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Verification of a Probabilistic Coastal Erosion Hazard Line Assessment - Coromandel Peninsula (NZ)

PIANC APAC Conference – August 2024

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28 August 2024

Background	Coromandel Peninsula (NZ) shoreline management planning project background Coastal Erosion Hazard
PCHA Methodology	Basic coastal erosion components Values and distributions, PCHA methodology
CEH Lines Comparison Methodology	Cyclones Hale and Gabrielle Comparison methodology
Comparison Results	Results of hazard line comparison (predicted vs. actual) at selected beaches
Conclusion	Thank you and acknowledgement

Locality Plan

Thames Coromandel SMP Project

- **April 2019** RHDHV commenced the Thames Coromandel Shoreline Management Pathways (SMP) project for Thames Coromandel District Council (TCDC)
  - Framework for the management and reduction of risks associated with coastal hazards
- **September 2022** TCDC adopted the project outputs, including 138 Coastal Adaptation Pathways (CAP) covering the entire coastline of the district
  - Addressing short- and medium-term issues
- **October 2023** Review of modelled coastal erosion hazard lines and comparison to coastal erosion following extreme weather events in January and February 2023 (cyclone Hale and cyclone Gabrielle)

Coastal Erosion Hazard

- Thames Coromandel Shoreline Management Pathways (SMP) project
  - Focus on the Coastal Erosion Hazard (CEH) assessment
  - Approach: Probabilistic Coastal Hazard Assessment (PCHA) – as opposed to 'deterministic'
  - Extreme weather events (cyclones Hale and Gabrielle in early 2023) prompted a comparison of:
    - modelled coastal erosion hazard lines vs. actual coastal erosion

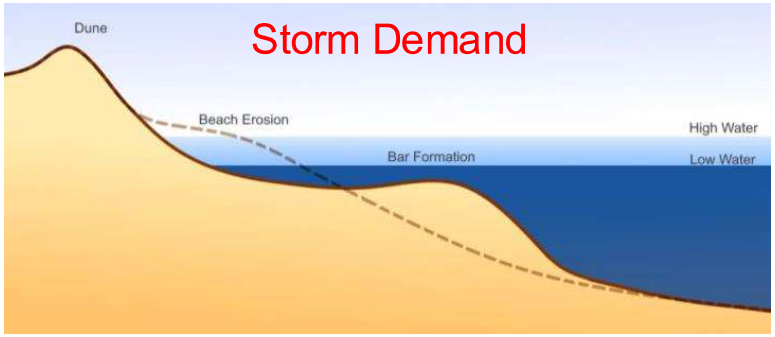
Coastal Erosion

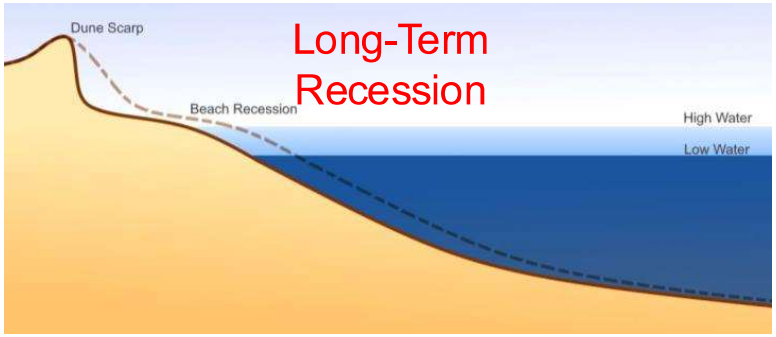
- Coastal erosion: response of shoreline position to several erosive processes occurring over varying timescales

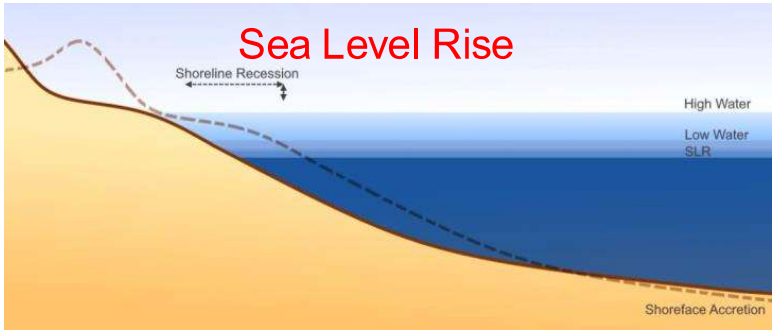
- Three (3) basic timescale components
  - Short-term erosion or ‘storm demand’ (SD)
  - Long-term erosion:
    - Long-term shoreline recession/progradation (LT)
    - Future shoreline response to sea level rise (SLR)

