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Simran Bassan, Tony Wang

Assessing Hazards! Filling the holes in our risk assessment methodology

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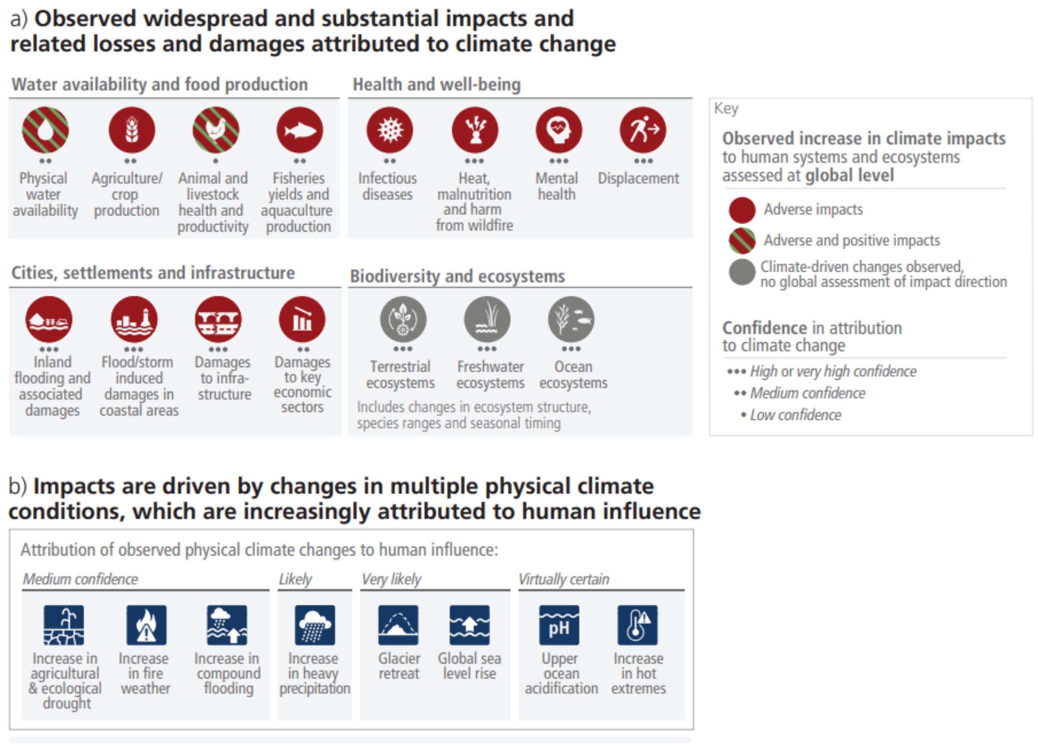
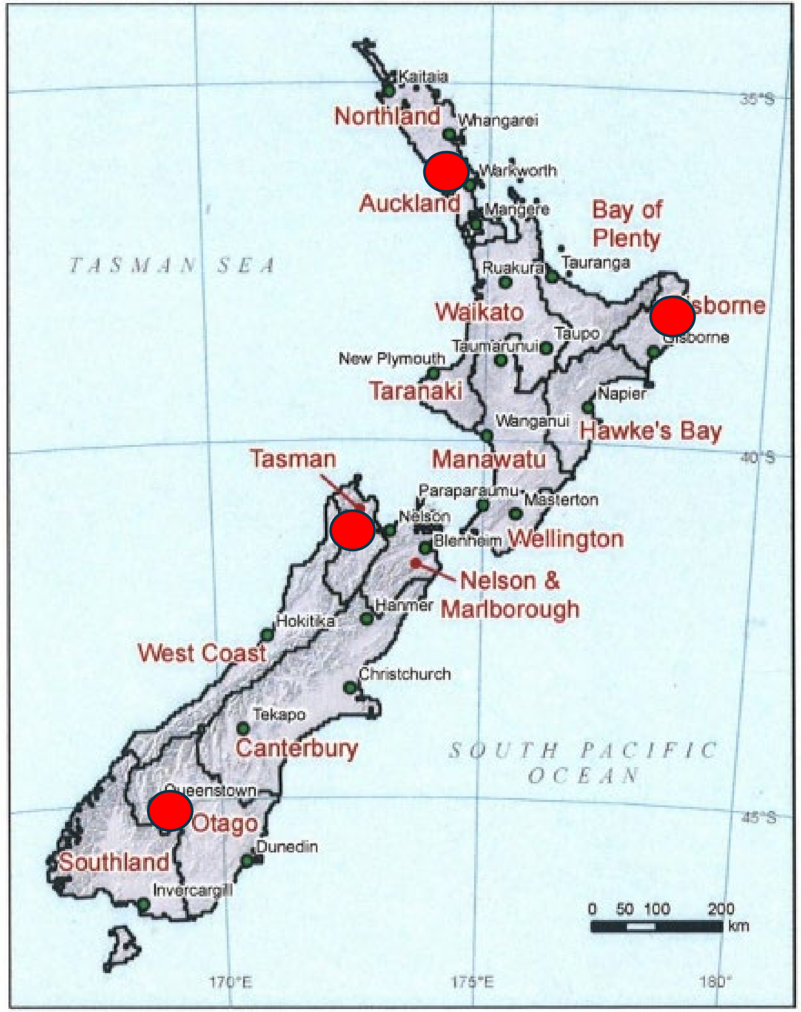
Understanding Flood Risk

- Flooding is one of the most consequential natural hazards that communities worldwide face
- Climate change is projected to increase the frequency and severity of extreme weather events
- Understanding flood risk becomes ever more important when considering severe storms
- There is an urgent need for communities to become more flood resilient



IPCC 6th Assessment

Severe Events 2023



- Historic storm, January 2023
- Cyclone Gabrielle, February 2023
- Tornado, April 2023
- Heavy storm, May 2023
- Heavy storm, June 2023
- Heavy storm, September 2023

