

COASTAL CONVERSATIONS

The environment is changing, **how will you?**



[Intro from Mayor Marie Black]
[Intro from CEO Hamish Dobbie]

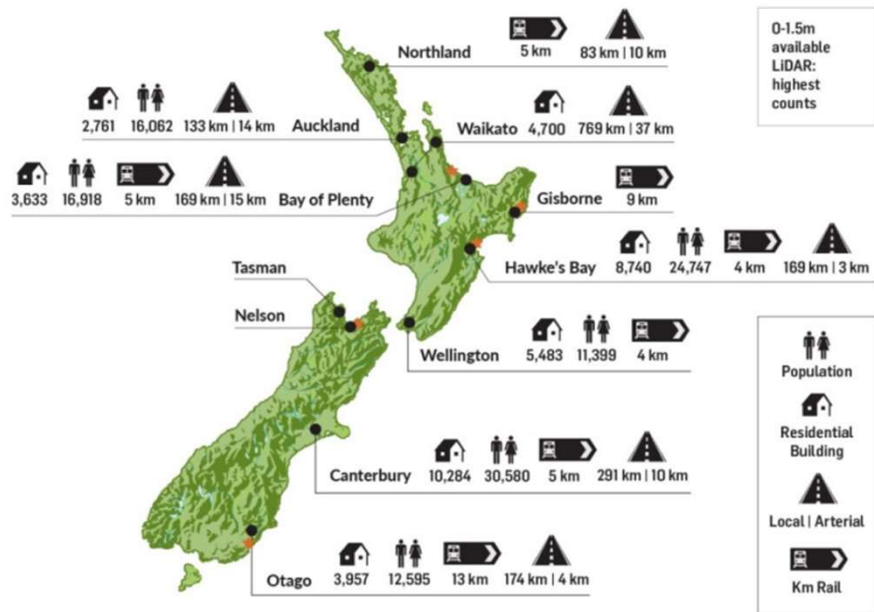
**Phase one:
What is happening?**

Sea level rise?

Coastal erosion?

Coastal inundation?

Rising groundwater?



What is happening?

We live on a long narrow island with an abundant coastline. Coastal hazards are part of our reality. The map on the slide summarises national assets that are currently at risk from a changing coastline.

HDC is just starting on a project looking at the communities and assets we have that might need to adapt as the coastline changes. To kick this off we have asked Jacobs to provide some scenarios based on the most up to date science available – these look 30, 50 and 100 years into the future. This work is what we would like to share with you tonight.

But before we hear from Jacobs I would like to spend a few minutes outlining how the presentation tonight fits into the bigger project.

Phase one is about determining what is happening to the coastline now and what we can expect to happen in the future. Tonight’s presentation is the first part of this.

Once we understand what is happening we can start to develop a plan.

Phase two: What matters most?

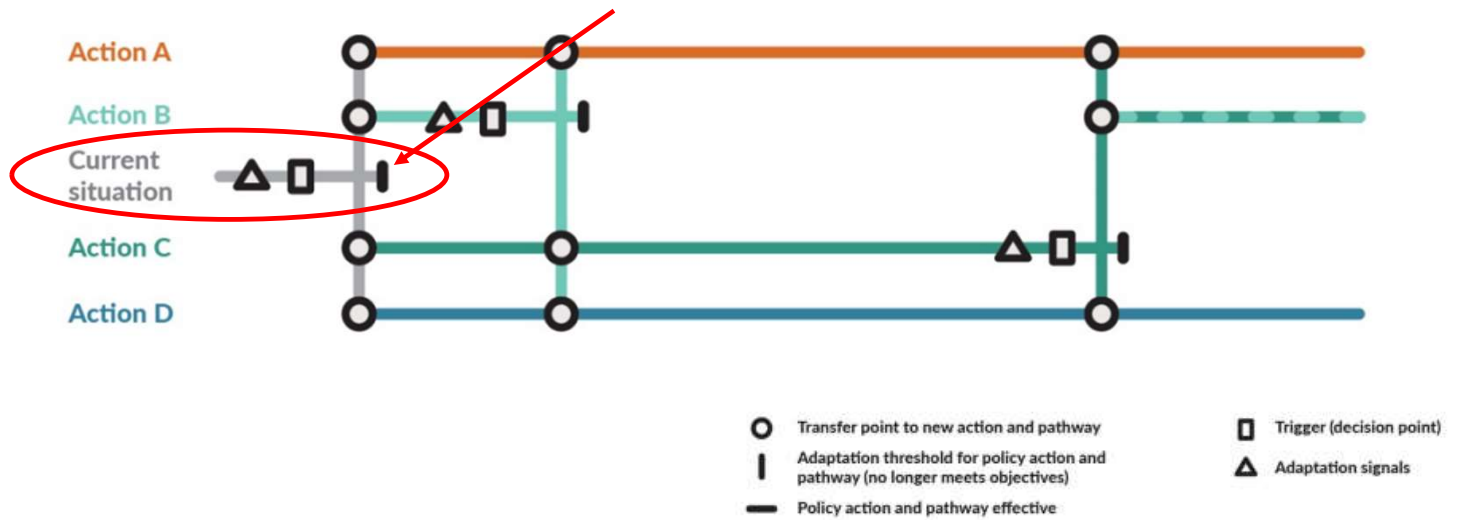


What matters most?

For a plan to be successful decisions need to be based on the right framework. This framework needs to be specific to the particular community. We know the coast is important to everyone for different reasons.

Any plan must recognise and prioritise these values. Once we understand what these values are we can use them to build a decision making framework – effectively those values become the lens in which we look through when assessing various options.

Phase three: What can we do about it?



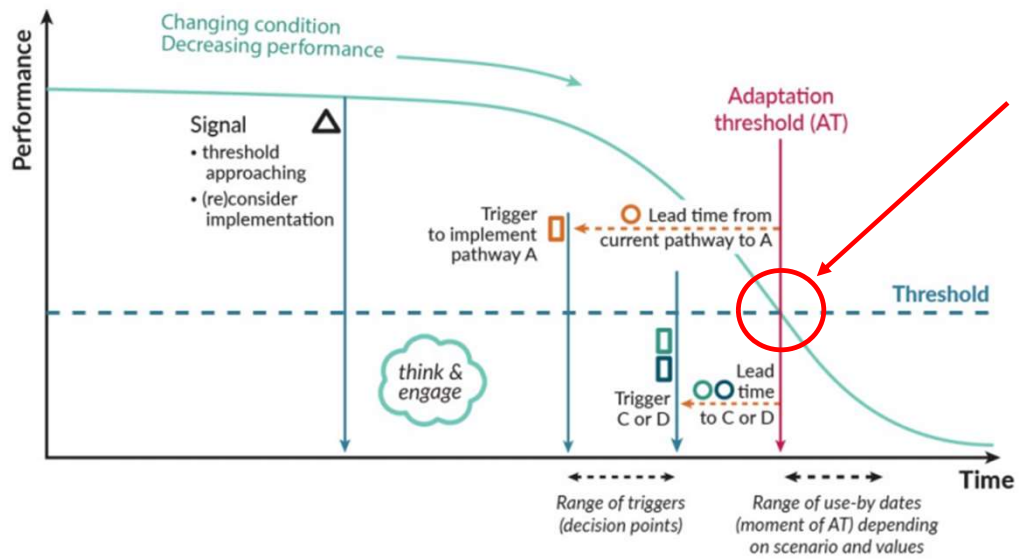
What can we do about it?

The image on the screen is an example of a dynamic adaptive pathway approach to planning. It shows that there is a time where the status quo will no longer protect the values identified in phase two. Before we reach this point we need to do something. This map shows that there are four possible options and there is the ability to move between various options. Each option has a different cost and a different life span.

Being an adaptive approach the end point of an option is based on a range of triggers. A trigger could be something visible like how often a piece of land is flooded in any given year or they could be more subtle but more constant like the depth to groundwater.

