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Climate Change Flood Impact Estimation on a National Scale

Pattle Delamore Partners | Z Energy Limited

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The New Zealand Water & Wastes Association Waiora Aotearoa

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Flooding in Auckland looking from Beach Rd at the bottom of Parnell towards the Auckland Domain. Photo / Tom McCondach

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A changing world

The Financial Sector (Climate-Related Disclosures and Other Matters) Amendment Act 2021 amended the Financial Markets Conduct Act 2013 (the Act) to make it mandatory for climate-reporting entities (CREs) to prepare and lodge climate-related disclosures.

The XRB issued the Aotearoa New Zealand Climate Standards framework in December 2022. The framework provides a consistent approach for NZ business to consider their climate-related risks and opportunities

The ultimate aim of the Aotearoa New Zealand Climate Standards is to support the allocation of capital towards activities that are consistent with a transition to a low-emissions, climate-resilient future.

What's involved?

Governance – the role of board and management in overseeing climate-related risks and opportunities

Strategy – the impacts of climate-related risks and opportunities on the entity's business model, strategy and financial planning, including through use of scenario analysis

Risk Management – how climate-related risks & opportunities are identified, assessed and managed

Metrics & Targets – how climate-related risks & opportunities are measured

Climate-related risks, opportunities & financial impact

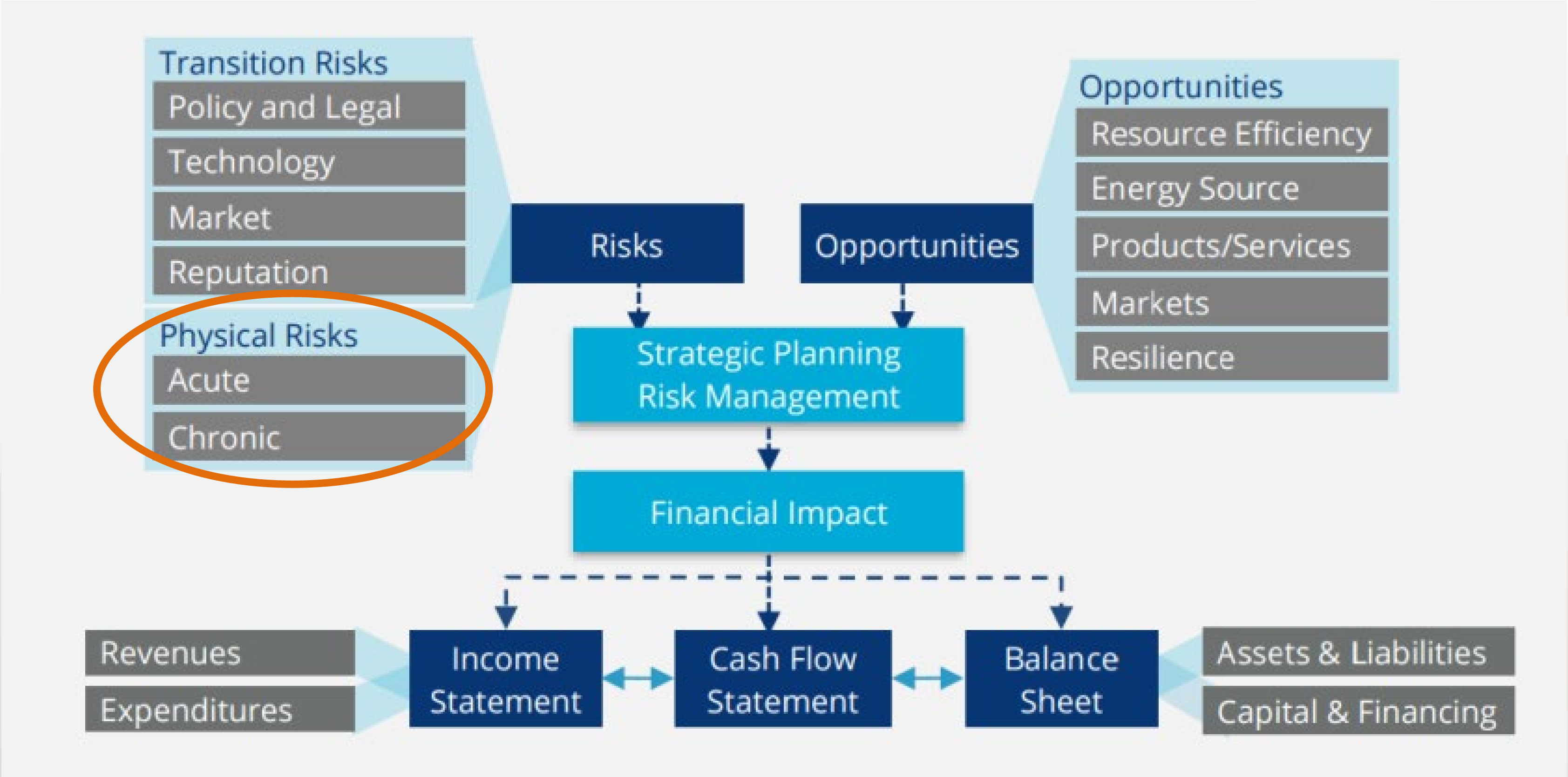
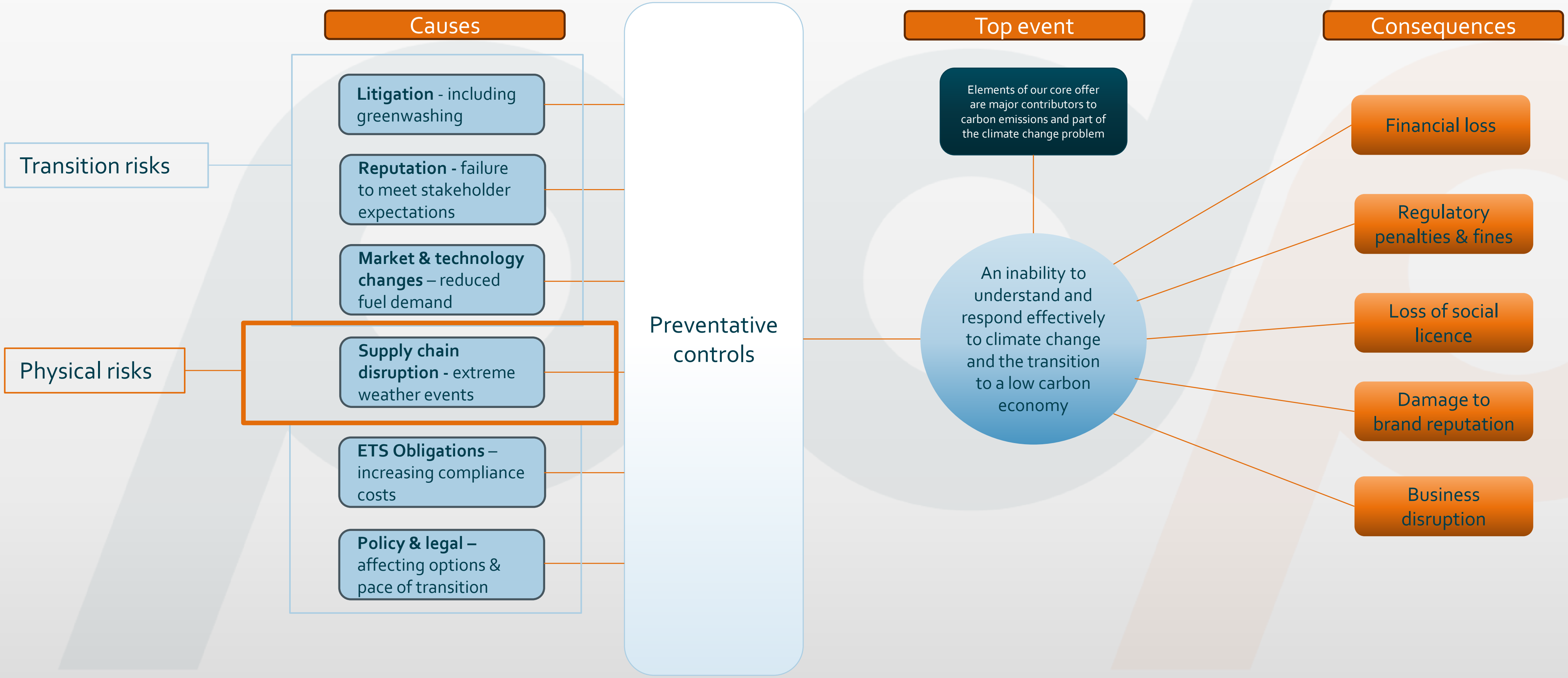


Figure 3, Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures, TCFD, October 2021

Z Energy climate-related risks

Impacts of climate change – simplified risk bow-tie



Z’s approach to physical risk assessment

1. Conduct a qualitative assessment of the physical climate impacts relevant to Z’s business. Completed alongside PDP in the form of an engineering HAZOP style assessment – but with a climate impacts focus.