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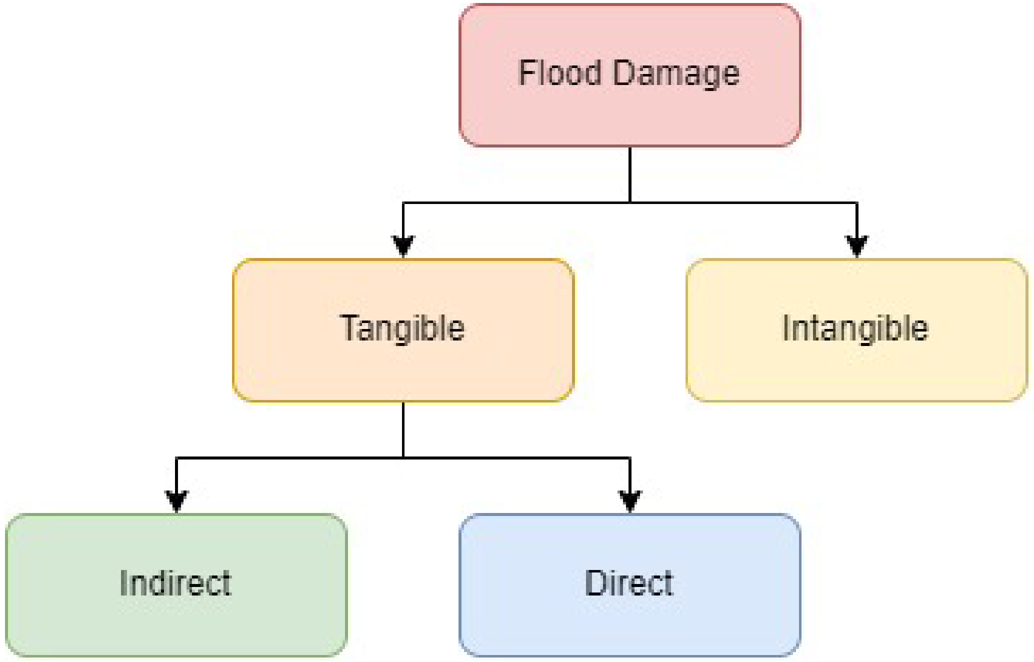
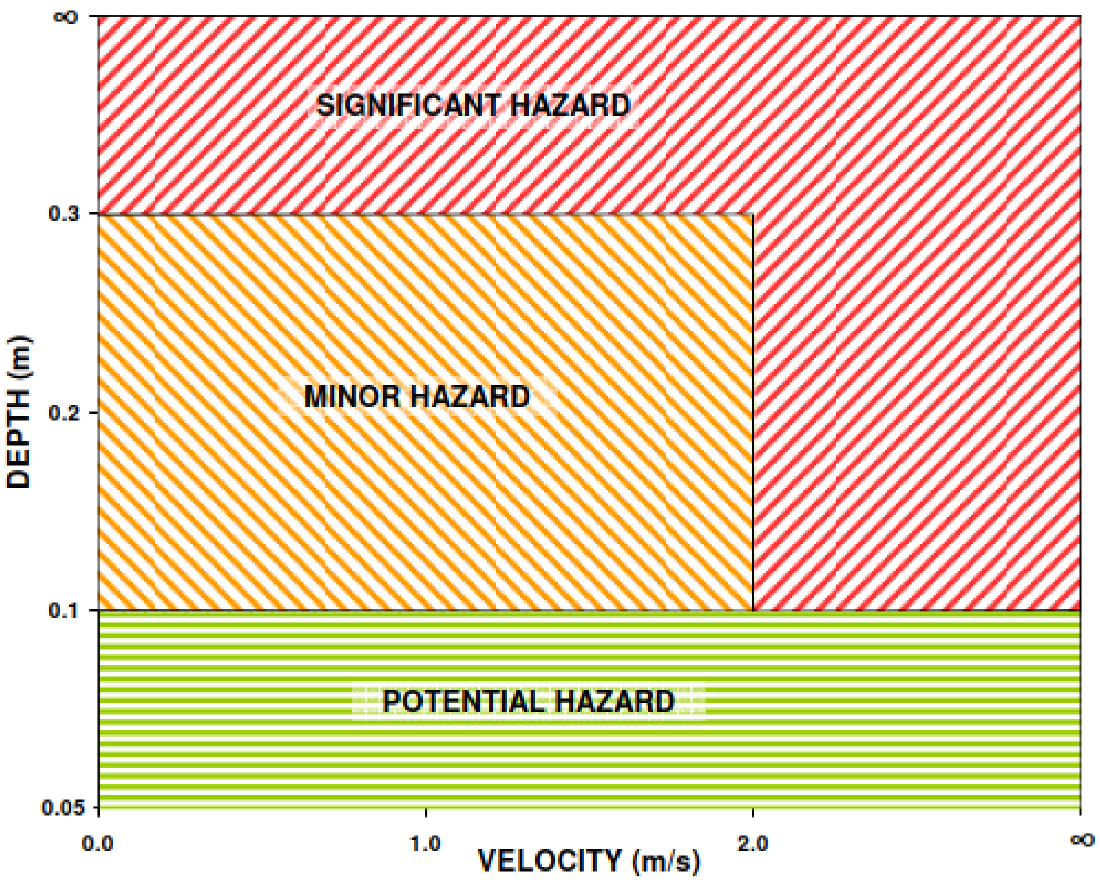
Flood Losses and Damages

- Flood losses comprise of tangible and intangible damage
- Economic and Social
- These losses encompass a wide range of negative impacts

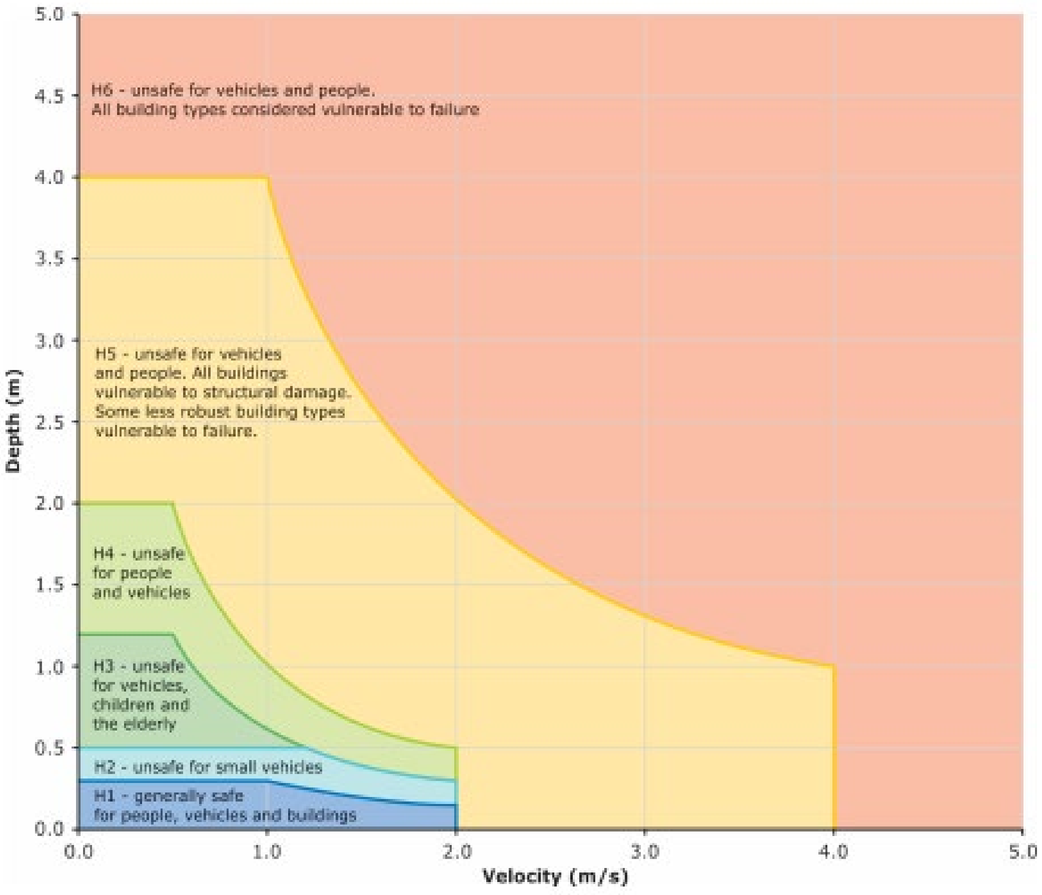


Existing Tools

Auckland Council Modelling Specifications Hazard Classification (Version 4 2011)



Australian Rainfall Runoff Guidelines (ARR 2019)