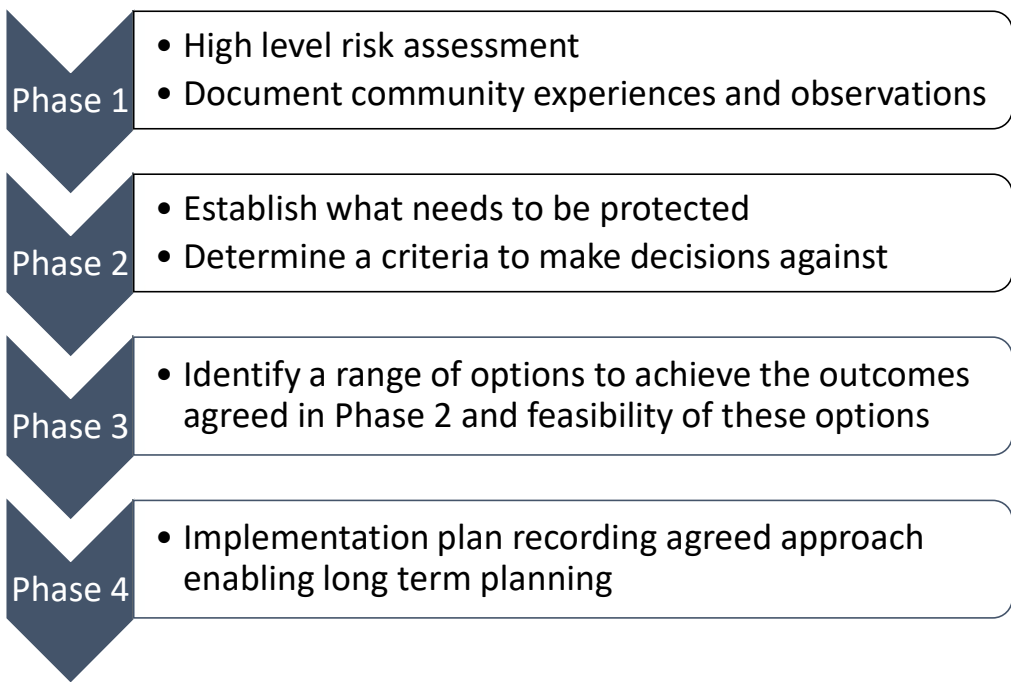
There is no timeframe associated with an action but there is an agreed point at which a particular situation is no longer acceptable. From this we can develop a plan to enable the preferred option or pathway when a change is required. An adaptive approach means no investment is required until necessary but it means we know what will happen if we get there.

Phase four: How can we implement the strategy?



How can we implement the strategy?

This shows how it all comes together. The blue dotted line shows the agreed minimum level of service or rather the point we have agreed is no longer acceptable. When the performance of the status quo decreases to this point something needs to be done immediately. However change takes time. Through identifying early warning signs and agreed trigger points we can ensure that the necessary change is ready to go when or just before it is needed.



In Summary

We can't do this alone. This is your future and this needs to be your plan. We would like today to be the start of a much longer conversation as we learn about the changing coastline together.

While we do need to do to have a plan we also need to make sure that this is the right plan and everyone has opportunity to design their future. This is your opportunity to look ahead.

Hurunui District Coastline Hazard and Risk Assessment

Motunau

Presented by Derek Todd, Principal Coastal Hazards Scientist of Jacobs (New Zealand) Ltd

In 2019 Hurunui District Council (HDC) engaged with Jacobs NZ Ltd to undertake an assessment of how coastal hazards will change with projected climate change scenarios over the next 100 years at five settlements throughout the district, and what the risks to coastal settlements and critical council infrastructure could be.

These notes will provide extra detail for the slides presented by Derek Todd of Jacobs at the “Coastal Conversations” talk held for Motunau on Monday 21st September 2020.

Agenda

1. Scope of the Assessment
2. Coastal Inundation
3. Coastal Erosion
4. Rising Groundwater



This presentation runs through the following items:

1. The scope of the assessment
2. The methods and the results of the coastal inundation assessment
3. The methods and results of the coastal erosion assessment
4. The methods and results of the rising groundwater assessment

Scope of Assessment

The following slide presents the scope of the assessment work.

Scope of Assessment

Undertake an assessment of how coastal hazards will change with projected climate change scenarios over the next 100 years, and the risks to coastal settlements and critical council infrastructure.

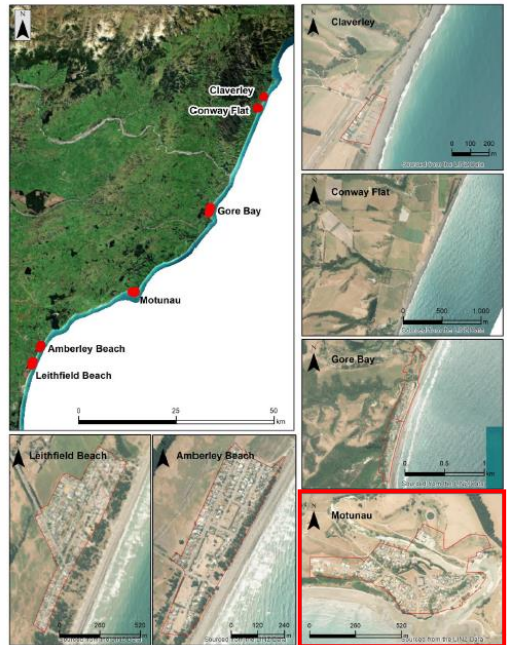
The three hazards covered in the assessment are:

- Coastal Erosion;
- Coastal Inundation; and
- Rising groundwater leading to shallow groundwater levels.

Five coastal settlements were assessed:

- Leithfield Beach;
- Amberley Beach;
- Motunau;
- Gore Bay; and
- Claverley and the section of Conway Flat Road that runs close to the coastal cliffs.

Dwellings, Properties and Council Infrastructure (wet wells, bore water supplies, roads and wastewater treatment ponds) were included in the high level risk assessment.



This slide outlines the scope of the *Hurunui District Coastline Hazard and Risk Assessment* report produced by Jacobs (2020).

The scope of this assessment was to:

- Create hazard maps of the likely extent of future coastal erosion, coastal inundation, and rising groundwater hazard, and increased salinity under a series of accepted sea level rise (SLR) scenarios.
- Undertake a high-level risk assessment on settlements and critical infrastructure to estimate the consequences of coastal erosion, inundation and groundwater rise associated with SLR on communities and council services.

There were three hazards covered within this assessment:

- Coastal erosion;
- Coastal inundation with sea water; and
- Rising groundwater leading to shallow groundwater levels

This assessment looked at the hazard footprint of these three hazards over a 30, 50, and 100 year timeframe.

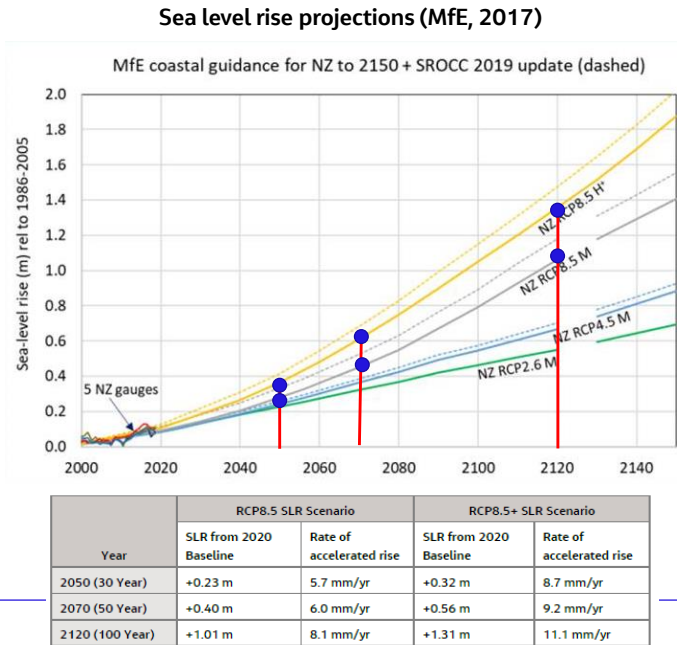
Each of these hazards were assessed across five coastal settlements (as seen in the map on the right) which were assessed within the Hurunui District, and one area of shoreline where infrastructure was assessed (Conway Flat Road).

