Accompanying Notes for Jacobs: Northern Adaptation Area Risk Assessment PowerPoint Presentation

Note: *Multiple slides within the PowerPoint presentation have notes accompanying the slides. For reading ease, these notes have been additionally transferred into this document for your assistance.*

Slide 1: Cover slide

No notes

Slide 2: Agenda

No notes

Slide 3: Terminology

In this risk assessment we use the term 'Domain' as an umbrella term to describe an overall theme of what potentially may be at risk from climate change.

The five domains assessed in this risk assessment are:

- Built environment (completed by Jacobs)
- Ecological (completed by KCDC)
- Natural Character (completed by Boffa Miskell)
- Human (completed by KCDC)
- Cultural (to be completed by Aroha Spinks)

The Cultural domain has not yet been completed, and will be led by Aroha Spinks over the next month and will be presented to the CAP next workshop with the draft risk assessment report.

The term 'element' is used to represent the individual aspects of the domain that have been assessed. A number of elements have been assessed under each domain based on available information.

Slide 4: Purpose

No notes

Slide 5: Process – Calculating Risk

This equation comes from Ministry for the Environment (2021) *He kupu ārahi mō te aromatawai tūraru huringa āhuarangi ā-rohe / A guide to local climate change risk assessments.* Wellington: Ministry for the Environment

Exposure refers to the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by a climate hazard. E.g. Do they intersect with the hazards layer.

Vulnerability refers to the propensity or predisposition to be adversely affected by a climate hazard. Vulnerability encompasses a variety of concepts, including **sensitivity** to harm, and **lack of capacity to naturally adapt (or adaptive capacity)** (e.g without intervention).

Sensitivity refers to the degree to which an element at risk is affected, either adversely or beneficially, by climate variability or change (IPCC, 2014a). Sensitivity relates to how the element will fare when exposed to a hazard, which is a function of its properties or characteristics.

Adaptive capacity refers to the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2014a). It relates to how easily/efficiently an element at-risk can adapt naturally.
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Slide 6: Process - Calculating Risk

This is the process that has been used by our subject matter specialists to calculate the risk to elements within their domain. Each subject matter specialist has completed a risk 'template' for each element which captures this material. These will all be appended to the risk assessment report for the NAA (which will be prepared for the CAP) along with the CAP's final recommendation report.

- Domains and Elements – Domains included are those for which information currently available. Elements within each domain have been selected based on a broad screening of what data is available, and what information is relevant to the NAA.
- Exposure is based on the intersection of the element with the hazard. For this risk assessment this is based on the exposure to coastal erosion and coastal inundation from mapping undertaken for Takutai Kapiti (See Slide 8 for scenarios and timeframes). For the AWA fluvial/plural flood mapping incorporating raising groundwater effects – Ōtaki model is currently undergoing its peer review process and has not been incorporated yet.
- Consequences have been described by the subject matter specialists. This is a description of what the consequences of the element being exposed would include.
- Sensitivity is subjectively measured based on how sensitive or tolerant an element is to being exposed. For example, some elements may not be sensitive to being flooded, whilst others are extremely sensitive. All elements are sensitive to erosion when exposed to that hazard.
- Adaptive capacity is subjectively measured based on how autonomously an element could adapt to the hazard. For example, if there is a landward area for dunes to migrate to with coastal erosion, then they would be considered to have a high adaptive capacity; however if there is infrastructure behind the dunes restricting their ability to migrate, then their adaptive capacity may be low.
- Opportunities have been described in the template – these are potential opportunities for positive outcomes as a result of the hazard occurring, or potential opportunities outside of the adaptation planning scope to deal with the hazards. For example, wastewater network pipes that are at extreme risk will likely need replacing prior to being exposed, and the replacement could consider avoiding the hazards (i.e. re-routing pipes). These opportunities are noted, but not included in the overall risk score.

Slide 7: Process – Risk Ranking

Risk rankings calculated for each element are based on this Matrix from MfE (2021).
Generally, low risk is something that is not very exposed, no matter how vulnerable it might be. Something that is low risk indicates that the risk is tolerable, and there is none to minor changes to the current conditions.
Something that is an extreme risk is something that has high exposure, and is also very vulnerable or sensitive to being exposed. Something that is at extreme risk would be expected to be intolerable,

and cause widespread loss, damage or disruption. Generally, a high-extreme ranking equates to >50% of the area assessed being exposed to the hazard.

