we categorized responses from each business leader by topic. This included information such as Seaview Business Association membership, business location, reliance on area, and awareness of sea-level rise. We identified patterns and made recommendations based on them. We also identified additional trigger points to those we already considered emergent. As we began to identify patterns, the development of our game progressed. After implementing new changes from field sessions, our team presented a final prototype to two business leaders in Seaview Gracefield.

FINDINGS

Trigger Points

We identified five trigger points that could be used to develop a dynamic adaptive pathways plan:

Lease Expiration	60%, or 12/20 business owners we interviewed, rented their building, rather than owning the land. When their lease is up, these businesses must reassess whether to remain in that location. Two business leaders we interviewed already had business continuity plans in place to leave after their lease ends sometime in the future.
Event of a Major Flood	Seaview has not experienced a memorable flood in over 10 years, leading many business leaders to severely downplay the risk of flooding. If a major flood were to take place, it would impact many businesses that have not recently experienced flooding. The effects of flooding, combined with a reality of increased flood events, may force businesses to reevaluate their location in Seaview, and potentially leave.
Decreasing Property Values	40% of respondents (8/20) were property owners. For these business owners, their property is an investment, for which the value is closely monitored. If the property value decreases substantially due to increasing flood risk, it may not be worth the investment to stay.
Increasing Insurance Rates	This was an emerging trigger point. Of the 18 Seaview Gracefield business leaders who could comment on insurance, 14 had seen recent increases. While 12 of these interviewees attributed the increase to earthquakes, it is possible that there could be more increases in the future due to flood risk. If premiums become too high, or it becomes even more difficult to get coverage, some businesses could be forced to operate elsewhere.
Interruption of Business Interdependence	We identified a small group of three businesses in Seaview Gracefield that depend on others in the area to succeed. If one business in this group were to relocate or shut down, it would have a profound effect on those that depend on it.

Key Perspectives

We identified key perspectives that did not tie directly to trigger points, but played a large role in the formation of our recommendations.

- **Awareness Surrounding Rising Sea Levels:** We encountered a broad range of knowledge among business leaders on climate change, as well as the sea-level rise in the Seaview Gracefield area. Out of 20 interviewees, four people had what we considered to be a substantial level of awareness. The majority of interviewees, 12, were aware that sea-level rise was happening, but did not understand how it would affect them or the urgency of the issue. Four interviewees were either in denial of the effects of sea-level rise or had misconceptions regarding climate change.
- **Misconceptions About Sea-level Rise:** Many interviewees did not understand the increasing threat of groundwater inundation due to the rising water table. To address the gap of knowledge, we developed a prototype for a serious game called the Seaview Sea-level "Sea-narios" Game. It is based on a game from the Red Cross/Red Crescent's Climate Centre called "Act to Adapt." This facilitated climate game teaches players about the consequences of sea-level rise, and its impacts on infrastructure through different types of floods.
- **Experiences with Flooding:** We encountered large variations in perceptions of when business leaders last experienced a flood. Some businesses flood yearly, some have not seen any flooding in a few years, and others have never seen flooding. We also found that there were varying levels of flood damage, with many businesses experiencing no damage, to one that reported approximately six inches of water in the building during a flood nine years ago.
- **Opinions on Local Government:** This was an unanticipated topic. We encountered a range of opinions on local government, with some interviewees deeply critical of GWRC, while others expressed satisfaction with the work done on the Waiwhetu stream.
- **Existing Business Continuity Planning:** We discovered that very few businesses had done any kind of business continuity planning regarding flooding and sea-level rise.
- **Viewpoints on Future Fortification and Relocation:** We gained insight into business opinions on fortification and retreat. Six businesses expressed a desire to continue to fortify, while five were open to considering a managed retreat.
- **Reflections on Workshops and Further Education:** 14 out of 19 leaders were interested in a workshop to learn more about sea-level rise and how to plan accordingly. A representative from the Seaview Business Association also stated that there would be interest in a workshop.

RECOMMENDATIONS

- **Educate the public on the effects of sea-level rise:** The majority of businesses did not know the effects sea-level rise will have on the Seaview Gracefield area in the future. Briefly educating the public before educating about planning would make it a more pressing issue for business leaders.
    - **Further develop the serious game, Seaview Sea-level "Sea-narios" to be used in a workshop:** Further develop the serious game, Seaview Sea-level "Sea-narios" to educate and spread awareness about the effects of rising sea levels based on the prototype we created. A facilitated activity such as this could strengthen the relationship between the GWRC and the community.
    - **Add information about groundwater inundation to GWRC sea level maps:** The GWRC flood maps on their website do not discuss groundwater inundation. Adding this information would be beneficial in correcting the common misconception that due to sea-level rise, water is not just coming over coastal barriers, but also from the ground as the water table rises.
- **Educate community on short-term and long-term planning:** These are two topics we suggest focusing on once further work has been completed to educate the community on the effects of sea-level rise.
- **Tailor communication to businesses time constraints:** Business owners have little time in general. This constraint should be kept in mind when designing a workshop.
- **Involve the Seaview Business Association:** The Seaview Business Association has a database of contacts and can help raise awareness, foster education, and help host a workshop.
- **Delay adapting the Deltares' Sustainable Delta Game**: This digital game focuses on long term planning, but we recommend that businesses first understand the issues surrounding sea-level rise. While using the Sustainable Delta game to demonstrate the issues at hand will be useful, the existing Deltares' Game requires too much time and too many resources for it to be worth adapting at this time.

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Addressing the Gap of Knowledge	Julia	Andrew
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Conclusion	Julia	Andrew, Nicole

Note: Any section where we stated ‘ALL’ represents areas where we divided the section amongst all four of us to write and then combined collaboratively.

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GLOSSARY

Adaptation: Anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause (Adaptation to climate change, 2017).
Business continuity planning: The process of creating a system of prevention and recovery from potential threats to a company (Kenton, 2019).
Business leader: Business leader is our umbrella term including property owners, CEOs, property managers, general managers, business owners and co-owners.
Chamber of Commerce: an association formed to promote and protect the interests of the business community in a particular place (OED, n.d.).
Channel: A wide strait or waterway between two landmasses that lie close to each other (National Geographic Society, 2012).
Climate scenario: A scenario used to predict human-induced changes in climate in the future and the effects it has on the target area (NIWA, 2017).
Convenience sample: A sampling method where subjects are selected due to their convenient accessibility and proximity to the researchers (Convenience sample, n.d.)
Cumec: one cubic meter of water passing a given point every second
Delta environment: The deposition of sediments by a river near its mouth before it drains into a body of water results in the formation of river deltas (Nag, 2017).
Design life: The period of time in which a product is expected to work within its specified parameters (Definitions for design life, n.d.).
Dynamic Adaptive Pathways Planning: It identifies ways forward (pathways) despite uncertainty, while remaining responsive to change should this be needed (dynamic). In the approach, a range of responses to climate change are tested against possible future scenarios (Ministry for the Environment, n.d.-a).
Ethnography: Ethnography is a type of qualitative research that gathers observations, interviews and documentary data to produce detailed and comprehensive accounts of different social phenomena (Reeves, 2013).
Floodplain: The flat area bordering a river, composed of sediment deposited during flooding (Collins, n.d.).
Flow rate of river: The volume of water passing a point in a fixed period of time (Rinehart, B., Johnson, K., & Mooney, M., 2019).
Fortification: hard engineering projects like sea walls, surge barriers, water pumps and overflow chambers to keep water out (Muggah, n.d.).
Inundation: Another term for flooding.
Impervious surfaces: Constructed or modified surfaces that cannot effectively allow for the infiltration of rainfall (Definition of impervious surfaces, n.d.).
Large businesses: In our research, we consider a large business to be a multinational business (with locations outside Australia).

Liquefaction: The process where, during earthquake shaking, sand and silt grains in wet soil are rearranged and the water in the spaces between the grains is squeezed (Canterbury Regional Council, n.d.).

Managed retreat: the calm and planned **retreat** of communities and infrastructure away from coastal areas before they are severely impacted by coastal hazards, including sea-level rise (Carew, 2018).

Mitigation: Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2020).

One in one hundred year flood: A flood that statistically has a one percent chance of happening in any given year (USGS, n.d.).

Rainfall-intensity: The ratio of the total amount of rain (rainfall depth) falling during a given period to the duration of the period It is expressed in depth units per unit time, usually as mm per hour (mm/h) (Critchley, W., & Siegert, K., n.d.).

Riverbank: The raised or sloping edge or border of a river (OED, n.d.)

Semi-structured interview: A meeting in which the interviewer does not strictly follow a formalized list of questions. They will ask more open-ended questions, allowing for a discussion with the interviewee rather than a straightforward question and answer format (Doyle, 2019).

Snowball sampling: a sampling technique, in which existing subjects provide referrals to recruit samples required for a research study (Baht, 2018).

Small to medium sized enterprises (SMEs): are non-subsidiary, independent firms which employ fewer than a given number of employees. This number varies across countries. The most frequent upper limit designating an SME is 250 employees, as in the European Union (OECD, 2005).

Stopbank: An embankment to prevent flooding. (Collins, n.d.).

Storm surge: an abnormal raising of the sea level in a region as a result of the wind and atmospheric pressure changes associated with a storm (OED, n.d.).

Storm water: the water that runs off surfaces such as roads, driveways, footpaths and rooftops. It travels down gutters, into sumps and enters the stormwater network to be discharged into harbors and streams (Wellington City Council, 2013).

Stream: A small, narrow river. (Collins, n.d.)

Tributary: A stream or river that flows into a larger one (Collins, n.d.).

Trigger point: Times where the course can change, while still staying on track for achieving the end goal.

Urban zoning: a planning control tool for regulating the built environment. It divides land into sections, permitting use on specific sites (The World Bank, n.d.).

Vulnerability: Refers to the degree to which people or the things they value are susceptible to, or are unable to cope with, the adverse impacts of climate change (Human Vulnerability to Climate Impacts, n.d.).

Water table: The level below the surface of ground where water can be found (Collins, n.d.).

CHAPTER 1: INTRODUCTION

The New Zealand coastline spans more than 15,000 kilometers (approximately 9,300 miles), and sea-level rise is negatively affecting coastal communities around the country (Coastline Lengths, n.d.). The sea level around New Zealand has risen by up to 220 millimeters in the last century, but is projected to rise 300-400 millimeters within the next 30-40 years. These rising sea levels will not put the Seaview Gracefield area underwater, but will cause flood hazards such as storm surges to occur much more frequently and be more damaging (Level, 2019).

Sea-level rise makes the Wellington area vulnerable due to the large amounts of reclaimed land. Areas of land have been reclaimed in both Wellington's Central Business District, as well as the Hutt Valley located on the opposite side of the harbor. Areas of land that have been reclaimed from the ocean were once uninhabited and acted as a natural buffer to protect from flood hazards. Reclaiming and developing land removes that buffer and puts communities in close proximity to the water, leaving them vulnerable to these

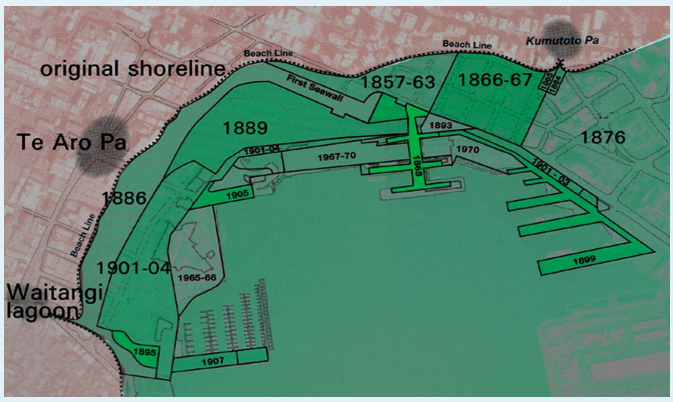


Figure 1: Map of Reclaimed Land in Wellington (Wellington Waterfront, 2018)

hazards that will intensify as sea-level rises. A map showing the reclaimed land of Wellington can be seen below in Figure 1, which shows the extent of reclaimed land between 1857-1970 in what is now Wellington's Central Business District (Wellington Waterfront, 2018).

In order for small businesses in the Lower Hutt region of Wellington to operate with the threat of rising sea levels, planning and adaptation strategies are crucial. Various councils are currently involved in preparing for this threat, but for flood mitigation policies to be effective, community support is imperative. To generate necessary community support planners must first understand community perceptions and expectations surrounding this complex issue. Many factors influence perceptions including trust in experts, prior experience with the risk of flooding, environmental beliefs, and socio-economic factors (Verlynde, 2019).

The Greater Wellington Regional Council (GWRC) represents the many city and district councils within their region. While the GWRC is the larger overarching council, it has eight councils working under them categorized by city and district, one of them being the Hutt City Council (Figure 2). Regional councils such as GWRC handle services and planning, including natural resource management, flood protection, and provision of regional parks. The GWRC has a significant role in the community response to flood protection by developing staged floodplain management plans in areas of high threat to flooding due to natural hazards as well as sea-level rise. City or district councils such as Hutt City Council are responsible for their local district. Hutt City Council governs 108,700 people,

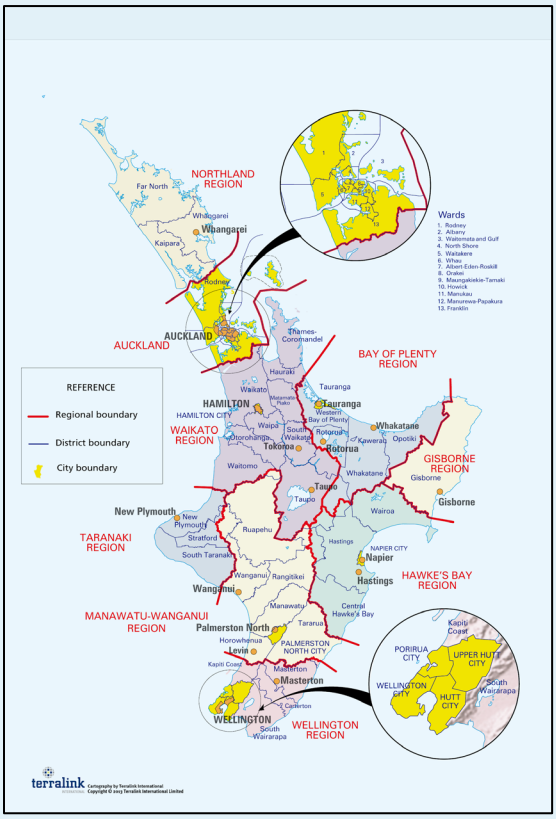


Figure 2: Regional and District Council Boundaries (LGNZ, n.d.)

37,664 hectares, and a span of coast, rural, and urban areas (Hutt City Council, 2019). The GWRC and Hutt City Council work collaboratively on flood mitigation projects in the area.

The Seaview Gracefield area is situated at the confluence of the Waiwhetu stream, the Te Awa Kairangi/Hutt River and the Wellington Harbor. Seaview Gracefield is the industrial hub and an economic pillar of the Hutt Valley. This industrial zone is separated from residential areas by natural barriers such as the Waiwhetu stream, Hutt Park, and Point Howard Hillside. Seaview Gracefield has a unique zoning called Special Business Activity Area which allows hazardous facilities to operate there (Hutt City Council, 2017).

In response to sea-level rise and increased risk of flooding, the Greater Wellington Regional Council is interested in developing a Dynamic Adaptive Pathways Land-use Plan. Dynamic Adaptive Pathway Planning (DAPP) accounts for uncertainty by incorporating long-term planning into short-term decisions (Lawrence, 2018). They want to develop a long-term plan to change the land usage to protect the area from economical loss and environmental damages that could occur from increased flood risk. In this process, trigger points are used to define points in time where short-term decisions must be made by the GWRC to work toward the long-term goal (Lawrence & Boston, 2018). The ultimate goal is to develop this plan so that the land usage can change from industry to something that may be safer for the area, such as a park. This is what the city of Christchurch did with an area that was deemed uninhabitable after the 2011 earthquake (Zaki, 2019).

In order to develop a future land use plan, the GWRC wants to incorporate the perspectives of Seaview Gracefield business leaders in the development of a plan to address sea-level rise that will alleviate flood risk in the area. The GWRC is equipped with regional climate predictions and has taken similar steps with residential areas within their region. They now plan to explore business perspectives to address how this approach must be different from the approach taken with residential areas.

The goal of this project is to catalyze the development of an adaptive pathways land use plan for the Greater Wellington Regional Council in response to rising sea levels in the Seaview Gracefield area. To accomplish this goal, we developed the following research objectives: 1) Establish a climate scenario to help educate business leaders about the future effects of sea-level

rise 2) Based on known and emerging trigger points, assess current business continuity planning and knowledge regarding climate change, and 3) Develop and test a facilitated climate game, and offer recommendations for further community engagement. This process explores ways to convey risk to the community and better understand how business leaders view the threat of rising seas and what solutions they consider to be feasible. Our analysis will aid the GWRC in determining further steps needed to protect businesses from the effects of rising sea-levels (GWRC, 2018).

CHAPTER 2: BACKGROUND

This chapter presents relevant background on the Hutt Valley in the Greater Wellington region of New Zealand. We examine the history of land use and the growing threat of flooding in the valley. We also evaluate recent interventions and approaches to community engagement and discuss how climate change has dramatically highlighted the threat of flooding.

The organization of the following chapter is mapped out in Figure 3. First, we introduce the Seaview community. It is a particularly vulnerable area due to two main characteristics: its susceptibility to flooding and its complex industrial nature. This vulnerability is exacerbated in two ways. Historically, the industrial development of the area has altered the natural landscape, affecting the way nature inherently mitigates flooding. Second, climate change intensifies the effects of coastal hazards. The second part of this chapter outlines methods of adapting to the threat of sea-level rise, including the more recent approach called Dynamic Adaptive Pathway Planning (DAPP) and the Red Cross/Red Crescent Climate Centre's serious games.