In the high-level risk assessment completed at each settlement, dwellings, properties and council infrastructure were assessed based on their intersection with the hazard footprint (e.g. whether the hazard overlays with a property). This was to give an indication of how many dwellings and properties could be affected in each timeframe as sea level rises.

Coastal Inundation Assessment

The following slides discuss the coastal inundation assessment methods and results.

Methodology



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This slide shows the sea level rise projections used in this assessment, which are projections from the Ministry for the Environment (2017) *Coastal Hazards and Climate Change: Guidance for Local Government*.

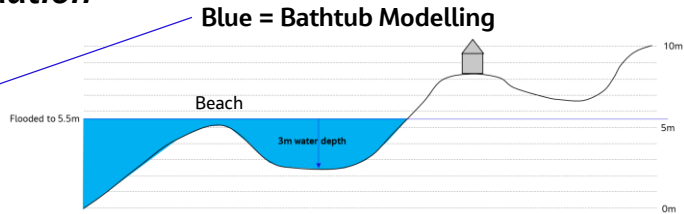
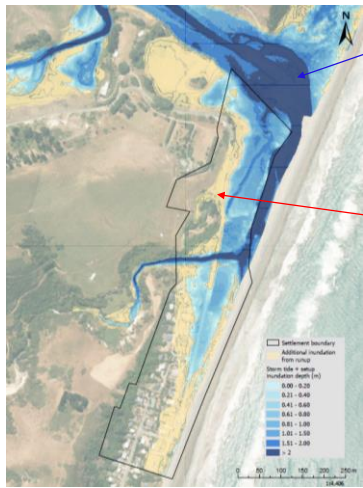
There are four commonly accepted sea level rise/climate change scenarios used both nationally and internationally, which are recognised by the New Zealand government. These scenarios are termed RCPs (Representative Concentration Pathways), and are based on the following global emissions scenarios:

- RCP2.6 – low/reduced emission
- RCP4.5 – moderate then declining emissions
- RCP8.5 – continuing status quo high emissions
- RCP8.5+ - continuing status quo high emissions and possible instabilities in the polar ice sheets

In this assessment, we looked at sea level rise over a 30, 50 and 100 year time frame (three red vertical lines) for a RCP8.5 and RCP8.5+ sea level rise scenario (blue dots) on the curved yellow and red lines), in which the sea level rise in metres in each of these scenarios is detailed in the table at the bottom of the slide.

As can be seen in this graph, there is less certainty around sea level rise projections as time progresses. We can be fairly certain about sea level rise over the next 30 years, moderately certain about sea level rise over the next 50 years, and there is some uncertainty around the magnitude of sea level rise we could expect over the next 100 years.

Methodology – Coastal Inundation



Blue = Bathtub Modelling

Yellow = Overtopping Volume Calculations

Table 2.5: 1% AEP event static water levels used in this study.

Year	RCP	Leithfield Beach	Amberley Beach	Motunau	Gore Bay (south)	Gore Bay (north)	Conway Flat	Claverley
Present Day		3.51 m	2.84 m	3.82 m	3.26 m	3.41 m	2.95 m	2.95 m
30 year (2050)	8.5	3.79 m	3.12 m	4.1 m	3.54 m	3.69 m	3.23 m	3.23 m
50 year (2070)	8.5	3.9 6m	3.29 m	4.27 m	3.71 m	3.86 m	3.40 m	3.40 m
	8.5+	4.12 m	3.45 m	4.43 m	3.87 m	4.02 m	3.56 m	3.56 m
100 year (2120)	8.5	4.57 m	3.90 m	4.88 m	4.32 m	4.47 m	4.01 m	4.01 m
	8.5+	4.87 m	4.20 m	5.18 m	4.62 m	4.77 m	4.31 m	4.31 m

This slides provides an overview of the approach used to assess the future coastal inundation hazard at each settlement. Further detail and explanation of the methods can be found in the report at www.hurunui.govt.nz/coastal

Two methods were used to determine the future coastal inundation hazard at each settlement:

- 1) Bathtub modelling:
- 2) Volumetric calculation of water overtopping the beach

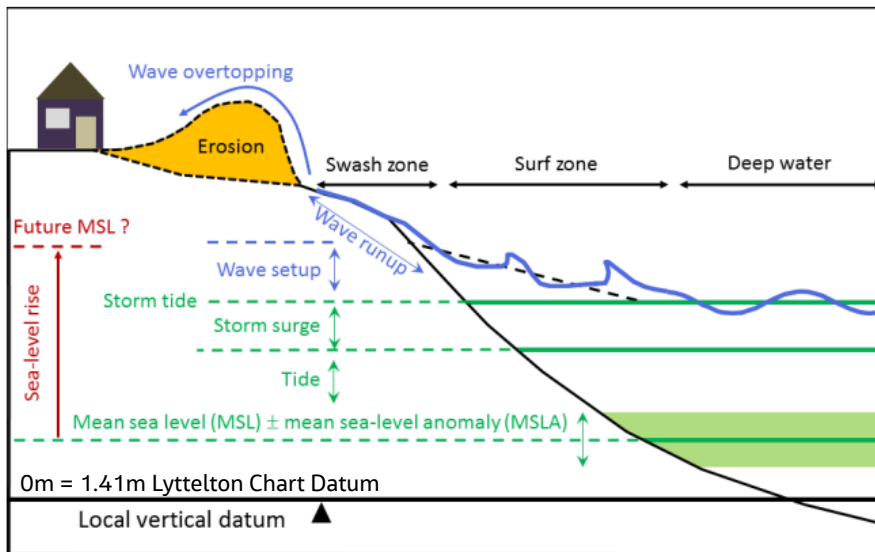
Bathtub model

- Bathtub modelling is a simplified flood model which floods land with elevations less than a set static water level, and has a connection to the sea. This is shown conceptually in the diagram on the top right of this slide, and is represented on the inundation hazard maps as the shaded blue area, which represent depth of water.
- The set 'static' water level used is a combination of wave set up, storm surge, astronomical tide, and sea level rise. The table on the bottom right of the slide shows the combined water levels used over each timeframe at each settlement.
- It is considered to be a conservative approach but it provides a basis for whether or not to proceed with more detailed and expensive hydrodynamic modelling.

Volume overtopping calculations from run-up:

- The yellow areas of the map shown on the left of this slide are the additional potential areas which could be inundated by wave overtopping caused by wave run-up on the beach. This is an additional component that is not input into the bathtub model.
- These areas were determined by calculating the likely volume of water that could overtop the beach in a 12 hour period with consideration of the tidal cycle.
- There is no depth associated with the areas shaded yellow, they are additional areas which could be effected by run-up, but it is unknown how deep the water would be there.

For this assessment, the combined water level used was a present day 1 in 100 year flood event combined with sea level rise for the 30, 50 and 100 year periods.



This slide shows the different components used to determine the ‘static’ water level – Astronomical tide, storm surge, wave setup and SLR.

Methodology – Hazard and Risk Assessment

$$\text{Risk} = \text{Consequence} \times \text{Likelihood}$$

The impact if the event occurs

Probability of occurrence

Assets assessed for each hazard:

Hazard	# of Dwellings	# of Properties	Critical Infrastructure
Coastal Erosion		X	X
Coastal Inundation	X	X	X
Rising Groundwater	X	X	X



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This slide outlines the approach used to conduct a high level risk assessment of each hazard in each settlement. Further details on the methods used can be found in the report at www.hurunui.govt.nz/coastal