Slide 8: Process – Likelihoods and Scenarios

This risk assessment looks at two SLR scenarios (SSP2-4.5 & SSP5-8.5) for the present day, 2050, 2070 and 2130. These are the scenarios recommended to be assessed by the National Adaptation Plan.

The black dots show the timeframes and SLR scenarios represented in the risk assessment.

Present Day is the same for both scenarios, and so is 2050 due to the difference in SLR estimate being <0.05m.

These scenarios have been remapped since the Volume 1 report to use the updated NZSeaRise data which includes local estimates of VLM.

For coastal erosion, we look at the area over which erosion is unlikely to be exceeded (10% likelihood of exceedance) in each timeframe.

For coastal inundation, we are looking at temporary inundation in an extreme event (1% AEP e.g. 1 in 100 year).

Slide 9: What does it look like?

Some examples of the outputs of the risk assessment:

- Comprehensive Matrices scoring/rankings (PDF provided with slides)
- Risk assessment templates completed for each element – these will be tabled at the next CAP workshop once the cultural value risk assessment has been completed.
- GIS information used to determine exposure and help define sensitivity and adaptive capacity.
- Draft risk assessment report to be completed when cultural risk is completed.

Slide 10: Built Environment Domain

NOTE: This presentation focuses on the high and extreme risks.

The built environment domain assessed seven different elements.

For private property, risk is determined in two ways: 1) all private properties within the total Northern Adaptation Area, and 2) split into the settlements of Ōtaki Beach, Te Horo Beach, and Peka Peka. For each of these settlements, coastal erosion risk has been calculated for beach front properties only within the settlement footprint. For coastal inundation, risk has been calculated for the total settlement footprint.

It is also key to note that most three waters infrastructure is located in the Ōtaki Beach settlement. We have not assessed information on the private septic tanks and water supply bores in Peka Peka and Te Horo. However, it is assumed that when a property is impacted by erosion then access to these septic tanks and water supply bores would also be impacted.

Slide 11: Built Environment Domain – Risk

This is the summary matrices of risk for the built environment domain. A break down of the sensitivity, adaptive capacity and exposure is provided in the pdf matrices.

Coastal erosion risks

Present Day

All elements are considered to be low risk.

SSP2-4.5 & SSP5-8.5 (2050)
All elements are considered to be low-moderate risk.

SSP2-4.5 (2070 & 2130)
*A*ll elements are considered to still be low to moderate risk.

SSP5-8.5 (2070 & 2130)
Over the 50-year period, all elements are still low to moderate risk.

In 2130, risk to properties relative to the total northern adaptation area is low (99 properties are affected; 5% of the total properties in the adaptation area).
However, from the settlement assessments, beachfront properties in Ōtaki Beach and Te Horo are at high risk over a 100-year timeframe due to high percentage of exposure (29 beachfront properties at Ōtaki Beach, and 18 properties at Te Horo) and extreme sensitivity due to erosion intersecting with dwellings on most exposed properties. Peka Peka is only a moderate risk over this timeframe, as there are is high exposure (52% of properties exposed), but the sensitivity to erosion is lower due to the setback of the majority of the houses there on large properties.
There is high risk to all infrastructure by 2130 – generally due to how sensitive the infrastructure is when it is exposed. For example, we have considered that the wastewater network is extremely sensitive, because if it were to be damaged by erosion, it would have significant impacts on the broader network and cascading effects onto the human domain.
The main area of infrastructure that is exposed to erosion is the stretch of Marine Parade in Ōtaki Beach, that separates the main settlement from the properties near the Ōtaki River mouth (e.g. near Rangiuru Road). This stretch of road connects the wastewater, water supply and transmission network back to the Ōtaki township. However, they are only considered 'high' risk rather than "extreme", because relative to the wider adaptation area, the amount of infrastructure exposed is small (e.g. 500 m of pipe out of 20 km).