- Total Erosion Setback = SD + LT + SLR

Typical Responses







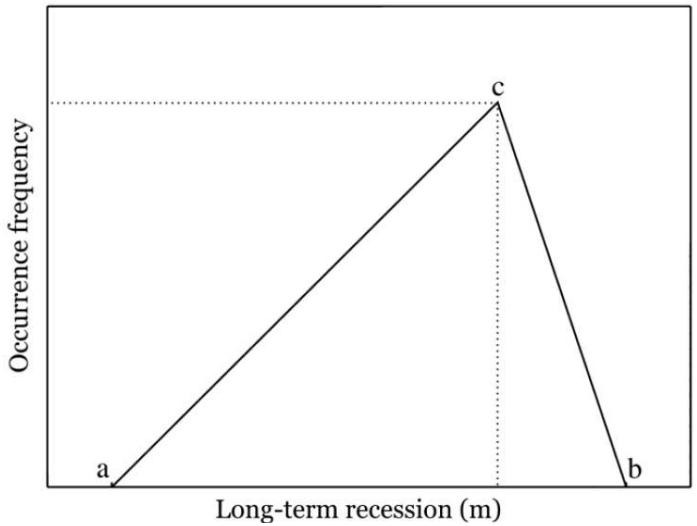
Coastal Erosion Hazard Assessment

- Traditionally: ‘deterministic’ approach
  - Each potential hazard (SD, LT, SLR) is assigned a single value
  - Generally conservative estimates applied (‘worst case’)

- In recent times: ‘probabilistic’ approach
  - A range of potential values used according to different probability distributions
  - Incorporate:
    - natural variability in erosion processes
    - inherent variability due to the limited understanding / lack of long-term data
  - More complete picture of risk

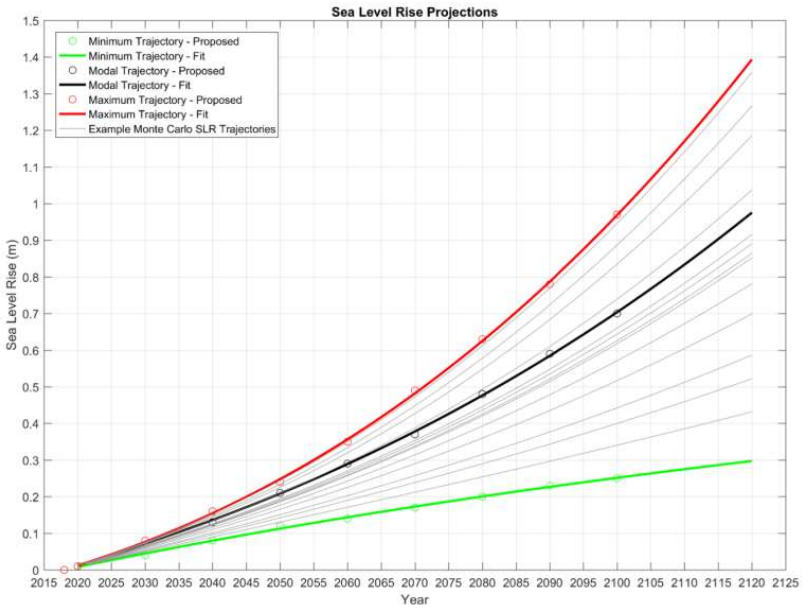
Values and Distributions - LT

- Long-term shoreline recession rates
  - Vary spatially (within beach compartment) and temporally (analysis period)
  - Estimated by analysis of a photogrammetry dataset spanning a sufficiently-long time period (shoreline movement → linear regression)
  - Triangular distribution (for unknown distribution)



