
# Coastal Hazards

## Risk Identification/Assessment and Hazard Management under RMA/NZCPS

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Dr Bryce Wilkinson (economics, policy analysis and decision-making under uncertainty)

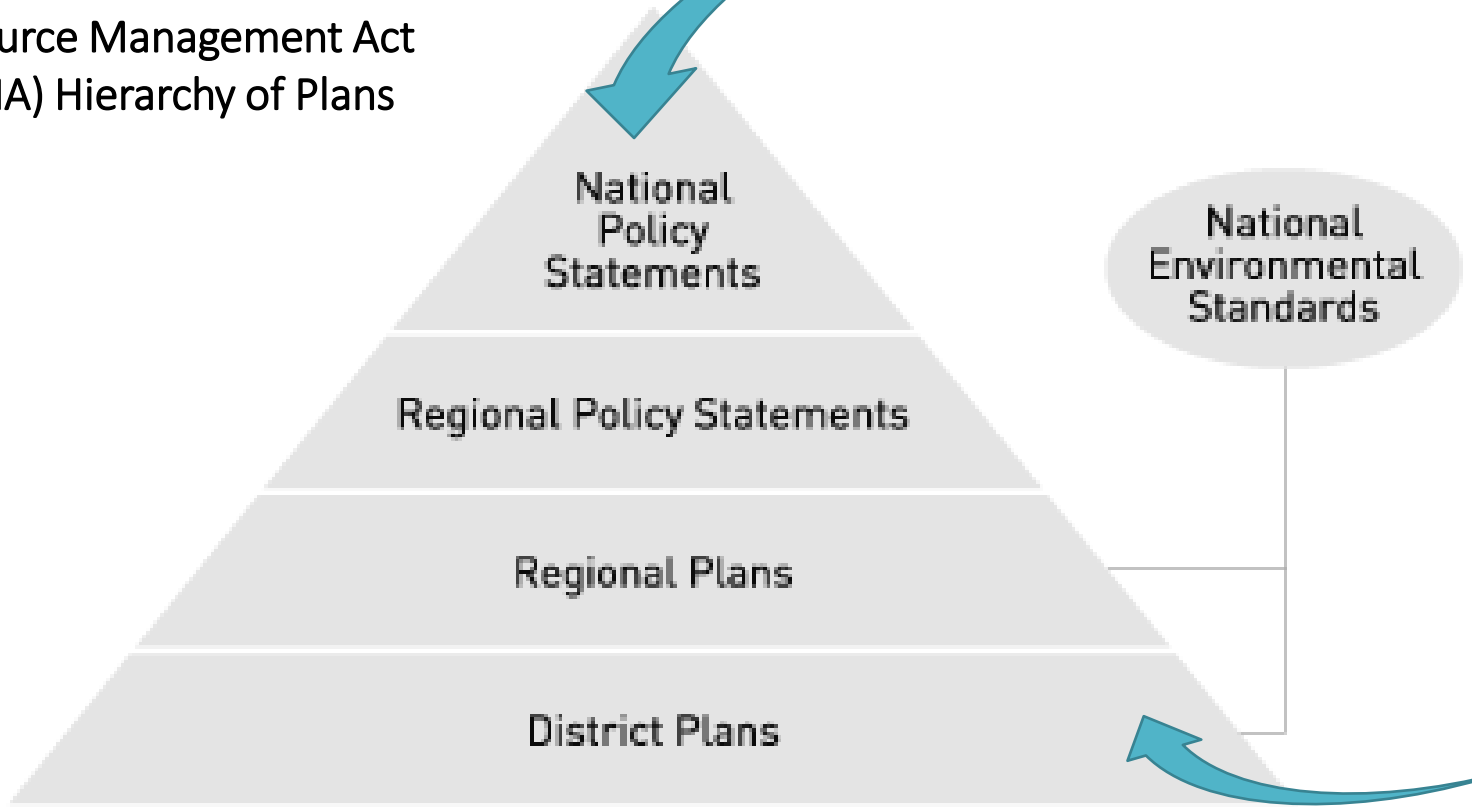
CRU's Technical Submissions to Jacobs regarding Volume 1: Methodology (and Jacobs' response to CRU) can be found at https://www.cru.org.nz/science-2021

Use tabs: CRU 2021 > Science 2021

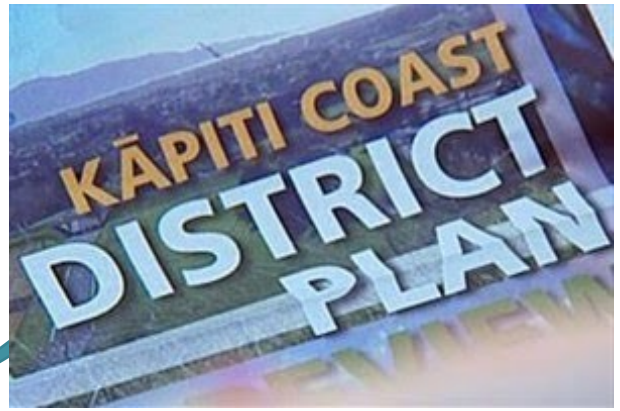
# TABLE OF CONTENTS

# Planning Law: RMA and NZCPS

Resource Management Act (RMA) Hierarchy of Plans








At the bottom of the planning hierarchy, the District Plan is bound by the higher plans and policy statements. Specifically, the District Plan must legally implement the policy requirements set out in the NZCPS

# New Zealand Coastal Policy Statement (NZCPS): Definition of "Risk"


**Risk**

Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence (AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009).

https://www.doc.govt.nz/about-us/science-publications/conservation-publications/marine-and-coastal/new-zealand-coastal-policy-statement/new-zealand-coastal-policy-statement-2010/glossary/

# NZCPS Risk Management Framework

RISK ASSESSMENT Objective – Physical Science


NZCPS Policy 24: Identification of coastal hazards

RISK MANAGEMENT Subjective – Decision-making

NZCPS Policy 25: Subdivision, use, and development in areas of coastal hazard risk

NZCPS Policy 27: Strategies for protecting significant existing development from coastal hazard risk

These are separate and distinct tasks – and that distinction is materially important in law. Considerations regarding the potential options for the management of coastal hazard risk must be based on a risk assessment that (in legal terms) “gives effect to” NZCPS Policy 24.