Coastal inundation risks
Present Day
All built environment elements are considered to be at low risk from inundation.

SSP2-4.5 & SSP5-8.5 (2050)
All built environment elements are considered to be at low risk from inundation.

SSP2-4.5 (2070 & 2130)
In 2070, all elements are low to moderate risk.

However, by 2130, properties are at high risk in Ōtaki to coastal flooding. Over the whole NAA, 48% of private properties are exposed (982 properties), but at varying degrees of depths of flooding (e.g. some properties will be more sensitive than others). 546 of these properties are within the Ōtaki Beach area.
This would result in many buildings being damaged, including damage to houses and their contents through waterlogging, sediment deposition, contamination from pollutants, debris impacts and erosion. Flood affected buildings need to be repaired or rebuilt, depending on the severity of the

damage, and contents replaced. The severity of the damage (and cost of repair or replacement) depends on the method of construction of the building and the materials used, its age and its contents and the depth and speed of the floodwater.
Roads and bridges are also at high risk to flooding in 2130. This is 8.3 km of road (13%) in Ōtaki Beach, Te Horo Beach and Peka Peka; Rangiuru Road bridge; all inland access routes from Ōtaki Beach and Te Horo Beach (access to Peka Peka available). This is a result of them being highly exposed and highly sensitive over this timeframe. Flooding could prevent them from being used to safely access properties in the community and can result in people becoming temporarily isolated during a flood event. Flooding of the four main roads which provide inland routes from the communities can prevent evacuation of people and property during a flood.
Flooding can also damage the road surface or structural integrity of bridges, resulting in the need for repairs and potentially affecting or preventing access to the communities over a longer period. The severity of the damage depends on factors such as depth, speed and duration of flooding and the construction method and materials of the road or bridge.

SSP5-8.5 (2070 & 2130)
Risks are still considered to be low to moderate over the next 50 years.

By 2130, the risk to private property is extreme in the NAA – especially at the Ōtaki beach settlement. 1187 private properties in the NAA will exposed to coastal flooding (58%); and 653 of these will be in the Ōtaki Beach settlement.
The consequences of this will be the same as those noted above, however more properties will be impacted under this high SLR scenario – indicating that there will be a greater number of people impacted.
There is also high risk to three waters infrastructure, indicating that wastewater infrastructure and stormwater infrastructure will be ineffective in extreme events over this timeframe. Stormwater outfalls and pipe mains are generally resilient to flooding although they do provide pathways for coastal flooding to inland areas. The electrical power supply and control systems for stormwater pumpstations can be damaged by surface flooding if this is sufficiently deep, causing the pump station to fail to operate during a storm event and so increasing flood hazard and requiring repair or replacement. Similarly, wastewater pipe mains are generally resilient to flooding, although they are susceptible to ingress of floodwater and consequent polluted flood water.
There is also extreme risk to roads and bridges over this timeframe – indicating that during these events, it will be difficult to evacuate people from the settlement, and works will be required following such events to repair the roads and bridges.

Key summary:

- Generally, the built environment in the Northern Adaptation Area is at low-moderate risk over the next 50 years to both erosion and inundation.
- For coastal erosion, there is a high risk to beach front property, and all infrastructure elements in 2130 under the higher SSP5-8.5 scenario by 2130.
- For inundation, in the lower SSP2-4.5 scenario there is a high risk to Ōtaki Beach properties, and NAA roads/bridges by 2130, which will have cascading impacts on the human domain – including the ability to evacuate people in significant events.

- Under the higher SSP5-8.5, there is extreme risk for Ōtaki beach properties, roads and bridges, and also high risk to three waters infrastructure.

Slide 12: Ecological Domain

The ecological domain has assessed five different elements. These elements represent the current available information.

Slide 13: Ecological Domain - Risk

This is the summary matrices of risk for the ecological domain. A break down of the sensitivity, adaptive capacity and exposure is provided in the pdf matrices.

Coastal erosion

Present day

All elements are considered to be low risk

SSP2-4.5 & SSP5-8.5 (2050)

All elements are considered to be low risk

SSP2-4.5 (2070 & 2130)

All elements are considered to be low risk

SSP5-8.5 (2130)

The risk to dunes and ecological sites over the next 50 years increases to moderate, and then high by 2130.