Values and Distributions - SLR

- Shoreline response rates due to sea level rise
  - Shoreline recession due to re-adjustment of the beach profile
  - Function of SLR and beach slope
  - Defined by separate triangular probability distributions and minimum, maximum and peak/modal values



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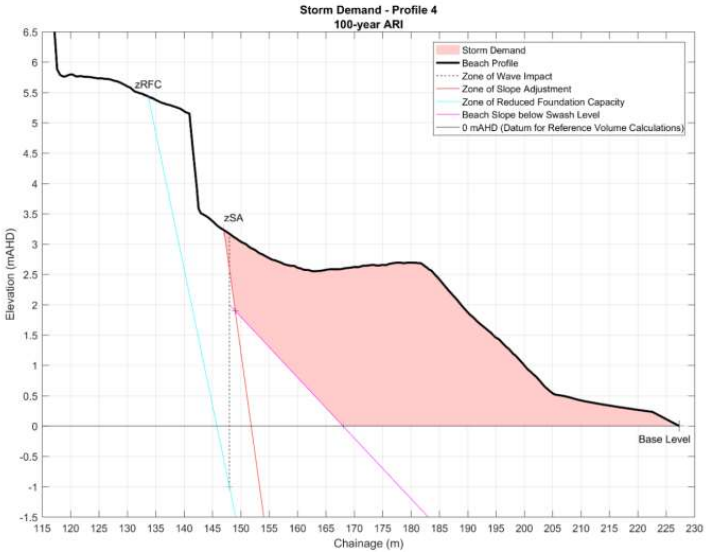
Values and Distributions - SD

- Storm demand volumes
  - Volume of sand removed from a beach in a severe storm or a series of closely spaced storms
  - Estimated by modelling or analysis of historical beach profiles (if available)
  - Typically defined for a 100-year ARI event and an appropriate curve fitted to enable the estimation of smaller return period events
  - Normal distribution of annual exceedance probability or AEP → translated back to storm demand volume



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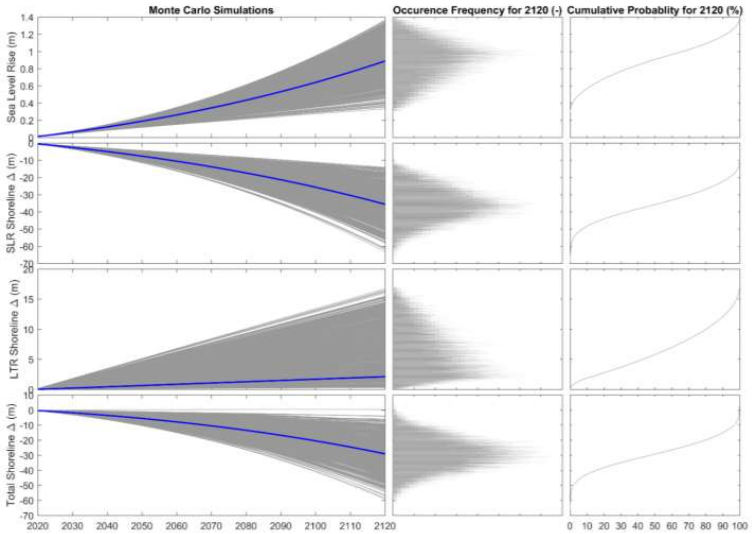
Monte Carlo Analysis