# NZCPS Risk Management Framework

## Policy 24: Identification of coastal hazards

1. Identify areas in the coastal environment that are potentially affected by coastal hazards (including tsunami), giving priority to the identification of areas at high risk of being affected. Hazard risks, over at least 100 years, are to be assessed having regard to:

a) physical drivers and processes that cause coastal change including sea level rise;
b) short-term and long-term natural dynamic fluctuations of erosion and accretion;
c) geomorphological character;
d) the potential for inundation of the coastal environment, taking into account potential sources, inundation pathways and overland extent;
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g) the extent and permanence of built development; and
h) the effects of climate change on:
   i. matters (a) to (g) above;
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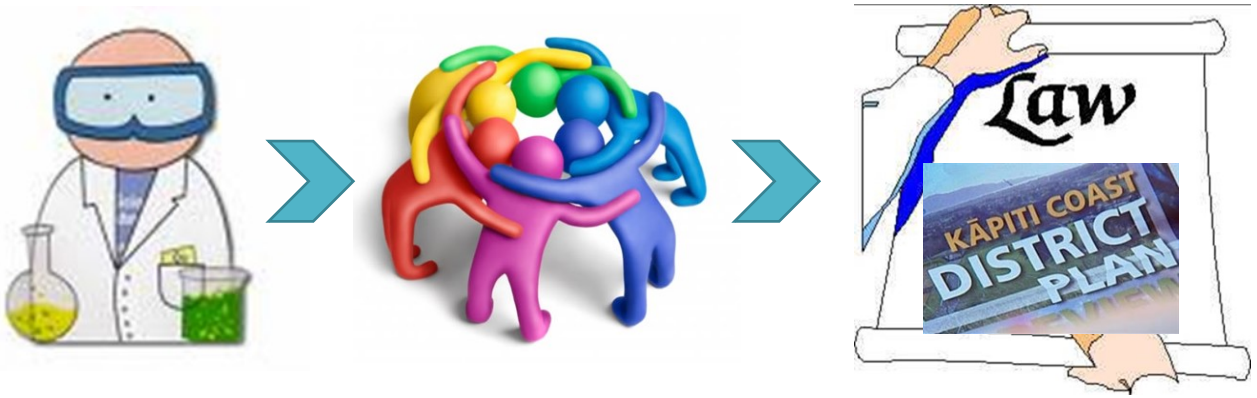
taking into account national guidance and the best available information on the likely effects of climate change on the region or district.




## Policy 25: Subdivision, use, and development in areas of coastal hazard risk

In areas potentially affected by coastal hazards over at least the next 100 years:

a. avoid increasing the risk of social, environmental and economic harm from coastal hazards;
b. avoid redevelopment, or change in land use, that would increase the risk of adverse effects from coastal hazards;
c. encourage redevelopment, or change in land use, where that would reduce the risk of adverse effects from coastal hazards, including managed retreat by relocation or removal of existing structures or their abandonment in extreme circumstances, and designing for relocatability or recoverability from hazard events;
d. encourage the location of infrastructure away from areas of hazard risk where practicable;
e. discourage hard protection structures and promote the use of alternatives to them, including natural defences; and
f. consider the potential effects of tsunami and how to avoid or mitigate them.

Risk – as defined in the Glossary.

## Policy 27: Strategies for protecting significant existing development from coastal hazard risk

1. In areas of significant existing development likely to be affected by coastal hazards, the range of options for reducing coastal hazard risk that should be assessed includes:

a. promoting and identifying long-term sustainable risk reduction approaches including the relocation or removal of existing development or structures at risk;
b. identifying the consequences of potential strategic options relative to the option of "do-nothing";
c. recognising that hard protection structures may be the only practical means to protect existing infrastructure of national or regional importance, to sustain the potential of built physical resources to meet the reasonably foreseeable needs of future generations;
d. recognising and considering the environmental and social costs of permitting hard protection structures to protect private property; and
e. identifying and planning for transition mechanisms and timeframes for moving to more sustainable approaches.

2. In evaluating options under (1):

a. focus on approaches to risk management that reduce the need for hard protection structures and similar engineering interventions;
b. take into account the nature of the coastal hazard risk and how it might change over at least a 100-year timeframe, including the expected effects of climate change; and
c. evaluate the likely costs and benefits of any proposed coastal hazard risk reduction options.
d. Where hard protection structures are considered to be necessary, ensure that the form and location of any structures are designed to minimise adverse effects on the coastal environment.
e. Hard protection structures, where considered necessary to protect private assets, should not be located on public land if there is no significant public or environmental benefit in doing so.

## The work of Jacobs and planning law – objective physical science

# Policy 24: Identification of coastal hazards

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# The work of CAP and planning law – subjective decision-making

## Policy 25: Subdivision, use and development

## Policy 27: Strategies for existing development

**The Outcomes**

Takutai Kāpiti will deliver recommendations on coastal adaptation options for Council's consideration.

The recommendations, including any potential costs, legislative requirements and benefits associated with those options, should also guide development of District Plan provisions to manage coastal issues and an approach for the district dealing with coastal hazards. These recommendations will be evaluated by the Council as part of the development of the future coastal plan change.

https://takutaikapiti.nz/


The basis for equitable decision-making relies on robust science.

# TABLE OF CONTENTS

# Scope of Works – KCDC/Jacobs

Jacobs *Volume 1: Coastal Hazard Susceptibility and Vulnerability Assessment: Methodology* does not give effect to NZCPS Policy 24.


And, if Jacobs *Volume 2: Coastal Hazard Susceptibility and Vulnerability Assessment* is based on this methodology, then the assessment itself will not give effect to NZCPS, and therefore reliance on it will not be suitable for making recommendations in relation to the District Plan.