For dunes, this is due to near to full loss of the dunes over this time period, and therefore loss of dune form and plant species. In Ōtaki Beach, erosion would extend into the settlement past the extent of dunes and a complete loss of dunes bordering hydrosystems. In Te Horo, 90-100% of the dune system will be lost. In Peka Peka, approximately 50% of the dunes are at risk. Any species that are at risk within the identified dune space is extremely likely to be permanently removed and therefore highly sensitive. However, dunes do have a moderate ranking for adaptive capacity, where dune land plants may extend inland further to accommodate for a loss of land. This is dependent on the space behind the dune to migrate around settlements due to human development (e.g. coastal squeeze).

For ecological sites, which are "areas of *significant indigenous vegetation, and significant habitats of indigenous fauna",* these are considered to be at high risk by 2130. Many of the sites in the northern adaptation area are associated with waterways and rivers, such as lake Wairongomai, Waitohu stream, Ōtaki River, and Te Hapua Road Wetland, and hence are highly exposed over this timeframe. The Waitohu Stream mouth, Ōtaki River mouth and Te Horo dune complexes will be most at risk in this scenario.

The dynamic river mouths will experience erosion of their banks leading out to the beach face affecting not only any rooting plants but the stability of the river mouths. Waitohu river mouth is a significant habitat for intertidal sandflats, marram-spinifex grassland, restiad rushland, sea rush-saltmarsh ribbonwood (regionally sparse) rush-shrubland, three square sedgeland, bachelors' button

herbfield, sand flats, fish spawning ground and beach. A loss of this habitat would remove a valued piece of biodiversity on the Ōtaki coastline.
The Ōtaki River mouth provides an important resource for kai moana and materials such as flax. Loss of and erosion of plant species here will have a negative biodiversity effects through loss of flora and loss of suitable habitat and protection for fauna.
Some of these sites have the ability to adapt, as they already exist in dynamic river systems. These sites are continually adapting to tidal cycles and high flow scenarios and may have the ability to continue to adapt in the short to medium term. Sites that are exposed to erosion that do not exist in typical dynamic riverine systems will be permanently lost once eroded.

Coastal inundation risks

Present day

All elements are considered to be low-moderate risk

SSP2-4.5 & SSP5-8.5 (2050)

All elements are considered to be low-moderate risk.

SSP2-4.5 (2070 & 2130)

All elements are considered to be low-moderate risk except for significant bird habitat sites – which are considered to be at high risk from 2070 onwards.
Ōtaki River mouth is a habitat for banded dotterel and Caspian tern. Waitohu stream mouth is host to 25 indigenous species of birds. Sea level rise induced hazards will threaten the stability and productivity of important breeding, feeding and resting habitats. Inundation due to sea level rise will reduce foraging area available to bird species in those areas where tidal zone movement (i.e. braided or meandering rivers) is limited or stopped by surrounding topography and human infrastructure (such as sea walls, stormwater infrastructure, roading and bridges). Nests of shorebirds and seabird species can be regularly washed out with storm surges (Holle, et al., 2019). Birds may not continue to return to sites due to continued flooding creating unsuitable nesting habitats. Overall reducing biodiversity and increasing opportunity for exotic fauna to settle in its place.
By 2070 and 2130, there is projected to be >90% flooding across the identified habitat areas. It is considered that there is a low adaptive capacity for these sites, as human activities such as harvesting, habitat clearance and fragmentation have already substantially reduced the ability of indigenous species to adapt. The adaptive capacity is also limited by the presence of surrounding dunes and human development which surrounds these sites, however it is noted that the adaptive capacity of coastal ecosystems will rely somewhat on effective management, rather than on their own characteristics.

SSP5-8.5 (2070 & 2130)

Under the high SLR scenario, over 50 years to 2070 the risk increases to high for ecological sites and significant bird habitat sites (see summary in SSP2-4.5 above).
For ecological sites, 8 ecological sites will experience inundation in some form. Most sites will experience minimal inundation (approx. 5%), however Ōtaki River and Waitohu stream mouth will experience the highest levels of inundation (approx. 80%), with Ōtaki conservation area continuing to experience similar levels.