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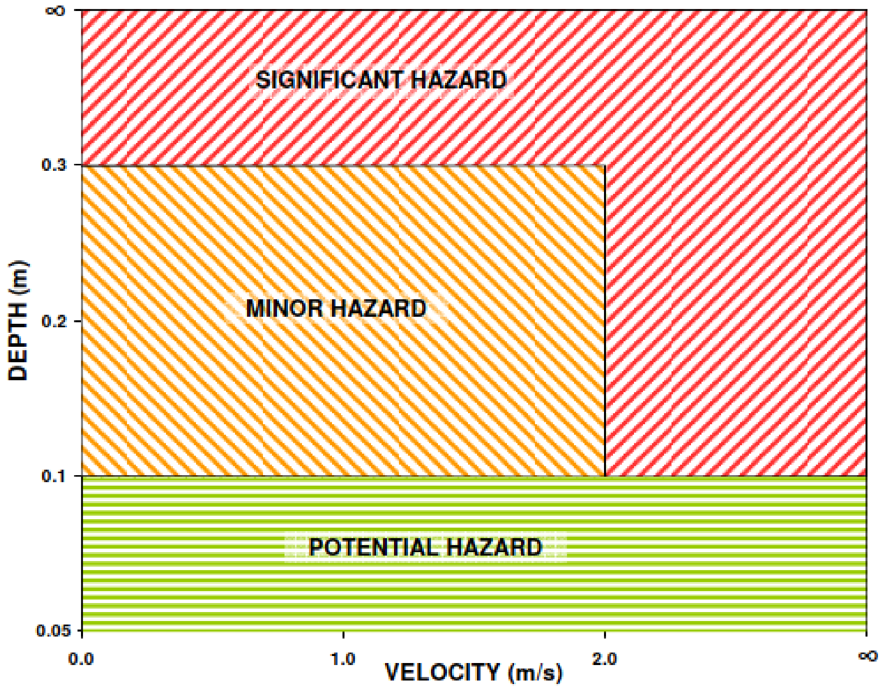
Auckland Council Modelling Specifications

- Framework for developing models that simulate hydrological processes
- Hazard Classification categories that can be used to assess flood hazard primarily to **buildings**



Hazard Classification	Description	Depth-Velocity Criteria
1	Potential Hazard	0.05m<Depth<0.1m
2	Minor Hazard	0.1m<Depth<0.3m and Velocity<2.0m/s
3	Significant Hazard	Depth>0.3m and Depth.0.1m&Velocity>2.0m/s

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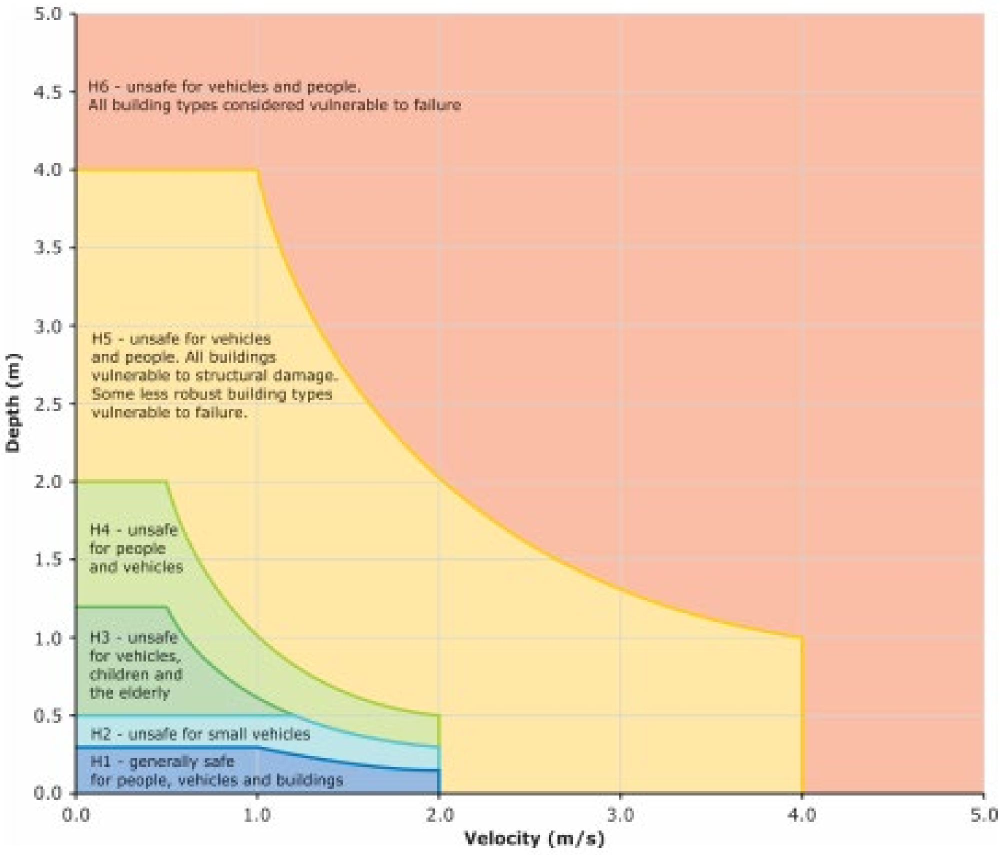
Australia Rainfall Runoff Guidelines

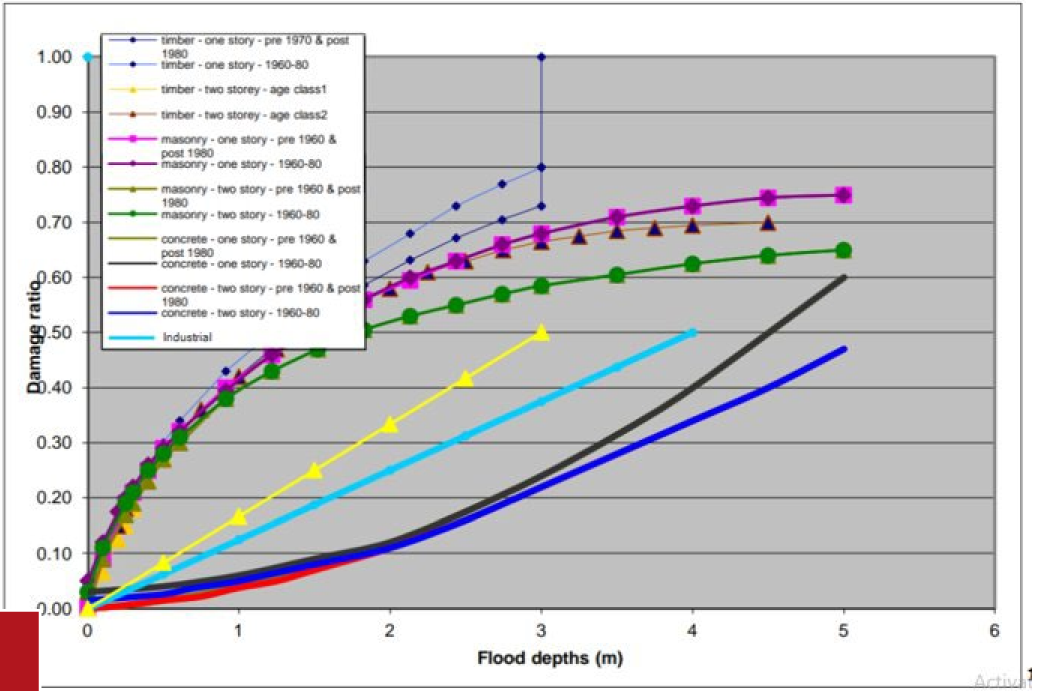
- Australian document commonly adopted in New Zealand as best practise
- Defines flood hazard with relation to their effect on **people, vehicles and structures**
- Helps develop safety response plans including evacuation plans etc.