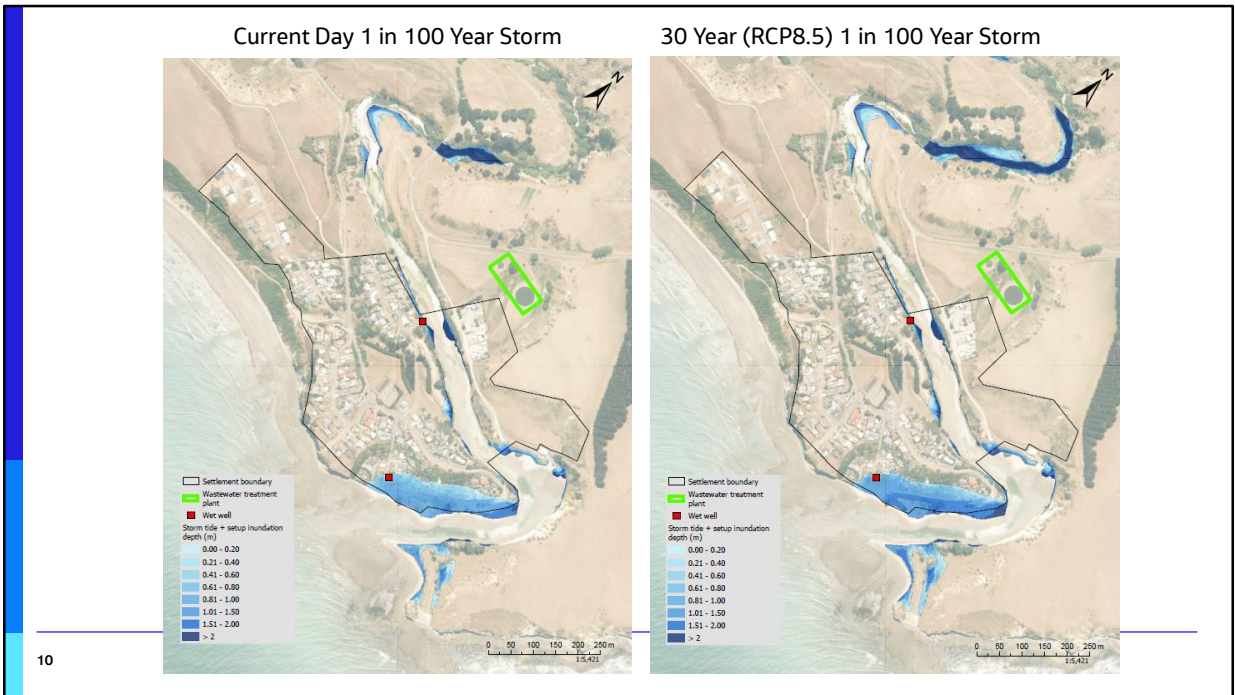
Risk is assessed as the consequence of the event, combined with the likelihood of that event occurring.

In this assessment, the consequence on the event was assessed by calculating the intersection of the hazard footprint with an asset (e.g. key critical infrastructure, dwellings, properties).

The table on the bottom left shows what assets were assessed for each hazard (e.g. dwellings, properties, key infrastructure), and the map on the right shows an example of how the number of properties effected were calculated for the erosion hazard.

Key infrastructure at each settlement was identified by Hurunui District Council. These were different for each settlement, but included roads, wet wells and waste water treatment ponds.

Properties and Dwellings were based on information from Land Information New Zealand (LINZ). Where possible, garages and sheds were removed from the building footprints provided by LINZ, however in some instances these could not be distinguished, and therefore some properties have more than one 'dwelling' on them, and are accounted for in the total numbers produced for each settlement.



This slide shows a the results of the coastal inundation hazard at Motunau for a 1 in 100 year storm for the present day (0m SLR), and in 30 years (0.28m of SLR).

The blue areas on the map show the indicative depth of water in this event, and yellow areas show the additional area which could be effected due to runoff. Inundation shown along the river is indicative and has not taken into account fluvial or tidal processes.

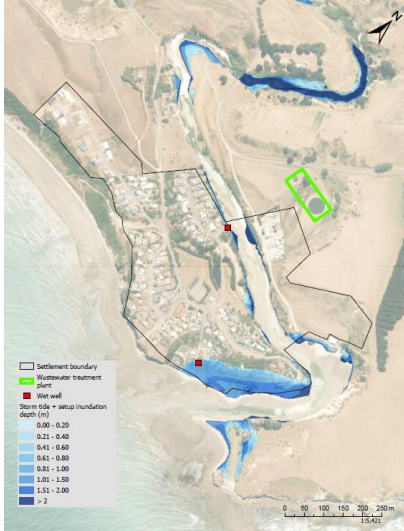
Present Day 1 in 100 year storm

- The map on the *left* shows the hazard footprint at the present day, with no sea level rise.
- This map shows that approximately 10% of the settlement footprint located on the low river terrace, with potential inundation depths being around 0.7m on average at the lower terrace.

30 year (RCP8.5) 1 in 100 year storm

- The map on the *right* shows the hazard footprint with 30 years, with 0.28m of SLR.
- This map shows that the hazard footprint within the settlement doesn't increase, but water depths on average increase, and could be in the order of 1.3m deep in some areas on the lower terrace.

30 Year (RCP8.5) 1 in 100 Year Storm



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		131	132
Present Day		12	11
30-Year (2050)	RCP 8.5	12	12
50-Year (2070)	RCP 8.5	12	12
	RCP 8.5+	12	13
100-Year (2120)	RCP 8.5	12	14
	RCP 8.5+	13	14

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wastewater treatment plant	Wet Well North (inland)	Wet Well South (coastal)
Present Day		Not inundated	Not inundated	0.2m
30-Year (2050)	RCP 8.5	Not inundated	0.3m	0.89m
50-Year (2070)	RCP 8.5	Not inundated	0.45m	1.16m
	RCP 8.5+	Not inundated	0.61m	1.31m
100-Year (2120)	RCP 8.5	Not inundated	1.06m	1.76m
	RCP 8.5+	Not inundated	1.36m	2.06m

This slide shows the results of the risk assessment for the 30 year inundation hazard, the map on the right of this slide.

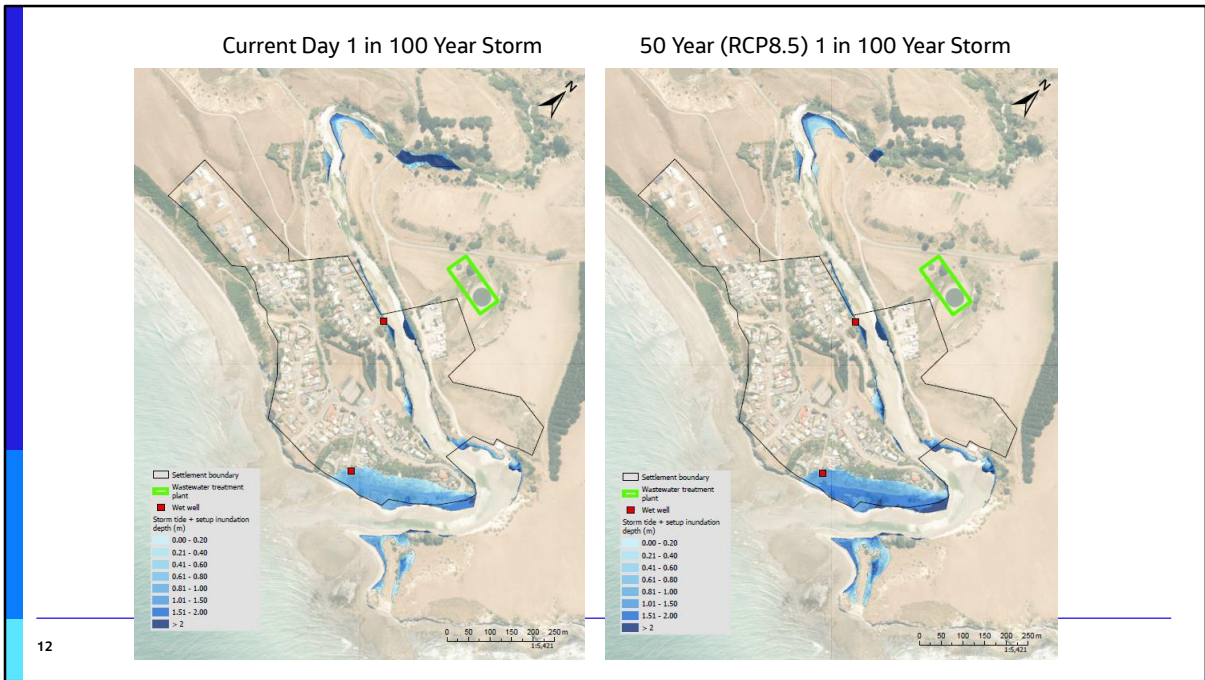
Key infrastructure at Motunau that was assessed in the risk assessment was the waste water treatment pond, and two wet wells (termed north and south).