2. Use Z’s Enterprise Risk Management (ERM) framework to assess the materiality of each impact identified and integrated into the framework accordingly.

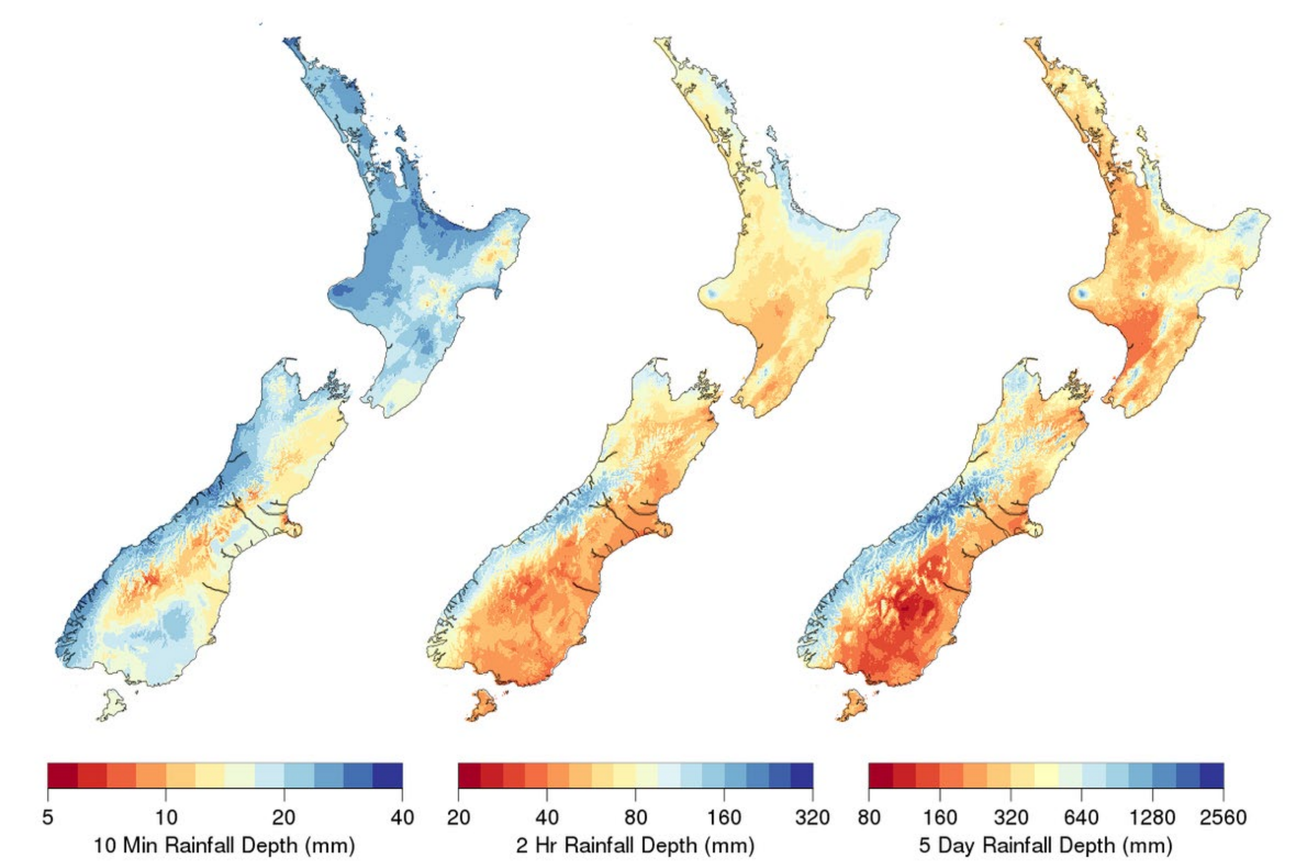
3. Refine the assessment to an asset level through conducting a quantitative nationwide screening assessment to ascertain which assets are likely to be exposed to physical climate impacts under three temperature aligned scenarios.

4. Quantify the anticipated financial impact (e.g. potential damage costs) of the main climate indicators applied in PDPs assessment, in addition to extreme weather across Z’s assets, completed by PwC.

5. Apply material findings to Z’s ERM and refine for disclosure.

Today we are discussing:

- Developing our methodology
- Data sources with a specific focus on precipitation, sea level rise and flood data
- Data gaps, limitations and considerations
- Future datasets!



