



WHAREKAWA COAST 2120

Natural hazard risk assessment –
community risk thresholds

Sub-compartment 3A (Whakatiwai)




HAURAKI
DISTRICT COUNCIL

Waikato

REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

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Overview



What is the Wharekawa Coast 2120 project?

Wharekawa Coast 2120 is a joint council, iwi and community-led project that looks at a range of issues and how we can provide for a resilient and prosperous future over the next 100 years.

Natural hazard risk is a particular concern, and understanding and evaluating this risk is essential to planning a response. The end plan will be used to guide decision making for local planning purposes and to secure support for funding specific projects. The plan will need to be regularly reviewed and adapted as our understanding changes, and the progress will be an evolving and ongoing conversation.

To help achieve this plan, a community panel of local volunteers and a project governance group was set up. The panel, which meets once a month, works with communities, councils and iwi to make recommendations to the governance group (comprising iwi and Hauraki district, Waikato regional and Waikato district council representatives) on actions over the next 5, 10, 20, 50 and 100 years.

To work out the plan of action, the community panel needs to know what matters most to the members of the community. Figure 1 and 2 show the draft themes and goals identified by the community panel.

This is not just a five-minute chat. It will take a while and will require in-depth conversations. This natural hazard risk assessment is part of those conversations. The councils, which collated all their knowledge of hazards within the Wharekawa coastal region, have developed this risk assessment of coastal inundation and river flooding. We need you to tell us the level of risk you think the community is prepared to tolerate moving forward.

This is the first attempt at determining community risk thresholds. As more technical, scientific and personal information becomes available, there will be opportunities to refine the thresholds.

Throughout this booklet we have provided a space for personal comments. Please feel free to comment. Your opinions are important.