Jacobs acknowledge in *Volume 1: Coastal Hazard Susceptibility and Vulnerability Assessment: Methodology* that they have <u>not completed a risk assessment</u> when describing their Scope of Works, in stating; –

# Scope of Works

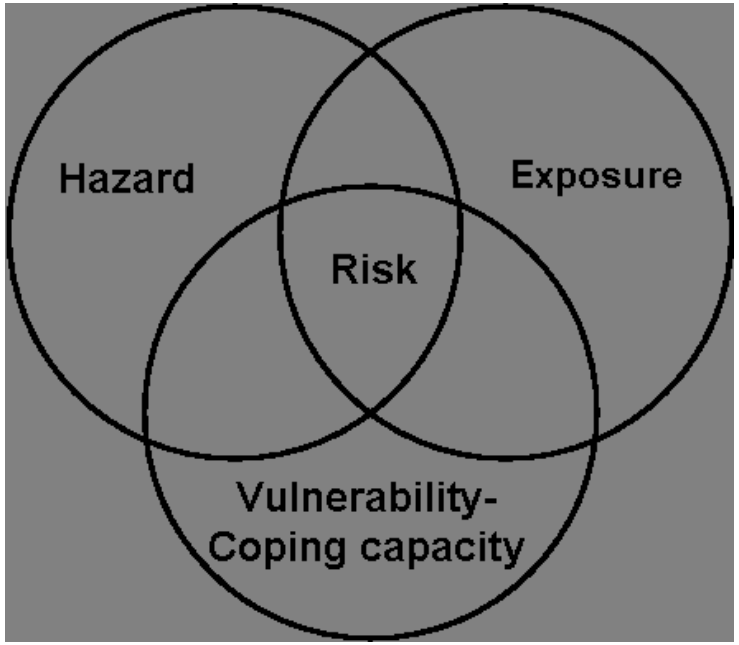
## Jacobs (2021). Volume 1: Coastal Hazard Susceptibility and Vulnerability Assessment: Methodology

*"It is noted that the* original Scope of Works *for the coastal hazard assessment referred to a Risk assessment. Risk is commonly defined to be likelihood x consequence, with the consequence component of the equation including the consideration of the full range of economic, social, cultural, and environmental consequences. Risk assessments also commonly include consideration of the above consequences on strategies and actions for dealing with the impacts of the hazards. However, consideration of the full range of these consequences and possible remediation/adaptation actions is both outside the scope of this assessment, and best considered in the Phase Two (community engagement) part of the Takutai Kāpiti project.* ***Therefore, we have re-defined the assessment to be coastal hazard vulnerability rather than coastal hazard risk****"* (Jacobs, 2021, p.8, para.1)

Emphasis added, text in red misinterprets the RMA/NZCPS risk management framework.
The matters in red are not part of hazard identification (risk assessment) under NZCPS Policy 24.

# Scope of Works – Vulnerability vs Risk

- Vulnerability is not a defined term in the NZCPS. It is used in the full legislative document elsewhere, but not in any of Policies 24, 25 or 27.
- Risk is a defined term in the NZCPS. It is used in all of Policies 24, 25 and 27.
- Vulnerability is the inability to resist a hazard or to respond when a disaster has occurred.
- Vulnerability is one-only component of Risk/Risk Assessment.
- Risk (all its components) must be lawfully assessed first under NZCPS Policy 24 in order for CAP to plan for a response under NZCPS Policies 25 and 27.
- Nowhere in NZCPS Policy 24, (or in the Venn diagram - right) are the matters quoted in red (previous slide) a component of risk assessment.




Intersection of hazard, exposure, and vulnerability yields the risk (Reese & Schmidt 2008, p.5)

- In the context of coastal hazard Risk Assessment (NZCPS Policy 24), the consequences are erosion and inundation and the likelihood quantifies the degree of exposure to the hazard.

https://niwa.co.nz/natural-hazards/hazards/risk-and-vulnerability

# Parliamentary Commissioner for the Environment (PCE, 2015) on Risk Assessment versus Risk Management

*"Also needed is a clear distinction between the role of technical analysts who undertake coastal risk assessments and the role of the decision-makers who sit around council tables.*

*"Because current government policy on sea level rise emphasises the need to take a 'precautionary approach', technical analysts have been embedding 'precaution' into coastal risk assessments to varying degrees. This takes various forms such as assuming 'high end' amounts of sea level rise.*

*"But undertaking a coastal risk assessment is very different from designing a building or a bridge where redundancy and safety factors are intrinsic to the design. Technical assessments of coastal risk should be based on best estimates of all the parameters and assumptions that are fed into the modelling. Decision-makers should then take the modelling outputs including estimates of uncertainty, and then openly and transparently decide how cautious to be in delineating hazard zones"*

Preparing New Zealand for rising seas:

Certainty and Uncertainty

November 2015

Parliamentary Commissioner for the Environment

Te Kaitiaki Taiao a Te Whare Pāremata

(PCE, 2015, 'Overview', p. 6).

# Parliamentary Commissioner for the Environment (PCE, 2015) on Risk Assessment versus Risk Management

## 8.5 Separating scientific assessment and decision-making

*"During this investigation, it has become clear that precaution is being embedded into scientific assessments of coastal hazards, sometimes to an extreme extent.*

*In the Kapiti situation, Justice Williams concluded that there was "a good argument" for describing the result of the coastal assessment as the "very worst case scenario"*[1]. *Judgements, such as those involved in adding safety margins or setting restrictions on development, should be made transparently by decision-makers, not rolled into technical assessments.*

*The standard results of running a coastal hazard model should instead be probability distributions with most likely values and ranges of potential values expressed with a level of confidence"* (PCE, 2015, p.77).

[1] *Weir v Kapiti Coast District Council* [2013] NZHC 3522, at para 71

Preparing New Zealand for rising seas:

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November 2015

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Te Kaitiaki Taiao a Te Whare Pāremata

Jacobs (2021) does not provide probability distributions; it uses unlikely values within the range of values expressed; and it has embedded precaution in using multiple conservative assumptions and models.

# The key aspects of Risk Identification/Assessment under NZCPS Policy 24 that Jacobs (2021) does not give effect to.

The work of Jacobs and planning law – objective physical science

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taking into account national guidance and the best available information on the likely effects of climate change on the region or district.