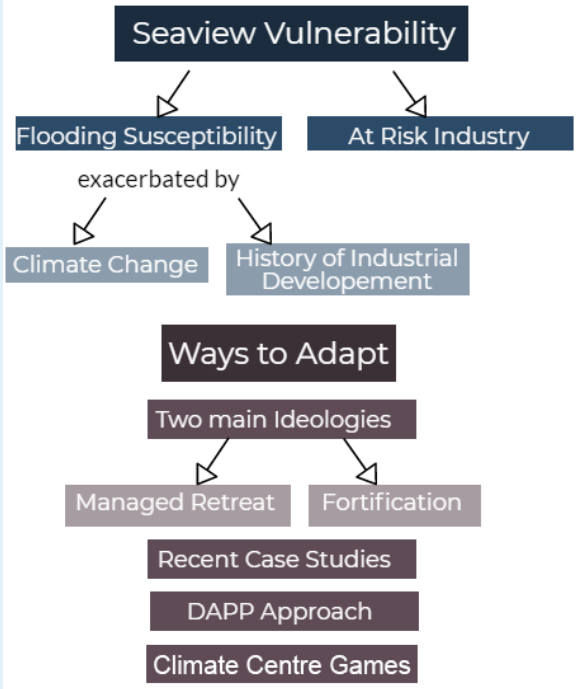


Figure 3: Seaview Gracefield's vulnerability and approaches to adaptation (Nicole Kring).

THE VULNERABILITY OF SEAVIEW GRACEFIELD

A 2019 report done by the GWRC identified Seaview Gracefield as the most vulnerable area to flooding in the Hutt City district. Vulnerability is assessed through the extent to which people, communities, the environment, and assets are affected by coastal hazards and what their capacity to cope and adapt is (Lawrence et al., 2011). As shown in Figure 4, Seaview (the orange bar) ranks relatively high in each category, particularly in the Lifelines (lifelines infrastructure) category. Lifelines infrastructure encompasses sectors such as transport, energy, communications, and water services (GWRC, 2019a). Seaview Gracefield also has high vulnerability in the "3 Waters" category, which encompasses drinking water, wastewater, and stormwater services (GWRC, 2019a)

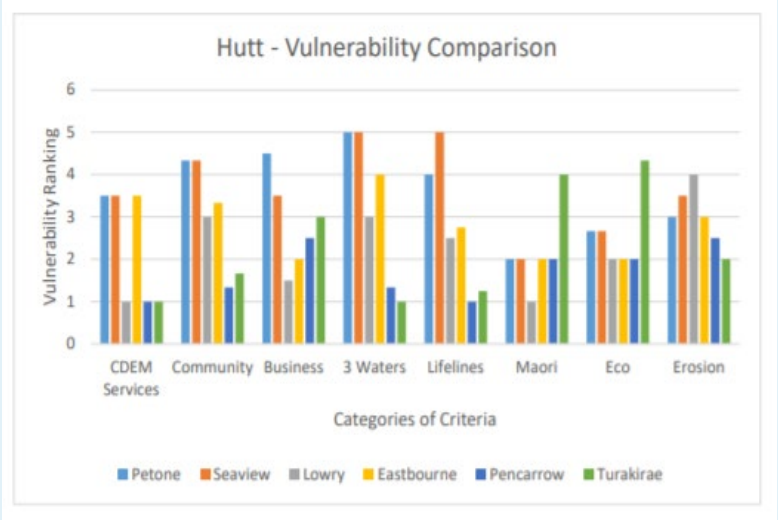


Figure 4: Vulnerability Comparison of Hutt City Districts (GWRC, 2019).

TYPES OF FLOODING IN SEAVIEW GRACEFIELD

To the east of Seaview Gracefield, lies the Hutt River. The Hutt River is located in the Wellington Region of the North Island of New Zealand. The Hutt River is a part of a catchment. Typically bounded by hills, a catchment is an area of land that collects water when it rains (Ministry for the Environment, n.d.-b). As the water flows over the landscape, it eventually feeds into a main river. This river system provides much of the freshwater needed for Wellington, including the Hutt Valley (which encompasses Lower and Upper Hutt). The catchment area

encompasses all the streams and tributaries that flow from the Tararua and Rimutaka mountain ranges, as well as the Eastern and Western Hutt hills. The Hutt River is fed by the Pakuratahi, Mangaroa, Akatarawa, and Whakatiki rivers and flows into the Wellington Harbor as shown in Figure 5.

Figure 5: The Hutt River catchment and its tributaries (GWRC).

When heavy rainfall or a storm in any part of the catchment systems overflows the tributaries, the excess water flows into the Hutt River. Consequently, the Hutt River is very susceptible to flooding. Within seven hours, heavy rain at the top of the catchment can turn into flood waters at the Hutt River mouth (GWRC, 2004). Seaview Gracefield is a suburb within the larger city of Lower Hutt. Lower Hutt has significant rainfall throughout the year, even during the driest months. Precipitation in Lower Hutt is about 1299 mm per year (Climate-Data, 2017). Figure 6 shows the monthly average rainfall at Wainuiomata Reservoir, located in a suburb of Lower Hutt (GWRC, 2017b). As shown, the year 2016/17 was historically much wetter, especially in the months of November and April.

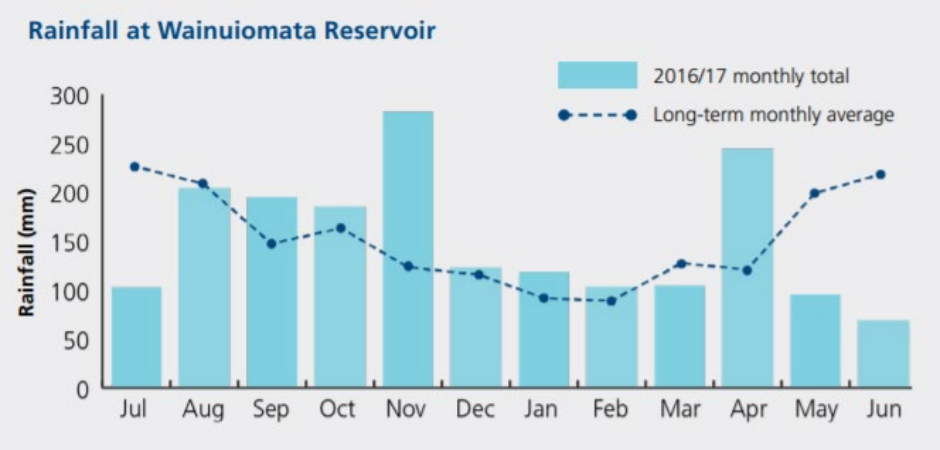


Figure 6: Average monthly rainfall at the Wainuiomata Reservoir (GWRC).

When rainfall-intense events occur, Seaview Gracefield is prone to several types of flooding. First, flooding can occur in the form of inundation in open fields with poor drainage capacity. Low lying areas are particularly at risk, as they are a topographical depression in elevation where floodwater has the potential to pool (GWRC, 2019b). The Hutt Valley is very flat and low-lying. The Seaview Gracefield area has the lowest lying land in the Greater Wellington area (Lawrence, 2011) (Figure 7).

Seaview Gracefield also experiences storm surges, and with 4.82 km of coastline, this leaves the area particularly at risk (GWRC, 2019b). A storm surge is the rise in the coastal water level that occurs just from a storm, measured relative to the normal predicted height of the tide (Ministry for the Environment, 2017). A storm surge is caused by the storm's winds pushing the tides onshore as well as low air pressure lifting the water level. The amount of storm surge depends on several things: the orientation of the coastline to the storm's path, the intensity and size of the storm, and the speed of the storm. Combined with large waves and high tide, it can cause local flooding and erosion (NOAA, 2019).

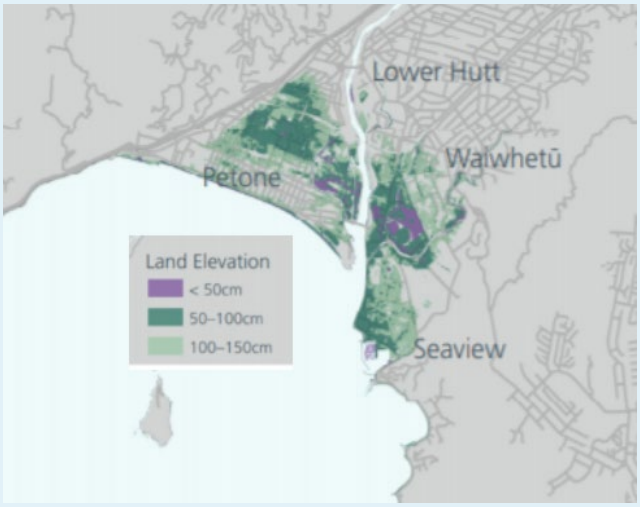


Figure 7: Low lying land elevation of the Greater Wellington Region (Parliamentary Commissioner for the Environment).

Seaview Gracefield also experiences flooding due to the overtopping of the Waiwhetu stream. Overtopping is the process of floodwaters flowing over the top of stopbanks. When floodwaters rush in, the stopbanks are eroded and eventually breached. The floodwaters then make their way to the floodplain area (GWRC, 2001). An example of this is the 2004 flood of the Waiwhetu stream, shown below in Figures 8 and 9. Heavy rain caused the banks along the Waiwhetu stream to be overtaken. As a result, Riverside Drive, the Hutt Park Raceway, and the industrial area in Gracefield experienced major flooding (GWRC, 2017a).

Figure 8: Location of Riverside Drive (Google Maps).

Figure 9: Flooding of Riverside Drive in 2004 Waiwhetu flooding (GWRC)

Stormwater is another source of flooding in Seaview Gracefield. As an area is developed, impervious surfaces are introduced such as asphalt, concrete, and brick. As a result, surface runoff and stormwater volumes increase into the drainage system as the stormwater pours into them. Flow rates and volumes of rivers and streams are increased drastically. Consequently, the risk of erosion and flooding is increased. In addition, litter has the potential to block stormwater grates and drains, causing additional flooding (GWRC, 2015).

Since parts of Seaview Gracefield are reclaimed land, this area is at risk of liquefaction during an earthquake. Below the reclaimed land, is softer, naturally deposited soil of a delta environment. When an earthquake occurs in Seaview Gracefield, this softer soil behaves like a liquid, causing loss of support for buildings above. Liquefaction also causes the groundwater to rise up as other denser materials like buildings are brought down. This causes a flooding hazard on top of the current earthquake hazards (Davis, 2015).

HAZARDOUS INDUSTRY AND COMMERCIAL BUSINESSES IN SEAVIEW GRACEFIELD:

Figure 11: Wastewater Management on Port Road (Julia Cuendet).

In addition to understanding topographical features, managing flood risk in dense, mixed-use, shoreline communities requires the consideration of complex social and economic dynamics. The industrial base is significant, as the 700 businesses located there employ approximately 7,000 people (Hutt City Council, 2018a). The average number of employees per business in Seaview Gracefield is also higher at 9.7 compared to Hutt City at 4.8 (Seaview Business Association, n.d.-a). Industries range from waste treatment plants, transportation industries, and petrol companies. Other industries in Seaview Gracefield include Wastewater Management (Figure 10), that manages drinking water, stormwater, and wastewater services. However, there are also non-industrial businesses within Seaview Gracefield including a recreational go-kart company, a doggy daycare, and a few cafes. The makeup of this industrial community is compact and distinct from the residential areas (Figure 11). A voluntary organization, the Seaview Business Association (SBA), is dedicated to the development of the Seaview Gracefield business district. The organization holds monthly meetings and the Hutt City Council provides funding for a coordinator (Seaview Business Association, n.d.-b).

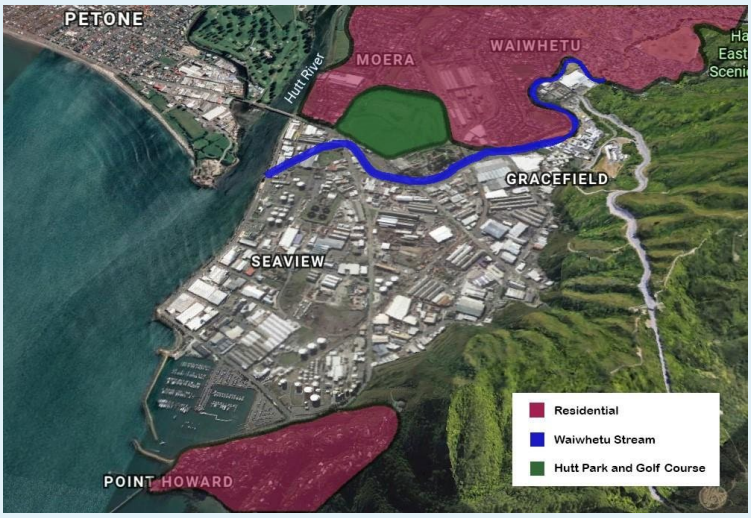


Figure 10: Density of industries in Seaview Gracefield (Edited from Google Earth).

Seaview in particular has unique land zoning for the Hutt Valley. According to the Hutt City Council, Seaview Gracefield is considered a Special Business Activity Area with, "hazardous facilities, including those which have a low probability of a hazardous incident, but have a high potential impact are accommodated in the Special Business Activity Area" (Hutt City, 2017). In this type of zone, there is a risk of harm to people and the environment due to the storage, transportation, and disposal of hazardous substances such as solvent based paints, electroplating, pharmaceutical, and some medical wastes (Hutt City, 2017).

Figure 12: Land Zoning of Special Business Activity in Seaview (Hutt City District Plan).

Figure 12 shows the urban planning done by the Hutt City Council for the area of Seaview. In the light purple are the areas zoned as Special Business Activity Areas. Seaview Gracefield is almost entirely designated to this type of land zoning. The rarity and difficulty of zoning additional Special Business Activity Areas make Seaview Gracefield "the single most important area for industrial activity in the Wellington region" (Hutt City Council, 2010).

AREA CLIMATE MODELS

Projections of climate change-related sea-level rise indicate that Seaview's vulnerability to flooding will intensify. Climate models project that the Seaview area will experience a sea-level rise of 0.12 to 0.24 meters by 2040. By 2070, sea levels are projected to increase by 0.36 to 0.98 meters (GWRC, 2017c). This increase in sea level, combined with warmer ocean temperatures, has many consequences for the area. One is an increase in extreme sea level events, which are water level heights consisting of tides, mean sea level, and storm surges. These

events in tandem with regional anomalies such as changes in river flow, wave run-up, and tidal level can create conditions where flood risk is intensified (Hinkel, 2019). According to the International Panel on Climate Change (IPCC), extreme sea level events that used to occur once per century are expected to start happening more frequently, and potentially every year, in low-lying coastal communities (International Panel on Climate Change, 2019). This puts locations such as Seaview, particularly at risk for future extreme sea-level events.

One in One Hundred Year Floods

In Seaview, there is substantial concern about major flood events occurring more frequently as the sea-level rises. These major flood events are typically categorized depending on their probability of occurring. For Seaview, the concern is mostly around "one in one hundred year" events. The term "one in one hundred year event" can be confusing. It refers to the concept of a flood that statistically has a one percent chance of happening in any given year (USGS, n.d.). In the Hutt Valley, a one in one hundred year flood is considered a 1900 cumec (1 cubic meter of water passing a given point every second) flood (Lawrence et al., 2011). Figure 13 compares the magnitude of sea-level rise with the frequency of 100-year events. This figure indicates that a sea-level rise of 30 centimeters will result in 100-year events occurring once a year. A sea-level rise of 30 centimeters is projected to occur within the next 50 years, contributing to the sense of urgency surrounding this issue.

SLR	Wellington
0cm	Every 100 years
10cm	Every 20 years
20cm	Every 4 years
30cm	Once a year
40cm	Every 2 months
50cm	Twice a month
60cm	3 times a week
70cm	Every tide
80cm	Every tide
90cm	Every tide
100cm	Every tide

Figure 13: Chart depicting a comparison of sea-level rise (SLR) and 1 in 100 year event frequency in Wellington (Dr. Jan Wright, Preparing New Zealand for rising seas: Certainty and Uncertainty, 2015).

These one in one hundred year floods are projected to primarily affect the coastal areas of Seaview, as well as the areas around the Waiwhetu stream. Current day projections show much of these areas being impacted by this type of flood (Figure 14). If these areas were to be flooded in this way yearly, it would interrupt business operations in the area immensely; one in one hundred year floods are not floods that can be recovered from overnight.

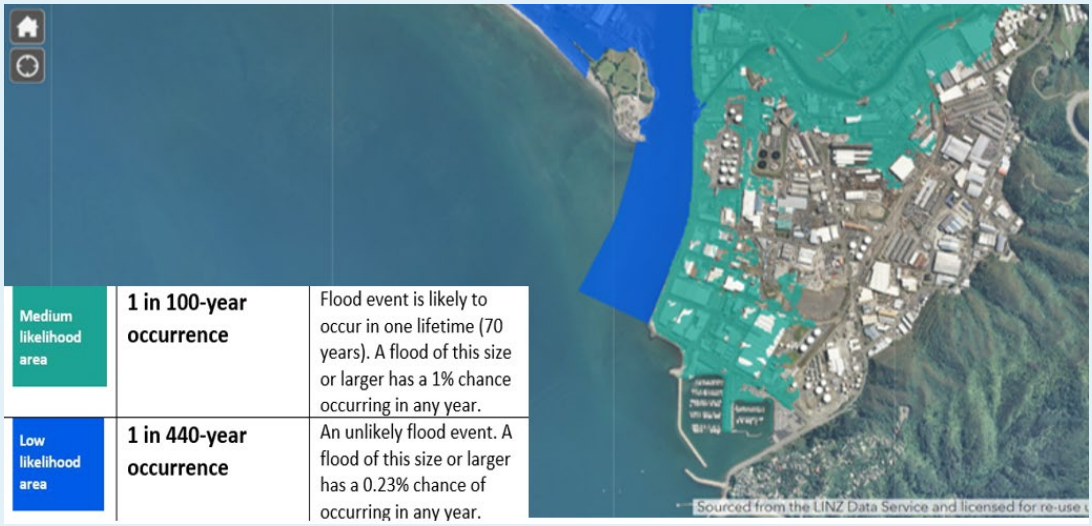


Figure 14: Map showing current flood likelihood in the Seaview area (GWRC)

Inundation

The Seaview Gracefield area faces emerging issues due to the rising water table. As the sea-level rises in Wellington Harbor, salt water saturates the ground. This saturated ground expands upwards, which then pushes up the fresh groundwater. The result is a rise in the overall water table (Figure 15). The water table is the boundary between the surface of the soil and the area in sediments and rocks that groundwater saturates (National Geographic Society, 2019). This has many adverse effects, including increased liquefaction risks, the spread of contaminants from wastewater, and an inflow of underground water and wastewater pipes (which refers to stormwater entering the wastewater network and vice versa) (Wellington Water, n.d. & Plane et. all, 2019). It also causes the soil to be saturated before storms even occur. So, when the area floods, the ground has a lower capacity to absorb rainfall, which adds even more stormwater to the flow of the flood. This phenomenon is called groundwater inundation, an issue that was largely unrecognized in past predictions of sea-level rise until 2012 when a University of Hawaii study published a report showing that low-lying coastal areas are also vulnerable to groundwater inundation.

