Modelling Group
WATER NEW ZEALAND

Modelling Symposium

Creating Resilient Communities; Understanding and Defining Flood Risk

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The New Zealand Water & Wastes Association Waiora Aotearoa

Understanding and Defining Flood Risk

- Flooding is one of the most significant natural hazards faced by communities around the world
- Understanding flood risk becomes evermore important when considering Auckland anniversary weekend flood and Cyclone Gabrielle

- Assess potential impact of flood hazards on the built environment - people and property

Tools for Assessing Flood Risk

- Assessment tools are critical in assessing flood hazards and associated damages

- Available tools:
    - Hazard vulnerability curves
        - Australia Rainfall Runoff Guidelines 2019 (ARR2019)
    - Flood fragility curves
        - RiskScape methodology - ‘RiskScape: Flood fragility methodology’, (NIWA, 2010)

What is a flood hazard?

- **Hazard**: A **source of potential harm** or a potential **to cause loss**.
- The focus here is flooding - it has the potential to cause damage to the community as we have seen in Auckland, Hawkes Bay and Gisborne/Tairawhiti
- **Flood Hazard**: The potential **loss of life, injury and economic loss** caused by **future flood events**.
- The degree of hazard is influenced by:
  - extent, depth, velocity
  - How isolated are you?
  - How quickly is the water rising?
  - What help can you get?

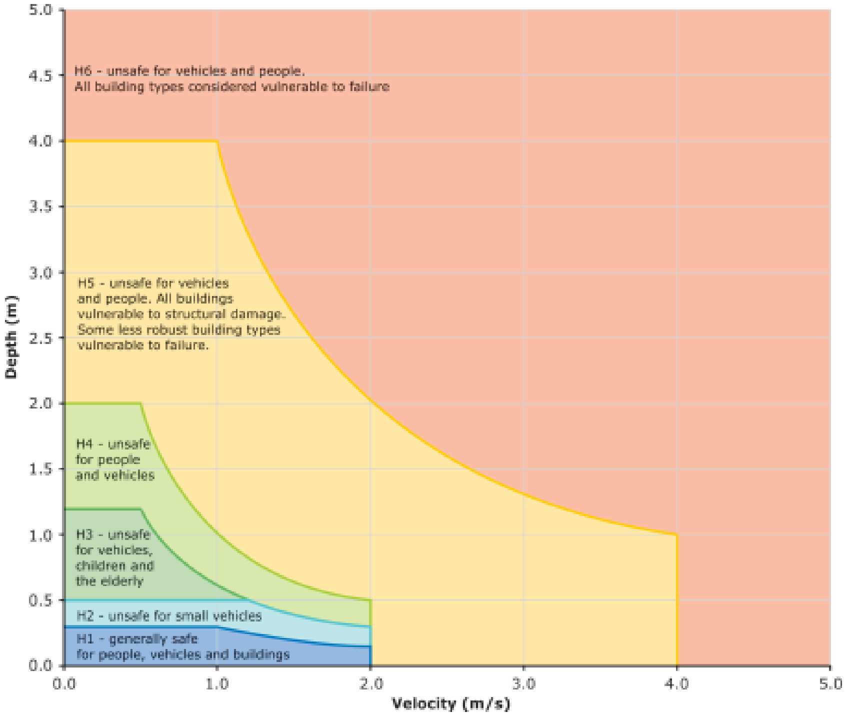
- **All of these influence flood hazard**

Hazard Vulnerability Curves and Flood Fragility Curve

- The ARR guidelines provides a set of standard flood hazard vulnerability curves which define the different levels of flood hazard for people, vehicles and structures

- Flood fragility curves provide relationship between **flood depth** and the **likelihood of damage** to a building
- Flood fragility curves are typically developed by experts by analysing historic flood events and damage datasets