Hazard Vulnerability Classification	Classification Limit (Depth*Velocity)	Limiting Water Depth (m)	Limiting Velocity (m/s)
H6	D*V > 4.0	-	-
H5	D*V <= 4.0	4.0	4.0
H4	D*V <= 1.0	2.0	2.0
H3	D*V <= 0.6	1.2	2.0
H2	D*V <= 0.6	0.5	2.0
H1	D*V <= 0.3	0.3	2.0

Loss Assessment

- Fragility Curves – Graphical representations of the relationship between flood depth and the likelihood of damage to a building or infrastructure.
- Fragility curves are used to define an associated damage ratio, which will help define a damage state



RiskScape Model (NIWA, 2010)

Damage State	Description	Damage Ratio
DS0	Insignificant	0.00 - 0.02
DS1	Light – Non-structural damage, or minor non-structural damage	0.02 - 0.10
DS2	Moderate – Reparable structural damage	0.10 - 0.50
DS3	Severe – Irreplaceable structural damage	0.50 - 0.95
DS4	Collapse – Structural integrity fails	➢ 0.95

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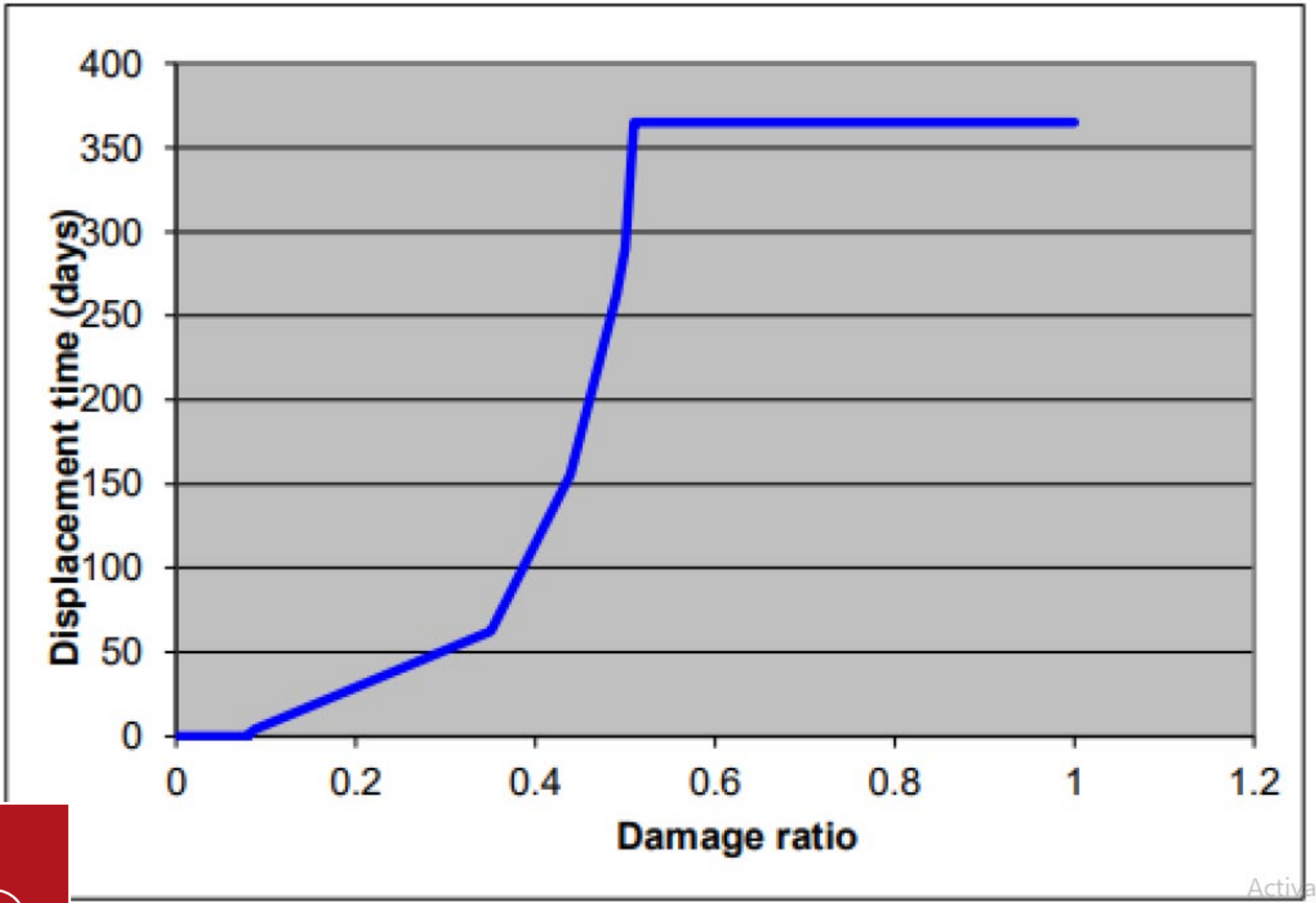
RESIDENTIAL BUILDING INTERRUPTION