1. The work fails to incorporate the best available information
2. The work fails to assign probabilities and embeds hidden conservative assumptions

# TABLE OF CONTENTS

## Legal matters not given effect to in Jacobs 2021

# Policy 24: Identification of coastal hazards

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## Legal matters not given effect to in Jacobs 2021

# Best available information on the likely effects of climate change

Climate Change Science

Assessment Reports (ARx)
Working Group 1, The Physical Science Basis – most recent report being AR6 (August, 2021)

Climate Change Policy

Convention of Parties (COPx)
UN Member States – most recent COP26 held in Glasgow, Scotland (November, 2021)

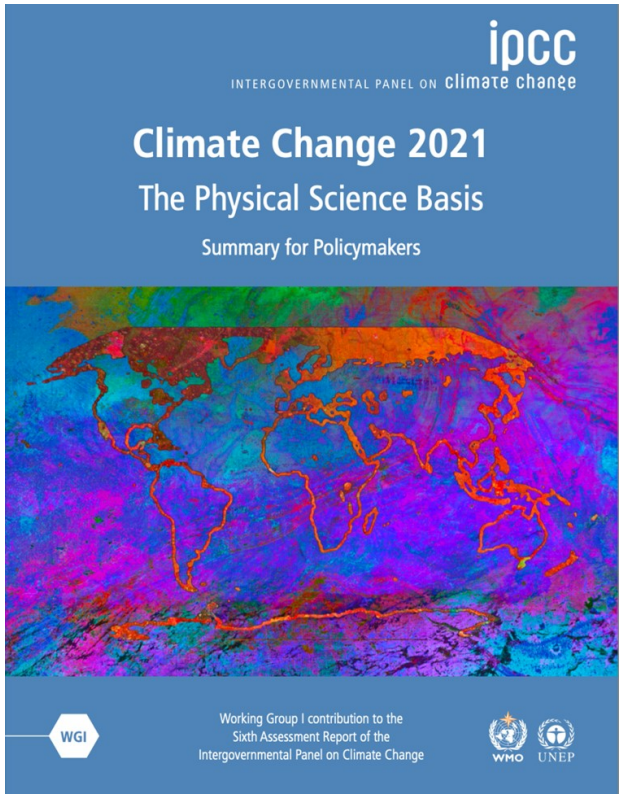
Jacobs (2021) has been prepared based on IPCC AR5 (2014) and updated to include changes from IPCC (2019).[2] Jacobs (2021) has not (at this stage) been updated to take into consideration the most recent IPCC AR6 (2021) findings.

[2] IPCC (2019). Special Report on the Ocean and Cryosphere in a Changing Climate: Summary for Policymakers.

## Legal matters not given effect to in Jacobs 2021

# Best available information – IPCC AR6 (2021)

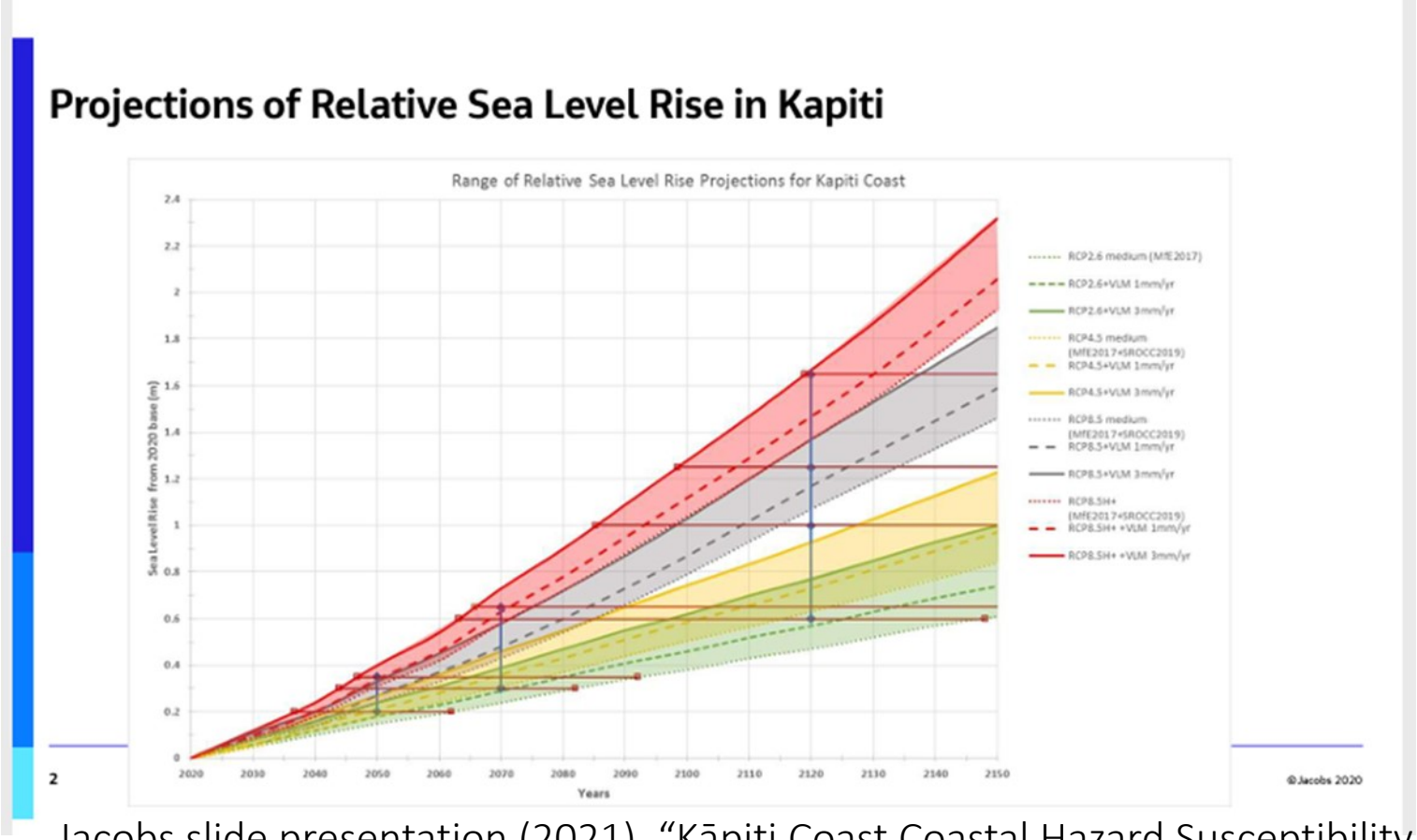
- IPCC AR6 (2021) provides many new and revised understandings in the science of climate change since IPCC AR5 (2014) was published.
- The IPCC assigns probabilities to its scenarios. These scenarios (called RCPs, Representative Concentration Pathways) have been complemented by a new metric, called narratives (called SSPs, Shared Socioeconomic Pathways).
- For the purpose of risk assessment under NZCPS Policy 24, a change by the IPCC to the assignment of probability for RCP8.5 is materially important.
- RCP8.5 is now considered "implausible to unfold" and it is included in AR6 only "for comparison between emission-driven (SSPs) and concentration-driven (RCPs) simulations".[3]
- Based on this, RCP8.5 (and RCP8.5H+) is an **unlikely** scenario and should not be used in risk assessment under NZCPS Policy 24.
- IPCC AR6 (2021) refers to SSP2-RCP4.5 as its best estimate (likely) scenario – and should be identified/used as such in the risk assessment.