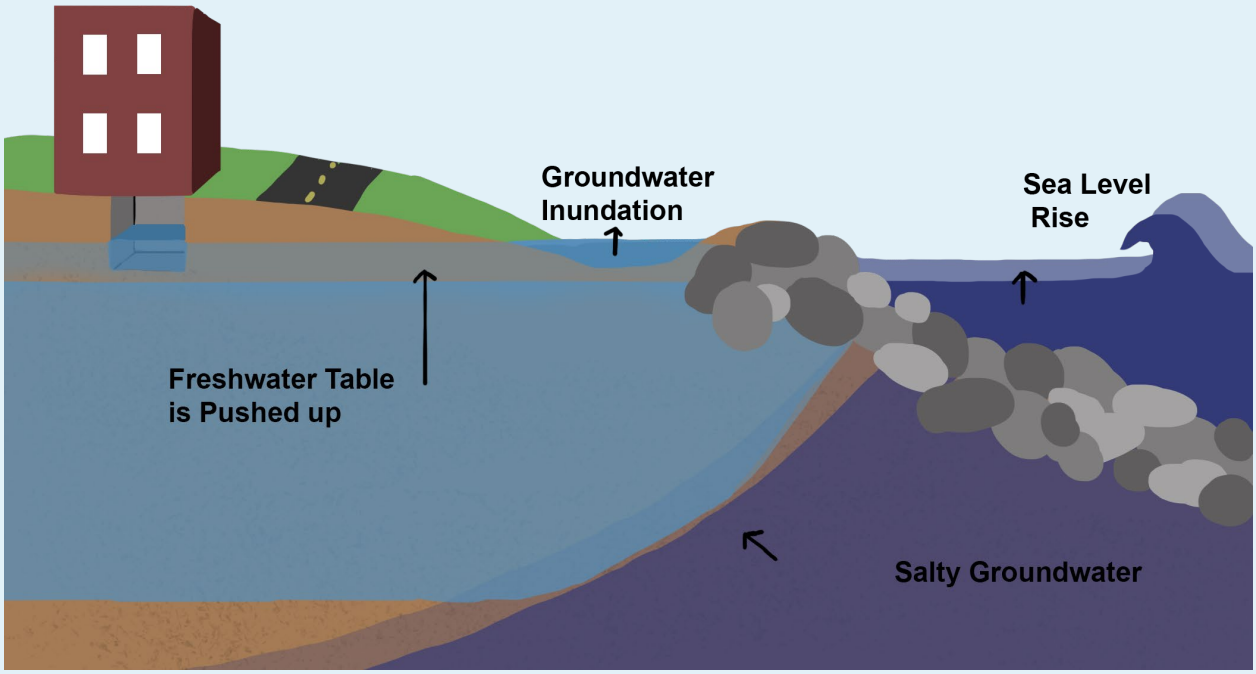


Figure 15: Depiction of how sea-level rise affects groundwater (Nina Taurich).

Storm Surges

Another side effect of climate change that will affect Seaview is worsening storm surges during extreme weather events. As sea level rises, more land area is vulnerable to storm surges; the more seawater that the wind can push inland, the more area the surge can reach (Environmental Defense Fund, n.d.). Additionally, the severity of extreme weather events is increasing. As seawater temperatures rise, more evaporation takes place; with every one-degree Fahrenheit warming, the atmosphere can hold approximately four percent more water vapor (Climate Central, 2017). Increased amounts of evaporation essentially fuel these storms, allowing them to pull in more water vapor, thereby causing more rainfall and flooding when storms make landfall (Environmental Defense Fund, n.d.). Figure 16 is a side-by-side comparison of the current day storm surge projections and projections when there has been 0.5 meters of sea-level rise in Seaview Gracefield. The coloring on the maps represent a range of storm surge depth, the darkest being five meters of depth.

In the next century, sea-level rise is expected to drastically change conditions in Seaview. With an increased flood risk, and the water table rise creating more issues in an already earthquake-prone zone, it will become an urgent issue in time. GWRC is eager for businesses to understand their risks in order to be better prepared.

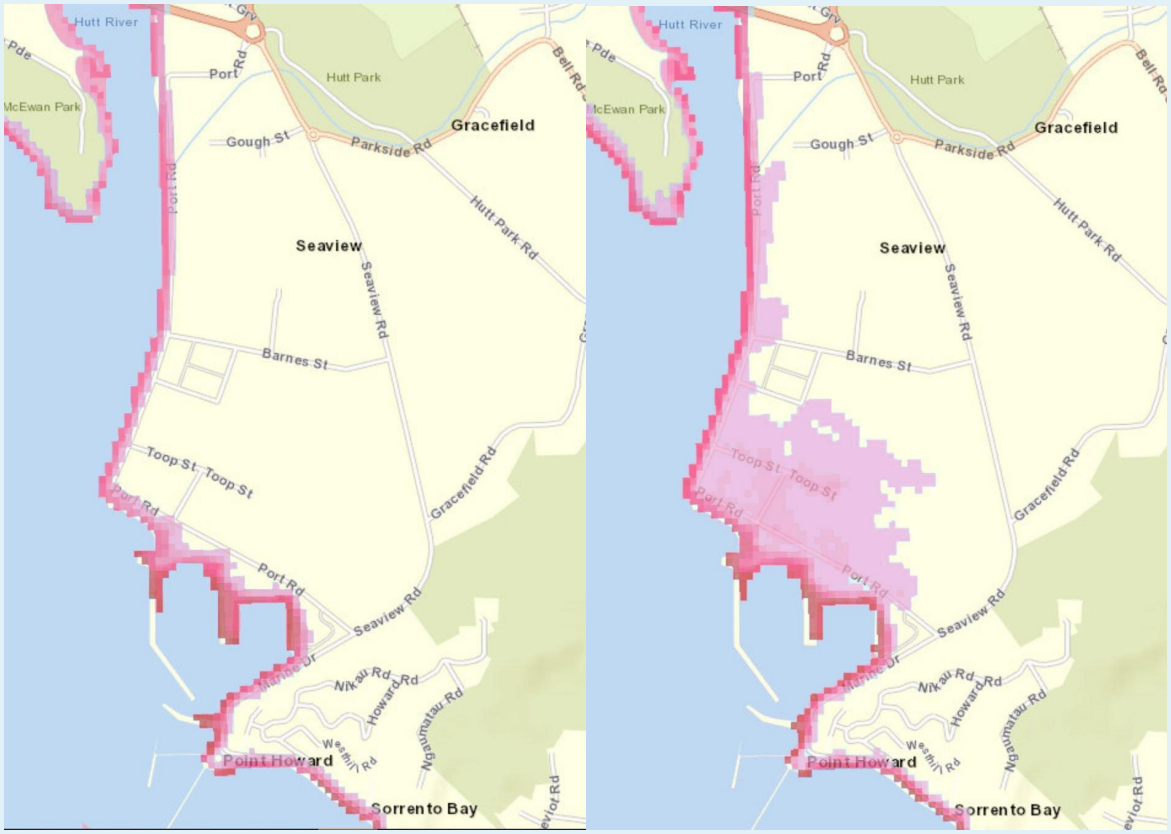


Figure 16: Side by side comparison of current day storm surge flooding (left) and storm surge flooding with 0.5 m sea level rise (right). (Edited from GWRC maps).

HISTORY OF FLOODING IN THE HUTT VALLEY

Before climate change exacerbated the threat of coastal hazards, flooding still occurred regularly in the Hutt Valley. More than 150 years ago, the Hutt Valley was covered in dense forest and swampland. These forests had controlled river alignment and erosion for centuries.

In 1839, the New Zealand Company arrived in the area. Within months of their arrival, the Hutt River flooded the settlement. While this initially deterred continued growth, a major earthquake in 1855 lifted the area. As a result, a portion of the lower valley was drained. Industrial growth intensified as the Railway Department moved its workshops from Pipitea to Petone in Lower Hutt. The Gear Meat Preserving and Freezing Company also moved into the area. More industries were attracted, and by the late 19th and early 20th century, Lower Hutt became known for its industrial intensity (Hutt City Council, 2018b). To make way for more industries, deforestation took place, disturbing the natural balances that had once regulated flooding (GWRC, 2014).

As flooding proved to be an imminent threat, the Hutt Valley community began to consider flood mitigation strategies. A major flood in 1898, which covered the entire valley floor, led to the construction of the first major stopbanks in 1901-1903 (Figure 17).

Early flood management gave little consideration to the impacts of hard engineering techniques to the environment. Ironically, the stopbanks caused the river environment to deteriorate and erode (GWRC, 2014). The relative isolation from residential areas, its close proximity to transportation networks, and its available flat land made it the ideal spot for industrial industries. Seaview Gracefield has been planned specifically for industrial activities since 1925 (Seaview Business Association, 2019). The Seaview area continued to develop during the 1930s (Figures 18 and 19). In 1955, a land reclamation extended the area significantly (Seaview Business Association, 2019).

Figure 17: Construction of Stopbank along tl (GWRC).

Figure 18: Landscape of Seaview next to the Hutt River Mouth, 1930 (GWRC).

Figure 19: Further Developed Landscape of Seaview and the Hutt River Mouth, 1934 (GWRC).

APPROACHES TO FLOOD MITIGATION

There are two main approaches surrounding flood mitigation techniques: managed retreat and fortification. Furthermore, new methods of adapting to coastal hazards are emerging. One of these methods is the Dynamic Adaptive Pathway Planning (DAPP). Community engagement also plays a key role in the DAPP method. Lastly, the Red Cross/Red Crescent Climate Centre has serious games that promote active learning about climate change and its effects.

RETREAT VS. FORTIFY

The two well-known approaches of adapting to rising sea levels in industrialized areas are managed retreat and fortification (Tyrrell, 2019).

Managed retreat is a deliberate and coordinated process of moving existing and planned development out of the pathway of coastal hazards (Lawrence & Boston, 2018). It aims to solve the issue permanently, rather than temporarily. By taking action before retreat becomes unavoidable, the plan avoids being disorderly and 'unmanaged'. It involves many staged actions over multiple years (Lawrence, 2018). In this process, legislation and governance decide the steps to take and affect whether the managed retreat is supported financially and socially (Ryan, 2018). Managed retreat may be seen as controversial due to not only its financial cost, but also its emotional and psychological costs on a community. Given that Seaview Gracefield has unique land zoning as well as critical infrastructure, managed retreat would be very complex.

Fortification often involves hard engineering practices such as placing sea walls or barriers to protect vulnerable areas (Ryan, 2018). These methods require a one-off cost and regular maintenance. Fortifying is often the preferred strategy of governments and the general public. Governments are reluctant to commit to a staged retreat (Flood risk management - A position statement from the local government, 2007). However, as sea levels continue to rise, more fortification may be necessary that was not predicted. The funding for this maintenance cannot be guaranteed in the long term. Since fortification is only a temporary solution, there will always be a residual risk (Flood risk management - A position statement from the local government, 2007).

RELEVANT CASE STUDIES ON RECENT FLOOD MITIGATION WORKS

Recent efforts have focused on careful gravel extraction from the river and on planting vegetation to strengthen the riverbanks. An additional consideration is being given to the environmental impacts of the work that councils are doing (GWRC, 2014).

We examined two cases in the Lower Hutt area regarding flood mitigation works. Both projects give context to our own. The first, the RiverLink Project, is not only an attempt at flood mitigation, but an example of community engagement. The project aims to maintain the integrity of the land by getting people to appreciate the river. The second case, the Waiwhetu stream, is relevant because our project serves as the basis for a revitalization of that project.

Case 1. Riverlink Project

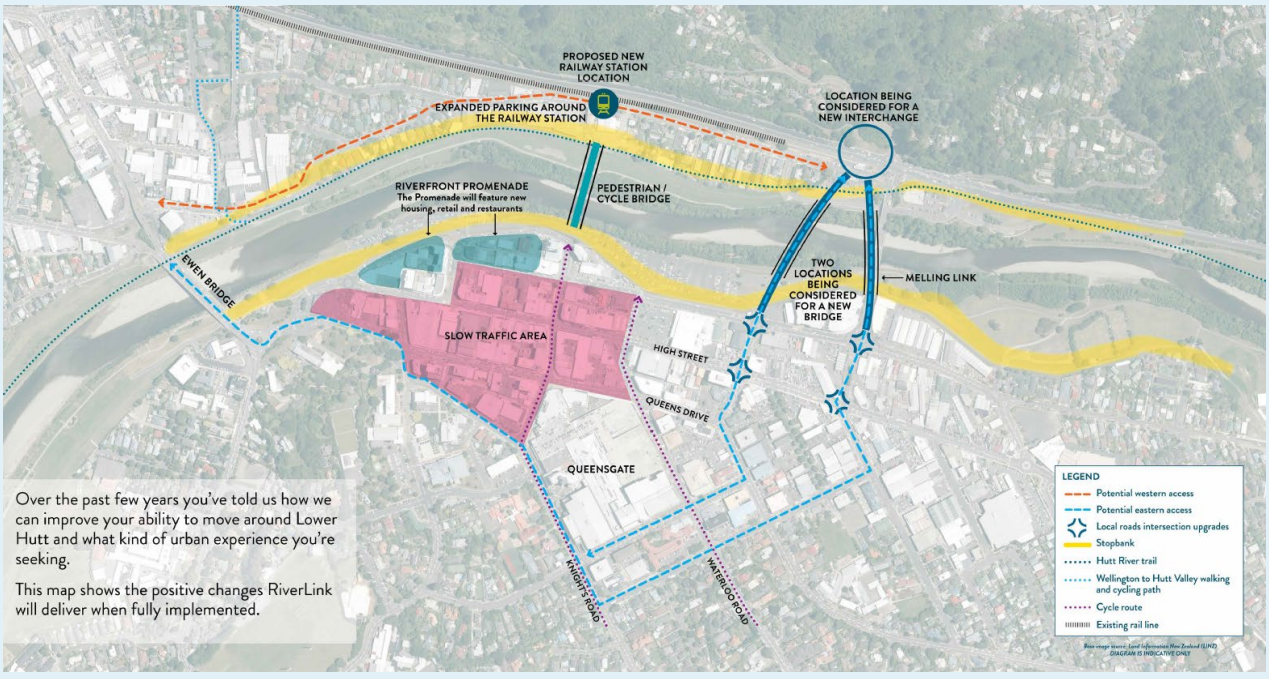


Figure 20: A map of the Hutt River showing the areas that will be affected by the Riverlink Project showing where the stop banks will be and the possibility of where the new Melling Bridge will be located (GWRC).

The RiverLink Project concerns the Hutt Valley combining both a managed retreat as well as a fortification tactic to protect the city. A collaborative project involving the GWRC, Hutt City Council, and the NZ Transport Agency, the RiverLink project plans to increase flood protection and make Hutt City more centralized around the Hutt River. RiverLink aims to "strengthen the flood defenses of central Lower Hutt – upgrading the protection of more than $2 billion worth of homes and business – and improve transport links" (RiverLink shifts up a gear, 2019a). The current plan requires the replacement of the current Melling Bridge, as this area is constricted causing it to be a vulnerable part of the river for flooding. Figure 20 shows a map of the areas that would be affected due to the RiverLink project. It shows the possibility of where the Melling Bridge will be located. As this area is constricted, it causes a higher risk of flooding due to the lower capacity of water that can flow here compared to other sections of the river. They plan to increase the width of the river channel to eliminate constrictions around the Melling Bridge, enhance the overall resilience of the river, and heighten stopbanks (RiverLink community engagement guide, 2018). These stopbanks are higher and further apart due to the widening of the river allowing for a larger volume of water to flow in the river without the risk of flooding. As the plan expands the width of the river, it enters an area that is currently residential. Due to this, the GWRC is putting resources into buying out the properties located in their work zone to prepare for the widening of the river. The GWRC is buying houses from willing sellers until they have reached the 118 properties needed to complete the project (RiverLink shifts up a gear, 2019b).

Case 2. Waiwhetu Stream

Branching off from the Hutt River, the Waiwhetu Stream (Figure 21) is located at the north end of Seaview. This stream has received much attention from the city councils due to its tendency to flood. The last time this stream majorly flooded was in 2004. As a result of this flood, 74 houses were flooded and 15 had to be evacuated. Following this flood, the GWRC took steps to mitigate the flood risk of the Waiwhetu. In 2004, the Waiwhetu Stream Floodplain Management Study (WSFMS) and Advisory Committee (WSAC) were established, under the

agreement that 25% would be funded by the Hutt City Council and the remaining 75% by the GWRC. Phase 1 of this project was completed in June 2006 (Breitenmoser, 2020).

This project saw significant delays due to the level of industrial waste pollution in the Waiwhetu stream. By September 2007, the project's main priority had shifted to commencing the cleanup and subsequent increase of capacity of the lower Waiwhetu channel. This widening and deepening increased the level of flood protection to a one in forty-year flood, enough to have prevented the damages from 2004 (Breitenmoser, 2020).

In July 2012, the plan was split into four preferred options. In 2013, the phase two draft of the flood management plan was delivered for workshopping. The Waiwhetu flood management plan was put on hold between December 2015 and March 2016, as the investigations team was only deemed to have resources to work on two things at a time. Due to other flood management plans being prioritized and a lack of funding, the Waiwhetu flood management plan has been on hold ever since. Some members of the GWRC see this project as a revitalization of the Waiwhetu project, as flood protection work in Seaview Gracefield could be considered an extension of this project (Breitenmoser, 2020).

Figure 21: Waiwhetu Stream (Nina Taurich).

DYNAMIC ADAPTIVE PATHWAY PLANNING (DAPP)

Dynamic Adaptive Pathway Planning (DAPP) is a relatively new and unique approach to adapting to coastal hazards that addresses climate change's unique challenges (Lawrence, 2018). Climate change presents a "decision challenge" because it involves uncertainty and occurs at long time scales (Lawrence, 2015). It is difficult for people to accept climate change consequences that they are not immediately noticeable. Particularly for businesses, day to day challenges may outweigh unforeseen climate challenges. Communities often prefer small, incremental change that does not threaten their way of life (Lawrence, 2015).

First developed in the Netherlands, this approach gained momentum in New Zealand largely through the work of leading climate scientist Dr. Judy Lawrence, a Senior Research Fellow at the Victoria University of Wellington. Among her many other accomplishments, Dr. Lawrence has served as Co-Chair of the Climate Change Adaptation Technical Working Group from 2016 - 2018, providing advice to the Minister for Climate Change Issues on a stock take of adaptation action. In addition, she is co-author of the revised Ministry for the Environment Coastal Hazards and Government (2017).