100-year return period rainfall depths for 10-minute, 2-hour and 5-day duration events (NIWA HIRDSv4, 2018)

The Method – Climate Risk and Impact Definitions

- The IPCC defines a climate impact driver as *"natural or human-induced climate events or trends that may have an impact (detrimental or beneficial) on an element of society or ecosystems".* (Reisinger, et al., 2020).

- A climate risk on the asset is interpreted as:

Climate risk = climate related hazard x exposure x asset vulnerability

- The assessment approach used identified climate impact drivers at the location of each asset but does not incorporate a vulnerability assessment to determine the resilience of assets in tolerating climate impact drivers.

Assessment Parameters

Timeframes:

Disclosures for risks and opportunities to the business over the short, medium, and long term are required. For this <u>initial</u> assessment, Z selected the following timeframes for the assessment as follows:

- Present Day
- Short-term: 2025
- Mid-term: 2030
- Long-term: 2040

Climate Impact Drivers:

These key drivers were identified in the early qualitative assessment & subsequent revisions as:

- Drought
- Wind
- **Precipitation (including snow & flooding)**
- **Sea level rise (including flooding)**

Assessment Parameters

Climate Scenarios:

Three different climate scenarios are required, a:

- 1.5 degrees Celsius climate-related scenario;
- 3 degrees Celsius or greater climate-related scenario; and
- third climate-related scenario.

Z selected Representative Concentration Pathway 2.6 (RCP2.6) meeting the required 1.5 degrees scenario, the RCP8.5 meeting the required 3 degrees or greater scenario and the RCP4.5 meeting the 'additional' scenario.

IPCC AR5 WG1 (IPCC Fifth Assessment Report , Working Group 1) RCP scenarios were chosen to as these aligned with NIWA's regional climate model projection grids applied in this assessment.

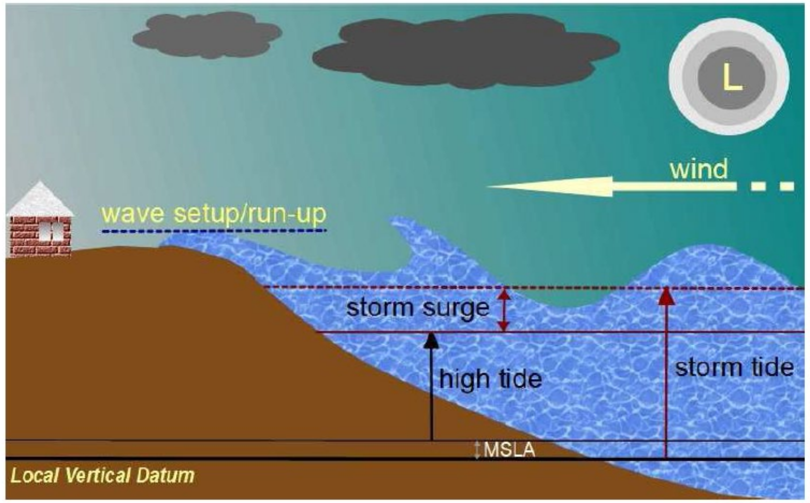
Notably IPCC Sixth Assessment Report, Working Group 1 (AR6 WG1) presents projected changes in the global climate corresponding to several Shared Socioeconomic Pathways (SSPs). AR6 SSPs and AR5 RCPs are not strictly comparable.

Projected global mean warming in 2081-2100, relative to 1850-1900, in AR5 and AR6 (Bodeker, 2022)

End-of-century nominal radiative forcing (Wm^{-2})	Warming in 2081-2100 (°C) under RCP scenarios (likely range; AR5 table SPM.2)	Warming in 2081-2100 (°C) under SSP scenarios (very likely range; AR6 SPM table B.1.2)
2.6	1.6 (0.9-2.3)	1.8 (1.3-2.4)
4.5	2.4 (1.7-3.2)	2.7 (2.1-3.5)
8.5	4.3 (3.2-5.4)	4.4 (3.3-5.7)

Climate Data

Example raster GIS grid for climate projections



Schematic diagram of tidal, weather and climate components contributing to extreme sea-levels and storm-induced coastal flooding (Ministry for the Environment, 2017)

NIWA
Taihoro Nukurangi

NZ SEA RISE
TE TAI PARI O AOTEAROA

CoreLogic®

AMBIENTAL
RISK ANALYTICS

Sources Used:

NIWA High Intensity Rainfall Design System (HIRDS)