[3] IPCC, AR6 WG1, Chapter 4, section 4.4.2. p. 13.

## Legal matters not given effect to in Jacobs 2021

# The effect of using RCP8.5 (and RCP8.5H+) is material




Jacobs slide presentation (2021), "Kāpiti Coast Coastal Hazard Susceptibility and Vulnerability Assessment Volume 1: Methodology", slide 2.

Two projections of relative sea level rise for Kāpiti in Jacobs (2021) are based on RCP8.5 (pictured in blue) and RCP8.5H+ (pictured in red).

Based on IPCC AR6 (2021) these RCP scenarios should be <u>excluded</u> and projections for Kāpiti should be updated accordingly.

## Legal matters not given effect to in Jacobs 2021

# The effect of using RCP8.5 (and RCP8.5H+) is material

### Projections of Relative Sea Level Rise in Kapiti

| Year | Lower Projection of RSLR since 2020 | Intermediate Projection of RSLR since 2020 | Upper Projection of RSLR since 2020 |
|---|---|---|---|
| 2050 | 0.2 m | | 0.40 m |
| 2070 | 0.3 m | | 0.70 m (Erosion)<br>0.65 m (Inundation)[1] |
| 2120 | 0.6 m (Erosion)<br>0.65 m (Inundation)[(1)] | 1.0 m, 1.25 m | 1.65 m |

[1]For inundation, the extent of the hazard is less sensitive to the timing of SLR. Therefore, a rise of 0.65 m has been applied as the upper projection for 2070 and the lower projection for 2120.

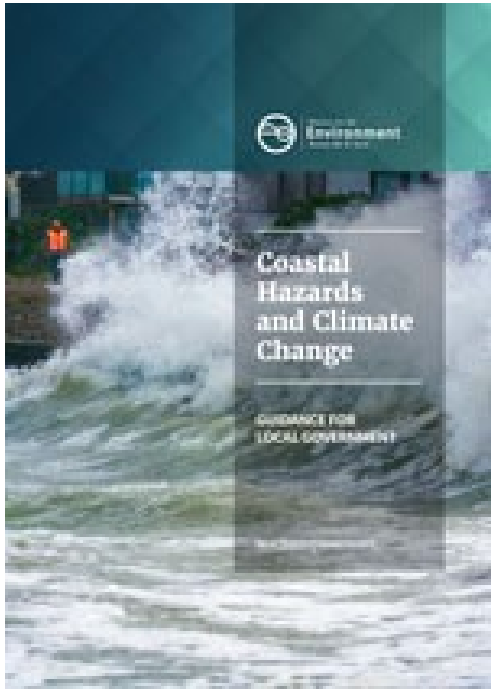
Jacobs slide presentation (2021), "Kāpiti Coast Coastal Hazard Susceptibility and Vulnerability Assessment Volume 1: Methodology", slide 3.

And consequently, the classifications (lower, intermediate, upper) in meters are not likely and this table should be updated accordingly.

These values do not represent "the likely effects of climate change" as required by NZCPS Policy 24.

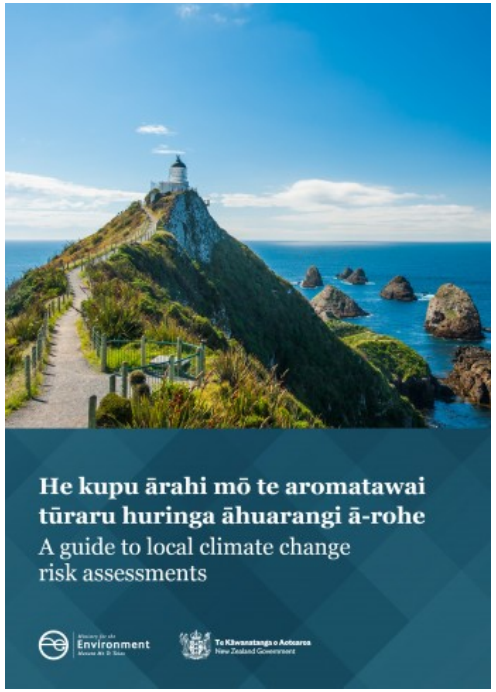
National Guidance

# Best Available Information – MFE (2021)




This guidance supports councils to manage and adapt to the increased coastal hazard risks posed by climate change and sea-level rise.
(MfE, 2017)

This guide sets out a climate change risk assessment framework for local use, which is broadly consistent with the National Climate Change Risk Assessment Framework.
(MfE, 2021)




Jacobs (2021) cites the former (MFE, 2017) but not the latter (MFE, 2021).
MFE (2021) no longer recommends use of the RCP8.5H+ SLR scenario.
Both will be updated with respect to IPCC AR6 findings (MFE, 2021 acknowledges this).

# TABLE OF CONTENTS

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## Legal matters not given effect to in Jacobs 2021

# Likelihoods – and the distribution of hazard risks

NZCPS Definition of Risk

Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.
(AS/NZS ISO 31000:2009 Risk management – Principles and guidelines, November 2009).

- Jacobs (2021) fails to address the NZCPS requirement to assign **likelihood(s) of occurrence** to the different scenarios used in their assessment.
- The assignment of probabilities (i.e., likelihoods) is a requirement of the identification of coastal hazards (i.e., risk assessment) under NZCPS Policy 24.
- Specifically, NZCPS Policy 24 refers to identifying areas "potentially affected" by coastal hazards, particularly those areas at "high risk of being affected" - taking into consideration the "likely effects" of climate change.
- All these words (e.g., potentially, high, likely) require the assignment of probabilities, based on a "best estimates and distribution of the hazard risks" (PCE, 2015, p.77). For example, 'a 1 in 10 chance of erosion and/or inundation occurring in an area within the next 10 years' would be considered a "high risk" area.
- And importantly, **unlikely** climate changes (for example, unlikely sea level rise scenarios) **should be set aside** (i.e., not considered in the technical analysis of risk).