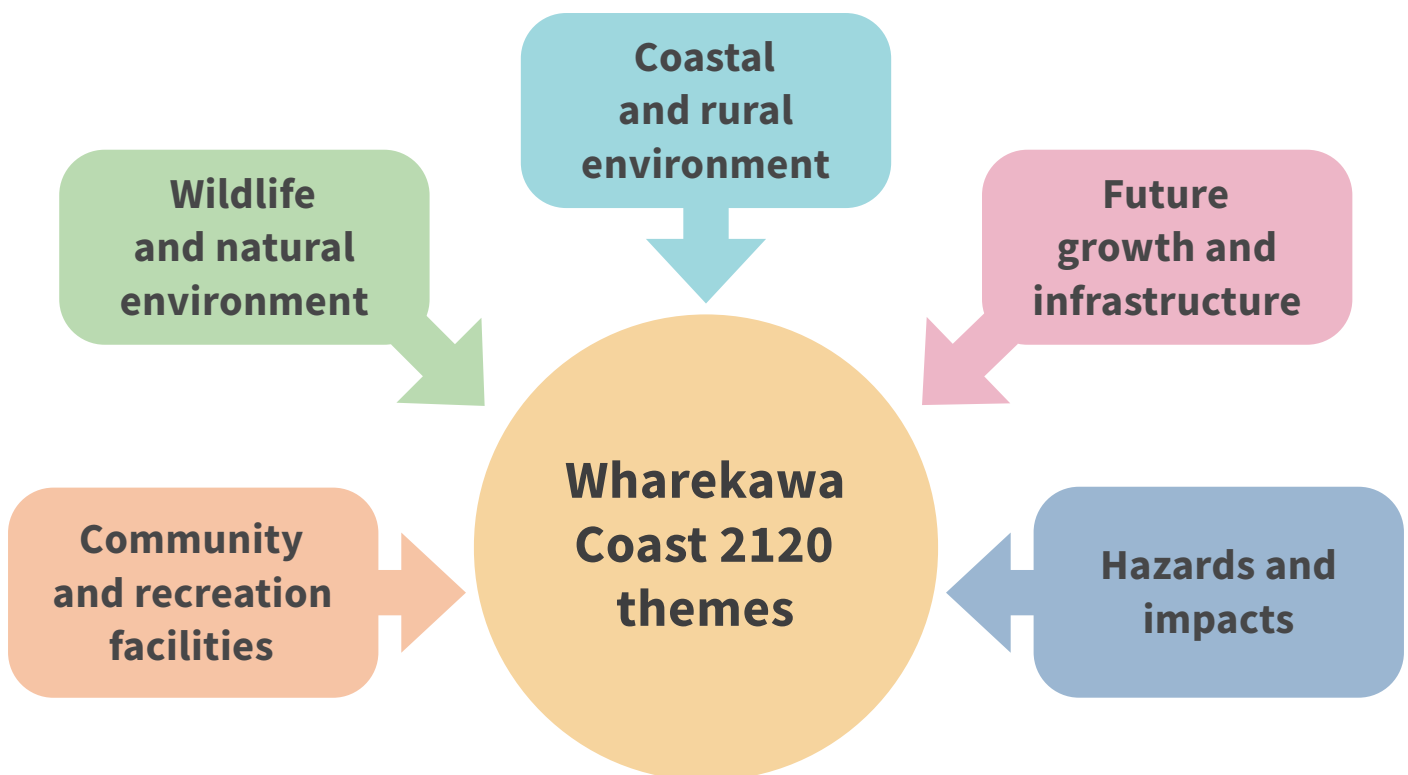


Figure 1: Wharekawa Coast 2120 key themes

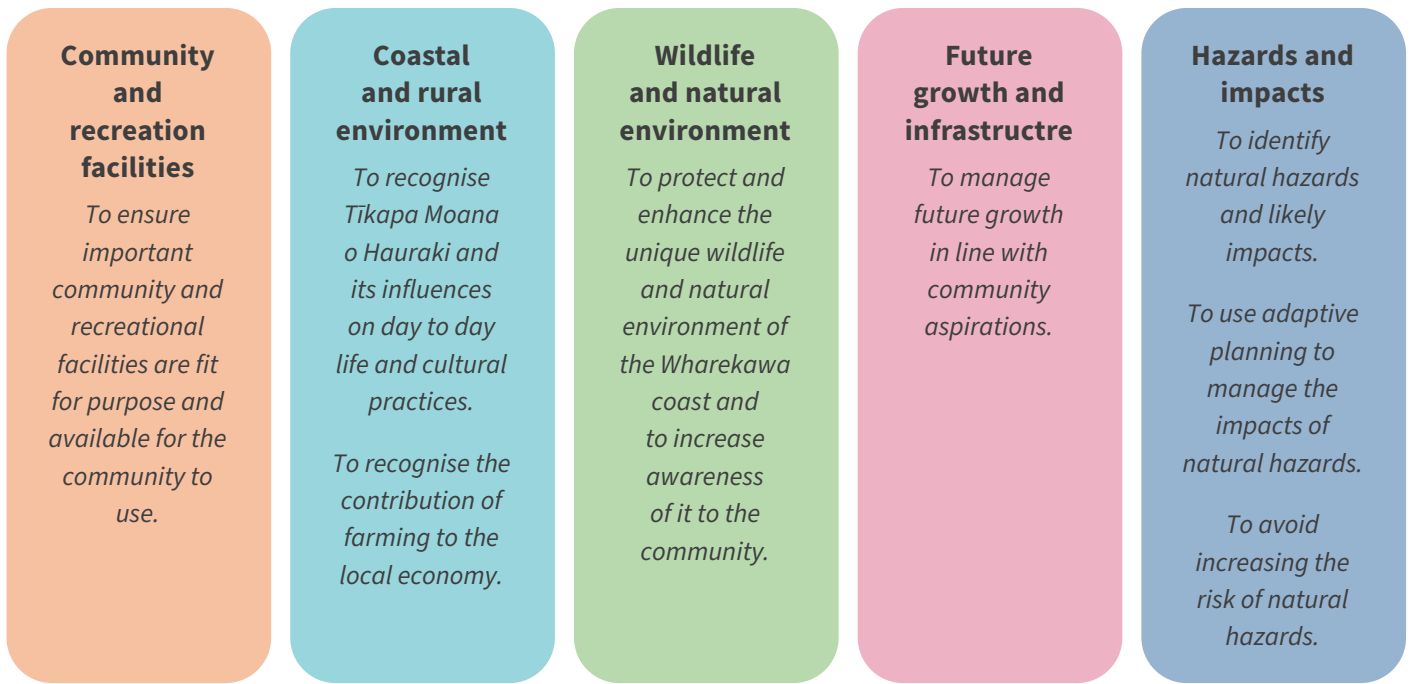


Figure 2: Wharekawa Coast 2120 goals

Write any comments here

Community risk thresholds exercise

The Wharekawa Coast has already experienced significant **coastal inundation** and freshwater flooding events, particularly from Huarahi Stream. With the projected effects of climate change, these events will become more frequent and more severe. To help plan for the future, we want to know when the community will no longer be able to **tolerate** the impacts from coastal inundation and Huarahi Stream flooding.

The information in this booklet is taken from the *Wharekawa Coast 2120 – Natural Hazard Risk Assessment*. The purpose of this **risk** assessment is to:

- work with and enable the community panel to understand the most significant **natural hazard** risks to the Wharekawa Coast 2120 project area
- enable the community to evaluate the risk posed by these hazards by determining initial **community risk thresholds** (thresholds) for the impacts of each hazard scenario
- compare the relative risk of these hazards across different **sub-compartments** and **impact categories** to inform the development of **adaptation actions and pathways**.

The information given in this booklet will help you assess your thresholds, and is provided as:

- project area information
- sub-compartment impact information.



Whakatiwai beachfront looking south.

The definition of each bolded term can be found in the glossary.

Project area impact information

This information comes from experts, community members and the impacts from recent coastal inundation and Huarahi Stream flooding events.

For some impact categories, the thresholds assessed by asset and emergency managers, determined during a workshop in September 2020, have been provided. These thresholds relate to what these managers can tolerate in terms of resources required for them to respond to natural hazard events. Beyond these thresholds, the level of service provided may reduce.

Sub-compartment impact information

This information comes from the results of **quantitative risk assessments** for both coastal inundation and Huarahi Stream flooding (as well as some impact information from recent events). Data is presented for:

- sub-compartments within the project area (see figure 4)
 - the project area has been divided into sub-compartments so that natural hazard risk, thresholds and adaptation actions can be assessed for each sub-compartment and so provide more useful outcomes
- natural hazard scenarios
 - two scenarios, a major and a moderate event (see figure 3), for both coastal inundation and Huarahi Stream flooding (the major coastal inundation event is approximately equivalent to the January 2018 storm tide event, and all scenarios can occur with the current climate and sea level)
- elements (e.g. buildings, roads, shops), divided into impact categories
 - homes, buildings and disruption to residents
 - rural land
 - roads and bridges
 - services
 - recreation and tourism
 - overall impacts.

What this information tells us

The natural hazard scenario models (figure 3) allowed us to assess the exposure of elements (e.g. buildings, roads, pasture) within the impact categories for moderate and major events. This tells us whether an element is within a flood area and how deep the flooding is expected to be.

We then estimated **damage costs** for buildings, roads and rural pasture land (based on numerical data available) and **resident displacement**. Assumptions have had to be made. For example, we do not know for sure what damage will occur, or what the characteristics of individual buildings are. However, the estimations are still useful, especially when comparing possible damage costs and resident displacement between the sub-compartments and hazard scenarios. Key assumptions and limitations are outlined in the appendix.