NIWA New Zealand Drought Monitor

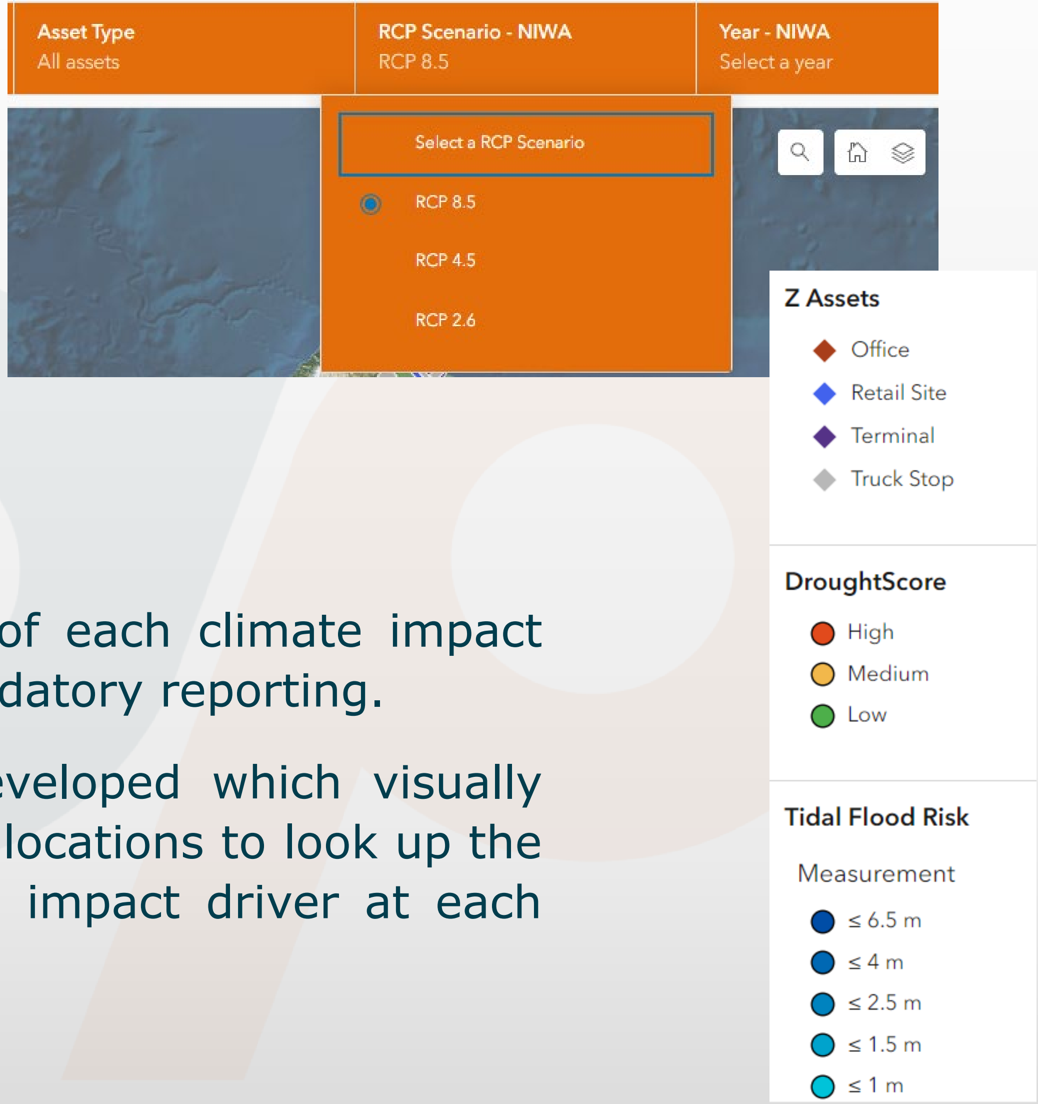
Climate change GIS grids from NIWA's regional climate model (temperatures, hot, dry & heatwave days, various rainfall data, snow, potential evapotranspiration deficit, winds)

NZ SeaRise: Te Tai Pari O Aotearoa programme

CoreLogic New Zealand Flood Map dataset for approximate depth information for River, Tidal and Surface Water flood layers for various Annual Exceedance Probabilities (AEPs)