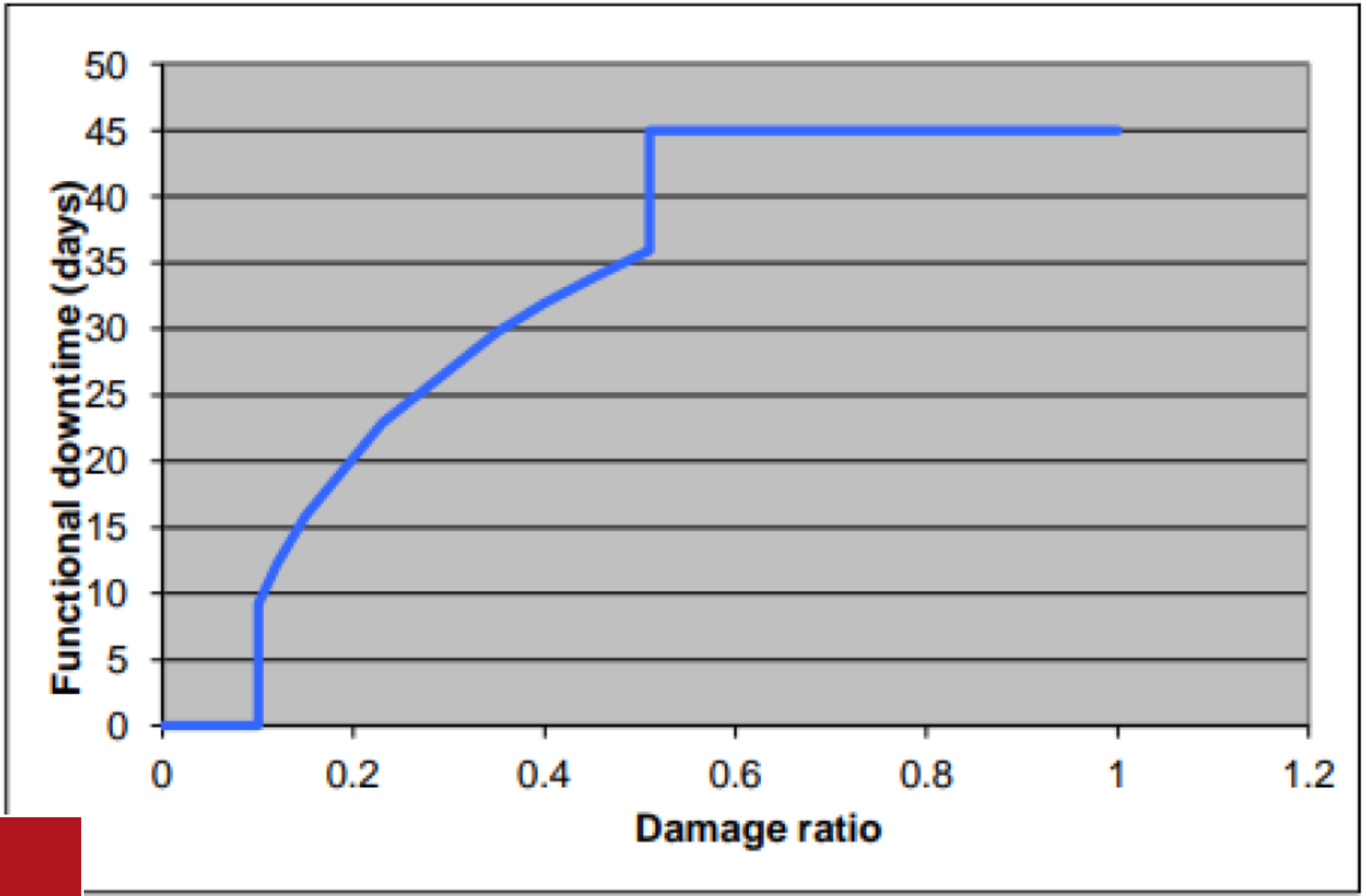


RiskScape Model (NIWA, 2010)

Displacement time is the span during which a building's inhabitants find themselves navigating the transition from their accustomed living or working spaces to alternative temporary arrangements.

The estimation is based on a logarithmic correlation scaled between 30 and 365 days

BUSINESS INTERRUPTION



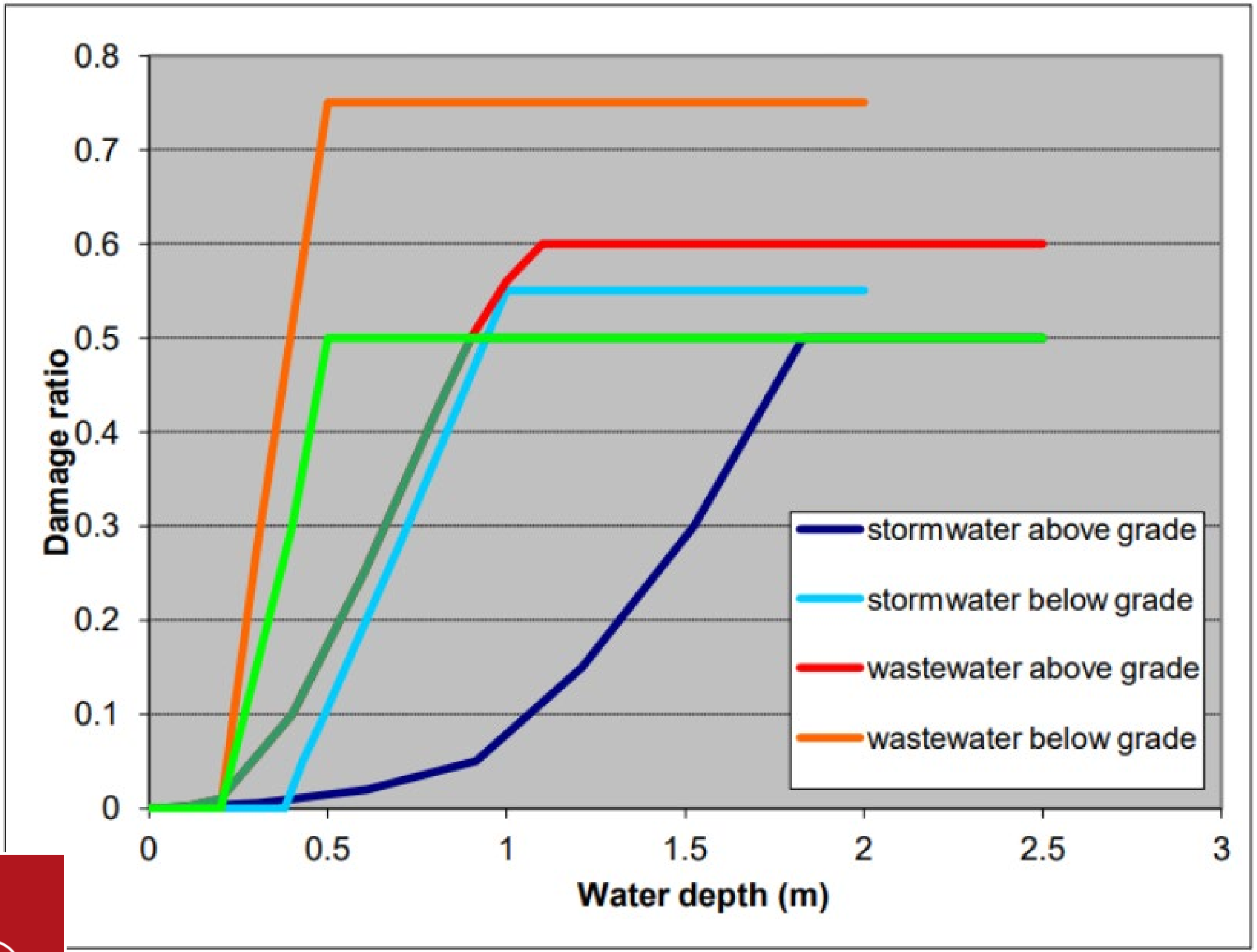
RiskScape Model (NIWA, 2010)

Functional downtime refers to the specific duration, measured in days, during which a business is unable to operate due to direct flood damage.

The fragility function below scales the functional downtime for a business between 10 and 45 days

Does not consider different financial capabilities.