When reviewing the impact information, something to keep in mind is that the **vulnerability** of different people and elements is not the same. For example, some people may be more vulnerable due to age or disability, and some businesses may be more vulnerable due to a greater reliance on favourable weather or tourism income.

How the thresholds will be used

Once members of the community have assessed their thresholds, Waikato Regional Council staff will collate and analyse the results, and present them back to the community, via the community panel, to check they accurately represent the community's thresholds.

These thresholds will then be used, together with the thresholds determined by asset and emergency managers, to figure out how much time is available to implement adaptation actions to reduce the natural hazard risk to the community. They can also be used to prioritise sub-compartments and impact categories where the risk will need to be addressed sooner.

This is the first attempt to determine the community's risk thresholds. As more information becomes available (particularly when investigating adaptation actions), there will be opportunities to refine these thresholds.



Rural land surrounding Whakatiwai village.



East Coast Road in Whakatiwai village.

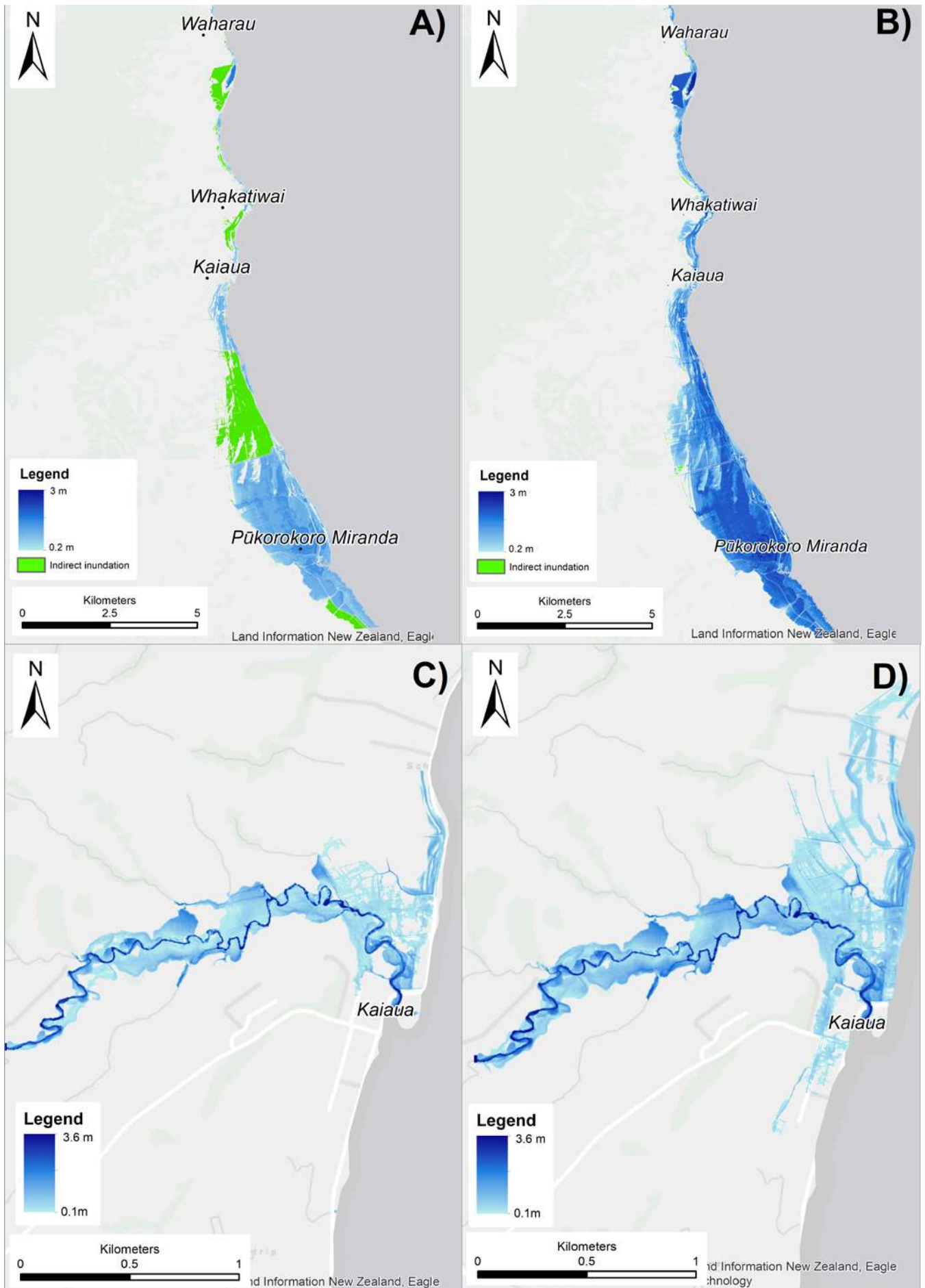


Figure 3: Natural hazard scenarios for the quantitative risk assessment: A) coastal inundation – moderate; B) coastal inundation – major; C) Haurahi Stream flooding – moderate; D) Haurahi Stream flooding – major

Instructions

This exercise contributes to finding out the community’s risk thresholds for coastal inundation and Haurahi Stream flooding in the Wharekawa Coast 2120 project area. You will be assessing thresholds for sub-compartment 3A (Whakatiwai).

We are asking community members to individually assess community risk thresholds for coastal inundation in sub-compartment 3A (Whakatiwai) (see figure 4). Thresholds will be assessed for both moderate and major events.