Geospatial Analysis

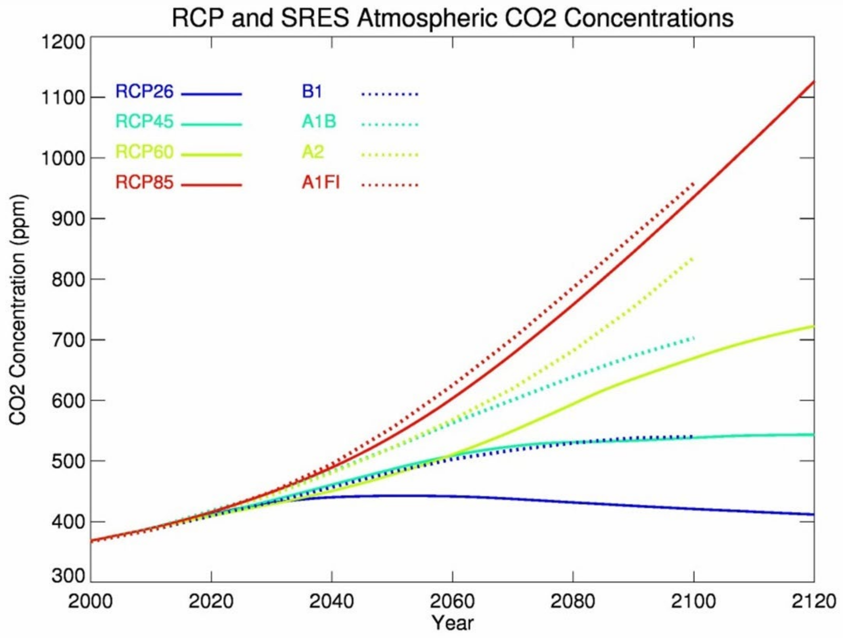
- Using Esri's ArcGIS software, data was processed to gain a spatial understanding of climate change risk.
- The data for climate impact drivers was extracted to provide site-specific results for each of the parameters to determine projected impacts of climate change at each asset location.



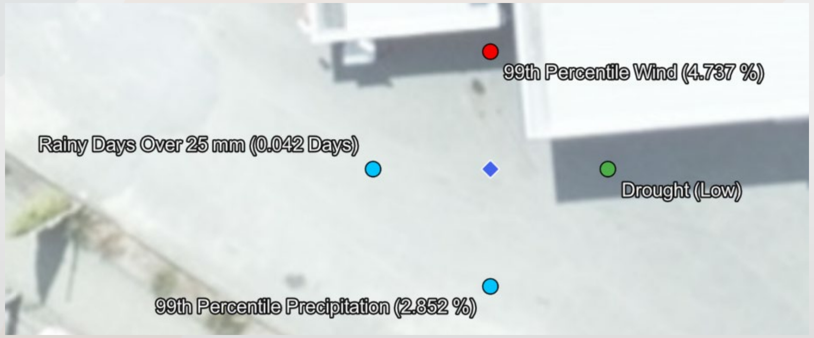
- Associated risk (or indication of exposure changes) of each climate impact driver was identified and interpreted to inform Z's mandatory reporting.
- An interactive online geospatial web viewer was developed which visually showcased the data and allows Z to navigate between locations to look up the relevant exposure risks associated with each climate impact driver at each asset.

Flood Analysis

- At the time of analysis, the CoreLogic New Zealand Flood Map dataset did not include climate change projections which means future pluvial and fluvial exposure can only be predicted by current exposure
- SLR was assessed by combining the NZ SeaRise data available publicly, with the CoreLogic tidal flooding datasets. The p50 SLR data for 2040 was extracted and added to the flood depth value.
- Only the RCP8.5 (SSP5-8.5) + VLM 2040 scenario was assessed due to the lack of divergence between the scenarios over this relatively short timeframe



Atmospheric carbon dioxide concentrations for the IPCC Fourth Assessment (dotted lines, SRES concentrations) and for the IPCC Fifth Assessment (solid lines, RCP concentrations) [NIWA]



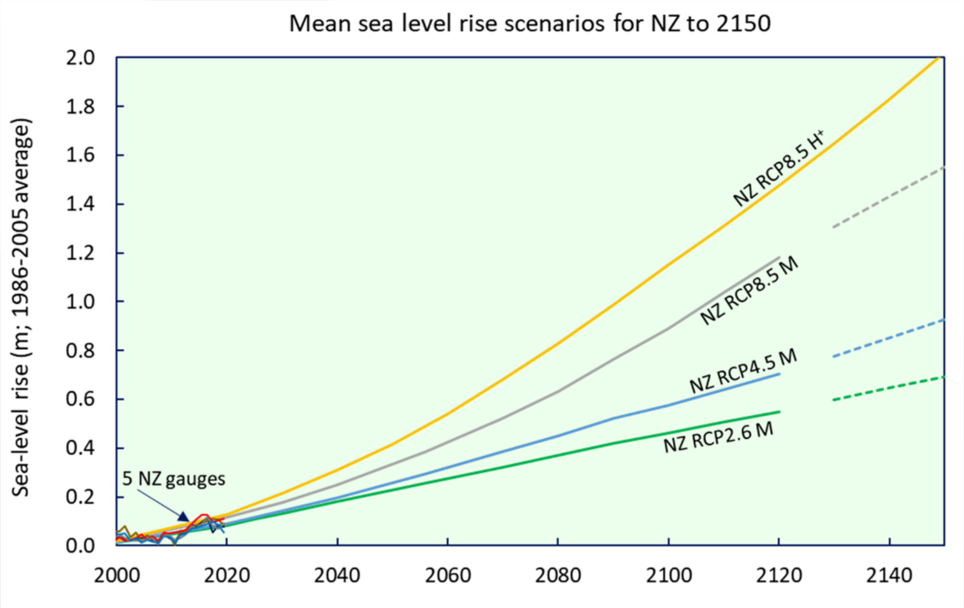
Example of results for an individual asset