The DAPP approach creates a flexible plan that involves a series of actions over time. These possible actions are called adaptive pathways. The aim of DAPP is to proactively plan for an uncertain future, changing in response over time to how things actually unfold. Within the DAPP approach, it is assumed that policies have a design life and might fail. DAPP asks, "Under what circumstances will this plan fail?" If an action fails, other actions must be considered to meet the goal. As a result, a series of pathways emerge (Lawrence, 2018). Trigger points are times when the course can change while still staying on track to achieving the goal. Adaptive thresholds (policy use-by dates) use trigger points to identify when to take action at the earliest or latest points. The DAPP approach creates a plan that includes both short and long term options (Lawrence, 2018).

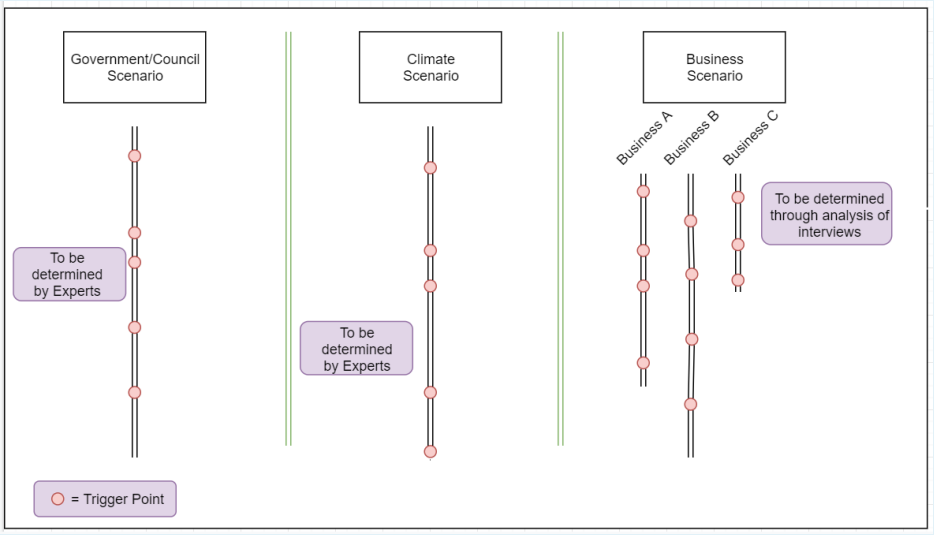


Figure 22: Example Adaptive Pathways Map.

The DAPP method has been applied in practice in a limited number of circumstances, mainly for large infrastructure projects and at national scales (Lawrence, 2018). In the Hutt River City Centre Upgrade project, the GWRC identified the climate and council trigger points to be used in an adaptive pathway map. However, there was a crucial piece of the puzzle missing in order to prepare an adaptive pathways map for the Seaview area: the business trigger points. Figure 22 helps depict how these pathways interconnect. For example, one trigger point on the government/council might involve the councils conducting voluntary buyouts of properties. This would allow for earlier preparation for a climate pathway trigger point, which might be a major storm surge coming in.

Part of what differentiates Dynamic Adaptive Pathway Planning from other flood mitigation strategies is its emphasis on community engagement. It "places community engagement at the center of decision-making processes" (Ministry of the Environment, n.d.-a). Adapting to issues such as sea-level rise requires a consensus of numerous parties, and reaching this can be difficult. The benefits and consequences of decisions are not going to be the same for everyone, which is why community engagement is so important. Discussions can promote a shared understanding of several aspects to the problem such as causes, risks and vulnerabilities, and values at stake (Ministry of the Environment, n.d.-a). One presentation from Judy Lawrence on Dynamic Adaptive Pathways Planning even lists community engagement as an "enabler for adaptation" (Lawrence, n.d.).

The DAPP approach can be better understood through the application of a game. The company Deltares has developed the Sustainable Delta Game which has both a physical and software component to it. This game involves fictional settings of areas such as lowland rivers, floodplain rivers, and urban harbors. The Sustainable Delta Game is modeled off a DAPP approach. It helps conceptualize the impacts of planning to a very long-term scale. This shows a much more proactive and adaptive approach to mitigating risk and the economic, environmental, and social effects of the decisions being made. The game puts the user at the forefront of policy decisions to let them experience the future and its uncertainties (Lawrence, J., & Haasnoot, M., 2017).

CLIMATE CENTRE GAMES

The Climate Centre is a specialist reference center of the International Federation of Red Cross and Red Crescent Societies, an international humanitarian movement. Its mission is to "help the Red Cross and Red Crescent Movement and its partners reduce the impacts of climate change and extreme-weather events on vulnerable people." The Red Cross/Red Crescent Climate Centre recognizes the importance of community engagement and the power of games (Red Cross/Red Crescent Climate Centre, n.d.-b). Games are an engaging yet impactful way of helping communities to understand the complexities of climate change and how they might adapt.

Climate change may often be accompanied by "climate grief" which happens when people feel defeated by a sense of inescapable doom. However, games give people an outlet to express their concerns in a fun and welcoming environment, without undermining the seriousness of the issues (Suarez, 2020). Also, games encourage active learning. In contrast to conventional lectures or powerpoints, games engage the mind but also emotions, making the experience more compelling and memorable (Bachofen, n.d.). Games also allow community members to interact with one another, further encouraging dialogue and active engagement. Games effectively communicate hazards associated with climate change by simplifying complex systems, making the discussion accessible to a larger audience. Lastly, actions must be made in games and those actions have consequences. This provides opportunities, to reflect and make discoveries, that conventional teaching methods cannot.

The Climate Centre has designed 45 games on humanitarian issues including disaster preparedness and climate information. These games have been put to the test across five continents and more than 40 countries. Students and farmers, to meteorologists and government officials, have all played the Climate Centre games (Red Cross/Red Crescent Climate Centre, n.d.-b). While more research is being done on the value of game-based learning, these games have sparked invaluable discussions across the world in communities that must adapt to climate change.

SUMMARY

Seaview Gracefield is a fragile yet critical industrial area, vital to the Wellington area. Due to its topography, it is susceptible to flooding. This reality, combined with its major industries, makes the area particularly vulnerable. As climate change worsens sea-level rise, the threat of flooding is imminent. The historical development of the Hutt Valley made Seaview Gracefield the industrial hub it is today. However, it also changed the landscape and characteristics of flooding within the valley forever. People throughout history have tried several different strategies to combat flooding. The future of Seaview Gracefield relies on new methods of approaching coastal hazards such as Dynamic Adaptive Pathways Planning and fun but serious games about climate change. Finding a way to adapt to sea-level rise with a pressure to maintain business growth, will prove to be a challenge in this area.

CHAPTER 3: METHODOLOGY

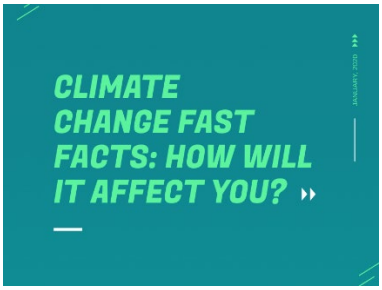
The goal of this project is to catalyze the development of an adaptive pathways land use plan for the Greater Wellington Regional Council in response to rising sea levels in the Seaview Gracefield area. To accomplish this goal, we developed the following research objectives.

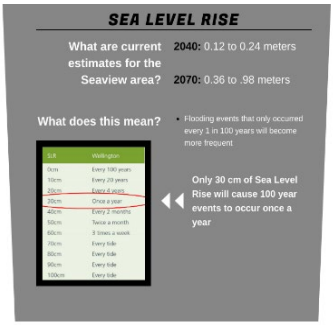
Objectives:

1) Establish a climate scenario to help educate business leaders about the future effects of sea-level rise.
2) Based on known and emerging trigger points, assess current business continuity planning and knowledge regarding climate change.
3) Develop and test a facilitated climate game, and offer recommendations for further community engagement.

ESTABLISH A CLIMATE SCENARIO TO HELP EDUCATE BUSINESS LEADERS ABOUT THE FUTURE EFFECTS OF SEA-LEVEL RISE

Our first objective was to establish a climate scenario to help educate business leaders about the future effects of sea-level rise. The climate scenario, which we made in the form of an infographic, served several purposes. By making the climate scenario, our team became more knowledgeable regarding flooding in the area. We used this infographic as a reference





throughout our interviews, so we did not share any inaccurate information. We chose an infographic for the climate scenario because visual aids such as maps communicate vulnerability quickly and clearly. Short textual facts supplement the visuals. By showing rather than telling what will happen due to climate change, we were able to both educate business leaders and gain their perspectives on how sea-level rise was, or might, affect their businesses.

We created a climate scenario with information from several climate experts. We spoke with climate experts from the GWRC who gave us maps regarding sea-level rise in the Seaview area. We then used snowball sampling as a method to talk to more experts who gave us additional information regarding climate change. We also contacted a representative from the Hutt City Chamber of Commerce to determine a way to present the climate change data in a way that would be relatable to business leaders. To relay information to business leaders, we aimed to find a way to show how climate change would affect business needs such as the effects of climate change on insurance premiums.

Appendix A shows the complete climate scenario infographic. The final climate scenario infographic included the following: an estimate of sea-level rise in the Seaview area, an explanation of how flooding will become more frequent, maps of storm surge predictions, changes in insurance, and an outline of urban infrastructure vulnerabilities.

BASED ON KNOWN AND EMERGING TRIGGER POINTS, ASSESS CURRENT BUSINESS CONTINUITY PLANNING AND KNOWLEDGE REGARDING CLIMATE CHANGE.

For our second objective, we used known and emerging trigger points to assess current business continuity planning and knowledge on long-term flood management planning regarding climate change in the Seaview area. Trigger points relating to Dynamic Adaptive Pathway Planning are defined in the background chapter. There were two parts to understanding the business perspective.

The first part was gaining key informants on the topics of trigger points, business concerns, and the Seaview Business Association. Our team learned the known trigger points through semi-structured interviews with key informants at the GWRC, the Hutt City Chamber of Commerce, and the Hutt City Council.

We talked to experts from the GWRC to determine what trigger points could already exist. Using these trigger points it allowed us to further tailor our interview questions for the business leaders to determine whether these identified trigger points were valid. We then talked to a representative from the Chamber of Commerce to determine what small businesses in the area may be concerned about, to further develop questions tailored toward figuring out what their current business planning would revolve around.

Our last key informant was Jen Houdalakis, coordinator of the Seaview Business Association. From this interview, we learned about the Seaview Business Association and details about their workshops and meetings.

The second method to understand the business perspective was interviewing business leaders. Our team continued to identify trigger points through these interviews. We took a stratified sample of 20 businesses mostly focusing on small to mid-sized enterprises (SMEs) in the Seaview Gracefield area. While the focus is on SMEs, our sample also included a few larger corporations. Our sample was also a convenience sample. Many businesses either were not interested or too busy to participate in interviews. The sample also included businesses mostly

along Port Road because they will immediately feel the effects of sea-level rise. However, due to convenience sampling, some businesses more inland and along the Waiwhetu stream were included as well.

We obtained our sample in several ways. First, our team visited the Seaview area several times with our sponsor in order to get a sense of the layout and types of business there. During these preliminary visits, our team took field notes and photographs (Seen in Figure 23). We created a letter addressed to businesses explaining who our team is and the purpose of our interviews (Appendix B). This way, we could establish a relationship between our team and the business leaders.

Figure 23: Preliminary Visit to Seaview (Nina Taurich).

For several days, our team used a walk-in method for conducting interviews (Appendix C). We split into pairs to increase efficiency. In total, our team talked to more than 50 businesses using this method. From these interactions, we obtained business cards and a few on-the-spot interviews. We followed up by emailing these businesses from the business cards. We set up interviews with the businesses that were willing and able.

Simultaneously, our team emailed the Seaview Business Association in order to get potential contacts. We obtained the email from snowball sampling because it was sent to us through staff at GWRC as well as the Hutt City Council. The Seaview Business Association (SBA) deals with the interests of businesses in Seaview and is in communication with the Hutt City Council.

Our team then reached out to the contacts we had made through our key informants. The Hutt City Council representatives stepped in by providing us with businesses to contact that they thought would be receptive to our interviews. We emailed these businesses in order to set up interviews. Our team created an excel sheet with all the businesses we contacted with their information as well as whether we interviewed them. In total, we interviewed 20 businesses, 16

of whom agreed to be named. The four that wished to be unnamed are not located on our map shown in Figure 24. Out of these four, two agreed to share their general location (Port Road and Seaview Road), and two wished to not be identified at all. We conducted face-to-face semi-structured interviews with 20 business leaders in Seaview Gracefield. Semi-structured interviews allow for a discussion to develop by including more open-ended questions rather than following a strict formalized list of questions (Ward, 2014). Our interview methods were also heavily influenced by ethnography. Ethnographic interviews employ descriptive questions that allow people to share their experiences. Ethnography reminds us that an interviewee is a person and not just data. It involves deep listening and encourages storytelling (Mai, 2009). Our interview questions are grouped together based on similar ideas rather than a certain order.

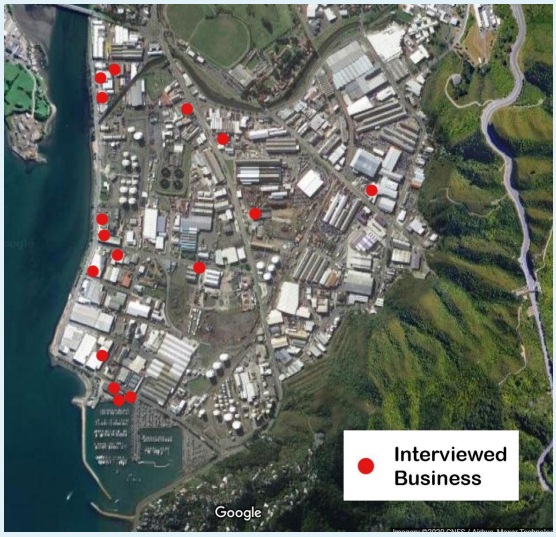


Figure 24: Map of interviewed businesses who agreed to be identified (four wished to be unidentified).

The main purpose of the interview was to understand how businesses will operate over time in response to sea-level rise. Our interview questions encouraged responses that aid in the understanding of:

- General information about the business
- Knowledge of climate change & sea-level rise
- Experiences with flooding
- Continuity planning regarding sea-level rise & flooding
- Changes in insurance

The interviews ended with a discussion on possible ways to further educate businesses on issues regarding climate change such as a possible workshop held by the councils or Chamber of Commerce. Sample questions can be found in Appendix D.

DEVELOP AND TEST A FACILITATED CLIMATE GAME, AND OFFER RECOMMENDATIONS FOR FURTHER COMMUNITY ENGAGEMENT

Our final objective was to develop and test a facilitated climate game and offer recommendations for further community engagement. We first analyzed and interpreted the data we gathered during interviews, then transcribed our handwritten notes into a shared Google drive folder. We created an excel sheet listing all of the business names in the left column and more columns on the right to categorize responses. Some examples of categories include business continuity planning, awareness of sea-level rise, business location, and reliance on area.

Once we coded our interviews and completed the excel sheet, we analyzed the data to see if there were any patterns. As we began to identify patterns, the development of our game progressed. First, we made a rudimentary design of a game prototype using scrap paper. We took this prototype to staff at the GWRC and our advisors. We enlisted their expertise to get recommendations for improving our game. We then played the game amongst ourselves to continue brainstorming new ideas for this prototype. Lastly, we made a polished version of the prototype by printing out game cards and making a facilitator's guide. We conducted field sessions with this version of the game involving students, professors, Hutt City staff, and GWRC staff. After implementing new changes from the field sessions, our team presented a final prototype to two business leaders in Seaview Gracefield.

CHAPTER 4: RESULTS AND ANALYSIS

Our team interviewed 20 local business leaders in the Seaview Gracefield area. A full list of interviewees can be found in Appendix E. We identified five emerging trigger points. We also identified some key perspectives that did not tie directly to our trigger points but played large roles in forming our recommendations. From these key perspectives, we developed our game, Seaview Sea-levels "Sea-narios" to address the observed lack of awareness of sea-level rise. These are:

Current Perceptions

- Awareness surrounding rising sea levels
- Misconceptions about sea level rise
- Experiences with flooding
- Opinions on local government

Future Development Perspectives

- Existing business continuity planning
- Viewpoints on future fortification and relocation
- Reflections on workshops and further education

TRIGGER POINTS

This section outlines the determined trigger points and gives examples of them. Trigger points identify points in time that an action can be taken. The GWRC can then incorporate these into a Dynamic Adaptive Pathways Plan (DAPP) in the future.

LEASE EXPIRATION

Five out of 11 interviewees who could comment on the topic, rent property rather than own it. A lease expiring is a trigger point because each time a business lease ends, they must reassess whether or not they want to renew and stay in the area. This may lead to plans to relocate or actions to fortify. A lease ending is an opportunity for small businesses with plans to grow to sell or move and establish more customers in a different location. They must decide if staying in the area is worth the consequences of flooding.

The owner of Redhot Marine, a local boat repair shop, gave an example of why flooding is not a big concern for him (Figure 25). As a business owner, he has been in this location for two- and-a-half years and plans to continue to grow the business. He has little to no concern with dealing with sea-level rise in his current location. This is due to his plan of growing his business for some time, and then selling. He has the option to resign his lease three times in six-year periods. He currently anticipates not renewing his lease for the next six years and instead relocating. His goal is to sell the business within the next 18 years.

Figure 25: Redhot Marine Business on Port Road (Boating New Zealand, 2018)

EVENT OF A MAJOR FLOOD

Seaview has not experienced a memorable flood in over 10 years, leading many business leaders to severely downplay the risk of flooding. As time goes on and flood events happen more often, businesses will need to be more

> "No one will care until there is a big flood"
>
> -Business owner on Port Rd

concerned and proactive about the issue of sea-level rise. For some, this may be too big of a hassle, making it a trigger for the government to step in if they choose to relocate away from the problem. One business leader located on Port Road told us that he thinks people will only care when they have no other choice. He expanded on how a flood would be terrible for the area, but will make it a more urgent issue similar to other disasters like earthquakes. If there is nothing physical for a business to see, there is less of a drive to care about it.

DECREASING PROPERTY VALUES

Figure 26: Outside of TItan Cranes (Titan Cranes Limited, n.d.).