DAMAGE TO UTILITIES



RiskScape Model (NIWA, 2010)

These fragility curves estimate the potential damages that water infrastructure might suffer based on the depth of water. Stormwater, water supply, and sewage pump stations have different damage characteristics and have separate fragility functions

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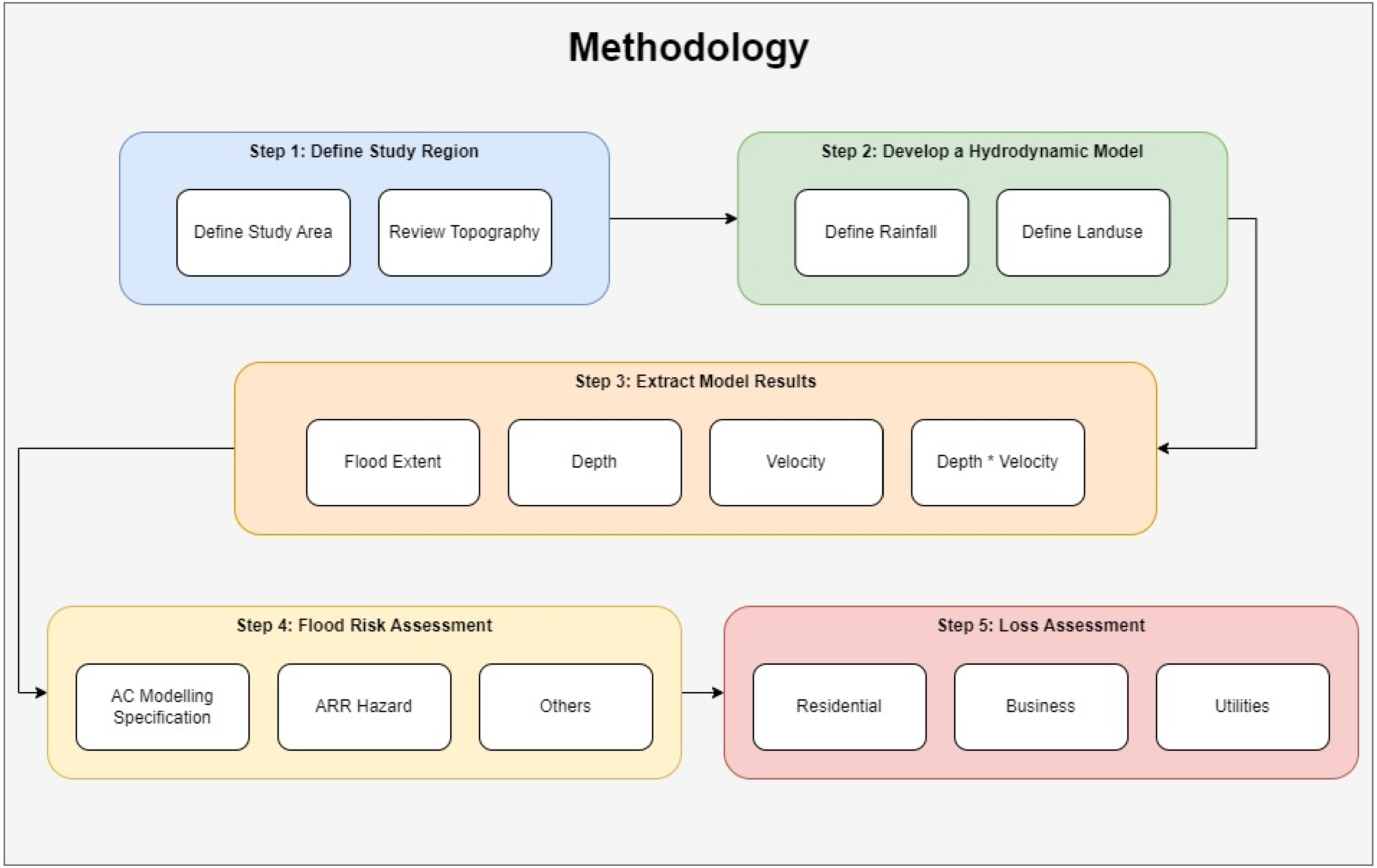
5 Step Assessment



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Case study 1 - Commercial buildings

Define Study Region

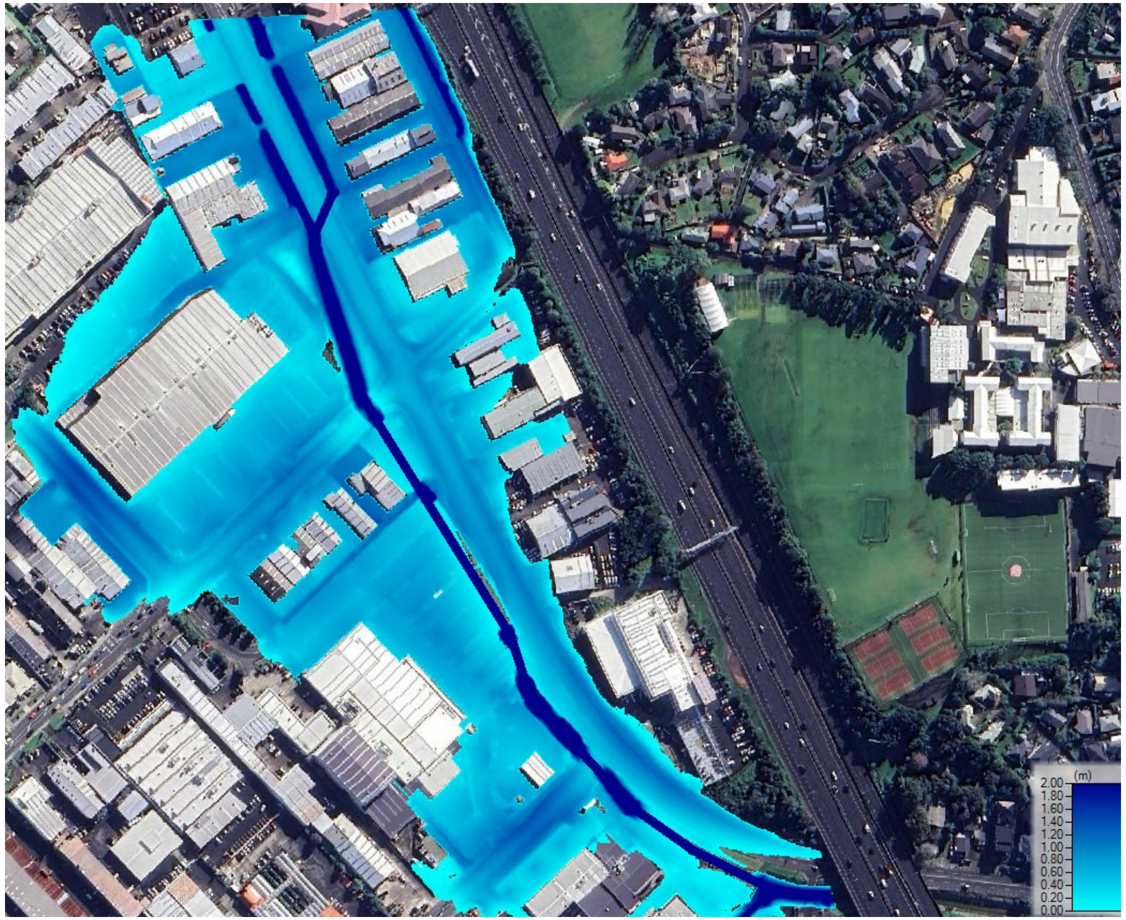
- Commercial and industrial areas.

Develop a Hydrodynamic Model

- 100-year ARI event inclusive of RCP8.5 climate change scenario was simulated for the study area.
- LiDAR 2016 Data, with buildings extruded from the ground surface.

Extract Model Results

- Model predicts up to 1m of flooding within the study area.