## Legal matters not given effect to in Jacobs 2021

# Likelihoods – and the distribution of hazard risks

*"Importantly, the requirement to take into account national guidance and the best available information on the likely effects of climate change on the region/district is taken to apply to all of the subclauses of Policy 24 (i.e. (1)(a)(h)).*" (DOC, 2017, p.30)

9

### The work of Jacobs and planning law – objective physical science

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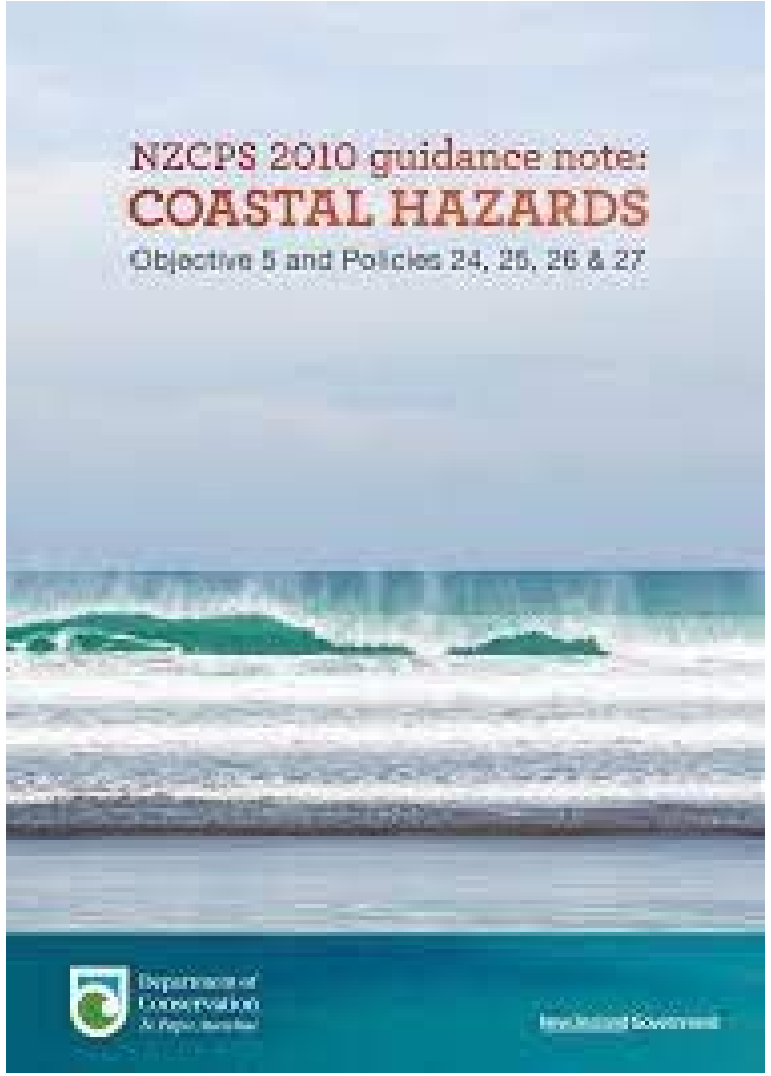

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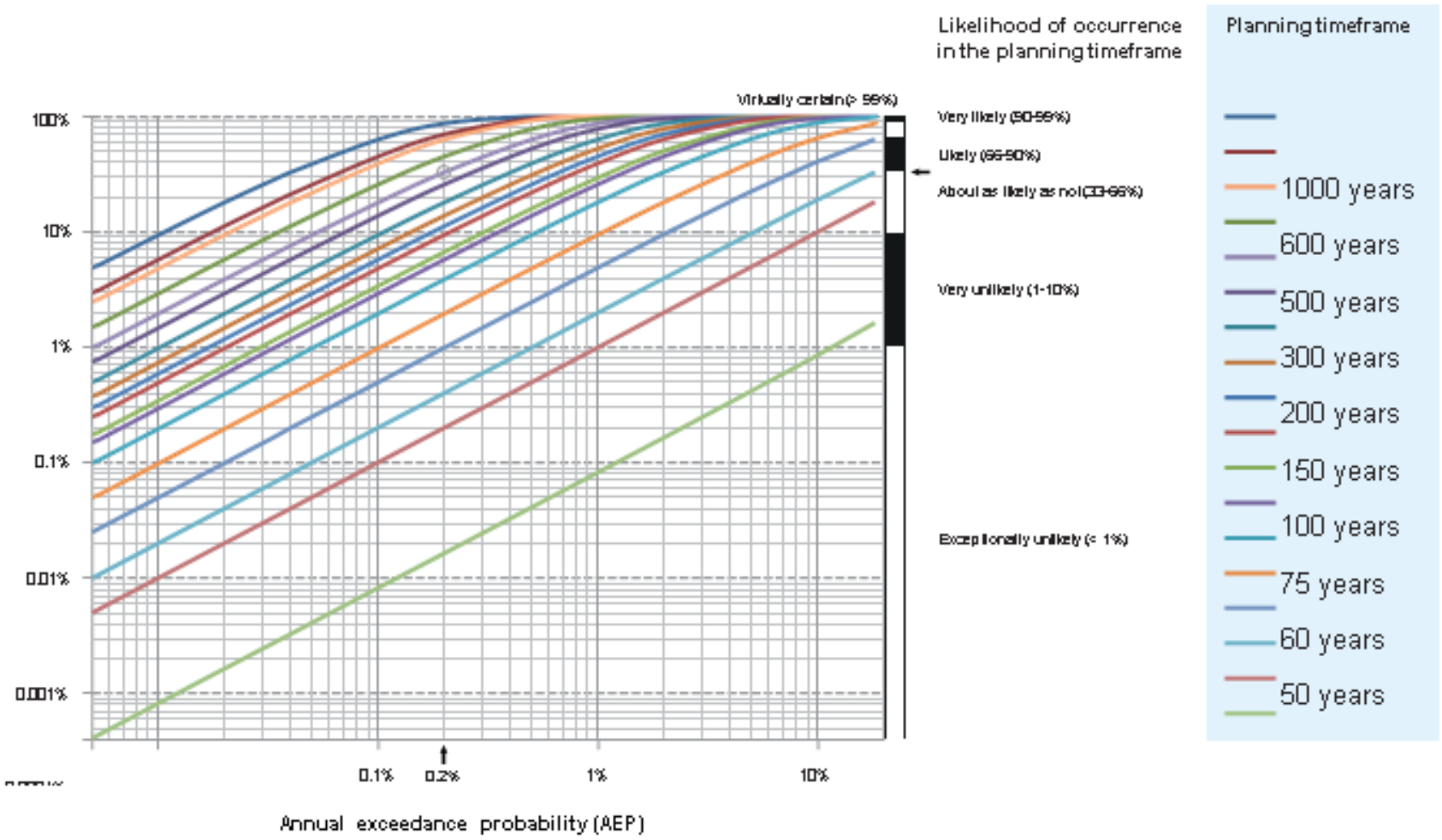
# Likelihoods – and the distribution of hazard risks