Present Day

- As per the top right table, in a 1 in 100 year event at the present day, 12 dwellings (9%) out of the 131 dwellings could be affected; and 11 properties (8%) out of the 132 could be affected.
- As per the bottom right table, the southern coastal wet well is the only piece of assessed infrastructure that is likely to be inundated in this event, with water depths being in the order of 0.2m at the well.
- The wastewater treatment plant is unlikely to be affected in this event.

30 year (RCP8.5) 1 in 100 year storm

- In the 30-year scenario, 12 property and dwellings (9%) are potentially affected.
- As per the bottom right table, both wet wells could be effected by inundation in this scenario, with water depth at the southern wet well being in the order of 0.9m, and water depths at the northern (inland) wet well being in the order of 0.3m.
- The wastewater treatment plant is unlikely to be affected in this event.

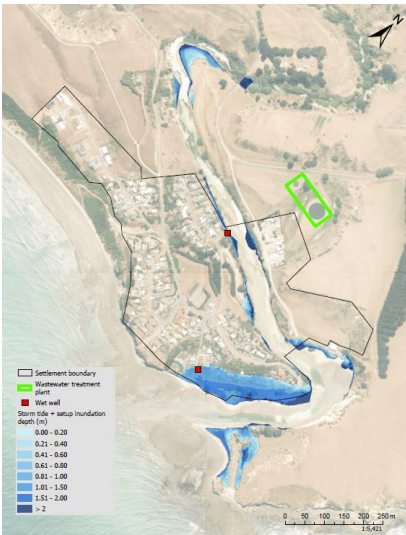


This slide shows a the results of the coastal inundation hazard at Motunau for a 1 in 100 year storm for the present day (0m SLR), and in 50 years (0.45m of SLR).

50 year (RCP8.5) 1 in 100 year storm

- The map on the *right* shows the hazard footprint with 50 years, with 0.45m of SLR.
- This map shows that approximately 10% of the settlement could become inundated in a 1 in 100 year event.
- The hazard footprint has not increased significantly, however the water depth across the flooded area has increased.
- Water depths on the lower terrace could be in the order of 1.8 to 1.9m.

50 Year (RCP8.5) 1 in 100 Year Storm



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Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		131	132
Present Day		12	11
30-Year (2050)	RCP 8.5	12	12
50-Year (2070)	RCP 8.5	12	12
	RCP 8.5+	12	13
100-Year (2120)	RCP 8.5	12	14
	RCP 8.5+	13	14

Inundation Depth at Key Infrastructure:

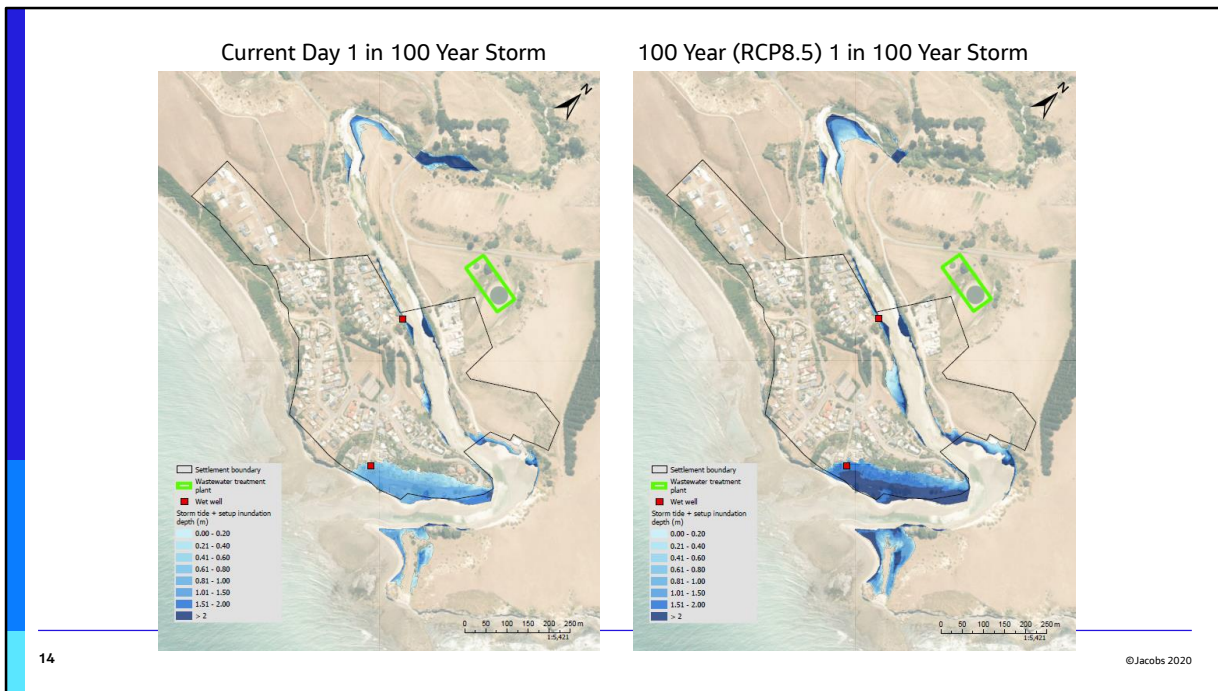
Timeframe	Scenario	Wastewater treatment plant	Wet Well North (inland)	Wet Well South (coastal)
Present Day		Not inundated	Not inundated	0.2m
30-Year (2050)	RCP 8.5	Not inundated	0.3m	0.89m
50-Year (2070)	RCP 8.5	Not inundated	0.45m	1.16m
	RCP 8.5+	Not inundated	0.61m	1.31m
100-Year (2120)	RCP 8.5	Not inundated	1.06m	1.76m
	RCP 8.5+	Not inundated	1.36m	2.06m

This slide shows the results of the risk assessment for the 50 year inundation hazard, the map on the right of this slide.

Key infrastructure at Motunau that was assessed in the risk assessment was the waste water treatment pond, and two wet wells (termed north and south).

50 year (RCP8.5 and RCP8.5+) 1 in 100 year storm

- In the 50-year scenarios, only 12 properties and dwellings (9%) are effected in the RCP8.5 scenario, which increases to 13 properties in the RCP8.5+ scenario.
- As per the bottom right table, both wet wells could be effected by inundation in this scenario, with water depth at the southern wet well being in the order of 1.16 to 1.31m deep, and water depths at the northern (inland) wet well being in the order of 0.45 to 0.61m deep.
- The wastewater treatment plant is unlikely to be affected in this event.

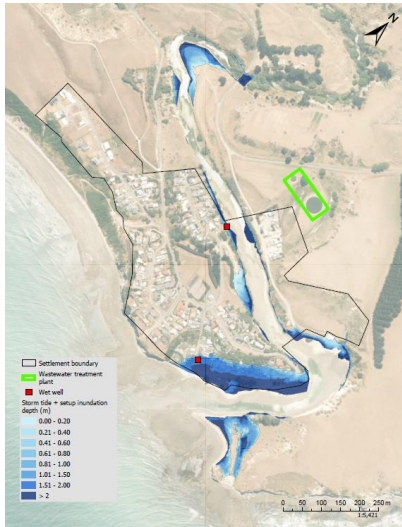


This slide shows a the results of the coastal inundation hazard at Motunau for a 1 in 100 year storm for the present day (0m SLR), and in 100 years (1.06m of SLR).

100 year (RCP8.5) 1 in 100 year storm

- The map on the *right* shows the hazard footprint with 100 years, with 1.06m of SLR. This map shows that there is very little increase in the hazard footprint from the 50 year event, and only 10% of the settlement on the lower terrace and a small section up the river is effected by inundation in this event.
- Water depths on average in this event with 100 years of SLR could be in the order of 2.2 to 2.4m on the lower terrace.