Community members should assess their thresholds from the perspective of the community in their sub-compartment, not as an individual. This is because the impact information is generally at the sub-compartment level of detail, rather than at individual property level, and because the results will inform a wider community strategy. The threshold is when you think your community in your sub-compartment will no longer be able to tolerate the impacts of an event.

Thresholds will be assessed for the following impact categories.

1. Homes and properties, and disruption to residents
2. Rural land
3. Roading and bridges (road access)
4. Services
5. Recreation and tourism
6. Overall impacts

Information on the expected impacts of each scenario is provided to help determine each threshold. Each impact category has information generally relevant to the whole Wharekawa Coast project area, and specific impact information for the relevant sub-compartment.

This is the first attempt at determining community risk thresholds. As more information becomes available, there will be opportunities to refine these thresholds.

Determining your thresholds

For each threshold:

1. Read and understand the accompanying impact information.
2. Use the method to the right and the tables provided to indicate when the impacts could no longer be tolerated (see figure 5).
3. On the table, your mark should be as far to the RIGHT as

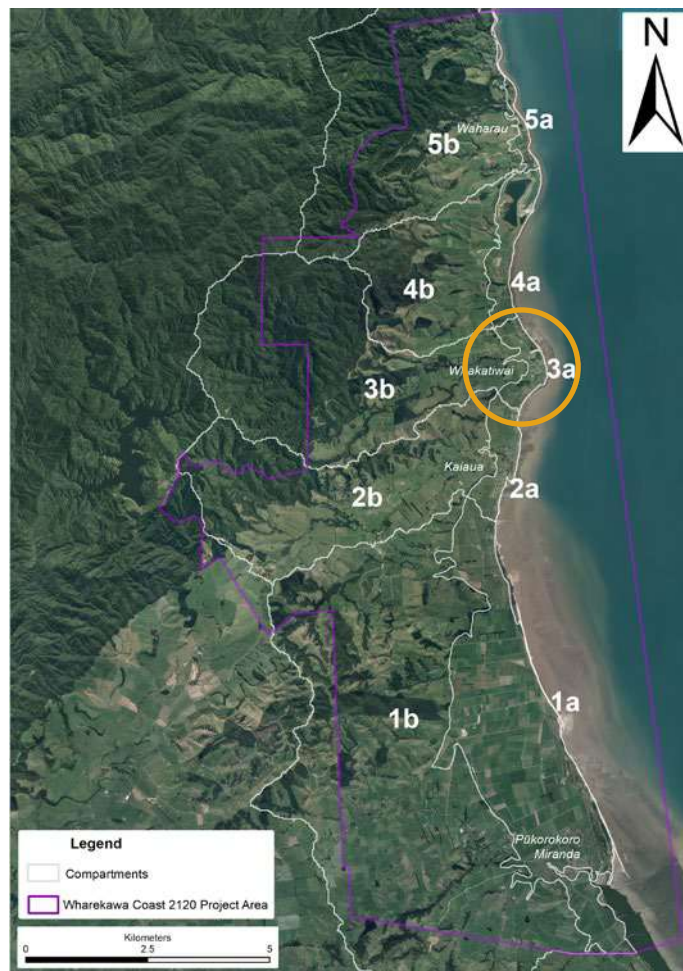


Figure 4: Wharekawa Coast 2120 project area and sub-compartments

possible. This is the point at which you think the community truly could no longer tolerate the impacts. The moderate event should be further to the RIGHT than the major event, as we could typically tolerate a moderate event more often.

Method

- a) Start at the left-hand side of the table and ask yourself if the community could tolerate the impacts occurring every 200 years?
- b) If YES, colour the square green and then ask yourself the same question but for the next **ARP** (100 years, 75 years and so on) until you say NO.
- c) Once you can say NO, put an X in that square and colour it and all those to the right red. This is your threshold.

Figure 5: Example of how to fill out the tables

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event				X							
Moderate event								X			

If a threshold is not reached because the impacts are low, colour all squares green.

Coastal inundation



Impacts to homes and buildings, and disruption to residents

Buildings refer to the main dwelling or business, service or community building on a property. They do not include sheds, sleepouts, etc.

Project area impact information

Impacts may include:

- damage or destruction of homes, other buildings, garages and sheds, and their contents, potentially resulting in:
 - large repair and cleanup costs (insurance coverage will influence financial impact)
 - loss of sentimental items
 - damage to vehicles
 - residents needing to live elsewhere while cleanup and repair works undertaken
 - increase in insurance premiums, exclusions added, or cover withdrawn
- damage to gardens (including food gardens), with potential die off due to salt water
- failure/overflow of septic tanks, potentially resulting in:
 - contamination of land and water and public health risk
 - need to use portaloos and drink only bottled water for some time
 - need to empty/clean out septic tanks, which may take weeks depending on demand
 - following the January 2018 event, the equivalent of a **major event**, this took up to three weeks
- power and communications outages
 - following the January 2018 event, the equivalent to a **major event**, there was disruption to power for up to five days; Counties Power restored 80 per cent of power within 24-36 hours, and 100 per cent within five days
- disruption to drinking water supply, including from damage to pumps from salt water
 - following the January 2018 event, the equivalent to a **major event**, there was disruption to water supply for three days; some pumps were ruined by salt water and were out for several days
- a shortage in rainwater tank supply due to increased demand during cleanup (particularly in summer).

Power and communications

- The power and communications networks generally follow East Coast Road and are buried, except over bridges where they are aerial. The networks are quite resilient to flooding events, but maintenance requirements are increased when the lines get wet from flooding.
- Chorus will repair the communications network should it get damaged, and may undertake work to increase the resilience of the network if required.
- The power network will be repaired if damaged, but if damage is frequent then the providers may discuss alternative options with residents, such as moving to distributed generation sources (e.g. solar panels, batteries) that are owned by the residents.
- Regarding repair time of the networks, there are industry-wide service level requirements based on annual averages but there are no requirements for repairing individual outages.