Existing sites provide important nursery habitats for juvenile fish which under increased flooding from inundation will reduce the habitat quality, increase sedimentation and salinity, and change the nutrients present in these sites, overall reducing the quality of breeding habitats and creating shifts in species distributions.
Over the 100-year timeframe, the risks to dunes and wetlands increase to high; and the risks to ecological sites and significant bird nesting sites is high.
For dunes, inundation from sea water into dune systems can dramatically affect the condition of the vegetation communities and or breeding succession of fauna within the dunes, and increased sedimentation from coastal flooding can reduce habitat suitability and smother existing indigenous species and increase the risk of invasion by more saline-tolerant, exotic species. Over 100 years in a storm event, approximately 80% of the Ōtaki dunes would be exposed to flooding; and 50-60% of the dunes system in Te Horo would be exposed. The dunes however do have a moderate adaptive capacity, as ecosystems and species that are more tolerant of periodic exposure to saline waters are likely to have a greater adaptive capacity.
Wetlands increase from moderate to high risk from inundation hazards over a 100-year timeframe. In total there are 12 wetlands in the Northern Adaptation area - two outstanding wetlands, two likely to be a natural wetland, and eight are identified natural wetlands. Inundation events of lowland rivers and wetlands will increase the zone of influence of tides, increasing the inland extent of salinity intrusion. Increased sediment deposition through increased storm and flood frequencies are likely to decrease light penetration, increase turbidity and reduce primary productivity. Changes in sediment size can reduce habitat suitability causing species mortality through, for example, fine silts deposited over coarser sandy sediments. There are cascading effects onto the agricultural sector who rely on freshwater systems. In addition, this risk to wetlands can pose a threat to Māori social, economic, cultural capital and cultural heritage values and spiritual wellbeing (Ministry for the Environment, 2020a). Wetlands have a moderate adaptive capacity, however will experience coastal squeeze in a similar way that dune systems will due to increasing human densities along the coast limited adequate space for adaptation.

Key Takeaways:

- Risks to the ecological domain from erosion are low under the lower SSP2-4.5 scenario for the next 100 years.
- High risks occur in 2130 under the higher SLR scenario to dunes and ecological sites due to high exposures and sensitivity.
- Risks to coastal inundation are low-moderate over the next 100 years for domains under the SSP2-4.5 scenario, except for significant bird nesting sites, which are very exposed, very sensitive, and have moderate adaptive capacity.
- Under the higher SSP5-8.5 scenario, the risk to ecological sites is high by 2070, and extreme by 2130. All other domains (excl. indigenous trees) are high.

Slide 14: Natural Character Domain

The natural character domain has assessed five separate elements.
The coastal terrestrial area (CTA) is representative of the broader coastal environment, and within the adaptation area there are two CTA – “Ōtaki”, and “Waikanae and Paraparaumu” – the northern end of which covers Peka Peka.

Within these two CTA's are areas of high natural characters, being the dune environments. Ōtaki and Te Horo dunes are within the broader Ōtaki CTA; and the Peka Peka dunes are within the Waikanae and Paraparaumu CTA.

Slide 15: Natural Character Domain - Risk

This is the summary matrices of risk for the natural character domain. A break down of the sensitivity, adaptive capacity and exposure is provided in the pdf matrices.

Coastal erosion

Present Day

All elements are considered to be low-moderate risk

SSP2-4.5 & SSP5-8.5 (2050)

All elements are considered to be low-moderate risk

SSP2-4.5 (2070 & 2130)

All elements are considered to be low-moderate risk

SSP5-8.5 (2070 & 2130)

In 2070 all elements are considered to be at low-moderate risk. However in 2130, the risk to the Peka Peka dunes, and the Waikanae and Paraparaumu CTA becomes high risk. The increase to high risk in the Waikanae and Paraparaumu CTA is closely linked to the impacts on the high natural character of the Peka Peka Dunes.