100 Year (RCP8.5) 1 in 100 Year Storm



Dwellings and Properties Affected:

Timeframe	Scenario	Dwellings	Properties
Total		131	132
Present Day		12	11
30-Year (2050)	RCP 8.5	12	12
50-Year (2070)	RCP 8.5	12	12
	RCP 8.5+	12	13
100-Year (2120)	RCP 8.5	12	14
	RCP 8.5+	13	14

Inundation Depth at Key Infrastructure:

Timeframe	Scenario	Wastewater treatment plant	Wet Well North (inland)	Wet Well South (coastal)
Present Day		Not inundated	Not inundated	0.2m
30-Year (2050)	RCP 8.5	Not inundated	0.3m	0.89m
50-Year (2070)	RCP 8.5	Not inundated	0.45m	1.16m
	RCP 8.5+	Not inundated	0.61m	1.31m
100-Year (2120)	RCP 8.5	Not inundated	1.06m	1.76m
	RCP 8.5+	Not inundated	1.36m	2.06m

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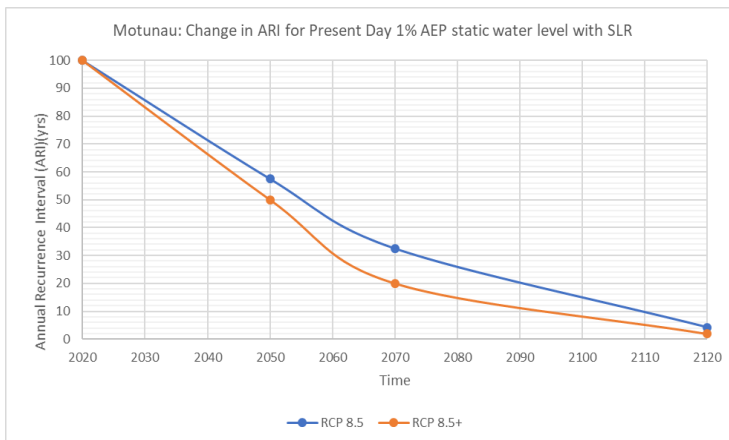
This slide shows the results of the risk assessment for the 100 year inundation hazard, the map on the right of this slide.

Key infrastructure at Motunau that was assessed in the risk assessment was the waste water treatment pond, and two wet wells (termed north and south).

100 year (RCP8.5 and RCP8.5+) 1 in 100 year storm

- In the 100-year scenarios, only 14 properties (10%) are effected in the RCP8.5 and RCP8.5+ scenarios.
- 12 dwellings in the RCP8.5 scenario could be effected by inundation, which increases to 13 dwellings under the RCP8.5+ scenario.
- As per the bottom right table, both wet wells could be effected by inundation in this scenario, with water depth at the southern wet well being in the order of 1.76 to 2.06m deep, and water depths at the northern (inland) wet well being in the order of 1.06 to 1.36m deep across both RCP scenarios.
- The wastewater treatment plant is unlikely to be effected in this event.

Increase in Frequency of 1 in 100 Year Events with SLR



1 in 100 year event could occur every:

- 50-60 Years by 2050
- 20-30 Years by 2070
- 1-5 Years by 2120

This slide shows the change in recurrence intervals of a 1 in 100 year event with sea level rise.

As well as water levels, future SLR will also increase the annual probability (e.g. frequency) that the present day 1 in 100 year event will occur.

As shown in the graph on this slide, the Annual Recurrence Interval (ARI) for the present day 1 in 100 year event with no sea level rise reduces from the current 100 years to:

- 50-60 years by 2050;
- 20-30 years by 2070; and
- 1-5 years by 2120.

Expressed another way, experiencing this area and depth of flooding, you would currently only expect it to occur once in 100 years at present. With SLR over 30, 50 and 100 years, it is twice as likely to occur in any one year by 2050, in the order of three to four times more likely to occur in any one year by 2070, and could occur every one to five years by 2120.

Coastal Erosion Assessment

The following slides discuss the coastal erosion assessment methods and results.

Methodology – Coastal Erosion

$$\text{Projected Future Shoreline Position (PFSP)} = (\text{LT} \times \text{T}) + \text{SL} + \text{ST}$$

Where:

- *T* = Timeframe considered (30, 50, 100 years);
- *LT* = Extrapolation of the rate of historical shoreline movement (m/yr);
- *SL* = Estimated erosion due to accelerated sea level rise over the timeframe (*T*); and
- *ST* = Short-term storm erosion

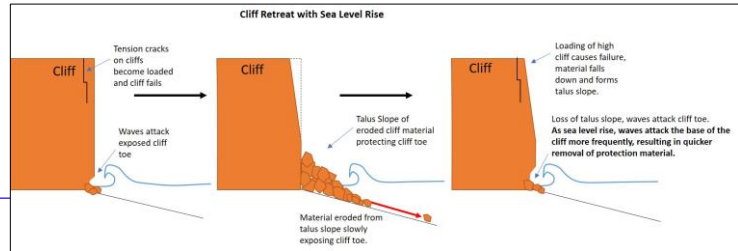


Long Term

Short Term Storm Erosion



SLR Effect



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This slide provides an overview of the approach used to assess the future erosion hazard at each settlement. Further detail and explanation of the methods can be found in the report at www.hurunui.govt.nz/coastal

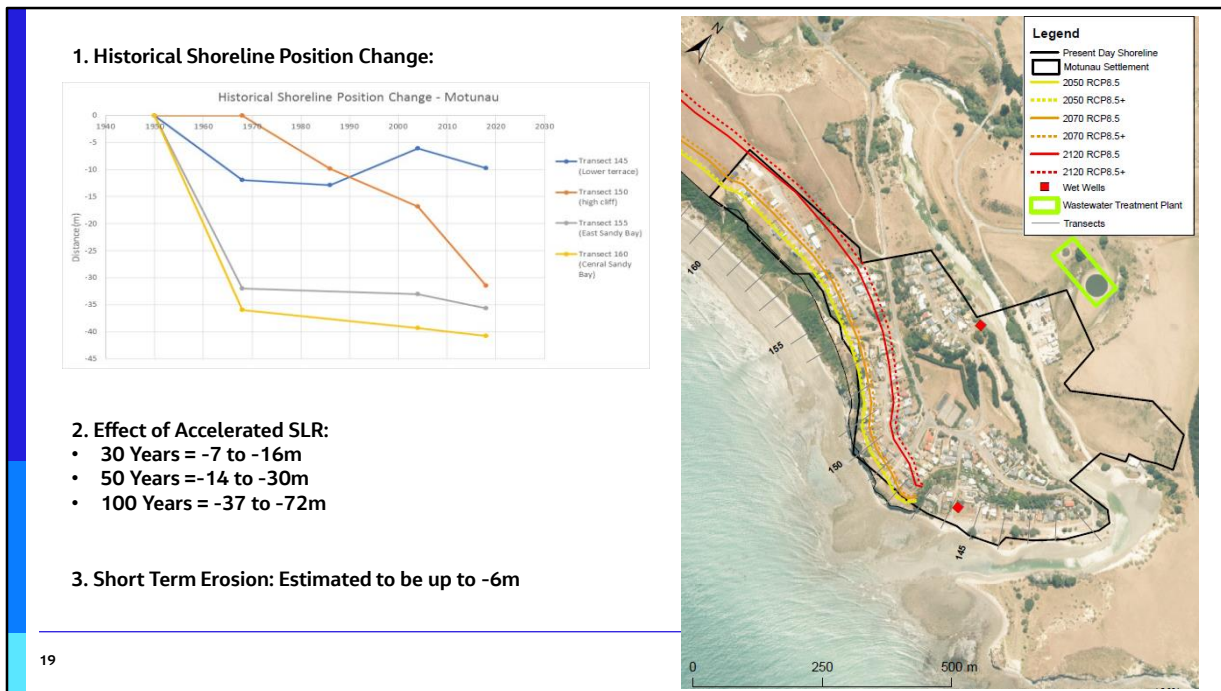
When assessing coastal erosion hazard into the future, there are three key components to consider:

1. **Long term trend** – This is considered to ensure that the past trend at the site (e.g. accretion due to good sediment supply, or erosion due to sediment deficit) is taken into account when determining where the shoreline will be in the future. This is calculated using historical aerial imagery from the site;
2. **Effect of sea level rise** – The inclusion of the effect of accelerated sea level rise in the future shoreline position is to account for the erosional response on the beach to rising sea levels. This is calculated using two-dimensional geometric models which are adjusted depending on the morphology of the beach. As shown on the schematic on the bottom right of this slide, in cliff environments, sea level rise will result in more frequent wave attack on the cliff toe. As a result the cliff becomes over-loaded and fails. These erosion events occur episodically rather than gradually, as eroded cliff material provides protection at the cliff toe for a period of time until it is eroded away and the cliff toe is exposed again.
3. **Short term erosion** – The inclusion of short-term erosion as a component in the PFSP calculation is to account for an extreme storm event or series of events resulting in significant erosion occurring close to or soon after the end of the planning timeframe. This is calculated using ECan beach profiles and calculating year-to-year changes between profiles.