Flood Analysis Limitations

- **National Scale?** - Resolution of data is coarser. The limited access to accurate elevation data is also a major limitation. Regional models may give better granularity but cannot always be used on a directly comparable basis and therefore a national model gives consistency.

- **Pluvial & Fluvial Data?** - Hydrological river (fluvial) modelling has shown a -40% to +40% change in river flows across the country with climate change (NIWA, 2018).

- **Tidal Flooding and SLR?** - An additive approach of SLR to existing tidal flood depths is a grossly simplified approach to approximate future tidal flooding with a high level of uncertainty. The combined effects of storm surge and tidal influences (which are both location specific) mean that even small increases in SLR will result in a given threshold being reached or exceeded much more frequently.



Source: https://niwa.co.nz/natural-hazards/hazards/sea-levels-and-sea-level-rise

Satellite-based altimeters measure absolute SLR: The diagram above shows sea level being measured by altimeters installed on board orbiting satellites. When calculating the average global SLR to date, using tide gauges from around the world, adjustments to each dataset are needed to account for the local vertical land movement.

Flood Analysis Limitations

Rough seas at Timaru. Credit: NZ Herald (https://niwa.co.nz/natural-hazards/hazards/coastal-storm-inundation)

This existing screening methodology is limited by available information and data.

While it has served a great & functional purpose to assist Z to understand risk to assets at a high level, we look forward to incorporating future datasets to make improvements!

We hope future work will incorporate more appropriate estimation of future pluvial and fluvial flooding with increased rainfall intensity as well as tidal flooding with incorporated sea level rise predictions.

Better datasets on the horizon?

- **CoreLogic** are in the process of incorporating 3 different **Ambiental Risk Analytics** potential emissions pathways
- **NIWA Extreme coastal flood maps** for Aotearoa New Zealand (released May 2023)
- The **NIWA "Mā te haumaru ō ngā puna wai ō Rākaihautū ka ora mō ake tonu" program**
- **Regional and district council modeling** for locations
- It is likely that a number of **other flood estimation datasets** and tools will emerge from different entities in addition to the above-mentioned data