The Peka Peka dunes are largely intact coastal dunes containing Taupo Pumice lapilli. They have native vegetation cover that has reduced but is still present. The area provides opportunities for swimming, walking, blow-carting, boating, and surfing in a relatively open and undeveloped context, and gives expansive views of Kāpiti Island and the Rauoterangi Channel.

Over this timeframe, erosion impact areas of duneland (up to 74 m) and impacts most of the extent of dunes identified with high natural character.

Erosion extends further inland at the mouth of Kowhai Stream and in close proximity of adjoining costal settlement.

Coastal erosion will primarily impact areas of beach berm and foredunes and the margins adjoining the mouth of Te Kowhai Stream. Formed by a mixture of Waitarere-Motuiti dunes. These contain a large amount of Taupo Pumice lapilli and support remaining populations of native duneland vegetation including spinifex and pingao amongst broader colonizing exotic grasses and scrub.

Broader areas of natural duneland and gentle sandy beaches form existing natural buffers between coastal hazards and settlement. Erosion of these dunes would result in loss of these environments if they are not able to migrate landward in response to SLR (e.g. coastal squeeze). Built coastal protection and associated human induced changes in response to coastal erosion has potential to adversely impact natural elements, patterns and processes and therefore reduce natural character.

Coastal inundation risks

Present Day

All elements are considered to be low-moderate risk

SSP2-4.5 & SSP5-8.5 (2050)
All elements are considered to be low-moderate risk

SSP2-4.5 (2070 & 2130)
All elements are considered to be low-moderate risk

SSP5-8.5 (2070 & 2130)
In 2070 all elements are considered to be at low-moderate risk. However in 2130, the risk to the Waikanae and Paraparaumu CTA near Peka Peka becomes high risk. Substantial flooding occurs within low lying dune swales, often inundating existing coastal settlement. Substantial coastal flooding extends inland of the coastal environment into back dunes and field drains formed along Te Kowhai Stream and encompassing oxidation ponds at Pharazyn Reserve. The coastal terrestrial area supports a range of natural elements including uncommon ecosystem types (e.g. coastal turfs, shingle beaches), native coastal plants (e.g. knobby clubrush, sand sedge, patches of pingao, remuremu, bachelor's button) and native avifauna and fish species, and flooding of these area has the potential to cause damage and reduce natural character. The responses to flood hazard and potential construction of flood defences with increased presence of built form also has potential to reduce natural character.
This area is considered to have a low adaptive capacity as within the coastal environment, most coastal flooding occurs in the context of mouths of streams, foredunes characteristic of these more dynamic areas of the coastal environment. Coastal flooding extends into dune swales and back dunes and beyond the coastal environment. Such areas retain some capacity to absorb areas of flooding through ponding in the context of existing coastal development. Where this extends in the immediate context of coastal development, there is more limited capacity to adapt.

Key take aways:

- Natural elements and patterns may express natural character through facilitating the continued operation of natural processes, including exposure to times of inundation and erosion. Within the NAA this risk principally applies to parts of the Peka Peka dunes and the identified 'coastal squeeze' here through which the erosion of dunes may result in increased exposure of built elements and infrastructure.
- Natural character in the NAA is fairly well preserved over the 100-year timeframe to both erosion and inundation under both SLR scenarios.
- The natural character in Peka Peka becomes high risk by 2130 under the higher SSP5-8.5 scenario – this is due to high exposure and low adaptive capacity due to coastal squeeze (i.e. the land behind the erosion line isn't big enough to foster a dune environment due to infrastructure (e.g. coastal squeeze).

Slide 16: Human Domain
Human domain has assessed four different elements, which has drawn on the information presented in the other domains – particularly built environment.
Displacement is the risks to social cohesion and community wellbeing from displacement of individuals, families and communities, due to climate change impacts. Extreme events such as flash floods, more frequent coastal flooding and erosion or landslides, or gradual, accumulating changes (particularly rising sea levels), may render some locations uninhabitable. When people are displaced,