These components are combined in the following formula to calculate the position of the Projected Future Shoreline Position (PFSP), in which this approach meets the requirements of NZCPS Policy 24 for the identification of coastal hazards:

$$\text{PFSP} = (\text{Long Term} \times \text{Timeframe}) + \text{Sea Level Rise effect} + \text{Short Term}$$

The PFSP lines seen on the maps in each settlement and at Conway Flat Road are a combination of all three components, and represent where the back of the beach (e.g. the vegetation line or cliff line) could be in 30, 50 and 100 years under two different sea level rise scenarios.



This slide presents the results of the Coastal Erosion hazard assessment for 30, 50 and 100 year timeframes.

1. Historical Shoreline Trend

The graph on the right shows the historical shoreline position at select locations along the Motunau shoreline since the 1950s. Key summary of the findings are as follows:

- Within the river mouth, the pattern of shoreline movement has been influenced by the placement of armour erosion as protection works. Close to the river mouth training walls, there is a net retreat of around -10 m since 1950, while further up the river it shows net advance in the range of 8-17 m since 1950 due to the rock placement.
- For the high cliffs, stability up to 1968 was followed by episodic erosion patterns with total retreat distances ranging from -4 m to -30 m over the next 50 years to 2018.
- Along Sandy Bay to the west of the settlement displayed beach retreat of up to -2 m/yr from 1950 to 1968, followed by a slow in retreat at rates of < 0.1 m/yr to give total retreat distances of -35 to -40 m.

2. Effects of Accelerated SLR

The effects of accelerated SLR at Motunau are calculated as the following:

- Over the next 30 years there could be 7 to 16m of erosion as a direct result of SLR;
- Over the next 50 years there could be 14 to 30m of erosion as a direct result of SLR; and
- Over the next 100 years there could be 37 to 72m of erosion as a direct result of SLR.

3. Short Term Erosion

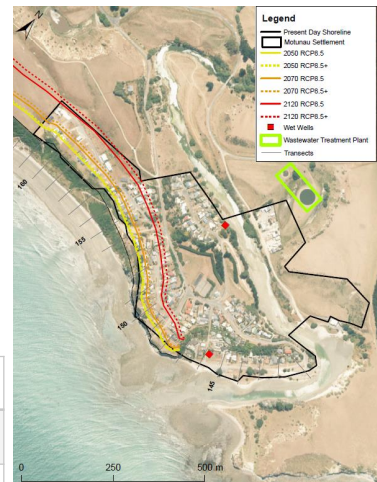
An assessment of Environment Canterbury beach profiles between 1997-2019 revealed that the maximum inter-survey erosion ranged from -0.6 to -6m.

Adopting this upper limit, an arbitrary value of 6m was used as the short-term erosion component for the PFSP for Motunau settlement.

These three components are then combined to calculate the Projected Future Shoreline Positions seen on the map on the right.

Distances from Current Shoreline to Projected Future Shoreline Position:

Timeframe	30-year (2050)		50-year (2070)		100-year (2120)	
	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+
Transect 150 (High mudstone cliff)	-22 m	-23 m	-34 m	-36 m	-66 m	-69 m
Transect 155 (East Sandy Bay)	-38 m	-39 m	-60 m	-62 m	-118 m	-122 m
Transect 160 (Central Sandy Bay)	-38 m	-40 m	-61 m	-63 m	-120 m	-124 m



Number of Properties Affected by Erosion:

Timeframe	Total	30-year (2050)		50-year (2070)		100-year (2120)	
		RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+	RCP 8.5	RCP 8.5+
Number of properties	150	>28	>28	>36	>36	>63	>69

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This slide presents the results of the Coastal Erosion hazard assessment for 30, 50 and 100 year timeframes.

Projected Future Shoreline Positions

The table on the top left of this slide shows the distance of the projected future shoreline position from the present day shoreline (cliff edge and vegetation line) for each scenario. These distances are shown spatially on the map on the right. It is noted that PFSP were not presented for the lower terrace due to complexities around rivermouth dynamics and response to sea level rise there.

These distances can be summarised as the following:

- In 2050, the shoreline could be in the order of -22 to -40m landward of its current position;
- In 2070, the shoreline could be in the order of -34 to -63m landward of its current position; and
- In 2120, the shoreline could be in the order of -66 to -124m landward of its current position.

The extrapolation of the long-term erosion component will be the main contribution to retreat over the next 50 years at Motunau, and that accelerated rates of SLR will only begin to contribute more than 50% of the projected erosion over a 100-year timeframe.

Coastal Erosion Risk Assessment

Properties: The property numbers presented in the table on the bottom left are shown as the lower limit of the properties within the settlement that may be affected at some stage in the future, as it does not include properties located on the low terrace near the river mouth. Of the 150 properties within the Motunau settlement footprint, 28 are projected to be at risk from cliff erosion over the next 30 years, 36 over the next 50 years, and 60-70 over the next 100 years.

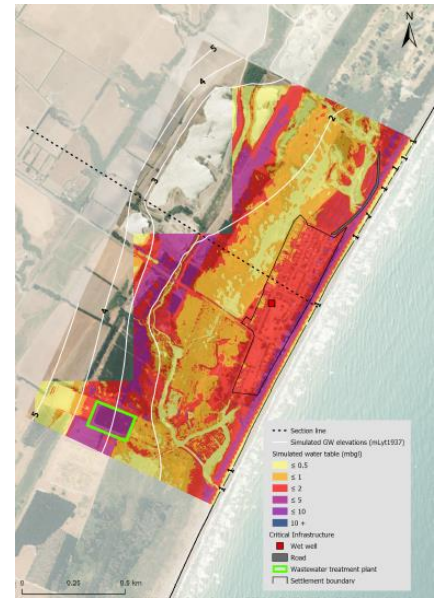
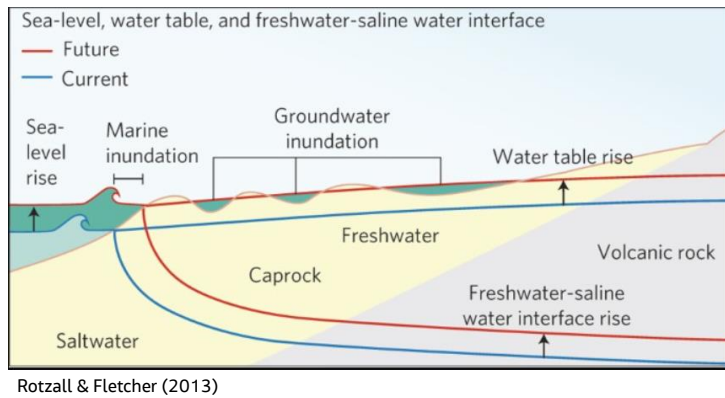
Critical Infrastructure: The wastewater treatment plant and wet well located up the river are not going to be at risk from coastal erosion over the next 100 years. The wet well on the lower terrace by the river mouth is located around 32 m from the current river bank, and although not covered by the assessment of the PFSP, is considered to be at possible risk from coastal erosion within 50 years and likely to be at risk within 100 years.

Groundwater Assessment

The following slides discuss the rising groundwater assessment methods and results.