Risk thresholds assessed by Hauraki District Council and Waikato Regional Council emergency management (CDEM) due to resources needed to respond to coastal inundation events:

- 20 years for a **major event**
- 5 years for a **moderate event**

Risk thresholds assessed by asset managers (to repair damage and blockages to stormwater system):

- 6 months for a **major event**
- 6 months for a **moderate event**



Properties in Whakatiwai.

Sub-compartment 3A (Whakatiwai) impact information

What's here

- 91 main buildings

Numbers and percentages presented may appear inconsistent because numbers have been rounded to reflect uncertainty and percentages are calculated using raw data.

Information regarding the key limitations and assumptions for building damage and resident displacement can be found in the appendix.

During a **major event**, it's estimated that:

- 21 buildings will be exposed to coastal inundation (23 per cent of buildings)
- 3 buildings will be flooded above floor level (3 per cent)
- the buildings damage cost will be \$105,000
- 7 people will be displaced from their homes while repairs are completed for a 2-week period.

During a **moderate event**, it's estimated that:

- no buildings are exposed to coastal inundation, thus no threshold is needed.

Mark your community risk threshold here

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											

Write any comments here

Impacts to rural land

Project area impact information

Impacts may include:

- direct costs:
 - to re-establish pasture (costs include grass seed and sowing, and fertiliser and application) that has been “burnt” by saltwater inundation (estimates provided below)
 - of spraying out paddocks or weeds and cultivation (estimated at up to \$305/ha)
 - to clear sediment and debris and repair infrastructure (e.g. fences) and equipment (e.g. milking machinery)
- loss of pasture productivity, resulting in:
 - additional feed requirements
 - relocation of, or reducing, stock numbers, etc.
 - following the January 2018 event, the equivalent to a **major event**, it took some farms two seasons before pasture quality returned to pre-event levels, with one farm bearing a cost of \$110,000
- reduced income for farm owner and/or loss of jobs or reduced income for employees
- saltwater flooding of groundwater and surface water contaminating rural water supply and damaging equipment
- ongoing effects, such as additional drainage requirements or compaction issues caused by the salt.

With climate change, weather is likely to become more unpredictable. If farms are already under stress, for example from drought, this is likely to worsen any impacts from coastal inundation events.



Rural land along Rata Road.



Rural land along East Coast Road in Whakatiwai Village.

Write any comments here

Sub-compartment 3A (Whakatiwai) impact information

What's here

- 64ha of rural land

Numbers and percentages presented may appear inconsistent because numbers have been rounded to reflect uncertainty and percentages are calculated using raw data.

Information regarding the key limitations and assumptions for pasture re-establishment cost can be found in the appendix.

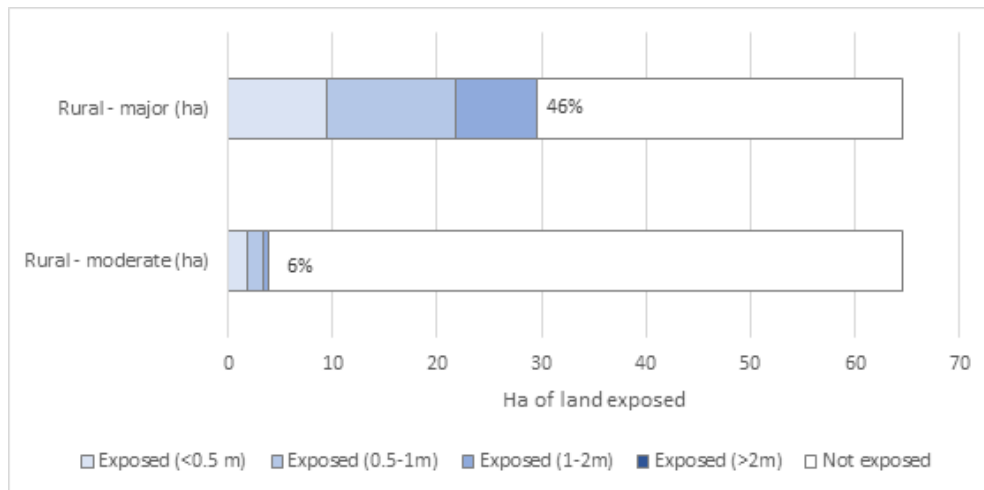
During a **major event**, it's estimated that:

- 30ha of rural land will be exposed to coastal inundation (46 per cent)
- the cost to re-establish pasture will be \$14,000.

During a **moderate event**, it's estimated that:

- 4ha of rural land will be exposed to coastal inundation (6 per cent)
- the cost to re-establish pasture will be \$2000.

Figure 6: Exposure of rural land to different flood depths during major and moderate events



Mark your community risk thresholds here

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

Write any comments here

Impacts to roads and bridges (road access)

Project area impact information

Roads and bridges may be closed for up to three days in a **major event**, and up to one day in a **moderate event**, with partial closures and delays for longer.

These closures and delays may mean:

- residents are unable to access services and recreation areas or meet for social occasions
- travel detours and longer travel times, including for residents travelling to Auckland (may need to use other service locations such as Ngātea)
- delay in restoration of services such as electricity, communications and stormwater.

Large repair costs may also result in rates increases for residents.

Risk thresholds assessed by asset managers (due to costs to repair damage):

- 25 years for **major event**
- 15 years for **moderate event**



Damage to East Coast Road, Anarau Bay.



East Coast Road along Anarau Bay, Whakatiwai.