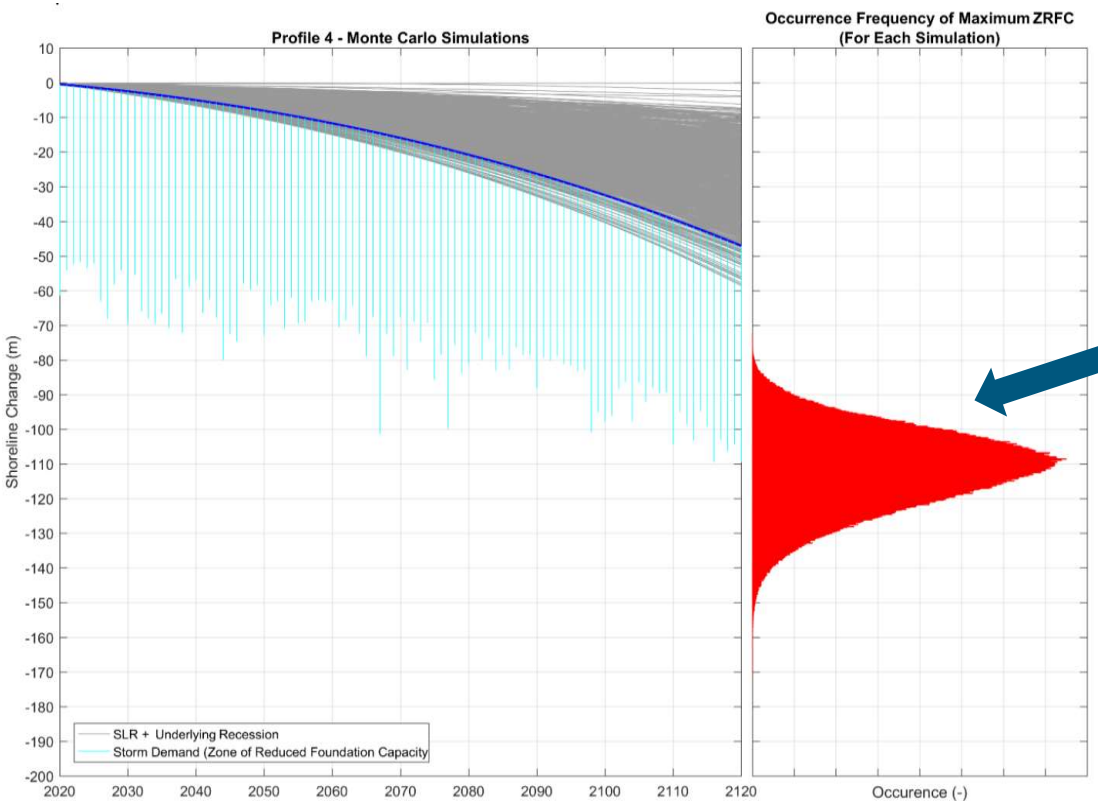
- Monte Carlo modelling approach:
  - Sample each of these likely ranges many times (e.g., 100k or 1M, enough for output statistics to converge) to generate a distribution of potential total erosion setbacks



  - Erosion hazard (setback) calculation:
    - Extract a particular selected output from this distribution (distance in meters)
    - Apply landward from an established ‘baseline’ shoreline position
    - Result: total shoreline movement along the beach (at each beach profile location)

Total shoreline movement

- Combined shoreline position due to LT, SLR and SD



- Distribution of 1M values of total shoreline change in a particular year
- Used to calculate probabilities of exceedance and produce hazard line on a map