Methodology – *Rising Groundwater*

- Calculating the depth to Groundwater with SLR
- Predicting the saline interface with SLR



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This slide provides an overview of the approach used to assess the rising of shallow groundwater at each settlement. Further detail and explanation of the methods can be found in the report at www.hurunui.govt.nz/coastal

Two components of groundwater hazards were assessed in the Hurunui District:

- 1) Rising shallow groundwater with sea level rise; and
- 2) Ingress of the saline interface with sea level rise as seawater encroaches into the groundwater table

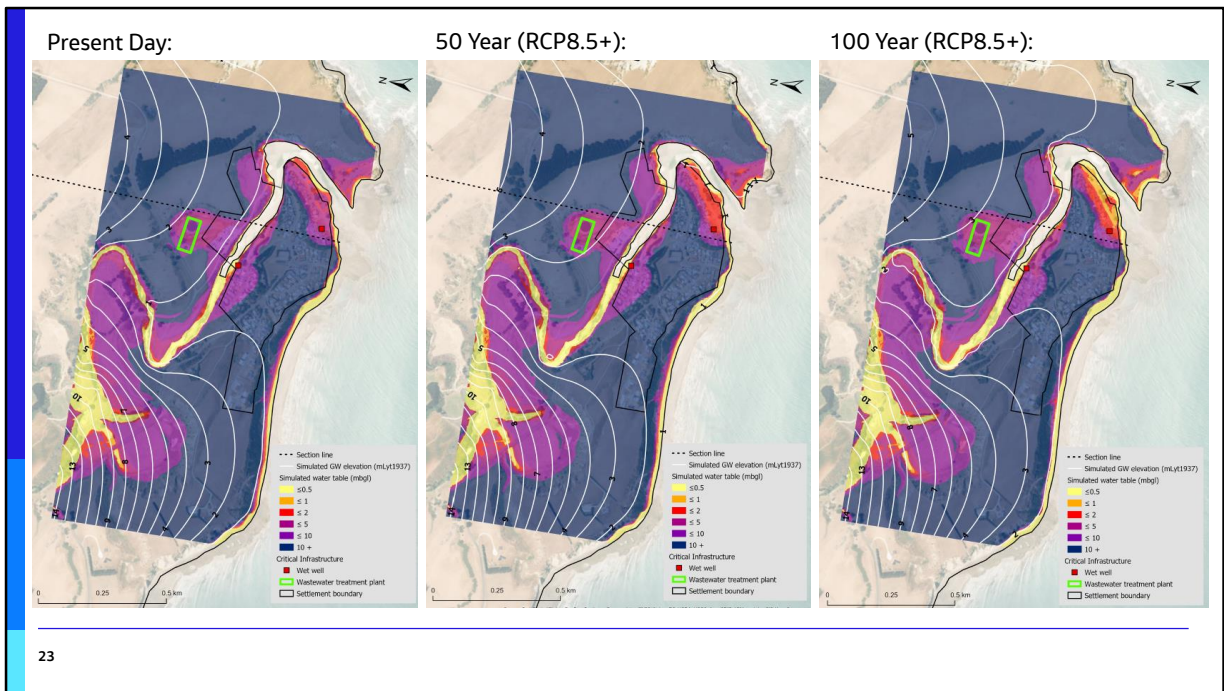
There were several limitations to calculating the rising groundwater hazard in the Hurunui District due to the lack of data available, and therefore only 50 year and 100 year scenarios were assessed.

The figure on the left (from Rotzall & Fletcher, 2013) shows an example of the effect of SLR on the water table and the saline interface. It demonstrates how groundwater water quality can be effected as the freshwater-saline interface moves inland with SLR, as well as reducing the ability for land to drain as the water table rises.

In this assessment, the change in the saline interface was assessed, which could have an effect on the water quality at a site where there is saltwater intrusion into water supplies or water treatment areas.

The map on the right shows an example of the output of the modelling assessing the rise in shallow groundwater, which shows the depth to ground water below 0m, which gives an indication of areas where the drainage capacity of the land could be reduced with sea level rise.

Rotzoll, K., Fletcher, C. Assessment of groundwater inundation as a consequence of sea-level rise. *Nature Clim Change* 3, 477–481 (2013)



This slide shows the results of the shallow groundwater mapping in the present day, with 50 years SLR (RCP 8.5+), and with 100 years SLR (RCP 8.5+).

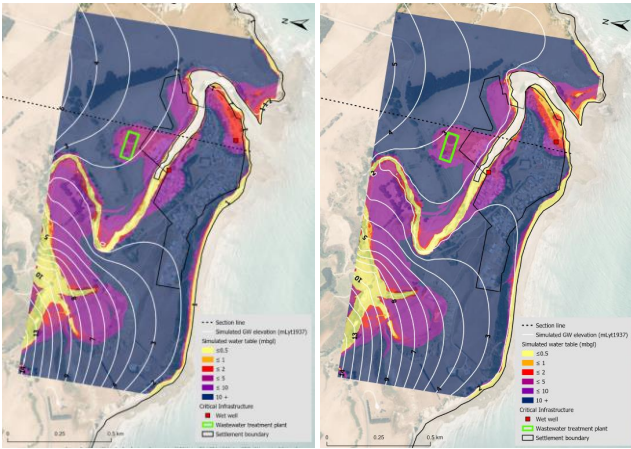
The map of depths to the indicative average shallow groundwater conditions at Motunau under present day and future sea levels is presented in the three maps in this slide.

Since the majority of Motunau settlement is elevated on the high terrace, depth to groundwater over most of the settlement is >10 m under all SLR scenarios and timeframes over the next 100 years.

On the lower river mouth terrace, current depth to groundwater is in the range 5-10 m. With 100 years of SLR reducing depths along the Parade to 1 m BGL and to <0.5 m along foreshore areas.

50 Year (RCP8.5+):

100 Year (RCP8.5+):



Number of Dwellings exposed to indicative average groundwater depths:

SLR Scenario	Depth to Groundwater (m BGL)			
	≤ 0.5	0.5-1	1-2	> 2
Present Sea level (2020)	0	0	0	131
50 year (0.6 m SLR)	0	0	7	124
100 year (1.3 m SLR)	0	0	12	119

Indicative Average Groundwater Depths at Critical Infrastructure:

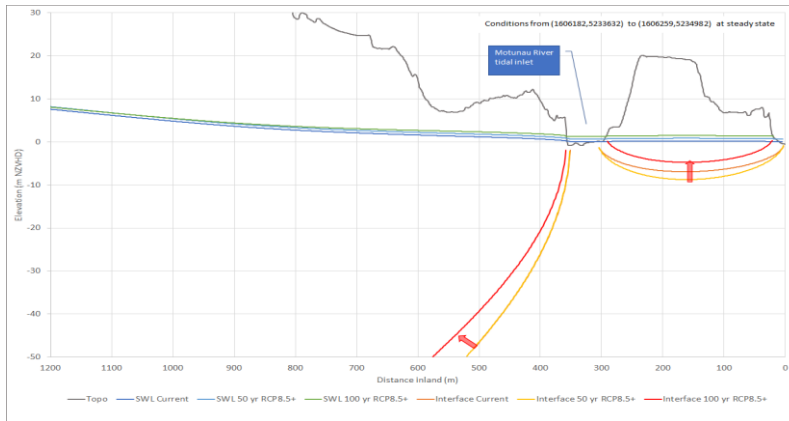
Infrastructure	Present day (2020)	100-year RCP 8.5+ (SLR=1.3 m)
Wet Well North (inland)	2-5m	2-5m
Wet Well South (coastal)	2-5m	1-2m
Wastewater treatment plant	2-5m	2-5m

This slide presents the results of the rising shallow groundwater risk assessment.

The number of dwellings subjected to potentially shallow groundwater is presented in the table on the top right of this slide. No dwellings are predicted to be at risk from groundwater shallower than 1m BGL over any timeframe in the next 100 years.

Predicted groundwater depths at nominated critical infrastructure is presented on the table on the bottom left of this slide. All critical infrastructure assessed not predicted to be at risk from rising groundwater levels with SLR.

Change in the Saline Interface



This slide shows the results of the assessment of the change in the saline interface with SLR.

The predicted saline interface with SLR is shown in the graph on this slide. It indicates a small saline incursion in the unconfined aquifer, which is not predicted to have any impacts on the water quality in Motunau.

Thank you

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