Eight out of 20 interviewees owned their property. If the property value drops significantly, the business owner's investment in that property might approach its break even point (Queensland Government, n.d.). This could prompt the owner to sell in order to still make a profit. One factor that could reduce the property value is if the frequency of flooding increases. This makes the land undesirable. Several studies have shown that the disclosure of flood risk has a negative effect on property values (Ebbwater Consulting, 2019). Bruce Whiley, the Business Development Manager at Titan Cranes briefly gave the idea of relocation some thought before our interview (Figure 26). Titan Cranes has three companies under its umbrella and leases property to approximately 10 Seaview businesses. Mr. Whiley stated that the biggest factor that could cause Titan Cranes to move would be if the property value dropped enough to not be profitable. If a company like Titan Cranes moves, the companies who rent from Titan Crane will be affected. They will either need to make a deal with the new owner of the property or move as well.

INCREASES IN INSURANCE RATES

Helen Down, the CEO of the Hutt City Chamber of Commerce, believed insurance premiums are a major concern for business leaders and are key in making them more aware of changing risk factors. This proved to be true, as out of the 18 Seaview and Gracefield business leaders that were able to comment on insurance, 14 stated that they saw insurance premium increases.

Since the Canterbury earthquake in 2010 and the Kaikoura earthquake in 2016, businesses have faced massive increases in the costs of insurance plans (Parker, 2019). For example, "a typical commercial block in Wellington has seen its insurance premiums 220% in just four years, from $99,000 in 2016 to $320,000 in 2019." In response to the Kaikoura earthquake, national insurance claims reached 900 million NZD, where the Wellington area took 65% of total losses (Insurance Council of New Zealand, 2017). Businesses in Seaview and Gracefield will likely continue to encounter difficulties with increasing insurance as time goes on and the flood risk becomes more apparent. According to a local insurance broker, as insurers become more aware of certain areas being prone to flooding, insurance premiums generally increase.

We found out what kind of insurance is necessary to protect against natural hazards such as floods, earthquakes, and fires. No single policy covers all of a business's risks, so a business's insurance plan typically is made up of several common policies. In regard to business continuity planning, there are three types of policies that a business may need (Business.govt.nz, n.d.):

Asset Insurance	Asset insurance covers theft and damaged items that are owned and used for work.
Commercial Property Insurance	Commercial property insurance covers damage to buildings. This includes damage from incidents such as fire and flooding. Some policies also include earthquake cover, but insurers require additional information about the building before agreeing to it. Some information that may be required includes when the building was built, seismic rating, any strengthening work, and what type of land that the property lies on.

Business Interruption Insurance	Business interruption insurance covers losses resulting from an interruption to business when work cannot be done, but costs still accrue (i.e., from rent and wages).

While most businesses did not say during interviews what type of insurance premiums increased, for a business, it is most likely that commercial property insurance is what they were referring to. These increases were largely (12 out of 14 interviewees) attributed to earthquakes, rather than flooding. In general, all classes of insurance containing natural disaster risk will see premium increases due to earthquake risk.

> "Getting insurance is virtually impossible [due to earthquakes]"
>
> -Rick Holmes Owner of Arthur Holmes Ltd.

Alan McLellan, CEO of the Seaview Marina stated that he has seen a 25% to 30% increase in insurance premiums after the Kaikoura earthquake.

Both Bruce Whiley of Titan Cranes and Rick Holmes of Arthur Holmes Ltd. (in Petone) stated that they have heard that if people change insurance companies, they run the risk of not being able to be insured. Mr. Whiley seemed concerned at the thought that insurance companies might be able to increase insurance premiums even further if the flood risk of Seaview Gracefield increases. Michael Meads, the owner of Compass Coffee, said that because he is directly on the fault line, he cannot get earthquake insurance. Compass Coffee has only been in Seaview since 2016.

To determine if the allegations that switching insurance companies causes businesses to possibly lose coverage altogether were justified, we asked a local insurance broker. They responded by saying that this may be due to capacity issues, that can be exacerbated after natural disaster catastrophes. The insurance broker stated that "their capacity for risk is based on the amount of risk that they can hold for their own account as well as the amount of reinsurance they could buy on top of that from the reinsurance market." This could explain why some business leaders have heard of this happening.

INTERRUPTION OF BUSINESS INTERDEPENDENCE

Reliance on other businesses is another trigger point. Three businesses rely on another business in the area to operate effectively. Shutdown or relocation of one of these businesses triggers interdependent businesses to reassess their location. Once one business leaves, it can cause the others to begin to have to shut down or leave.

> "It makes sense for all three to be together"
>
> -Brendan Walker from TYKE Recycling

In the Seaview area, we located a group of businesses that have a relation to each other. Brendan Walker at TYKE Recycling informed us that their business is heavily connected to Envirowaste as well as Waste Management. The roles of these businesses are intertwined, as all three to work involved with solid waste and/or recycling. Envirowaste provides collection services to residential communities and businesses, hazardous waste treatment, disposals, etc. (Envirowaste, n.d.). Waste Management has a facility that handles mostly hazardous waste, as well as a facility for recycling and disposal of waste (Waste Management, n.d.). TYKE recycling, per its namesake, does recycling collection in the Wellington area. As the three separate companies all play a role in collecting and handling waste, "it makes sense for all three to be together" according to Walker. If either was to move he would heavily consider relocating as well.

CURRENT PERCEPTIONS

Through our interviews, we identified key perspectives of the business leaders. While we prompted some of these perspectives through interview questions, such as awareness surrounding rising sea levels, others emerged unexpectedly, such as misconceptions regarding sea-level rise. These perspectives focus on what businesses are currently experiencing.

AWARENESS SURROUNDING RISING SEA LEVELS

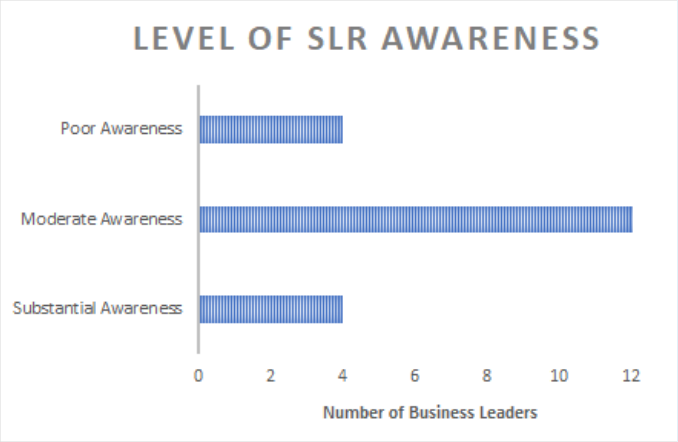


Figure 27: Comparison of levels of awareness of sea-level rise (SLR). Notice that a majority of business leaders had a moderate level of awareness. (Julia Cuendet).

There was a broad range of knowledge among business leaders on climate change as well as the sea-level rise in the Seaview Gracefield area.

We distributed the level of awareness into three categories. Out of 20 interviewees, four people understood how sea-level rise will affect them and saw it as an urgent issue (substantial awareness). The majority of interviewees, 12, were aware that sea-level rise was happening, but did not understand how it would affect them or the urgency of the issue (moderate awareness). Lastly, four interviewees were either in denial of the effects of sea-level rise or had misconceptions regarding climate change, which we consider to be poor awareness (Figure 27).

Business leaders such as Alan McLellan from the Seaview Marina, Carl Longstaff from Metal Arts, and Ross O'Loughlin from Waste Management have an excellent understanding and have been thinking about the future effects of sea-level rise for a while now. Mr. McLellan commented "you have to be naive" to not know what's going on. Waste Management, a large multinational company, is one of the few businesses we interviewed that has a continuity plan. The Waste Management facility that Ross O'Loughlin manages in Seaview handles 150-200 tons of hazardous waste per week. If a flood were to ensue, Waste Management has much more at stake due to the biohazard risk of the facility. In fact, Waste Management is required to have business continuity planning in order to receive insurance.

> "You have to be naive [to not understand what is going on]"
>
> -Allan McLellan from the Seaview Marina

> “[Climate change] is not going to be in our lifetime”
>
> -Michael Meeds owner of Compass Coffee

Mr. Longstaff is an active member of the Seaview Business Association and has been very attentive towards the issue of flooding and is an advocate for the erosion control put in place. For a span of three years, Mr. Longstaff took pictures and videos of the major floods that occurred. These pictures highlight the extent of flooding that Port Road receives regularly, about every two or three years [according to Mr. Longstaff]. After 2015, Mr. Longstaff stopped taking pictures of the flooding, believing that they were not effective in conveying concern to the Regional and City Councils.

Of the four interviewees that do not believe that climate change will affect them, there was a common disbelief that it will be seen in the near future. Michael Meads, owner of Compass Coffee, echoed this sentiment by saying that he believes climate change is “not going to be in our lifetime.” Meads’ business is located right on the water and would be one of the first to notice the effects of sea-level rise. Despite this, Mr. Meads is not perturbed. Another interviewee mentioned the general rise and fall of temperatures of the world over centuries; suggesting that there is no upward trend of rising temperatures globally.

Many business leaders were not aware of the educational resources available to them. After presenting our infographic with maps from the GWRC, several business leaders indicated that they were not aware that this information existed. The information and tools on the GWRC website were effective during the interviews because business leaders could make sense of the problem visually. While the maps are effective, they are not being used widely by the business community in Seaview Gracefield. In addition to a lack of awareness of educational material, this variance in knowledge may also be attributed to climate change and sea-level rise not being an issue at the forefront of business leader’s minds. Businesses have other more pressing concerns to worry about, and sea-level rise is a more gradual issue. The natural hazards that businesses are more concerned about are earthquakes and tsunamis. This concern stems from the immediateness of earthquakes and tsunamis.

Eight out of 20 interviewees saw earthquakes and tsunamis as a higher priority than sea-level rise. Brendan Walker, the general manager of the Seaview TYKE Recycling plant voiced his concern about a major earthquake. Mr. Walker spoke about how Seaview is in an area of reclaimed land. Because of this, he is more concerned about the possibility of liquefaction after an earthquake. Robert Baldock, the owner of Shipwreck Trading, commented that he was not worried about sea-level rise. However, Mr. Baldock expressed concern over tsunami warning systems to our team.

MISCONCEPTIONS ABOUT SEA-LEVEL RISE

Misconceptions about sea-level rise also emerged during interviews. We found that many people do not understand that the effects of sea-level rise are not just water coming over the barriers, but also groundwater inundation and increased flooding. By talking to experts on climate change and business owners, we found that the common idea of a solution, to the general public, is a "seawall." For example, Garth Mcinnes from Placemakers said, "Can we just build a wall? Can we just start now?" Businesses were more concerned about the continued maintenance of the erosion protection on the coast rather than the groundwater. This could be because information about the water table rising and increased flooding, in general, is less focused on when discussing sea-level rise. The first paper about how groundwater inundation would affect coastal communities was not published until 2012 (Grabowski, M., Rotzoll, K., 2012). In addition, there is little to no discussion of the effects of groundwater inundation due to sea-level rise on the GWRC website.

> "Can we just build a [sea]wall? Can't we just start right now?"
>
> -Garth Mcinnes General Manager of Placemakers Seaview Location

Many businesses are overlooking the effects of the rising water table. For example, Dominique Heller from Speedy Signs has looked at the sea-level rise maps on the GWRC website, but concluded that even at three meters sea-level rise, his business would be unaffected because they would not be underwater. He said, "I never thought of it that way" when we explained how increased flooding and the rising water table would still be an issue for him.

Addressing the Gap of Knowledge

Without a baseline of knowledge of the effects of sea-level rise on infrastructure and business operations, we determined that it is premature to expect businesses to be planning for something they do not understand. Identifying this gap led us to realize that if business owners are told to prepare for sea-level rise, many of them may ask, "Why do I have to do this in the first place?" To address this knowledge gap and misconceptions, we created a prototype of a serious climate game which we call Seaview Sea-level "Sea-narios." This game is designed to spark conversations about how worsening sea-level rise in Seaview Gracefield could affect business owners, by exploring self-interests and community interests. We brainstormed a game with GWRC experts such as Alistair Allan and Steve Kamo, who gave us many recommendations on the game. Alistair Allan made a prototype of a serious game that focuses on short-term business planning that helped inspire our Seaview Sea-levels "Sea-nario" game (Figure 28).

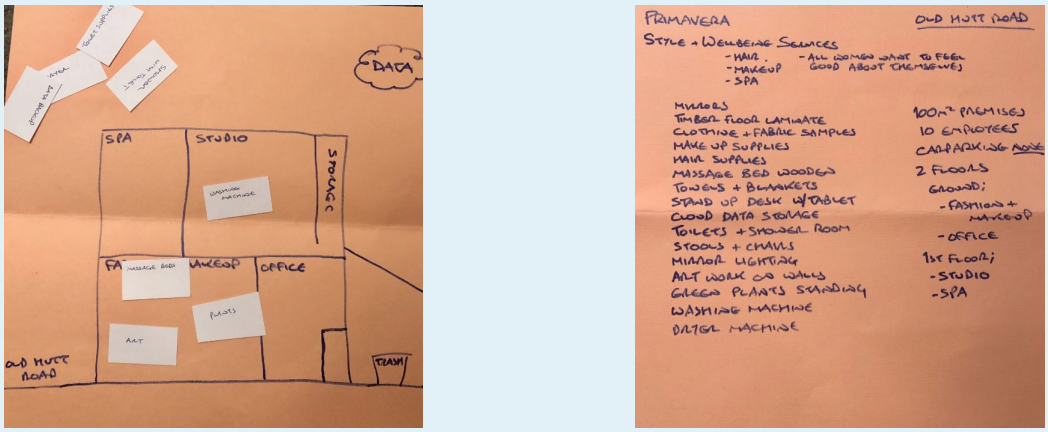


Figure 28: Prototype of an analog game that focuses on short term planning for businesses, created by Alistair Allan

The Red Cross/Red Crescent Climate Centre website provides a large database of games, which we used as a starting point to identify a game that could be adapted to address our needs. The 'Act to Adapt' climate game was a suitable starting point for our game. 'Act to Adapt' is a giant board game where a 'community team' competes with a 'hazard team' (Figure 29) (Red Cross/Red Crescent Climate Centre, n.d.-a). The community team must collectively decide to

Figure 29: Participants in Haiti playing Act to Adapt Game, 2017 (Red Cross/Red Crescent Climate Centre).

prioritize certain resources to protect them from the hazard team. This game is meant to help players understand the impacts of climate change and explore how different community resources are vulnerable to climate change-related hazards (Red Cross/Red Crescent Climate Centre, n.d.-a).

We adapted this game for our use by changing the 'hazards' to flood related hazards, and changing the community resources to assets that would be important to businesses. We also gave each player a 'role' card with three critical assets to their (role) business, and had the game progress through time where the odds for certain assets to be affected increased (Figure 30).

Through the several iterations of our game, we made many adjustments. Two of our 'flood hazards', groundwater inundation and stormwater drain blockage, were changed to stay in the game for every round. These two flood hazards worsen as rounds continue and sea-level rise becomes a larger issue. We also changed the name of the community team to business community team, and implemented a token system (Figure 31). Figure 32 shows one version of our prototype. Professor Dodson, one of our advisors, also has experience with serious games about climate change and provided useful feedback and recommendations.

Figure 31: Our team playing a finalized version of the game prototype with fellow WPI students

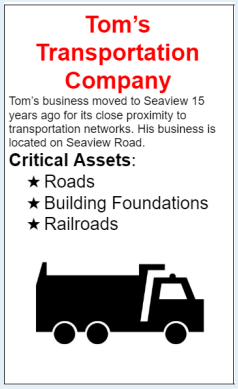


Figure 30: Example Game Cards

Figure 32: Our team developing the prototype game, prior to meeting with Steve Kamo

We then brought our physical prototype to our project presentation at GWRC to get feedback from GWRC employees and other government employees. After our presentation at the GWRC, we played through and explained our prototype to four people (Figure 33). We had several key takeaways from this run through of the game:

- **Clarify certain asset cards.** There was confusion about whether the "underground pipelines" card represented stormwater, or high pressure gas lines. Players also wanted more details of the bridge card, i.e., how high is the bridge.
- **Separate assets into three categories: private, personal, and public assets.** Players were confused as to why some shared assets, like roads, might *only* be critical to certain players.
- **Have players invest tokens.** It allows for more freedom in the game and for players to really understand the ramifications of their decisions.
- **Pre-determine the results of the scenarios.** This would allow for a better story to be told, and reduces the chances of a round where too many or not enough assets are affected.

- **Allow players to invest in planning.** This could be a good way to introduce the idea of planning to business leaders. By investing tokens in planning, players might feel the effects of the hazard less, showing them how investing in planning could help them in their own business.

We used this feedback to further develop our game. While we did not implement everything from this session, we did add an investment aspect to the game, distinguished personal and public assets, and replaced the odds and dice system with pre-determined scenarios. This game session was extremely successful. Not only did we gain a lot of useful feedback, but we were able to generate a fair amount of interest in our game.

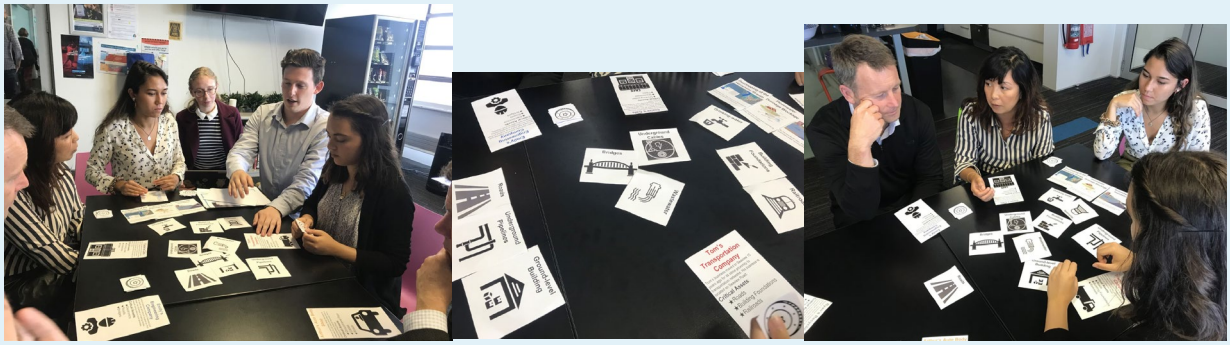


Figure 33: Playtesting at GWRC (Leslie Dodson)

We then took the prototype to the Seaview to have another game session. We had two business leaders, Ross O'Loughlin from Waste Management and Alan McClellan from the Seaview Marina, participate with three members from the GWRC (Figure 34).