they can suffer trauma from leaving familiar surroundings, breaking social and cultural bonds, and the challenges of resettlement. There are two sides to the risk: the impact on those who move away, and the impact on the community left behind. To assess the risk to displacement, number of private dwellings, occupants at risk, reliance on infrastructure, and impact to health have been considered.
Inequities considers the risks of exacerbating existing inequities and creating new and additional inequities, due to differential distribution of climate change impacts. Exposure to extreme weather events such as flooding or heatwaves, or to gradual changes such as inundation of low-lying areas, will be the same for communities and individuals in affected areas. However, the ability to respond, adapt or cope with these risks is uneven, due to existing inequalities. Those marginalised by age, race, ethnicity, socioeconomic status, gender, literacy or health may be unable to access resources to respond to climate risks. An inability to convert resources to action can create and worsen inequity. New inequities may appear, especially due to slowly emerging risks such as sea-level rise. Exacerbation of existing inequalities and creation of new inequalities can have cascading implications for livelihoods and wellbeing. This assessment considered the NZ Deprivation Index decile ratings, as well as 'Ability to recover' characteristics.
Health considers the risks to physical and mental health. To assess the risks to physical and mental health of individuals and communities, the number of health and public services were considered, as well as impact to key transport routes to services. This information was overlaid with a social deprivation dataset (NZDep2018) to identify the existing areas of population already experiencing hardship.
Daily Routines considers the risk to key locations where the population lives, works and plays, recognising that these activities contribute to social connectedness and sense of place and community. This considers the exposure of locations that we access on a daily basis for education, health (GP's and pharmacies, retirement villages, etc), safety (emergency and welfare services), recreation (sportsgrounds, clubs, beach access, parks and reserves), and other sites that provide cultural or spiritual wellbeing, e.g. cultural heritage sites, cemeteries, places of worship, etc.

Slide 17: Human Domain – Risk
This is the summary matrices of risk for the human domain. A break down of the sensitivity, adaptive capacity and exposure is provided in the pdf matrices.

Coastal erosion
Present Day
All elements are considered to be low risk

SSP2-4.5 & SSP5-8.5 (2050)
All elements are considered to be low risk

SSP2-4.5 (2070 & 2130)
All elements are considered to be low-moderate risk

SSP5-8.5 (2070 & 2130)
Most elements are considered to be moderate risk

Coastal inundation risks

Present Day

All elements are considered to be low-moderate risk

SSP2-4.5 & SSP5-8.5 (2050)

All elements are considered to be low-moderate risk

SSP2-4.5 (2070 & 2130)

By 2070, Inequities and health become high risk; with health then increasing to Extreme by 2130 (and inequities remaining high risk).

For **inequities**, this assessment looked at a community's ability to recover ranking, compared to a NZ average. In all timeframes the population in Ōtaki Beach is more vulnerable than Te Horo and Peka Peka residents. The Ōtaki beach community has a NZDep2018 decile rating of 9 -10, the highest levels of deprivation. People in more deprived areas are more vulnerable to environmental risks. As such, the resilience and adaptive capacity of Ōtaki Beach community is less than that of Te Horo beach and Peka Peka beach, due socio-economic factors, as informed by the higher deprivation index rating (decile 7-10).

This indicates that many residents in Ōtaki Beach will have less capacity to cope with the effects of environmental risks, and fewer resources to protect themselves from environmental hazards. An estimated 598 households (29 % of private properties in the NAA) are likely to experience the impacts of flooding under this SLR scenario by 2070. This will negatively impact the ability of approx. 1196 residents, to respond and recover.

Consequences largely from coastal inundation can exacerbate inequities and can also impact health outcomes. For example:

- Impacts to housing, where older homes with poor heating and ventilation will be most affected by standing water, impacting adverse health impacts for residents from damp and mould. Residents of older, poorly ventilated homes may already be vulnerable due to social or economic marginalisation.
- Impacts of standing water may lead to contamination of water and land from untreated wastewater or other legacy toxins in inundated coastal areas.
- Impacts to roading from floods will delay or hamper recovery efforts if emergency response systems cannot access communities in a timely manner. This in turn could increase the occurrence of houses and public buildings affected by standing water, contributing to airborne disease or causing damp and mould, which will compromise indoor air quality.