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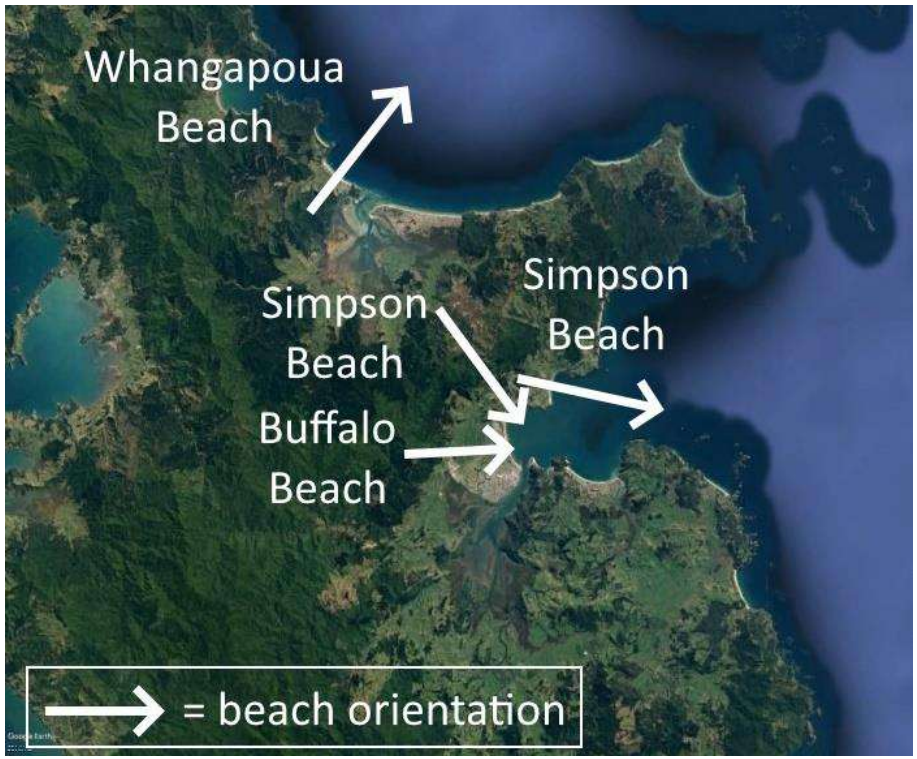
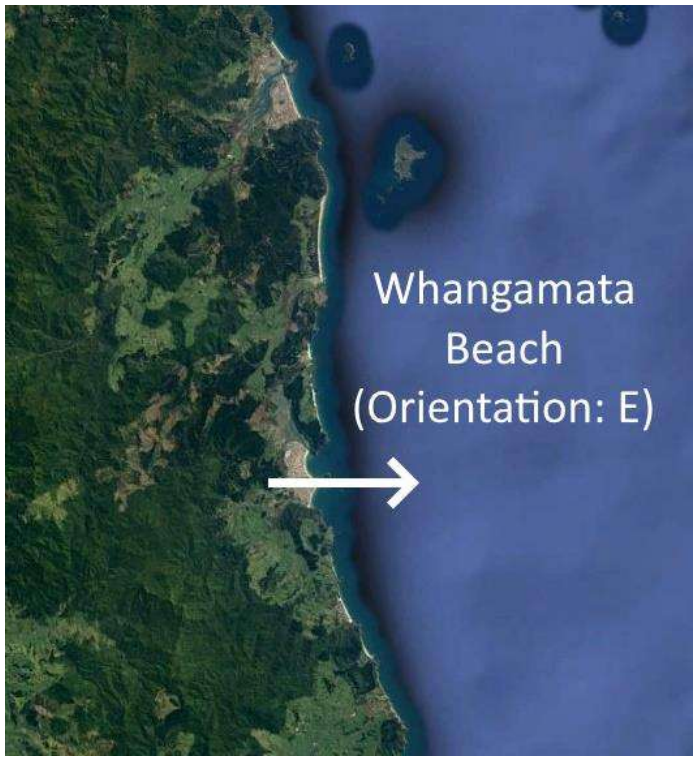
Review locations

- Review of PCHA lines at locations that were affected by the two cyclones:
  - Whangamatā Beach
  - Simpson Beach
  - Brophys Beach
  - Buffalo Beach
  - Whangapoua Beach