Write any comments here

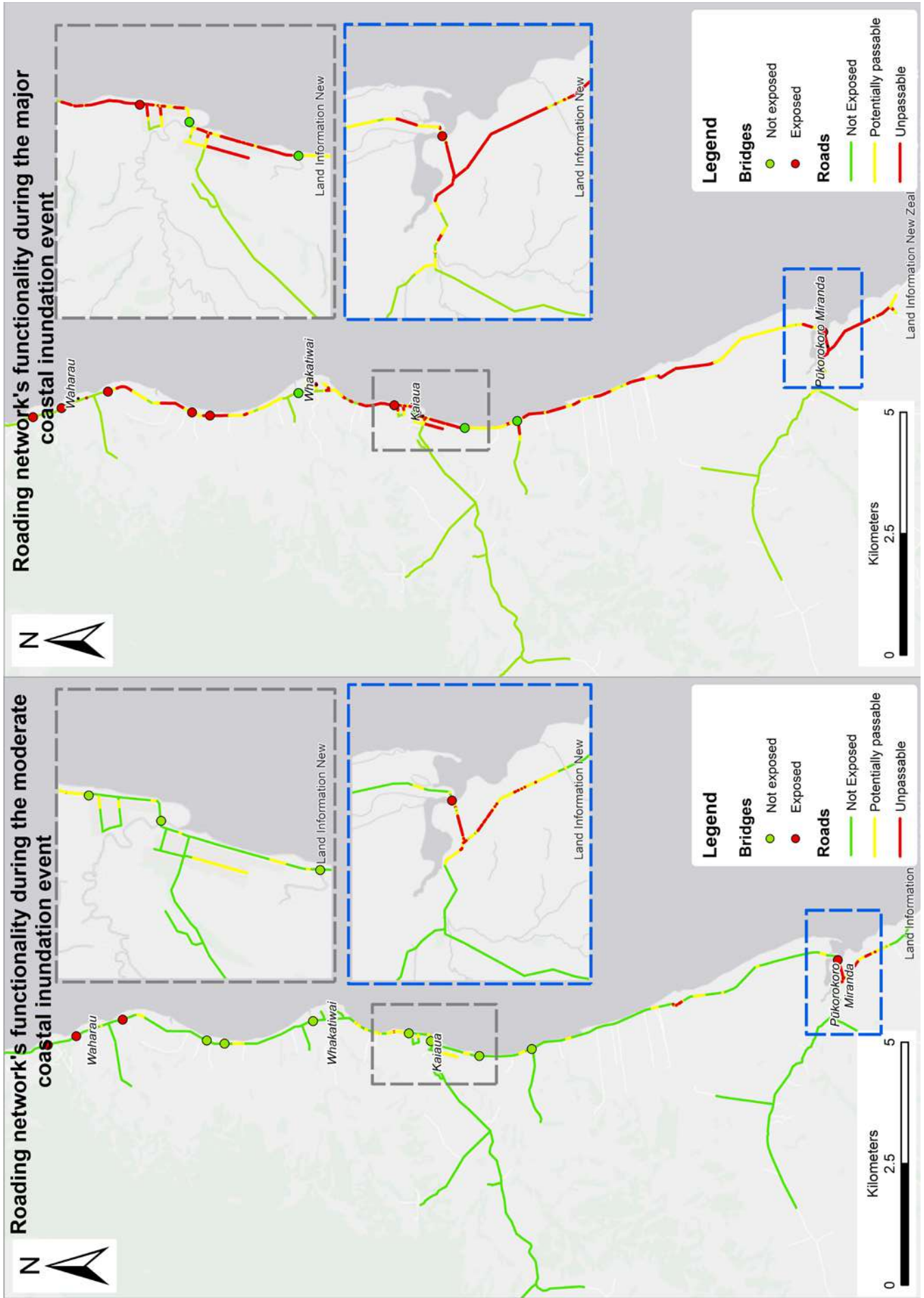


Figure 7: Exposure of roads and bridges to coastal inundation (note: potentially passable is <math><0.5\text{ m}</math> flood depth; unpassable is >0.5 m flood depth).

Sub-compartment 3A (Whakatiwai) impact information

What's here

- 3km of road
- 1 bridge

Numbers and percentages presented may appear inconsistent because numbers have been rounded to reflect uncertainty and percentages are calculated using raw data.

Information regarding the key limitations and assumptions for road damage cost can be found in the appendix.

During a **major event**, it's estimated that:

- 1km of road is exposed to coastal inundation (40 per cent)
- no bridges will be exposed to coastal inundation
- 400m of road will not be passable due to floodwaters (13 per cent)
- the cost of road damage will be \$18,000.

During a **moderate event**, it's estimated that:

- 100m of road is exposed to coastal inundation (5 per cent)
- no bridges will be exposed to coastal inundation
- 20m of road will not be passable due to floodwaters (1 per cent)
- the cost of road damage will be less than \$1000 (not including bridge).

This sub-compartment may be completely cut off by road, meaning emergency and other essential services cannot get through.

Mark your community risk thresholds here

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

Write any comments here

Impacts to services

Project area impact information

Impacts may include:

- damage to, or loss of, services (may include building and contents), e.g. initiatives such as EcoQuest Education Foundation, resulting in:
 - repair/replacement/cleanup costs to service owners/providers
 - loss of income while cleanup/repair underway
 - potential job losses
 - increase in insurance premiums, exclusions added, or cover withdrawn
 - without insurance cover, some business owners may not be able to raise capital to purchase business assets
- loss of revenue and reduced ability for businesses to operate if roads are closed for an extended period.

Write any comments here



EcoQuest on 5 January 2018.