Figure 34: Playing the Game with Business Leaders (Nicole Kring and Julia Cuendet)

Overall, the feedback was positive and every player was engaged in the game. We observed that the rules of the game were understood quickly. However, during each round, there was not much discussion between the players. At first, the players put an excessive number of tokens on the roads asset. Later in the game, they learned from their mistakes. They allocated their tokens to different assets and discussed how they can come together to protect more assets. Feedback we received from this session included:

- The game has good, descriptive scenarios that show how critical the Waiwhetu stream is
- Start with more tokens so players do not end up in negative debt at the end
- These business leaders had no misconceptions about sea-level rise, but this game would help those who did
- Get rid of the railroad asset card, as it is not as critical for Seaview Gracefield
- Include manufacturing equipment as an asset card
- Incorporate the aspect of interconnectivity of businesses to encourage a team dynamic
- Bring in a political aspect, where one person chooses what community asset is prioritized

Ross O'Loughlin and Alan McClellan, the only attendees, were both identified as having a substantial sea-level awareness. This supports the idea that business owners only see sea-level rise as an urgent issue if they already have a good awareness of it. This game session was particularly valuable, as it was the first time playing with actual business leaders from Seaview.

This prototype is meant to be a tool for GWRC to further develop. It can be used to teach businesses not only about flood hazards and sea-level rise, but with some simple additions, can also teach about the local government's role in flood protection and adaptive planning. The feedback and interest gained will surely aid the GWRC with further development. Full details of how to play the game, titled Seaview Sea-level "Sea-narios," can be found in Appendix F.

EXPERIENCES WITH FLOODING

There was a large variation in perceptions of when the last major flood occurred. Even though 10 of the 20 companies we interviewed were along the coast (Port Road), nearly all had different experiences with flooding. Waste Management experiences floods almost yearly but Morné Van Rensburg from Leap- located directly next to the Waste Management plant- stated the last flood was around 2016-2017. Older businesses, such as the owner of Redhot Marine, who has worked in Seaview since 2006, commented that it has been several years since the last major flood. This aligns with other accounts of flooding like that of Bruce Whiley from Titan Cranes, who remembered the last major flood happening about five years ago. However, two businesses located on Port Road reported no memories of flooding at all, and three businesses indicated that they have not seen much flooding. These varying perceptions of flooding contribute to the overall lack of urgency surrounding flooding in the area. If businesses have not experienced flooding in many years, there is no motivation to take any action.

There also was no clear trend in levels of damage to businesses from floods. For example, the flood that Titan Cranes experienced five years ago only halted operations for one day. Because the areas flooded were not carpeted, the damage was very minor. Meanwhile, Gray Hydraulics dealt with a flood in 2011 which interrupted operations for a couple of weeks. These two businesses are only a short three minute, 1.6-kilometer drive from each other, yet have had drastically different flood experiences.

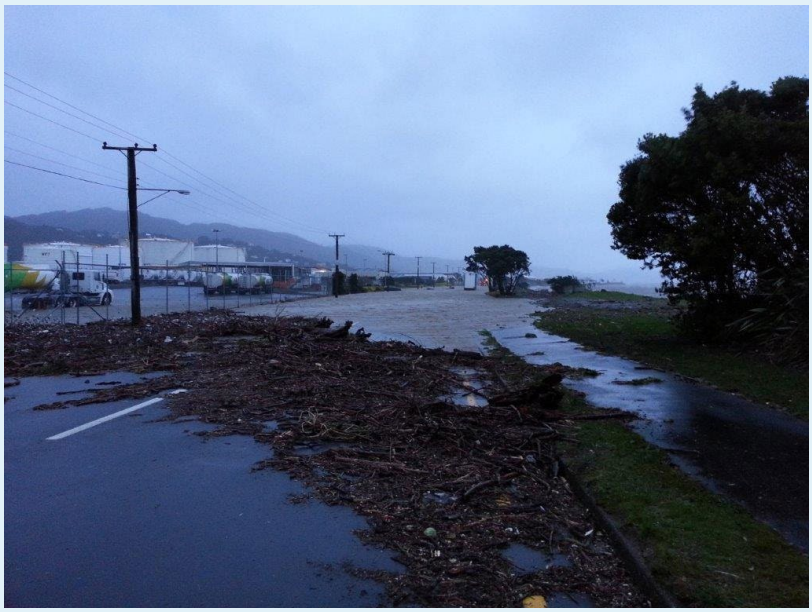


Figure 35: 2013 Flood on Port Road (Picture Credit: Carl Longstaff).

Through our interview with Carl Longstaff from Metal Art, we learned that a business's relative location to storm drains may contribute to these variances. Longstaff mentioned that the storm drains frequently get blocked by debris during storms, which can cause some businesses to get flooded. Mr. Longstaff mentioned that during the last major flood, the only reason his business did not get flooded was because the storm drain nearby was the only one that did not get blocked. Figure 35 demonstrates the debris that gets washed up. It also depicts how some parts of the road floods while others do not.

The finding that some businesses experience frequent flooding while others do not could potentially affect the success of community engagement. The businesses that had no interest in workshops tended to not have experienced frequent or recent flooding. If they do not see flooding as a pressing issue, they may not be interested in learning how to plan for a flood.

OPINIONS ON LOCAL GOVERNMENT

Our interview questions did not explicitly elicit responses around perceptions of the local government. However, this was an unforeseen topic that emerged during our fieldwork. Out of the 20 interviews, five specifically mentioned perceptions regarding local government. These perceptions ranged from being pleased with GWRC's past work to being frustrated with a perceived lack of work.

For instance, the Seaview Business Association lobbied to have erosion control put in to protect from storm surges and additional erosion (Figure 36 and Figure 37). Two business leaders, both active members of the Seaview Business Association, voiced frustrations with the GWRC over the lack of completion on GWRC's part of the erosion control. When asking the GWRC about this issue, we learned that they have indeed not done their part of the erosion control, but this is due to a lack of funding and a desire to take the time to come up with a lasting solution. The Seaview Business Association has been notified of this several times in the past.

Figure 36: Erosion Control on the Coast of Seaview (Julia Cuendet).

Figure 37: Erosion Control along Port Rd (Julia Cuendet)

The remaining two business leaders instead mentioned the work that GWRC had done on the Waiwhetu stream. One expressed approval of the work, stating that they had seen less flooding since it was completed.

These perspectives highlight how the work, or lack of work, the GWRC does in an area can affect their public perceptions. For example, Carl Longstaff documented floods in the area until 2015. He stopped because he believed that they were not doing anything to convince the local government to take action. The belief that the local government does not listen to public concerns could have a negative effect on any community engagement initiatives.

FUTURE DEVELOPMENT PERSPECTIVES

These perspectives outline the opinions of businesses about the future of their businesses and the future of dealing with sea-level rise due to climate change. We specifically asked businesses about future planning and education so the GWRC can apply this information to their future plans.

EXISTING BUSINESS CONTINUITY PLANNING

Figure 38: Comparison of Business Planning for Sea-Level Rise (Nina Taurich).

Our team aimed to evaluate the level of business continuity planning with regards to flooding. Nine of 18 businesses who commented on continuity planning had done no planning (Figure 38). Furthermore, none of the small businesses interviewed had a business continuity plan regarding flooding in the future.

This lack of planning for rising sea levels may be attributed to a sense that the problem is not their own responsibility to combat. A majority of interviewees indicated that they believe city councils hold a great deal of the responsibility to combat sea-level rise. Out of the 10 interviewees who commented on their expectations of the government, eight believed the government plays a major role in combating sea-level rise. Four out of those eight believed the government should take a more passive role through better education on the issue. The other four indicated that the government has an obligation to take the lead entirely.

Many business leaders talked about how critical Seaview Gracefield is to Lower Hutt and the Wellington region. Since it contains such critical infrastructure, there is an expectation that the city councils will take action. One business owner commented, “to flood this factory, you have to flood everything else too.” This business owner was suggesting that flooding is not solely his problem, and that the issue will be addressed before it becomes a concern for him. Only two interviewees commented that they will handle the matter on their own. Such is the case for the Redhot Marine owner, whose mentality is to “worry about myself.”

Seven out of 18 interviewees who commented on this topic had limited business continuity planning. Morné Van Rensburg, the Sales Manager from Leap said his company has reorganized their warehouse in response to the threat of rising seas. Now, the electronics are on the second floor. However, Mr. Rensburg does not have any long term planning in place. Ranjini Singh has taken steps for her business to operate remotely. Her company, RM Engineering, which provides electronic and engineering services, holds most of its equipment in the vans of its employees. If a major disaster were to happen at their Seaview location, Ranjini comments that her business would still be able to do 60% of the work from the company's vans.

Lastly, two interviewees indicated that their business had a long-term business plan for rising sea levels. These businesses include Waste Management and Redhot Marine. Waste Management’s plans include working with a sustainability manager at Hutt City Council to update their continuity plans yearly. They’ve built a dike, and the facility is designed to survive a one in ten year storm. Redhot Marine’s plans, detailed already in the lease expiration trigger point section, includes selling the business before sea-level rise effects severely worsen.

VIEWPOINTS ON RELOCATION AND FORTIFICATION

There are two prevalent methods of managing or mitigating sea-level rise: fortification and managed retreat. During our interviews, we gained business perspectives on fortification and retreat.

> "Relocation will likely be the ultimate outcome"
>
> -Business Owner on Port Rd

Six businesses indicated a desire to continue to fortify, which was heavily influenced by the businesses' reliance on the area. We identified three major ties a business may have to the Seaview area: investments made, the local clientele, and geographical reliance. Large businesses that have made significant investments are less willing or able to relocate. For instance, Ross O'Loughlin, the General Manager of the Seaview Waste Management plant, explained that major investments have been made in the infrastructure in the area. This specific Waste Management plant has a growth rate of five percent each year, and has major business continuity plans in place. Based on these factors, relocation is nearly impossible for this business. In addition, two small businesses had a reliance on the area because they rely on local customers in the area. This is the case for one small business owner on Seaview Road. After nine years of being located in Seaview, the business has established a local and loyal clientele. The owner opposed the idea of relocation and plans to remain in Seaview for another 20 years. For Alan McLellan, CEO of the Seaview Marina, relocation is not only undesirable but impossible. As a marina operator, he is geographically reliant on proximity to the water, there are limited options to be located.

However, five Seaview and Gracefield business leaders expressed a willingness to consider managed retreat. Dominique Heller, the owner of a Speedy Signs franchise, an advertising solution company located on Seaview Road, is less reliant on the area because each time he moves he is able to maintain his current customers and gain new local customers. His plan is to move to Petone where he will continue to grow his customer pool. Due to these plans, he has low reliance on his location as he has already established customers since 2009 when he moved to Seaview. He not only has the ability to move and avoid sea-level rise issues, but he will also grow his business by doing so.

> "No one can fully stop sea-level rise"
>
> -Business owner on Port Road

While Speedy Signs does not require a Seaview location, other businesses do or prefer it as their base of operations. One such business is RM Engineering. Ranjini Singh, Director of RM Engineering commented that she has chosen to operate out of Seaview for a reason. It is a convenient place for her business to grow, being surrounded by similar businesses, as well as easy access to clients and the motorway. While Seaview is an important location for her, she also believes relocation will be necessary for the future. Similarly, a small business owner on Port Road commented, "No one can fully stop sea-level rise." While they do rely on the convenience of Seaview, they acknowledge that relocation is the ultimate outcome.

REFLECTIONS ON WORKSHOPS AND FURTHER EDUCATION

During interviews, our climate scenario served as a tool to help understand business leaders' current education level of sea-level rise and climate change. We found that showing maps of not just sea-level rise and storm surges, but also of the one in one hundred year flood maps to be the most attention-grabbing. When we showed them the one in one hundred year flood maps and the predictions for them to increase, interviewees were able to easily grasp the idea that increased flooding and the water table rising were the important concerns. We found the facts of insurance and urban infrastructure impacts harder to explain because people wanted to be shown, not told.

In addition to understanding the business leaders' current awareness of climate change, we also wanted to understand what information they wished to learn more about. 14 of the 19 businesses that were asked, voiced their interest in being further educated in a workshop on the issue of sea-level rise. We found that people want to learn more about how they will be affected in the future, why they should think about this now, and what they can do now.

Two main ideas were suggested to help get the information to them. The first was organizing workshops. While many business leaders expressed interest in learning more, they also voiced concerns that it would be hard to get people to attend. One business leader said people would only go with the Seaview Business Association's support and if they knew their peers were attending. Generally, business leaders preferred shorter (less than 30-minute)

meetings when speaking with us. The Seaview Business Association Coordinator said that businesses expressed that they liked morning meetings, but not for longer than an hour. She said if a meeting had to be longer than an hour, one after work hours would be easier to attend. Workshops were not the only form of information wanted by companies. Others suggested that information delivered by email or website would be effective. This way they would still get the information, but would not have to spend time at a workshop.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

We have catalyzed the development of an adaptive pathways land use plan for the Greater Wellington Regional Council in response to rising sea levels in the Seaview Gracefield area. We have also developed and tested a facilitated climate game, and offered recommendations for further community engagement. Our conclusions indicate several areas where GWRC can take actions to start and continue a conversation between businesses and local government. In addition, we identified several trigger points that can be used in an adaptive pathway plan for the Seaview area. Table 1 shows and explains our identified trigger points. In addition to this we have developed future ideas for further developing the Seaview Sea-Level "Sea-narios" game. Development of this game may be used to further educate the business leaders of Seaview Gracefield.

IDENTIFIED TRIGGER POINTS

Trigger Point	Lease Ends	Major Flood	Property Value Decreases	Insurance Premiums Increase	Reliance on Other Businesses Success
Explanation	Reassessment occurs at the end of a lease period which may lead to relocation.	A major flood increases awareness and causes reassessment of repairing damages, fortifying, or relocating.	Decreasing property value causes a reassessment of relocation.	Rising insurance premiums decrease profitability and drive businesses to reassess relocation.	If a string of businesses are reliant on each other the failure of one may cause a chain reaction of failure.
Example	The owner of a local boat repair shop has a plan to sell his company in the next 18 years. Depending on his business' success, he has the option to release his lease three times in this span.	One business leader on Port Road stated that he believed that a major flood would need to happen before people started caring about flood risk.	A business development manager stated that after giving relocation some thought, the property value going down is the main factor in this decision.	15 out of 18 business leaders that could comment on insurance said that they have seen increases in insurance premiums due to earthquakes. Many were concerned about what will happen. when the increasing flood risk is considered.	TYKE Recycling, Envirowaste, and Waste Management benefit greatly from being in close proximity to each other.

SUMMARY OF KEY FINDINGS

We identified several key perspectives that did not tie directly to trigger points, but played large roles in the development of our recommendations.

- Lack of awareness surrounding effects of rising sea levels
- Lack of understanding regarding rising water table
- Large variation in perceptions of when business leaders last experienced a flood
- Range of opinions about government
- Little business continuity planning regarding sea-level rise
- varying viewpoints on future fortification and retreat
- Interest in workshops to learn more about sea-level rise and how to plan accordingly

SEAVIEW SEA-LEVEL "SEA-NARIOS"

To address the misunderstandings and lack of awareness of sea-level rise, we created a prototype of a serious game called Seaview Sea-Level "Sea-narios." This game, based on the Red Cross/Red Crescent Climate Centre game 'Act to Adapt', is meant to help Seaview business leaders learn about the flood hazards they may face, as well as how sea-level rise will impact assets that are vital to their businesses. We believe this to be the first step towards getting businesses to think about and develop more long-term plans. We played through our prototype with many parties, such as GWRC employees and Seaview business leaders, to get feedback. Using this feedback, we were able to further refine the game, and give GWRC plenty of ideas for future development.

RECOMMENDATIONS

The goal of our recommendations is twofold: to strengthen the relationship between the GWRC and the community and to educate and spread awareness of rising sea levels, both critical to community engagement. Community engagement is an important consideration in adaptive pathway land use planning, as it is considered an enabler for adapting. We have developed five main recommendations for a workshop to achieve these two goals towards community engagement.

1. EDUCATE THE PUBLIC OF THE EFFECTS OF SEA-LEVEL RISE

The majority of business leaders did not know of the effects sea-level rise will have on the Seaview Gracefield area in the future. If they do not see sea-level rise as a pressing issue, then they are less likely to make future plans for it. We explained our climate scenario to business leaders before discussing workshops and there was a lot of interest in further education. This is why we advise explaining the effects of sea-level rise before holding a workshop about future planning. Business leaders need to understand that they will see effects in their lifetime, and it is something they should plan for sooner rather than later. This could be done by further developing our Seaview Sea-Level "Sea-narios" game and updating the information on the GWRC website.

Develop a Game to be Used in a Workshop

We recommend future development of the game our team prototyped, Seaview Sea-level "Sea-narios" game (Figure 39), to be used during a workshop with Seaview Gracefield business leaders. Further development of the Seaview Sea-level "Sea-narios" game would achieve both goals of our recommendations. This would involve both business leaders and GWRC employees and would help strengthen their relationship. It is important to repair the relationship to allow for easier communication between both parties. In addition to educating business leaders on the effects of sea-level rise, playing a serious game detaches them from their own experiences. This allows them to learn about the issues in the context of a playful perspective. Progressing the development of our prototype would also allow the GWRC to continue the conversation we started, discover more trigger points, and understand how to help the community engagement in the future.

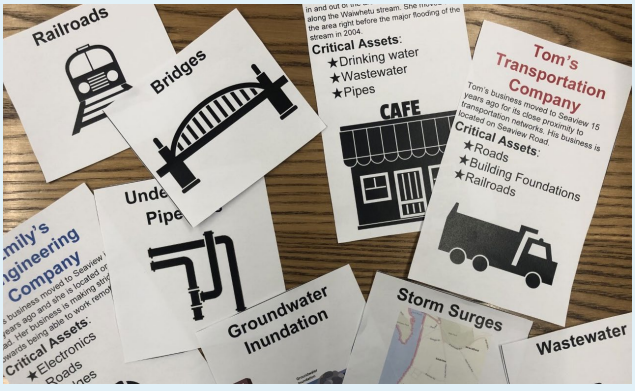


Figure 39: Prototype Game Cards

For future development, we suggest refinement of the game by testing with both groups outside of Seaview Gracefield, such as GWRC members, and with volunteer Seaview Gracefield community members. We also recommend continuing to refine the narrative of the game so that the flood hazard scenarios are as realistic as possible. Finally, we believe adding interconnectivity between business profiles would create more discussions and emphasize the team dynamic of the game. Profiles for local council members could also be added so business leaders and GWRC members can switch places and learn to see each other's perspectives.