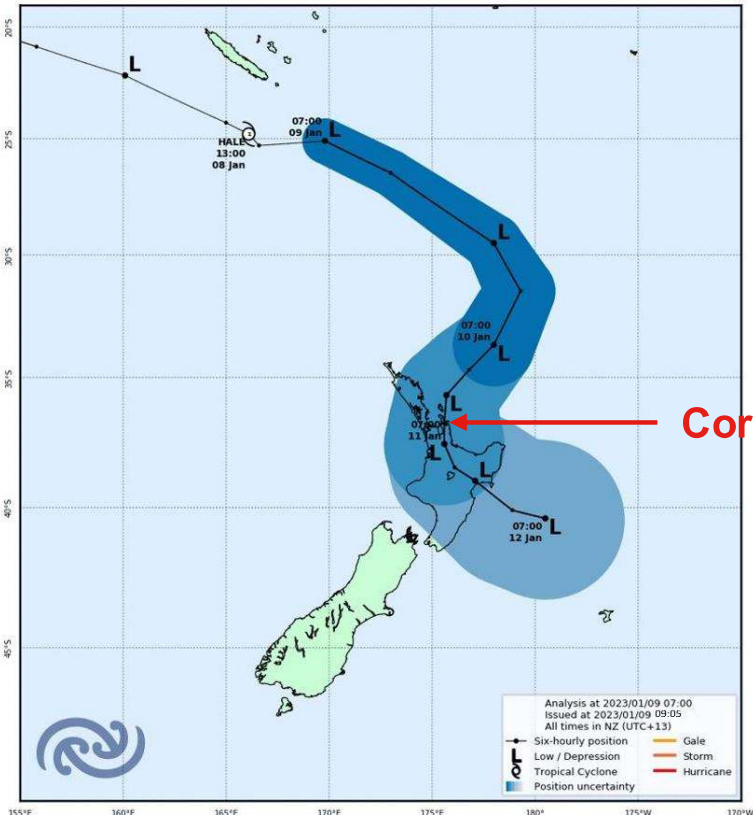
Beach Orientation





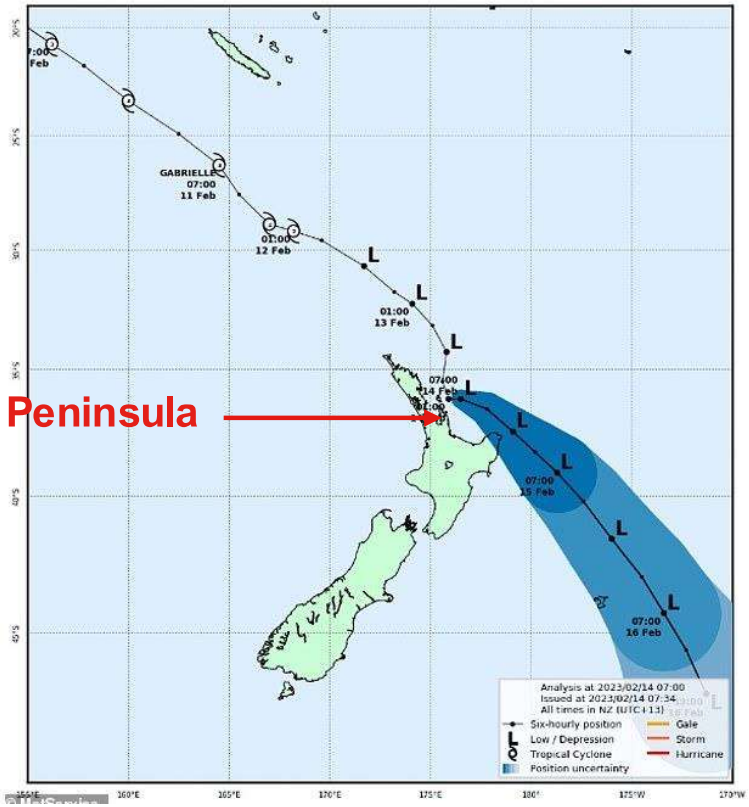
Cyclones

Hale



Coromandel Peninsula

Gabrielle



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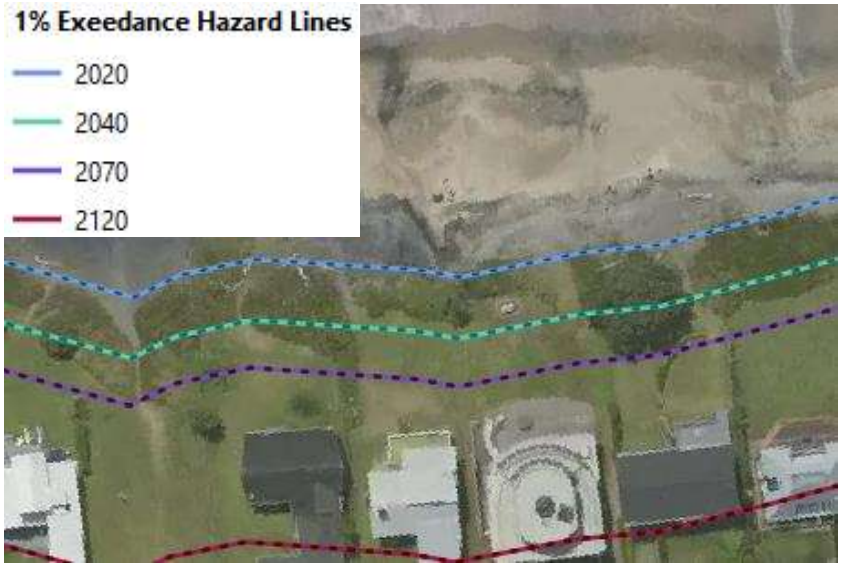
Comparison Methodology