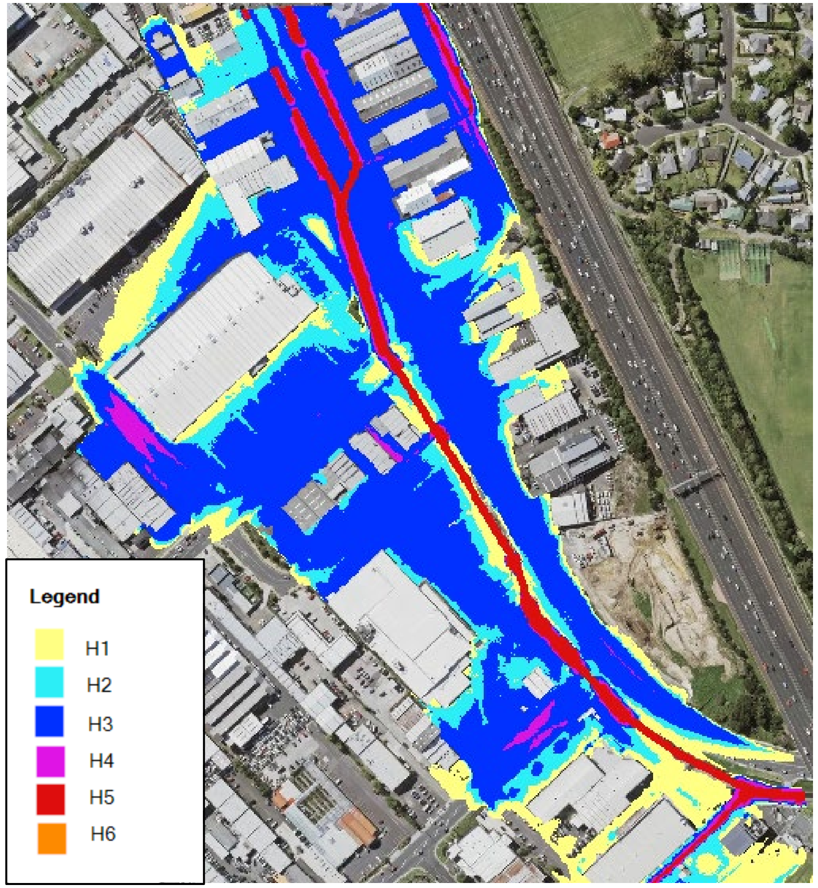
Case study 1 – Commercial buildings

Flood Risk Assessment

- Under AC modelling specification, the building within the study area is subjected to minor to significant hazards.
- Under ARR assessment, the study area is generally unsafe for vehicles, children, and the elderly (ARR, Hazard Class H3).

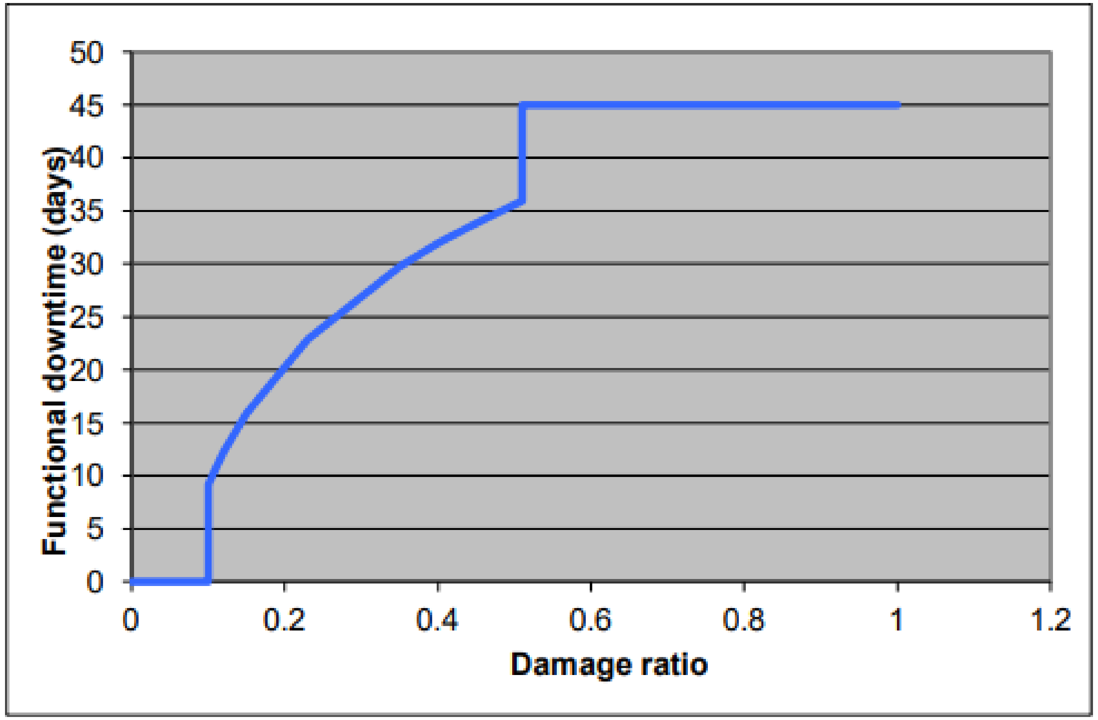
Loss Assessment

- The buildings are expected to be inundated within the study area.
- Based on the affected area, flood depth and corresponding damage ratio, the economic loss can be estimated.



Case study 1 - Commercial buildings

Business Closure – Pakn'Save Wairau Road Example



Pakn'Save Wairau Road Example
(NZ Herald, 3 Feb 2023)