Likelihood of occurrence of different annual exceedance probability (AEP) events over planning timeframes ranging from 30 days to 1000 years. For example, in a 200 year planning timeframe, an area is "potentially affected" by a 0.2% AEP event.

**Likelihood of occurrence**

Virtually certain (>99%)
**Very likely (90-99%)** High
**Likely (66-90%)** Medium
About as likely as not (33-66%)
**Potentially (33%)** Low
Unlikely (10-33%)
Very unlikely (1-10%)
Exceptionally unlikely (<1%)

BOPRC (n.d.). Natural Hazard Risk Assessment User Guide, p.17 and DOC (2017) Guidance Note: Coastal Hazards, Section 3.2.pp.14-17.

## Legal matters not given effect to in Jacobs 2021

# Embedding precaution: e.g., the Bruun Rule

*"During this investigation, it has become clear that precaution is being embedded into scientific assessments of coastal hazards, sometimes to an extreme extent"* (PCE, 2015, p.77).

Preparing New Zealand for rising seas:
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November 2015

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Paremata

Jacobs (October 5, 2021). Memorandum Response to CRU comments on Volume 1 Methodology Report, p. 1

*CRU make as a general statement, that they "have been struck by the pervasiveness of "conservative" approaches presented in the report", and list the Bruun rule, coastal inlet migration, the bathtub model, extreme sea levels, and groundwater levels as being methods of particular concern.*

*We note that in each of these sections of our Volume 1 Methodology Report we have stated in the report that there is a degree of conservativeness in the method.*

*However, we reject the notation that there is a strong conservative bias to the assessment approach as these methods are only a small subset of the total assessment and in most cases there are no alternative methods for the data that is available.*

## Legal matters not given effect to in Jacobs 2021

# Embedding precaution: e.g., the Bruun Rule

Jacobs (October 5, 2021). Memorandum Response to CRU comments on Volume 1 Methodology Report, p. 2

*"General limitations of the Bruun Rule: While the limitations are recognised, the Bruun Rule is an internationally well used method for assessing the erosional effect of sea level rise (SLR) on sandy beach environments; has been used in the majority of coastal hazard assessments in New Zealand; and has been accepted as an appropriate method by the Environment Court"* (Jacobs (2021). Response…p.2).

Incorrect. Scientific understanding has moved on considerably since then with respect to assessment of longshore sediment transport. The scientific literature now points out that use of the Bruun Rule (1962) exaggerates the impacts of SLR on sandy beaches, such as those on the Kāpiti Coast, e.g.,

Robin G.D. Davidson-Arnott and B.O. Bauer, (2021). Controls on the geomorphic response of beach-dune systems to water level rise, *Journal of Great Lakes Research* (in press)

Rosati, J.D., Dean, R.G. and Walton, T.L. (2013). The modified Bruun Rule extended for landward transport. *Mar. Geol*. 340: 71-81

Cooper, J.A. and Pilkey, O.H. 2004. Sea-level rise and shoreline retreat: time to abandon the Bruun Rule. *Global Planetary Change* 43: 157-171

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Jacobs (October 5, 2021). Memorandum Response to CRU comments on Volume 1 Methodology Report, p. 2

*"General limitations of the Bruun Rule: While the limitations are recognised, the Bruun Rule is an internationally well used method for assessing the erosional effect of sea level rise (SLR) on sandy beach environments; has been used in the majority of coastal hazard assessments in New Zealand; and has been accepted as an appropriate method by the Environment Court"* (Jacobs (2021) Response..., p.2).

Incorrect. The Environment Court considerations regarding use of the Bruun Rule are historical (not recent). Both cases are dated prior to NZCPS 2010 being brought into law, and moreover - ;

- Skinner v Tauranga District Council (A 163/2002) in part turned on whether the beach was a closed system justifying the use of Bruun. In the event the Court determined it was, accepting the use of Bruun. Had it not been a closed system the Bruun rule was clearly at risk in the Court's mind.
- Fore World Developments Ltd v Napier City Council (W 029/2006) addressed whether Bruun could be used on a gravel beach and determined its underlying assumption was reasonable for "our purposes". No evidence was given on open and closed systems.

http://www.nzlii.org/cgi-bin/sinodisp/nz/cases/NZEnvC/2002/288.html?query=163/02
http://www.nzlii.org/cgi-bin/sinodisp/nz/cases/NZEnvC/2006/120.html?query=029/06