Sub-compartment 3A (Whakatiwai) impact information

What's here

- Ecoquest Education Foundation
- Te Kohanga Reo O Whare Kawa

During a **major event**, it's estimated that:

- Ecoquest Education Foundation centre is exposed to <0.5m of coastal inundation
 - in the January 2018 event, the equivalent to a major event, nine out of 13 cabins, two teaching areas, the ablutions block, sheds and storage spaces were all inundated by an estimated 0.6m of seawater; three vehicles, pumps and equipment were destroyed; food gardens and ornamental trees died
- Te Kohanga Reo O Whare Kawa is not exposed.

During a **moderate event**, it's estimated that

- no services are exposed to coastal inundation, thus no threshold is needed.

Mark your community risk threshold here

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											

Write any comments here

Impacts to recreation and tourism

Project area impact information

Impacts may include:

- damage to, or loss of, recreational and tourism assets and infrastructure (including building contents) resulting in:
 - reduced recreational and social opportunities in the area, at least in the short term
 - repair/replacement/cleanup costs to private owners and Hauraki District Council
 - loss of income while cleanup/repair underway
 - potential job losses
 - increase in insurance premiums, exclusions added, or cover withdrawn
 - without insurance cover, some business owners may not be able to raise capital to purchase business assets
- loss of tourism revenue and reduced ability for businesses to operate if roads are closed for an extended period
- reduction in aesthetic of beach environment, and the area as a whole.

In the long term, coastal inundation and erosion due to projected sea level rises may cause loss of habitat and a decline in shorebird numbers – this would make the branding of “the shorebird coast” redundant and result in a decline in visitor numbers.

Assessed risk thresholds by asset managers (for resources needed to repair council-managed recreation and community facilities):

- 5 years for a **major event**
- 2 years for a **moderate event**



Beachfront at Whakatiwai at F Lowrie road on 5 January 2018.



Whakatiwai beachfront.

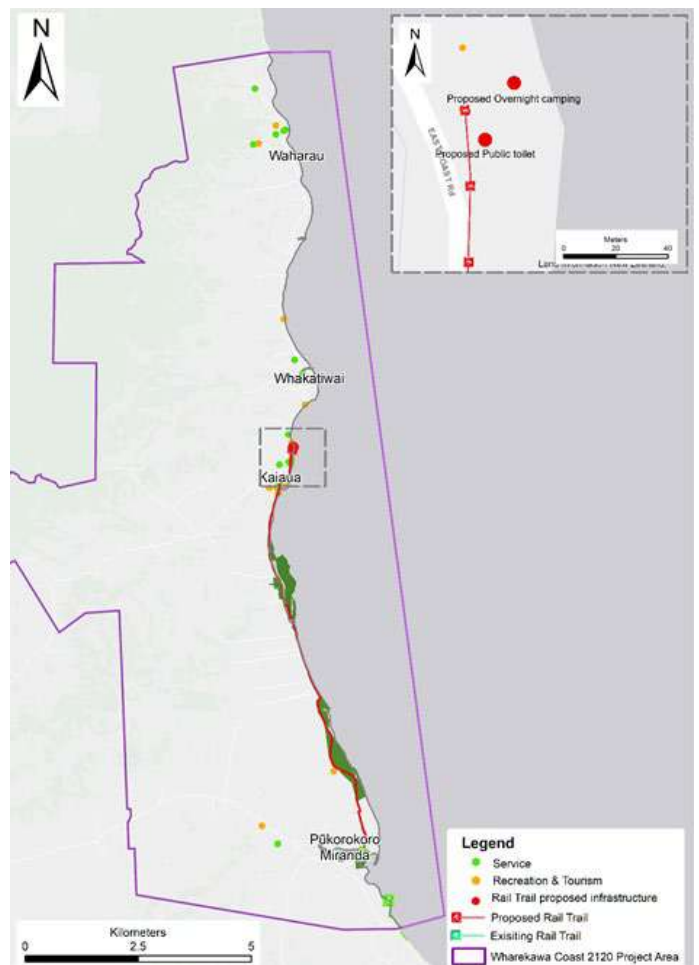


Figure 8: Services, recreation and tourism data for the Wharekawa Coast 2120 project area.

Sub-compartment 3A (Whakatiwai) impact information

What's here

- picnic site
- Whakatiwai Beach

During a **major event**, it's estimated that

- the picnic site is exposed to 1m-2m of coastal inundation
- Whakatiwai beach is exposed to inundation
 - following the January 2018 event, the equivalent of a **major event**, the beach was accessible but littered with inundated caravans which stayed "in a jumble for months". Eventually some were taken away and others dried out.

During a **moderate event**, it's estimated that:

- the picnic site is not exposed
- Whakatiwai beach is exposed to inundation

Mark your community risk thresholds here

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

Write any comments here

Overall impacts

Overall impacts from coastal inundation include all the impacts provided in each of the previous impact categories. When considered together, these impacts may interact in ways that are cumulative, increasing the overall risk. Because of this, it is important to assess thresholds for overall impacts, i.e. all the impacts combined.

Here are some examples of ways that impacts may interact to be cumulative:

- If East Coast Road is closed, it may be more intolerable for local services, recreation areas/assets and conservation areas to be closed because residents are unable to access those outside of their community.
- If the homes of families with school-aged children are damaged or uninhabitable, it may be more intolerable if the school is also closed, meaning that children must be cared for at home (or elsewhere) during the day.
- If owners of businesses that benefit from tourists incur large cleanup/repair costs, it may be more intolerable if tourist numbers are also reduced longer term due to factors such as restricted road access and damaged tourism and recreation infrastructure.
- If insurance premiums for homes or businesses have increased due to natural hazard risk, it may be more intolerable if rates also increase (because of more frequently damaged council assets).