- Pre-event aerials (2016-2022)
- Photographic data and drone images taken within a few weeks after cyclone Gabrielle
- Extreme water level analysis by TCDC indicated an approx. 100-yr Average Recurrence Interval (ARI)
  - Water level = key driver for erosion (+ waves)

Existing 1% exceedance hazard lines for the years 2020, 2040, 2070 and 2120 were compared against the coastal erosion line captured on photographic data and drone images

Simpson Beach



PCHA

Actual erosion

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Brophys Beach

PCHA

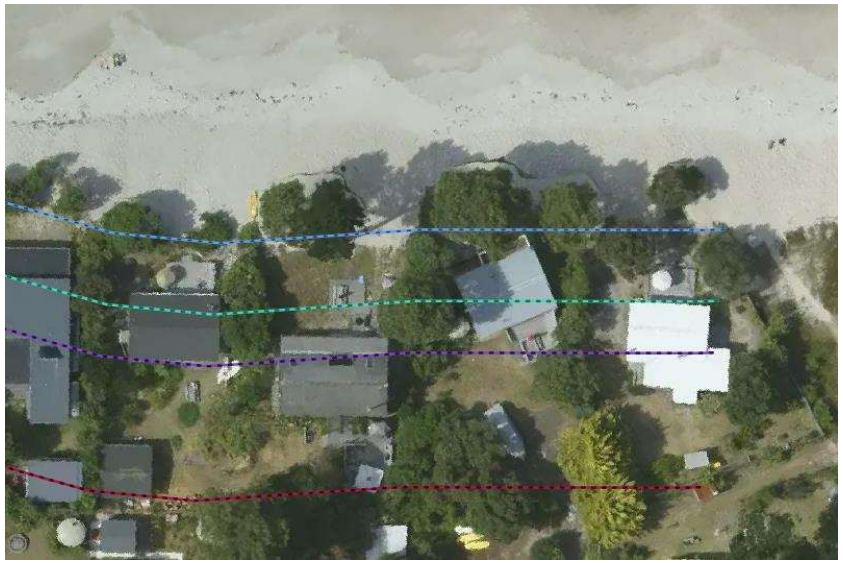
Actual erosion

Buffalo Beach

PCHA

Actual erosion

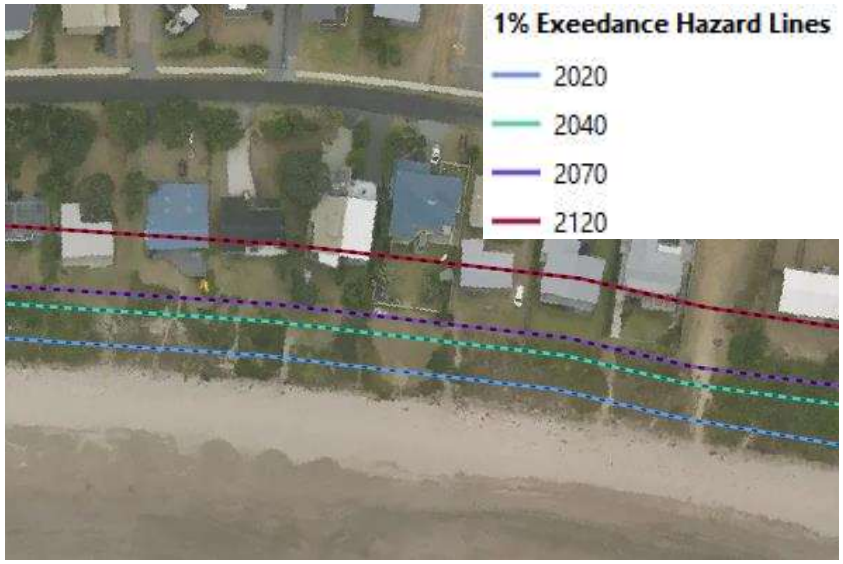
Whangapoua Beach



PCHA

Actual erosion

Whangamatā Beach



PCHA

Actual erosion

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Conclusion

- Comparison of predicted vs. actual erosion
- Result: storm erosion in line with expectations (modelled present day 1% exceedance CEH lines)

THANK YOU

- **Acknowledgement of Thames Coromandel District Council for contribution towards the assessment**