Add Information About Groundwater Inundation to GWRC Sea-Level Maps

Currently, the main way businesses in Seaview Gracefield can research how they will be affected from sea-level rise is by looking at the flood and sea-level rise maps on the GWRC website. The maps show how the Wellington region will be affected from sea-level rise and how the storm surges intensify with change. However, they leave out one major effect: groundwater inundation. The sea-level rise map does demonstrate inundation in low-lying lands but gives no explanation as to why. We suggest adding explanations of all the effects of sea-level rise that communities might experience. This will help correct the misconception that the main concern of sea-level rise is water overtopping barriers on the coast.

2. EDUCATE COMMUNITY ON SHORT TERM AND LONG TERM PLANNING

We suggest teaching the community about how to plan with sea-level rise and its effects in mind. Currently, half of the business leaders we interviewed have done no planning and would not even know where to start. Helping them to create more long-term plans will allow the GWRC to understand what assets businesses will want to prioritize, and what local business plans are. The GWRC will then be able to factor this knowledge into their future land use plans.

It is important to help business leaders understand how to create a continuity plan and short-term actions they can take now to prepare. It gives the business leaders a reason to attend

the workshops. In addition to continuity planning, teaching them about adaptive pathways plans will help business owners think more long-term. Only two companies mentioned they had long-term plans during our interviews. Educating the business leaders on planning will allow the Seaview Gracefield community to understand the process the GWRC is taking to make a long-term plan for the area.

3. TAILOR COMMUNICATION TO BUSINESSES TIME CONSTRAINTS

While interviewing, we found it most effective to limit our interactions to 15-30 minutes and advertise it as such. Some business leaders are more talkative than others, and the actual time of interaction may very well go over this amount. However, telling business leaders that the meeting will be short, painless, and easy to fit into their busy days makes them much more agreeable to sitting down and chatting. We suggest holding a workshop either for an hour at the beginning of the workday or longer (maximum two hours) at the end of the workday.

4. INVOLVE THE SEAVIEW BUSINESS ASSOCIATION

We suggest strengthening the relationship with the Seaview Business Association. Many business leaders mentioned an involvement in the SBA or a desire to be involved. However, some of the business leaders who were very active within the SBA had more negative views of GWRC. Improving this relationship, and potentially spreading informative material through the SBA could be a very useful tool for spreading awareness. They are a good resource for delivering information because they have a database of emails for businesses. This would be a more efficient use of time than going door-to-door.

5. DELAY ADAPTING THE DELTARES' SUSTAINABLE DELTA GAME

Throughout our project, GWRC suggested that we make recommendations and take the first steps to adapt Deltares' Sustainable Delta Game to be used with the Seaview Gracefield community. Using the game would be useful because it teaches about the adaptive pathways technique and allows players to understand what goes into creating policies. It teaches about uncertainty and educates them on the issues surrounding flooding. Currently, there are two versions of the game developed for New Zealand. Neither is suitable for the purposes of a workshop for Seaview Gracefield business leaders. The first is about a river and the second is

about sea-level rise. The problem with both is that neither explain the water table rising, the main misconception amongst business owners. Also, they were not created with business owners in mind. The game takes more than two hours to complete, which businesses might not make time for. It also does not discuss issues business owners might face such as rising insurance premiums.

If the game alone was to achieve all the goals of our recommendations, it would need to be adapted. Judy Lawrence, who has adapted the game in the past, advised against adapting the game at this point. Adapting the game for New Zealand was expensive and took over a year. It also plays out scenarios over 100 years, which is a larger amount of time than what businesses currently care about. This, and the amount of time and resources it would require is why we suggest against adapting the game. Business leaders must first understand why they should care about climate change now.

LIMITATIONS

While we were able to speak to many business leaders in the Seaview Gracefield area, we understand that our results from a sample of 20 is a very small snapshot of a business community of more than 700 businesses. We also faced time constraints on our interviews, which limited the nature of our interviews. Due to business leaders' schedules, most could only devote 15-30 minute to our interviews. While we were able to gather an array of perspectives, we were not able to go as in-depth about the issue of sea-level rise or ask follow-up questions to the extent which we would have preferred. In addition, four business leaders did not wish to be identified, limiting us in the information we are able to share in this report.

CONCLUSION

This project connects GWRC's flood protection team with perspectives of business leaders in Seaview Gracefield. As GWRC resumes flood protection work around the Waiwhetu Stream, community engagement will become increasingly important. We hope that this information, and the perspectives of nearly two dozen business leaders in Seaview Gracefield, provides the sponsor with material and insight they can use for additional community engagement in the area. Furthermore, we hope our work not only benefits the GWRC, but also

the business leaders in Seaview Gracefield along with other entities that may be interested in our work, including the Hutt City Council, Hutt City Chamber of Commerce, and the Seaview Business Association. This project helps elevate the viewpoints and concerns of business leaders in Seaview Gracefield. We also hope that this project inspires business leaders to learn about sea-level rise that already affects and will continue to affect them. We hope that bringing this issue directly to businesses helps spark a sense of urgency regarding sea-level rise, and that our conversations inspire more discussions and decision-making about climate change. By doing so, we wish to incite planning for further in the future, rather than just day-to-day operations. We believe that our game prototype, Seaview Sea-level "Sea-narios," will help serve as a first step towards getting businesses to care about sea-level rise, short-term planning, and long-term planning. During our time in New Zealand, we grew both professionally and academically. Our project brought us to the crossroads of science and society, proving engineering projects are much more than just the design and its technicalities.

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APPENDIX A:


CLIMATE CHANGE FAST FACTS: HOW WILL IT AFFECT YOU?
JANUARY, 2020

SEA LEVEL RISE

What are current estimates for the Seaview area?

2040: 0.12 to 0.24 meters

2070: 0.36 to .98 meters

What does this mean?

- Flooding events that only occurred every 1 in 100 years will become more frequent

SLR	Wellington
0cm	Every 100 years
10cm	Every 20 years
20cm	Every 4 years
30cm	Once a year
40cm	Every 2 months
50cm	Twice a month
60cm	3 times a week
70cm	Every tide
80cm	Every tide
90cm	Every tide
100cm	Every tide

Only 30 cm of Sea Level Rise will cause 100 year events to occur once a year

1 in 100 Year Flood Event

Sea Level Rise Model: https://mapping.gw.govt.nz/GW/Floods/

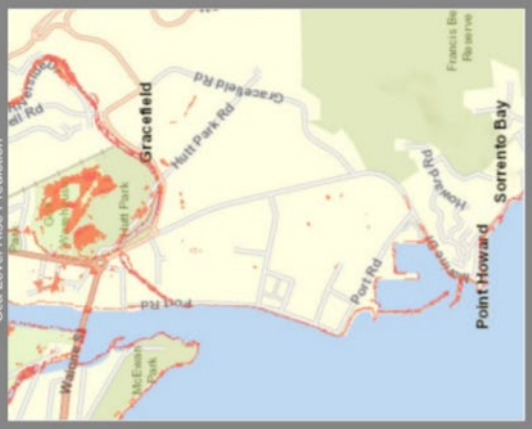
Flood Awareness Map likelihood area	Percentage chance of a flood occurring in any year (AEP*)	Average period between occurrences of a given flood event (ARI**)	Definition
Medium likelihood area	1%	**1 in 100 years** (Q100***)	This flood event is likely to occur during a single lifetime (70 years). Over a very long period of time an event of similar size may occur, on average, once every 100 years; however it may occur more frequently. A flood of this size or larger has a 1% chance of occurring in any year.
Low likelihood area	0.23%	**1 in 440 years**	An unlikely flood event. Over a very long period of time an event of similar size may occur on average once every 440 years. When an event of this size occurs it is considered to be very rare. A flood of this size or larger has a 0.23% chance of occurring in any year.

*AEP Annual Exceedance Probability. The likelihood of a flood of a given size or larger occurring in any year, usually expressed as a percentage.

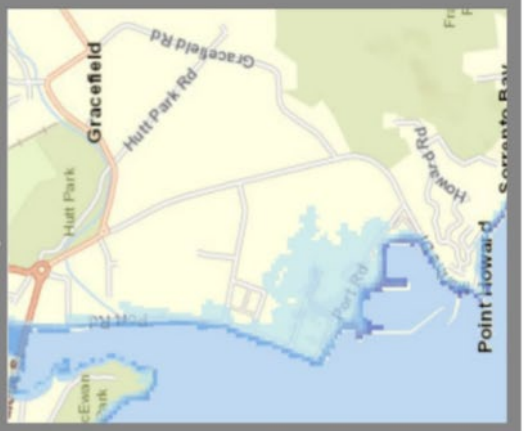
WHAT DOES THIS LOOK LIKE IN SEAVIEW?

Sea Level Rise Model: https://mapping1.gw.govt.nz/GW/SLR/

0.6 meters Sea Level Rise
Sea Level Rise Prediction



0.5 meters Sea Level Rise
Sorm Surge Prediction



CHANGES IN INSURANCE

The insurance industry is changing how it assesses risk

- Population increase, higher value assets, investment in vulnerable areas, and climate change have increased the cost of weather-related hazards
- This has prompted the insurance industry to make changes to the coverage they provide

What does this mean for property owners?

Increased Premiums, Decreased Coverage

When the natural disaster risks related to climate change become more certain, private insurers may:

- Reduce or remove cover from certain areas
- Continue to provide coverage, but with significantly increased premiums and excesses
- Require mitigation measures are put in place

URBAN INFRASTRUCTURE IMPACTS

Climate Change is Expected to put Strain on Some Urban Infrastructure

Main Rd Closure Increased

Lost Business Days

- Increases in extreme rainfall magnitudes may cause:
  - Pressure on urban water infrastructure & disruptions to levels of service
  - Reduced road and rail connectivity
- Sea-level rise will likely cause:
  - Problems for coastal storm-water, wastewater and drinking water infrastructure due to sea water flooding into pipes
  - Coastal erosion
  - Increased Port Rd Closure

APPENDIX B

WORCESTER POLYTECHNIC INSTITUTE

23 January 2020

Dear Seaview Business Leader,

We are a group of third year university students from Worcester Polytechnic Institute in Massachusetts who are working on a project in collaboration with the local government in the Wellington area. Our project aims to understand businesses in the Seaview area and gain insight into their plans for growth within the next 50 years. We would like to interview business owners like yourself to spark a conversation between businesses and government about future planning regarding climate change and sea level rise.

Please contact gr-NZRisingSea@wpi.edu or call +64 27 341 2620 to let us know what times are best to stop by and visit to meet you briefly, and if you are interested in sharing your story we can set up an interview date and time.

Thank you for your consideration,

Julia Cuendet
Mechanical Engineering & Fire Protection Engineering

Andrew Hunt
Electrical & Computer Engineering

Nicole Kring
Mechanical Engineering

Nina Taurich
Computer Science & Interactive Media and Game Design

100 INSTITUTE ROAD, WORCESTER MA 01609 USA

APPENDIX C:

Elevator Pitch:

We are a group of engineering students from Massachusetts. We are here working on a research project with the Greater Wellington Regional Council regarding long-term flood protection planning in the Seaview area. Our project aims to understand businesses in the Seaview area and gain insight into business continuity planning.

APPENDIX D:

Sample Interview Outline:

1. Greet interviewee
2. Introduce ourselves
3. Fill out Consent Forms
4. Explain contextual inquiry (i.e., we are trying to understand how you approach future business planning)
5. Ask interviewee if they have any questions
6. Start asking interview questions:

Intro/Business Overview:

- What does this business do?
- What is your role here?
- How did you get into this field?
- Do you personally live in the area?
- How long has this business been in Seaview?

- Do you plan on staying in the area long? What is your lease?
- Have you seen any changes in the area?

Knowledge on Issue:

- Have you experienced a flood and did it affect your business?
  - If yes: Can you tell us about this experience? What were your main concerns at the moment? How did it make you feel? How did your business recover? How did your business outlook change after that experience? Etc.
  - If no: How knowledgeable are you about flooding are storm surges in this area? (explain infographic maybe) Do you think there is a lack of awareness about the issue? How would you like this information to be conveyed by the Councils?

Future Planning:

- What kind of business continuity planning have you done regarding floods? **only if they know about flooding
- What are your initial thoughts on adapting to this problem?
- How do you see your business map onto these maps- how long do you plan for our business to be around- do you have a plan B, how many lost business days you can afford

Insurance Related:

- Do you have any disaster recovery plans?
- Do you have flood insurance?
- Do you have business interruption insurance?
- Would you be able to absorb an insurance increase?
- Would you be able to get insurance?

Workshop/Future Education:

- Have you attended any workshops rub by chamber of commerce, councils, business associations etc.
- Would you be interested in a sort of workshop that deals with business continuity planning and raising awareness of the potential flood risk
- Is the information we brought presented in an easy to understand format?
- How would you like this information to be conveyed by the Councils?

7. Thank interviewee for participating
8. Let them know how to find info on the project
9. Ask if it is okay to identify them/ how they would like to be identified
10. Ask interviewee if they know anyone else that may be interested in participating

*Use climate scenario supplementary material as necessary

APPENDIX E

Business Name	Interviewee Name	Type of Business	Location
--	--	--	Port Road
--	--	--	Seaview Road
Shipwreck Trading	Robert Baldock	Vintage Marine Art	Port Road
Compass Coffee	Michael Meeds	Cafe	Port Road
Gray Engineering	Shaun Gray	Engineering	Near Port Road
Redhot Marine	--	Sell & Repair Boats	Port Road
BBR Contech	Bojan Radosavijevic	Engineering	Port Road
Racetech	David Black	Design Racecar Seats	Barnes Street
Placemakers	Garth Mcinnes	Building Materials	Seaview Road
RM Engineering	Ranjini Singh	Electrical Work	Barnes Street
Leap	Morné Van Rensburg	Plumbing/Heating/Fire Sprinklers	Port Road
Speedy Signs	Dominique Heller	Advertising Solutions	Seaview Road
TYKE Recycling	Brendan Walker	Paper Recycling	Seaview Road

Metal Art	Carl Longstaff	Metal Art Works	Port Road
Litho & Label	Wayne Emerson	Label Making	Hutt Park Road
Titan Cranes	Bruce Whiley	Crane Hire	Port Road
--	--	--	Gracefield
Waste Management	Ross O'Loughlin	Wastewater Treatment Plant	Port Road
Seaview Marina	Allan McLellan	Marina	Port Road

Roads in Relation to Waterfront:

Port Road: Along Waterfront

Seaview Road: Farther from Waterfront, closer to the Waiwhetu stream

Barnes Street: Relatively close to waterfront. Located right off of Port Road

Hutt Park Road: Far from waterfront. Closer to Waiwhetu stream. In Gracefield

APPENDIX F:

Seaview Sea-level "Sea-narios"

"Sea" if you can outlast *sea*-level rise in *Seaview*!

By: Julia Cuednet, Andrew Hunt, Nicole Kring, Nina Taurich
Advisors: Leslie Dodson and Gary Pollice

greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

WPI

Acknowledgements: This game was adapted from Red Cross/Red Crescent Climate Centre's game "Act to Adapt." See the database of climate games at: https://www.climatecentre.org/resources-games/games/6/act-to-adapt

Description: Each player is a business community member (BCM) with 'assets' that are critical to running their business. Each round, the business community must decide collectively which vulnerable assets to prioritize in the event of a 'flood hazard scenario.' These 'assets' are split into two categories: personal and communal. Players must invest in the protection of personal assets, as well as invest their tokens as a group into the community assets. If these assets are damaged by the 'flood hazard scenario' and not protected by investment, the BCM will take a hit by losing 'tokens.' Damage to critical assets results in a higher token cost if damaged. The goal of the game is to end the scenarios with the most amount of tokens.

Learning Outcomes: To experience the impact of flooding and sea-level rise in Seaview; to explore what infrastructure is vulnerable to which types of flooding; to recognize the importance and urgency of proactive planning in the context of climate change uncertainty; to recognize the importance of business interconnectivity as the players must work together to succeed

Intended Audience: Business leaders in the Seaview Gracefield area

Number of Players: Small groups of 3-5 players with one facilitator.
In the event of more than 5 players, the separate business communities (group of players) are competing against one another to keep the most BCMs in the game.

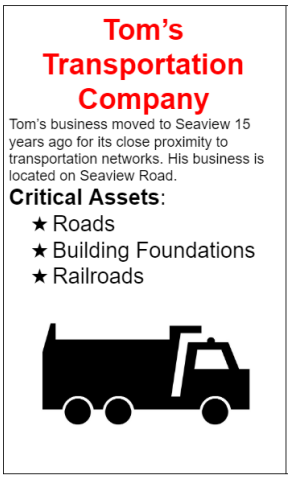
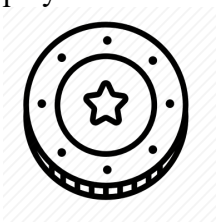
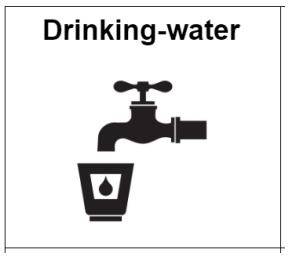
Time Needed: 30-45 minutes

Playspace Requirements: a large space, big enough for all participants

Materials:

- **Tokens**
- **BCM cards**
- **Flood hazard scenario cards**
- **Asset Cards**

Key Components of Game:

Component	Number per Group	Types	Purpose
Business Community Member (BCM) Cards	5 	(See BCM card table)	Lists three unique "assets" that are critical to running that business. One critical personal asset and two public assets
Token	15 x number of players 	All value of 1 unit	A 'token' represents a business's resources to invest in planning against the effects of a flooding hazard'. If a BCM's asset is damaged by a 'flood hazard scenario', tokens are taken away unless the asset had investments.
Asset Cards	9 	Personal • Drinking water • Ground-level building • Foundation Communal/Public • Underground Gas Pipes • Bridges • Underground Cables • Sewage System • Railroads • Roads	These cards identify specific assets that exist within the community that can be damaged by the flooding events.