Beachfront looking north.



East Coast Road.

Method

1. Review the impact information and your thresholds for each impact category.
2. Transfer your coastal inundation impact category thresholds here.

Homes and properties, and disruption to residents

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											

Rural land

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

Roads and bridges (road access)

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

Services

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											

Recreation and tourism

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

- For both major and moderate events, identify which of your thresholds would be reached first, i.e. the threshold which is farthest left on the table, or with the less frequent ARP, i.e. 200 years has the least frequent ARP.
 - Your threshold for overall impacts must be **at least** this far to the left.
- Decide whether the combination of all impacts across all categories make the risk less tolerable, i.e. is the overall impact less tolerable than the threshold you have identified as being first reached (farthest left).
 - If yes, move the overall impact threshold to the left (to a less frequent ARP) as appropriate.
 - If no, the overall impact threshold is the one you have already identified as being reached first (farthest left)

e.g. Your least frequent ARP may be 50 years for 'homes and buildings and disruption to residents', however, you decide that the combination of all the impacts are less tolerable so move your threshold left to 75 years.

Mark your overall community risk thresholds here

ARP	200yr	100yr	75yr	50yr	20yr	10yr	5yr	2yr	1yr	6mth	2.4mth
Major event											
Moderate event											

Write any comments here

Appendix



Glossary

Adaptation actions and pathways

A response strategy to anticipate and cope with natural hazard impacts that cannot be (or are not) avoided under different scenarios of climate change. Can also be referred to as (natural hazard) mitigation measures.

Average return period (ARP)

How often a given size event is expected to happen on average, e.g. once every 100 years.

Coastal inundation

Flooding from the sea.

Community risk threshold

The point at which the community can no longer tolerate the impacts of a natural hazard event. Adaptation actions or pathways should be implemented prior to a community risk threshold being reached.

Damage cost

The estimated cost of damage to buildings, roads or rural pasture land due to damage from coastal inundation or Hauarahi Stream flooding.

Exposure

People, property, or other elements present in hazard zones that are therefore subject to potential loss.

Impact categories

Data on what is present in the project area (e.g. buildings, roads, shops, known here as elements) has been divided into categories to group similar elements together.

Natural hazard

A natural process or phenomenon that may cause loss of life, injury, other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Quantitative risk assessment

The quantitative risk assessment uses numerical data and other information to numerically describe how things may be impacted from coastal inundation and Hauarahi Stream flooding events.

Resident displacement

The average time that residents are unable to live in their home while repairs are made to the building due to damage from a natural hazard event.

Risk

The effect of uncertainty on objectives. Risk is often expressed in terms of a combination of consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.

Sub-compartments

The project area has been divided into five compartments, each with one coastal and one inland sub-compartment. This is so that natural hazard risk, thresholds and adaptation actions can be assessed for each sub-compartment and so provide more useful outcomes.

Tolerable

A range of risk that a community is able to endure to allow them to continue to receive the benefits of an area or situation. It is not something to ignore, but should be kept under review and mitigated if possible. When the risk is no longer tolerable (intolerable), it cannot be justified and risk reduction is essential.

Vulnerability

The predisposition to be adversely affected, or the lack of capacity to cope and adapt. Many characteristics can affect the vulnerability of a community, including social and economic characteristics, as well as characteristics caused by the location of communities, e.g. road access.

Key limitations and assumptions for damage cost and resident displacement estimates

Damage cost estimates are unlikely to represent actual repair/replacement/re-establishment costs following an event, however, they provide a means to estimate and compare these costs across the sub-compartments and for different hazard and event scenarios. Costs have only been estimated where fragility (physical vulnerability) and cost information is readily available.

1) Homes and buildings, and distribution to residents

- Buildings refer to the main dwelling or business, service or community building on a property. They do not include sheds, sleeps outs, etc.
- An average floor level of 0.6m has been assumed because individual building floor level information is unavailable. An average building type of “timber, single storey, 1960-80s” has been assumed as individual building type information is not available.
 - These assumptions were made based on a desktop study using Google Street View and information from Hauraki District Council staff.
- An average household size of 2.3 people has been assumed based on 2013 Census statistics.
- Building damage cost has been estimated using individual property improvement values, which are derived by subtracting the land value from the capital value. Property improvement value is not the replacement cost of buildings and services on a property (and is likely to be lower), but it is the best readily available information on the value of buildings in the project area.

2) Rural land

- Coastal inundation
 - The rural pasture land data set (used to estimate pasture re-establishment costs) was created by removing areas of known native and exotic vegetation from areas of rural land use type.
 - The only cost estimates are for pasture re-establishment, because other potential costs, such as those resulting from damage to equipment, loss of production or additional feed requirements, were unable to be estimated due to the high level of uncertainty.
 - A pasture establishment cost of \$700/ha was assumed, based on estimates provided by the Ravensdown Principal Consultants involved in recovery following the January 2018 storm tide event.

3) Road access

- Roading damage cost has been estimated using the average depreciated replacement cost of \$313,000 per kilometre, which is the cost to replace the roads at their current value rather than as new. This value has been calculated for the roads in the project area by the Hauraki District Council roading manager, based on information from that council’s valuation of roading assets as at 01 July 2019.
- Bridge damage costs have not been estimated due to insufficient information.
- The damage cost estimates are based on flood depth, though in reality most damage occurs as a result of high flow velocities or wave activity and depends on the shoulder/embankment material and geometry. However, much of this information is either unavailable or outside the scope of this assessment.

Write any comments here

He taiao mauriora

Healthy environment

He ōhanga pakari

Strong economy

He hapori hihiri

Vibrant communities

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