Kāpiti is an open (not closed) coast with a sandy (not gravel) beach

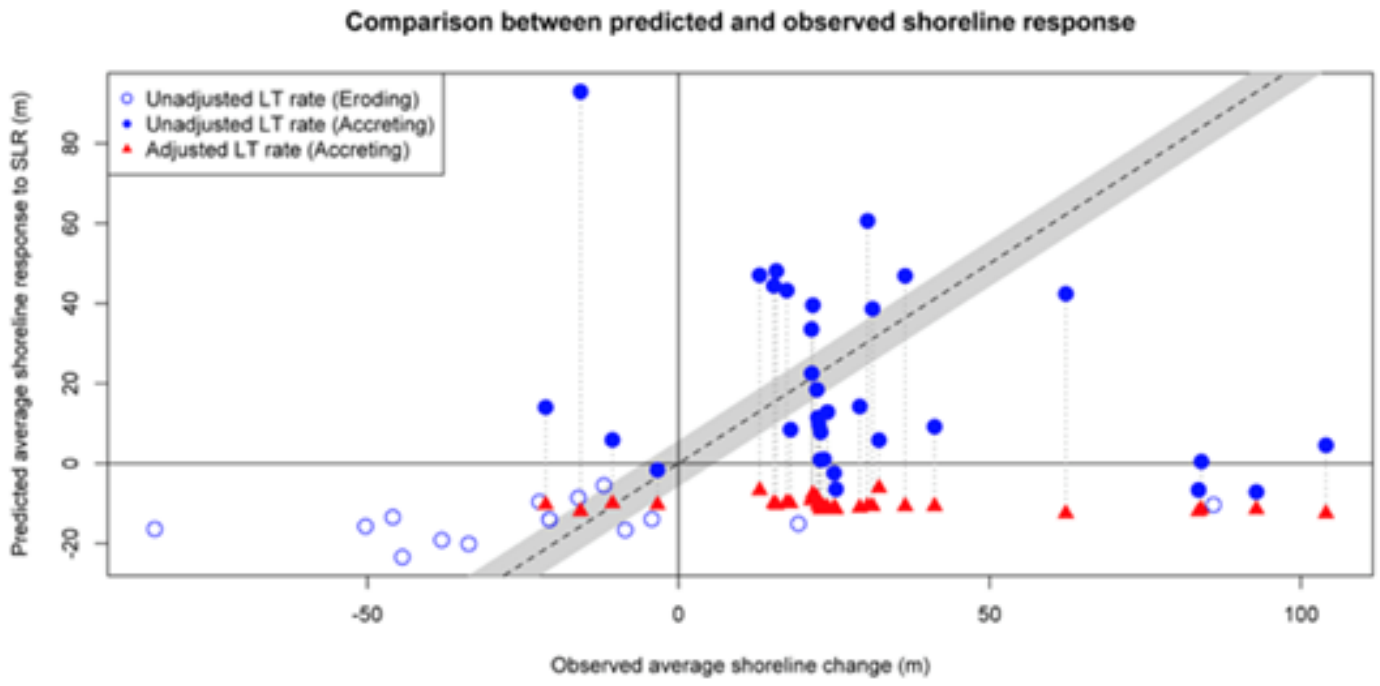
Legal matters not given effect to in Jacobs 2021

# Embedding precaution: e.g., the Bruun Rule

(In)validating use of the Bruun Rule – Jacobs (2021) includes no method/intent regarding validation

## Hindcast coastal erosion

- I applied methodology to 47 sites without seawalls to predict shoreline change over 1950-2007
- Compared this to observed shoreline changes – No skill evident




- The solid circles are observed trends for Kāpiti sites that accreted over the data period (all north of Paraparaumu Boat Club) and those eroding (without sea walls).
- 3 out of 47 sites fall within the shaded area [Shand, 2014] <u>indicating a skill of ~6%, which is much worse than tossing a coin</u>.
- To make it less credible the 3 data points that fit would only do so for the <u>Bruun Rule</u> if sea level fell over the historical period.

Evidence presented in *Weir v Kapiti Coast District Council* [2013] NZHC 3522

## Legal matters not given effect to in Jacobs 2021

# Embedding precaution: alternative methods

*"During this investigation, it has become clear that precaution is being* *embedded into scientific assessments* *of coastal hazards, sometimes to an extreme extent"* (PCE, 2015, p.77).

Preparing New Zealand for rising seas:
Certainty and Uncertainty

November 2015

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

Jacobs (October 5, 2021). Memorandum Response to CRU comments on Volume 1 Methodology Report, p.1

*"However, we reject the notation that there is a strong conservative bias to the assessment approach as these methods are only a small subset of the total assessment* *and in most cases there are no alternative methods for the data that is available".*

Incorrect. The 'unavailable' data referred to is an instrumentally measured sediment budget. However, there are more robust methods to derive (model) sediment budgets on the Kāpiti Coast and the data needed to use those methods *is* available.

Legal matters not given effect to in Jacobs 2021

# Embedding precaution: alternative methods

## The One-Line Concept/Model

**Dr Willem de Lange recommends:**

As a first attempt I would simplify the one-line model to ignore wave conditions and only work on annual estimates of sea level rise and sediment transport.
For each cell starting in the north, do the following
1) Use the year's sea level rise to calculate the volume now available to deposit sediment in (volume below new sea level)
2) Take the sediment input into the cell, deposit the required volume, and pass any residual volume to the next cell to the south
3) Repeat steps 1 & 2 until all the sediment is accounted for.
4) Flag any cells with remaining available space (all at southern end if any exist) as having a sediment deficit. Top them up by eroding the coast to provide sufficient volume
5) Repeat for the next year

# TABLE OF CONTENTS

# Summary - RMA/NZCPS

- RMA legislation dictates that District Plans are bound by the higher plans and policy statements - therefore Council must legally implement the general policy requirements set out in the NZCPS
- Considerations regarding the potential options for management of coastal hazards must be based on a risk assessment that “gives effect to” NZCPS Policy 24
- Any risk assessment used to develop recommendations regarding adaptation options for District Plan guidance must meet the legislative requirements of the NZCPS

# Summary – Jacobs, 2021

- In describing their Scope of Works, Jacobs (2021) explain that *Volume 1: Coastal Hazard Susceptibility and Vulnerability Assessment: Methodology* is not a risk assessment (p.8, para 1)
- Jacobs (2021) does not differentiate between risk assessment (NZCPS Policy 24) and risk management (NZCPS Policy 25 and 27)
- Jacobs (2021) does not provide probability distributions: It uses unlikely values in the range of values expressed and it has embedded precaution – i.e., used multiple "conservative" scenarios, assumptions and models
- Jacobs (2021) needs to be updated to reflect the most recent IPCC AR6 (2021) information, most importantly, to reflect the IPCC stance that RCP8.5 is "implausible" (unlikely) and that RCP4.5 is the IPCC's best estimate (likely) scenario
- In particular Jacobs (2021) use of RCP8.5H+ is not recognised internationally (it is a New Zealand construct only used in MFE (2017)) and any local guidance regarding RCP8.5H+ has now been rejected in this application by MFE (2021)

# TABLE OF CONTENTS