Risks to **health** are high by 2070 and considered to be extreme by 2130. Coastal communities will be exposed to a range of potential health impacts arising from both the direct and indirect effects of sea level rise on the natural and built environment. Coastal inundation may lead to the following impacts on health:

- Contamination of water and land from untreated wastewater.
- Impacts to health from standing water getting inside poorly ventilated homes, exacerbating adverse health impacts for residents from damp and mould.
- Community access to food supplies being affected.
- Reduced water quality and water security if water supply becomes salinated.

- Impacted transportation networks, limiting the mobility of residents to seek healthcare. Additional impacts from mobility having a a flow on effects for community functionality and ability to earn an income (causing mental stress).
- Issues to transport effecting emergency response systems and could hamper recovery from floods.
- The effects of coastal flooding or storm surge could increase the potential for deaths due to drowning and other physical injuries near the sea.

By 2130, Coastal flooding impacts large areas of coastal communities, indicating a high risk to residents' health, and their ability to use road to access health and social services and hospitals. Significant flood events could result in intolerable living conditions. Estimated 982 houses (48% of private properties in the NAA) could be exposed to damp and mould due to water on their property. Roading exposed to coastal flooding – 8.3 km (equates to 13% of total NAA road length).

SSP5-8.5 (2070 & 2130)

By 2070, inequities and health are at high risk (consequences detailed above); which both increase it extreme risk by 2130. Daily routines is considered to be only moderate risk over both timeframes. Displacement increases from moderate risk to high risk by 2130.

Risk to displacement is assessed by the increased impact on road access, the number of homes damaged, and residents experiencing trauma. The few main roads that connect the local coastal communities to the main towns and expressways are the vital infrastructure routes used by residents, visitors, and emergency services. Any closure of roads would lead to significant disruption as there are limited alternative access routes at present. Public transport routes may need to be re-routed in the future to reduce disruption to transport and enable the community to access the township (and beyond) for shopping, access to health services and workplaces. More frequent disruption from coastal flooding to daily living will impact local health and wellbeing. These impacts include traffic disruption and cause possible short term or permanent displacement of residents with effected properties. As the disruptions increase, so does the likelihood that those who can move will move.

As increased impacts from inundation occur, there is an increased likelihood of economic and housing stressors contributing to increasing number of individuals experiencing mental health issues and trauma. This is likely to affect the ability of individuals/communities to respond (protect, avoid, retreat) to immediate or prolonged events. This in turn can impact social cohesion and diminish community resilience.

Key take aways:

- All elements are considered to be low-moderate risk across all timeframes and SLR scenarios for coastal erosion.
- For coastal inundation, by 2070 the risk will manifest in higher impacts to health outcomes and greater inequities. These will increase to extreme by 2130. Displacement becomes high risk under the high SLR scenario by 2130.
- Note: individuals and communities are more likely to bounce back if they can apply flexible adaptation. This is a key resilience contributor, that can be activated in communities where community awareness of risks are high and preparedness is promoted and strengthened (ie. create an increased adaptive capacity).

Slide 18: Summary of timeframe

No notes

Slide 19: *No title*

This is the full risk summary of the domains and elements assessed in this risk assessment.
Matrices with exposure, sensitivity, vulnerability and adaptive capacity rankings is included on the pdf.

Slide 20: Summary – Present Day & 2050

Over the next 30 years, risks to are generally all low-moderate.

Slide 21: Summary – 2070

Over the next 50 years, there is an increase in risk to our ecological sites and bird habitats; as well as to the human domain for inequities and health. There is no significant difference between the SLR scenario for most of these high-risk elements.

Slide 22: Summary – 2130

Over 100 years, we see a significant increase in high and extreme risks.
There are no extreme risks to coastal erosion in the NAA, however most infrastructure becomes high risk, as well as ecological sites and the dune systems.
All extreme risks are to coastal inundation over a 2130 timeframe and are generally in relation to private properties being flooded and the impacts that this will have on peoples' health, as well as the complexities of this occurring in currently more deprived areas. As well as this, roads and bridges are also at extreme risk, which will impact peoples' mobility to leave the area in large events. This will have flow on impacts to peoples' health and wellbeing.

Slide 23: Copyright notice

No notes

Slide 24: Back cover

No notes