Flood Hazard Scenarios/ Rounds	3 rounds in total	(See Gameplay Scenarios)	Each round presents a different flood hazard resulting in different assets being affected.
Flood Hazard Cards	8 	• Storm Surges • Overtopping of Waiwhetu • Groundwater Inundation • Stormwater drainage blockage	Represents the different types of flood events.
Timeline of the Game	NA	NA	This game has a timeline of 20 years starting in 2020, with the second round in 2030, and final round in 2040.

Setting up the Game:

1. Divide the players into small groups of 3-5, allowing for one facilitator to be with each group.
2. Give each player a BCM card.
3. Give each player 15 tokens.

Playing the Game:

Rules:

- Each player can use a max of 3 tokens per round to invest in infrastructure
- Players can invest in their own personal assets or public assets
- It takes 1 token to protect a players personal assets and 1x (the number of players) to protect a public asset
- An asset is damaged if it is listed as being affected and doesn't have enough tokens
- If a asset is damaged each player must give four tokens for each a critical asset damaged and two tokens for each regular asset damaged
- If an affected asset was prioritized by the community (had enough tokens) 1x(the number of payers) tokens are removed
- If an affected asset was damaged due to not enough tokens the tokens remain
- Tokens on unaffected assets remain on the board

Prior to the First Round:

1. Each player chooses a business community member card
2. Each player is given 15 tokens
3. Each player is given their three critical asset cards
4. Players are introduced to the communal asset cards
5. Read the introduction script

Round 1:

1. Present and explain the first flood scenario by reading the script. Place down the relevant flood hazard cards for that scenario. Explain the types of flooding and how this is a realistic and current flood scenario for Seaview. The purpose is for them to decide which assets they think are most vulnerable to this flooding based on their understanding of the scenario.
2. Each player must decide how they will divide their three tokens up each round. Players must discuss why they believe certain infrastructure will get affected and try to convince the group to pool their tokens to protect an asset. Give each group 2 minutes to discuss and invest.
3. Explain the outcome/effects of the scenario. For each asset damaged, a certain amount of tokens are taken away from each BCM. More are taken away from them if it is listed as a critical asset for them. If it is protected, however, no tokens are taken away but tokens are removed from the asset. When all tokens of a BCM are lost, that player is eliminated from the game.

4. Debrief after each round/ flood hazard scenario:

a. What assets did they choose correctly to prioritize, why?

b. What assets did they not choose correctly to prioritize, why?

Round 2:

1. Preface this round with an explanation of climate change and sea-level rise. As these increase, coastal hazards worsen. Therefore, each round will have more severe flood hazard scenarios.
2. Explain that 10 years have passed since the last flood hazard scenario and explain the next scenario
3. Insurance Premiums Increase: Insurance companies realize the area is at risk and check businesses preparedness. For each personal asset not being invested in the player loses one token to pay for the increase in insurance premiums.
4. Repeat steps 2-4 of Round 1 for this flood hazard scenario.

Round 3:

1. (See instructions for Round 2)
2. If there is more than one group present, count the remaining BCM left. Whichever group with the most BCMs left wins.

Debrief after the game:

- Did you learn new information about the types of floods in Seaview?
- Did any misconceptions about flooding you have surface after playing this game?
- Was it difficult to figure out which assets should be prioritized?
- Was it difficult to come to a decision collectively?
- How did your team strategize choosing which assets to prioritize?
- Did working together increase the chances of everyone's success?

Flood Hazard Scenarios/ Rounds:

Introduction Script:

You are all business community members of Seaview Gracefield. Each business card given to you has a brief description of the business and its location. In addition, each business has a list of three critical assets to them, which are crucial to your business's day to day function. Being in an area vulnerable to flooding, you are aware that these assets may have the potential to be affected by flood events. Each business owner is allocated 15 tokens. These tokens represent resources used to invest in protecting personal and communal assets.

The game will consist of three rounds. The first round is the current day, the second is 2030, and the third is 2040. In each of these rounds, a flooding event will occur. As a business owner and community member, you must decide what assets to be invested in. There are three assets labeled as personal assets. These are drinking water, building foundations, and ground-

level buildings. The rest of the assets are considered to be communal. After each scenario, each business owner may use a maximum of three tokens to invest in these assets. To protect a personal asset you must personally have one token invested in the asset that you would like to protect. To protect a communal asset, there must be the same number of tokens on the asset as there are players.

After each scenario, the facilitator will tell the group what assets have been affected by the flooding hazard. If the asset was protected, the tokens invested on that asset will go to upkeep of that asset. If the asset has been affected by the flooding but was not invested in, each player will use two tokens to repair that asset. If this asset is a critical asset to your business, you will use four instead. The goal of the game is to end the scenarios with the most amount of tokens. Remember that relationships and interconnectivity may play a crucial role in managing your own resources.

Round 1 (2020)

A large southerly storm is occurring in Seaview. This storm brought very severe winds but not a large volume of rain. The wind in addition to the high tide has led to waves crashing over the coastline and washing on to the roads.

Effects:
Roads were affected. The waves were coming far enough to cause a severe safety hazard for driving. Due to this, your workers were unable to drive to work today.

Buildings that were not raised were slightly flooded, damaging equipment kept on the first floor.

Round 2 (2030)

Sea level has risen around 0.12m. The result of frequent heavy rainfall over the course of a month has led to the Waiwhetu rising and causing minor floods throughout the month. This time the heavy rainfall occurred at the same time as a king tide causing the Waiwhetu to completely overtop. This flood is a 1 in 40-year flood. In addition to this king tide, the SLR has caused the water table to rise, there is very little space in the soil for the absorption of the rain and river water that has overtopped the river banks.

Effects:
Roads were affected again. This flood has made it a hazard to drive along many of the roads in Seaview. You and your workers were unable to make it into work for multiple days.

Buildings that were not raised were flooded causing damages to anything kept on the bottom floor.

This storm halted railway transportation for the day.

Round 3 (2040)

The sea level has risen by 0.24m. As the SLR has risen the high tides have become higher. Due to this the water level is closer to breaching over the coast as well as the Waiwhetu. A 1 in 20-year storm event comes from the south with severe winds. The brunt of this storm hit during high tide causing a severe storm surge. In addition to this, the intensity of the rainfall has caused the Waiwhetu stream to simultaneously flood during this storm surge event. The heavy winds are causing debris to get caught in the storm drains causing a severe blockage. In addition to this, the water table has risen even higher and is starting to have more long-term effects.

<u>Effects:</u>
Your building foundation was found to be heavily damaged and eroded due to the rising of seawater in the ground. Before your building can continue to be used the damage must be fixed.

Additionally, groundwater inundation has led to the damage of your building's gas pipes, and if not protected some cracks in your sewage system have led to the contamination of drinking water.

The stormwater drains along the coast have all been blocked by debris causing there to be more than half a meter of water on the roads. This makes the roads completely unusable for multiple days as work is done to try and clean.

This also led to the severe flooding of buildings damaging entire floors.

Gameplay Materials:

Stormwater Drainage Blockage


- Storm drains can be blocked overtime by dirt, trees, silt, and rubbish.
- Pipes can become cracked

Intensity:			

Stormwater Drainage Blockage


- Storm drains can be blocked overtime by dirt, trees, silt, and rubbish.
- Pipes can become cracked

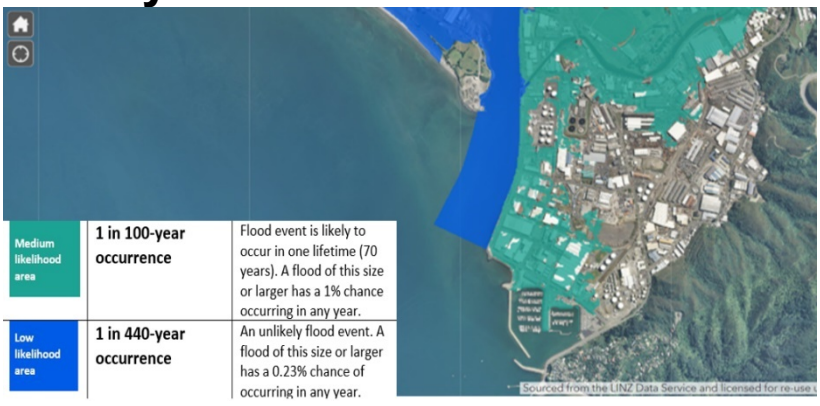
Intensity:			

Overtopping of the Waiwhetu Stream

Overtopping is the process of floodwaters flowing over the top of stopbanks.

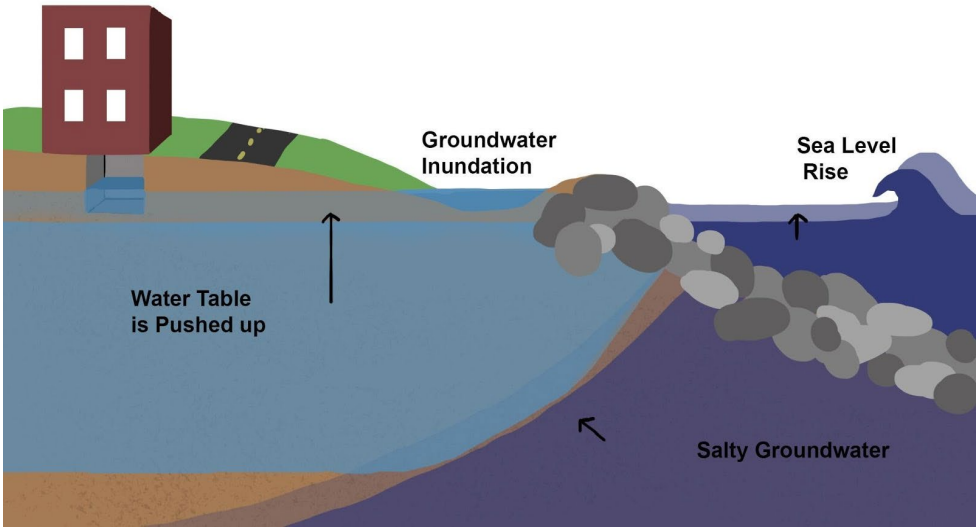
1-in-40 year flood

1-in-100 year flood



SLR	Wellington
0cm	Every 100 years
10cm	Every 20 years
20cm	Every 4 years
30cm	Once a year
40cm	Every 2 months
50cm	Twice a month
60cm	3 times a week
70cm	Every tide
80cm	Every tide
90cm	Every tide
100cm	Every tide

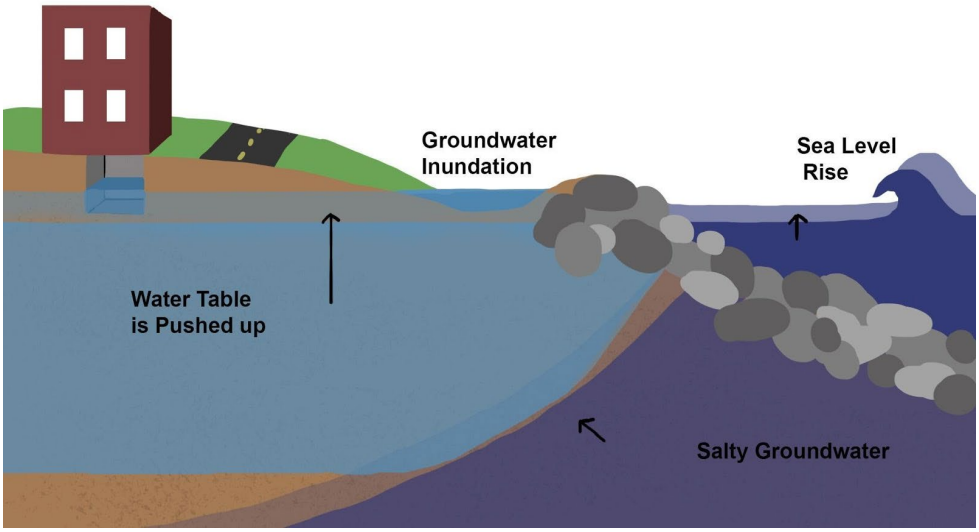
Groundwater Inundation



As the sea-level rises, it pushes up the freshwater table causing flooding.

Intensity:			

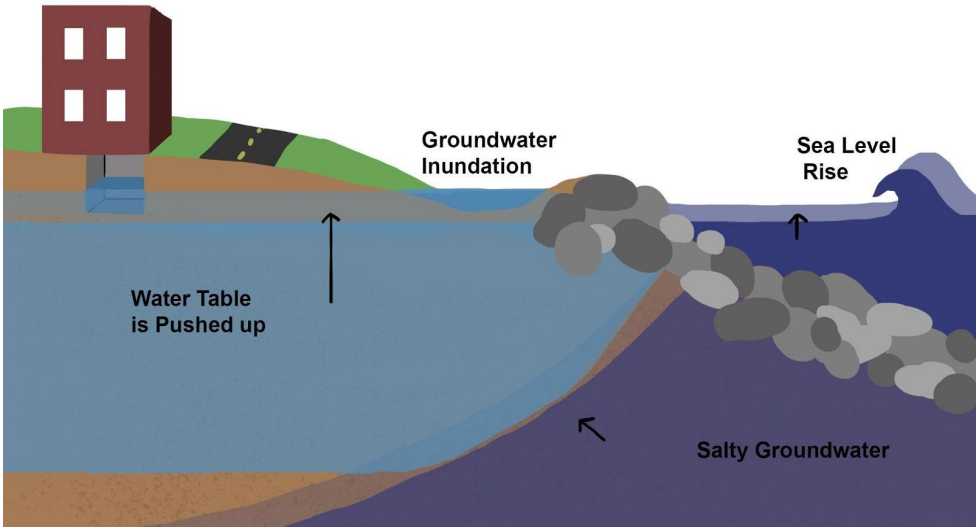
Groundwater Inundation



As the sea-level rises, it pushes up the freshwater table causing flooding.

Intensity:			

Groundwater Inundation



As the sea-level rises, it pushes up the freshwater table causing flooding.

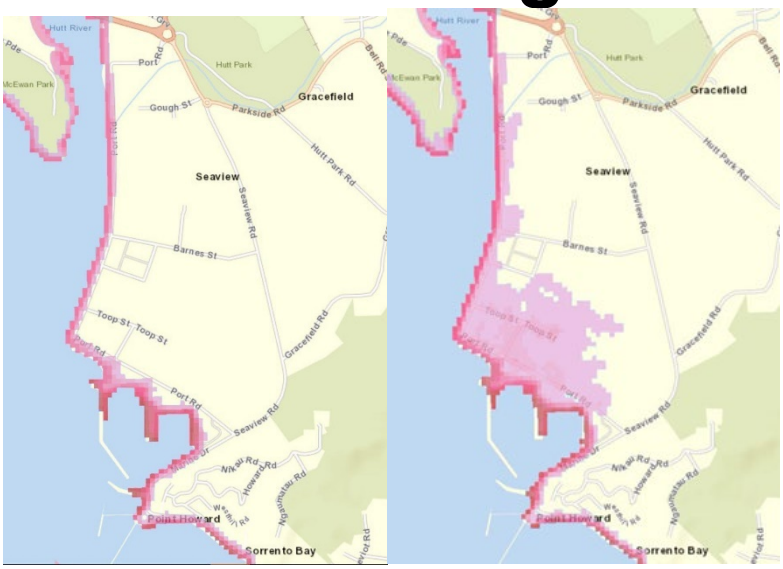
Intensity:			

Stormwater Drainage Blockage

- Storm drains can be blocked overtime by: dirt, trees, silt, and rubbish.
- Pipes can become cracked

Intensity:			

Storm Surges



Storm surges cause a rising of the sea as a result of wind and atmospheric pressure changes during a storm.

- Causes erosion along the coast
- Debris washes up along the coast
- Waves crash over coastal barriers

Tracy's Transportation Company

Tom's business moved to Seaview 15 years ago for its close proximity to transportation networks. His business is located on Seaview Road and transports car parts.

Critical Assets:

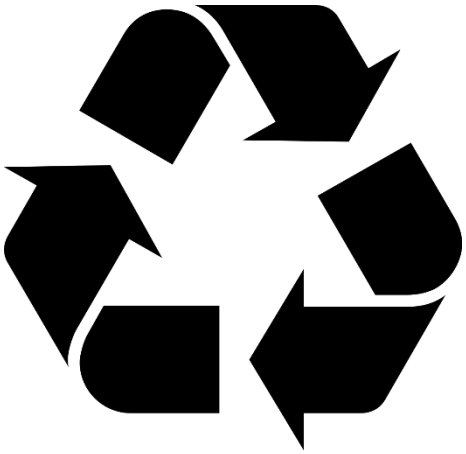
- Roads
- Building foundations
- Railroads

Ryan's Recycling

Ryan's business, located on Barnes Street, has been in the area for 10 years. It is a large company and currently has business continuity planning in place regarding sea-level rise.

Critical Assets:

- Gas lines
- Cables
- Building Foundations



Emily's Engineering Company

Emily's business moved to Seaview just two years ago and she is located on Port Road. Her business is making strides towards being able to work remotely.

Critical Assets:

- Ground-level floor
- Roads
- Bridges

Arthur's Auto Body Shop

Arthur's Auto Body Shop has been in Seaview for 20 years and they have a loyal clientele, local to the area. He is located on Port Road.

Critical Assets:

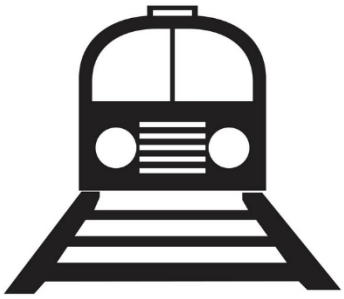
- Ground-level floor
- Cables
- Roads

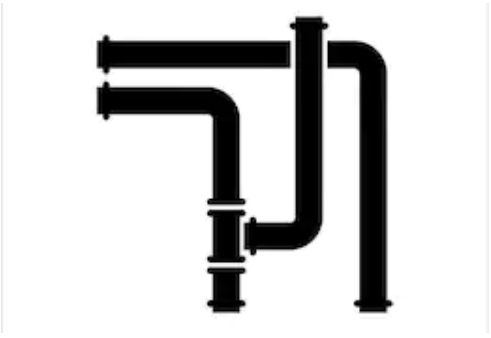
Chris' Cafe

Claire's Cafe feeds many of the business owners in Seaview as well as visitors coming in and out of the area. The cafe is located along the Waiwhetu stream. She moved to the area right before the major flooding of the stream in 2004.

Critical Assets:

- Drinking water
- Sewage system
- Gas lines

Drinking-water	Sewage System
	
Railroads	**Bridges**
	

Roads	Building Foundations
	
Ground-level of Building	**Underground Gas Pipes**
	

Underground Cables