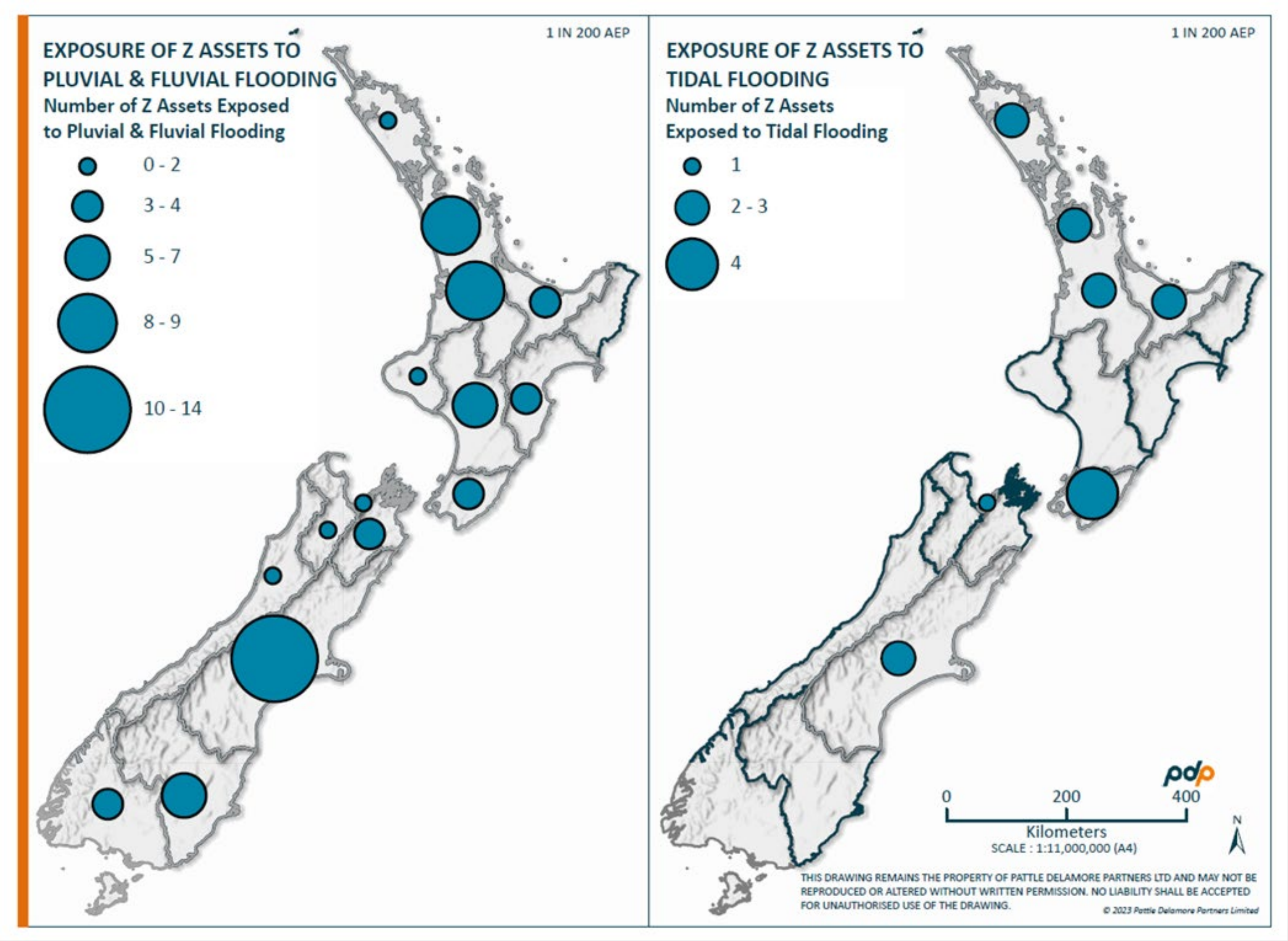
The name of this programme, "Mā te haumaru ō ngā puna wai ō Rākaihautū ka ora mō ake tonu" acknowledges an ancestor of Wairewa Rūnanga, who are partners in the research.

It translates to "By keeping the water of Rākaihautū safe the water will survive eternally". Rākaihautū was an ancestor who was said to traverse the South Island, digging and naming lakes as he travelled

Source: https://niwa.co.nz/natural-hazards/research-projects/m%C4%81-te-haumaru-%C5%8D-te-wai-increasing-flood-resilience-across-aotearoa#:~:text=The%20name%20of%20this%20programme,the%20water%20will%20survive%20eternally%E2%80%9D.

Application & Conclusions

- This assessment was undertaken to increase Z's knowledge of climate-related risks to assets as part of the transition to mandated climate reporting under the Aotearoa New Zealand Climate Standards (2022).
- Z can incorporate this in future planning for asset resilience, climate change adaptation and alongside scenario analysis to further assess transition risks.
- Results identified Z asset sites which may be at risk of exposure to sea level rise, pluvial/fluvial flood, increased precipitation intensity, drought or wind and were reported using an interactive geospatial viewer.
- This information, alongside inputs from PwC financial analysis, has led to further investigation of asset vulnerability at 'higher' risk locations.



Exposure of Z assets by region to pluvial, fluvial and tidal flooding for a 1 in 200 AEP

Where to go next?

- The isolated effects to an individual asset from a climate impact is only one story
- The cascading effects and wider business disruption need to be assessed. Therefore, next steps for physical impact assessment includes:
  - Physical impacts supply chain assessment including cascading effects
  - Deeper look at critical assets to better define the exposure to physical impacts, potential vulnerability and therefore risk of disruption
  - Case studies on recent climate events such as the Cyclone Gabrielle event to ascertain the real-life business disruption experienced and calibrate assessments to reflect
  - Pass this analysis onto financial professionals to estimate the anticipated financial impacts that may occur from climate-related supply disruptions in the future.

Pātai/Questions?

Thanks for listening

Whakawhetai mo te whakarongo

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