Case study 2 – Wastewater utilities

Define Study Region

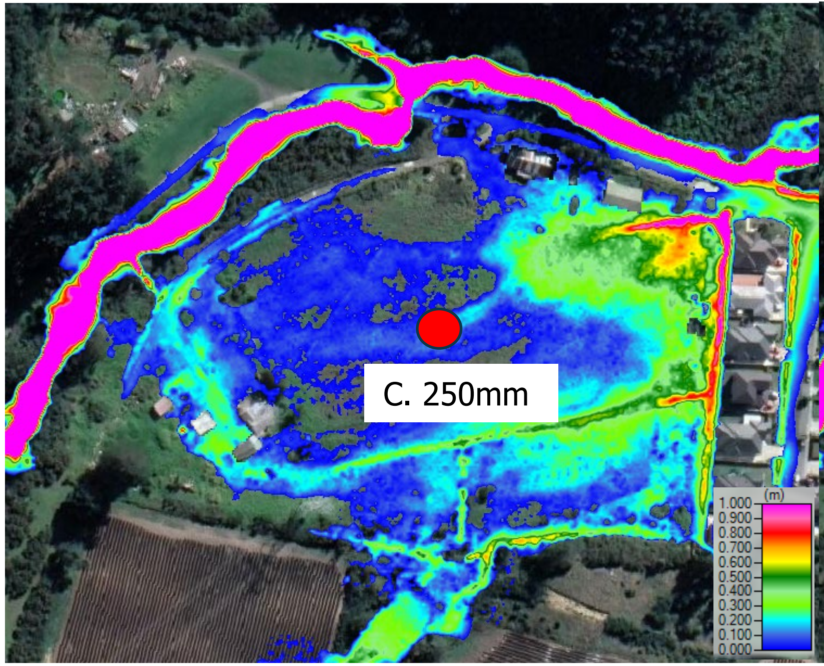
- Rural area

Develop a Hydrodynamic Model

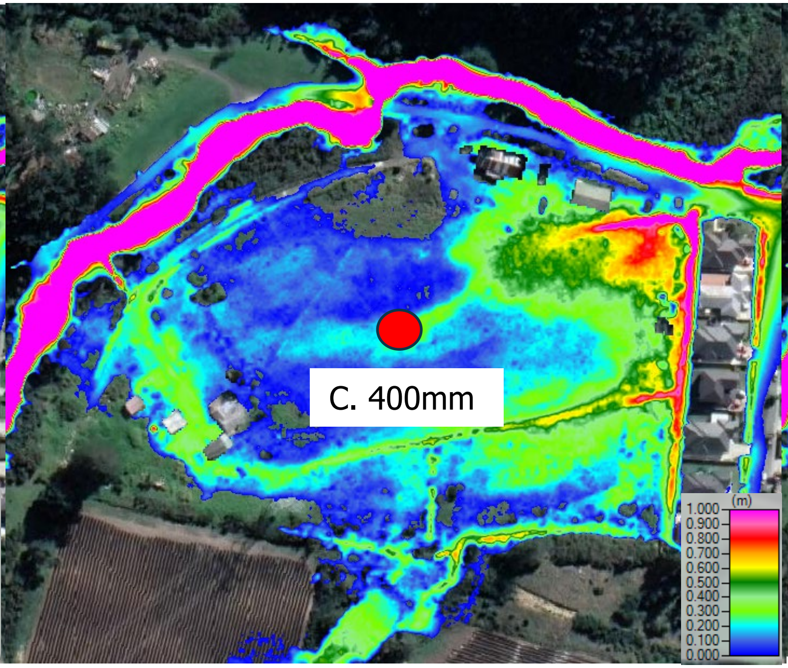
- 100-year ARI event scenario
- 100-year ARI event inclusive of RCP6.0 climate change scenario
- 100-year ARI event inclusive of RCP8.5 climate change scenario

Case study 2 – Wastewater utilities

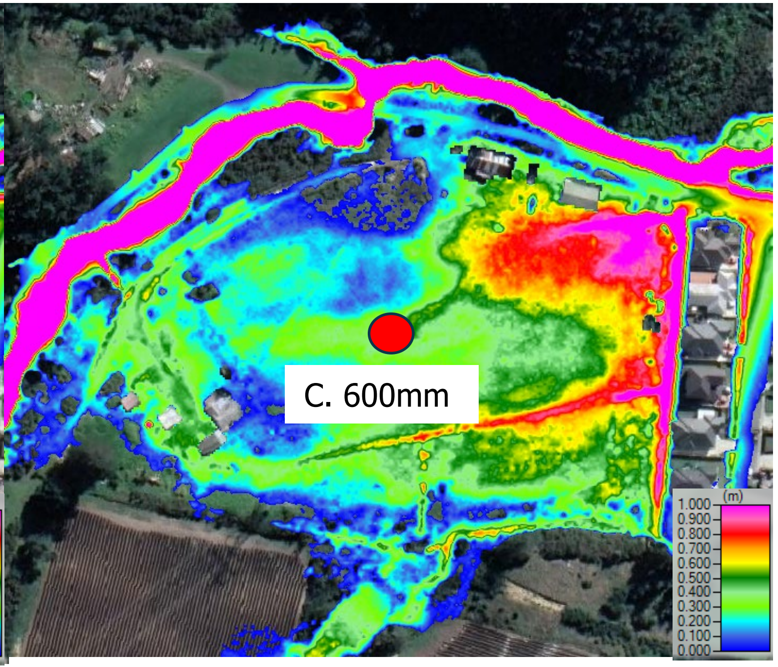
Extract Model Results



No Climate Change Scenario



RCP6.0 Scenario



RCP8.5 Scenario

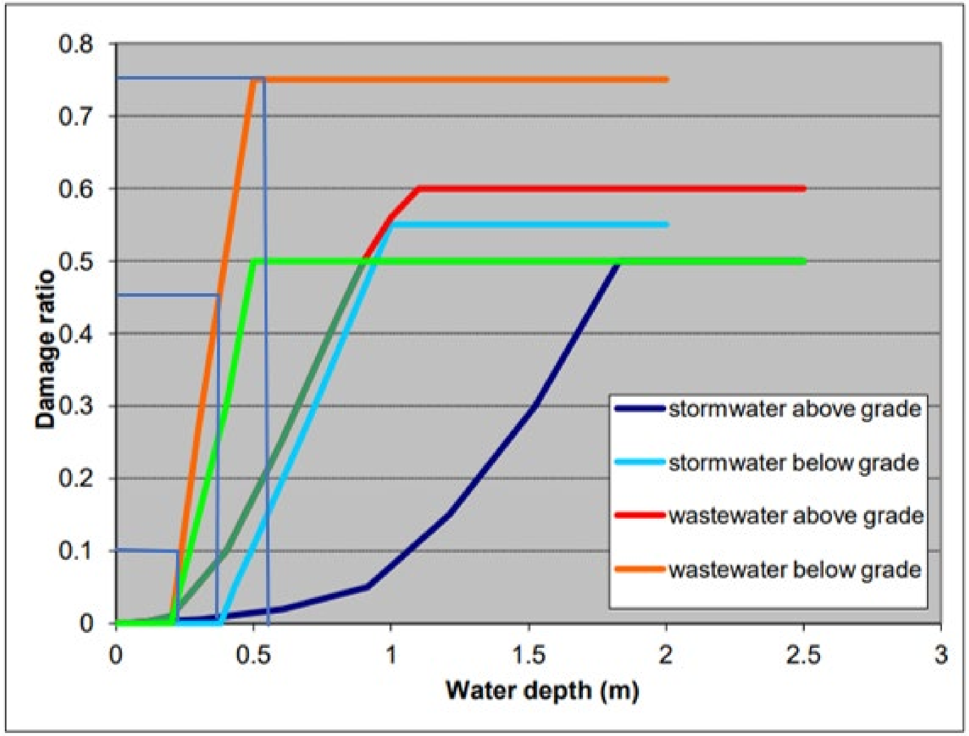
Case study 2 – Wastewater utilities

Flood Risk Assessment

Damage ratio - below-ground wastewater pump example

- 0.1 in a 100-year storm event
- 0.45 in a 100-year storm event (RCP 6.0)
- 0.75 in a 100-year storm event (RCP 8.5).

The assessment indicates that there is a significant change in the level of risk experienced by these utilities when considering different climate change scenarios.



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Challenges and Opportunities

- Globally, we are facing a series of climate crises, and flood risk is undoubtedly one of them.
- Climate change affects more than just stormwater and should be considered in all risk assessments.
- We are witnessing a large number of developments taking place on challenging land.
- Tangible and intangible risks during the decision-making phase of a flood risk assessment.
- Planning for future resilience. Typically, greenfield development holds more opportunities to build resilience when compared to brownfield developments due to the presence of existing infrastructure and buildings.

Current Works

Auckland Council

- Storm Recovery and Resilience Long-term Recovery Plans(Late 2023), involve
  - Tāmaki Makaurau Recovery Plan
  - 'Making Space for Water’

Nation-Wide

- National Code of Practice for Three Waters Reticulation
- National Stormwater Modelling Guide

Questions