Hazard Vulnerability Curves – ARR 2019

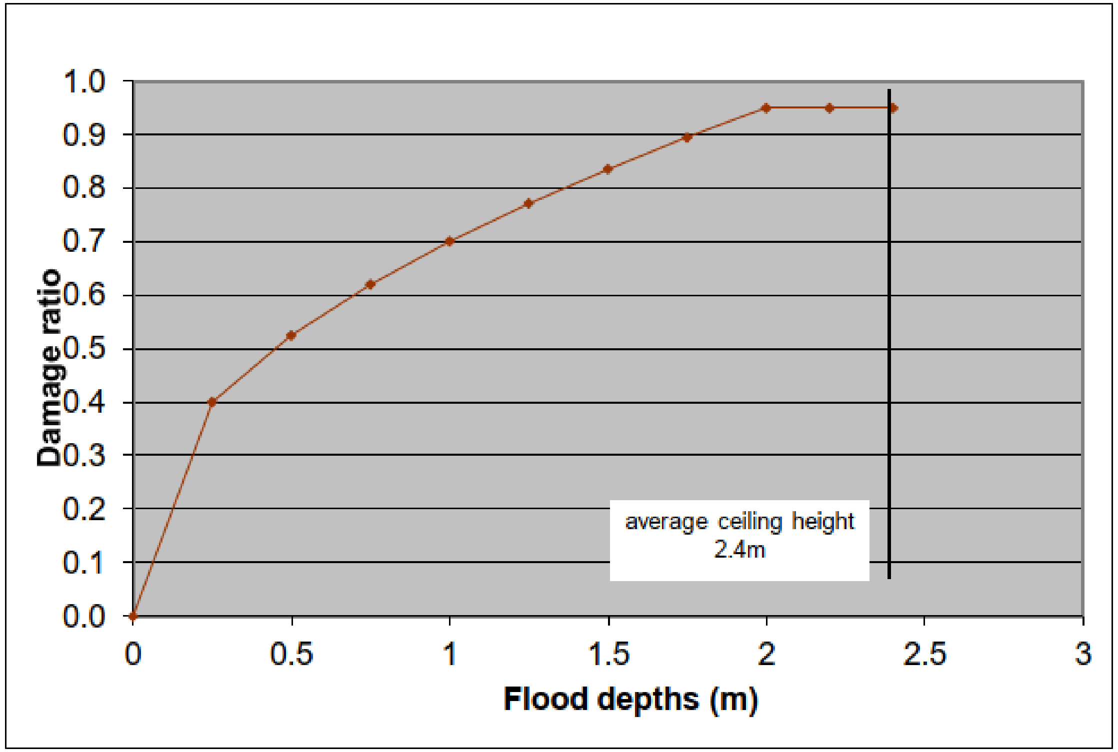


Hazard Vulnerability Classification		Classification Limit (D*V)	Limiting Still Water Depth (m)	Limiting Velocity (m/s)
H6	Structural failure	D*V > 4.0	-	-
H5	Structural damage	D*V <= 4.0	4.0	4.0
H4	All people and vehicles	D*V <= 1.0	2.0	2.0
H3	Children/elderly	D*V <= 0.6	1.2	2.0
H2	Small vehicles	D*V <= 0.6	0.5	2.0
H1	Generally safe	D*V <= 0.3	0.3	2.0

- Hazards are classified as H1 – H6 depicting increasing levels of flood risk
- Thresholds identify which different parties which will be at risk in different flood conditions

Flood Fragility Curves – Risk Scape model

- Fragility curves relate depth to damage ratio and damage state



Damage state	Description	Damage ratio
DS0	Insignificant	0–0.02
DS1	Light—Non-structural damage, or minor non-structural damage	0.02–0.1
DS2	Moderate—Reparable structural damage	0.1–0.5
DS3	Severe—Irreparable structural damage	0.5–0.95
DS4	Collapse—Structural integrity fails	> 0.95

- Damage states identify –
  - Extent of damages to a building and its content
  - Repair actions required to restore the structure to its pre-flood condition

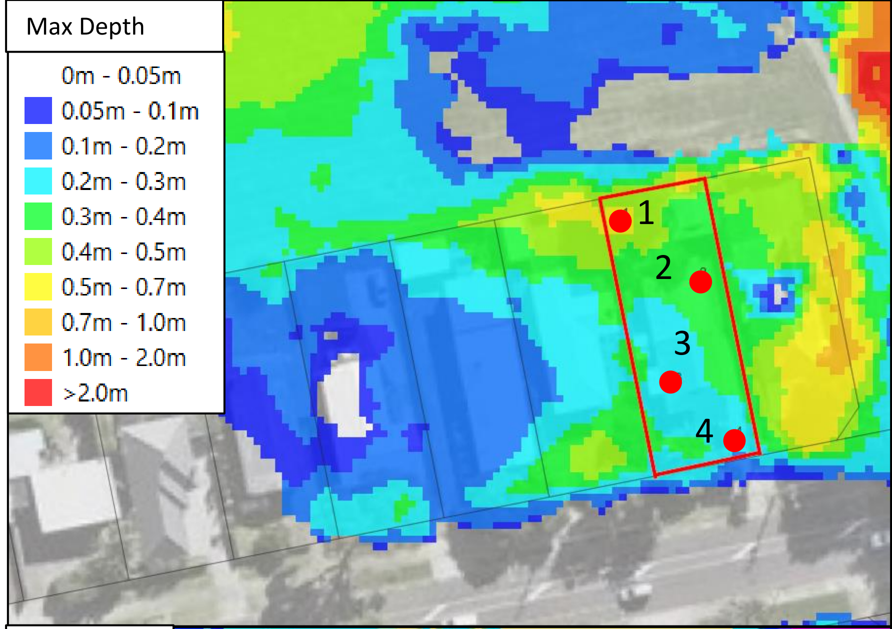
Assessing flood risk

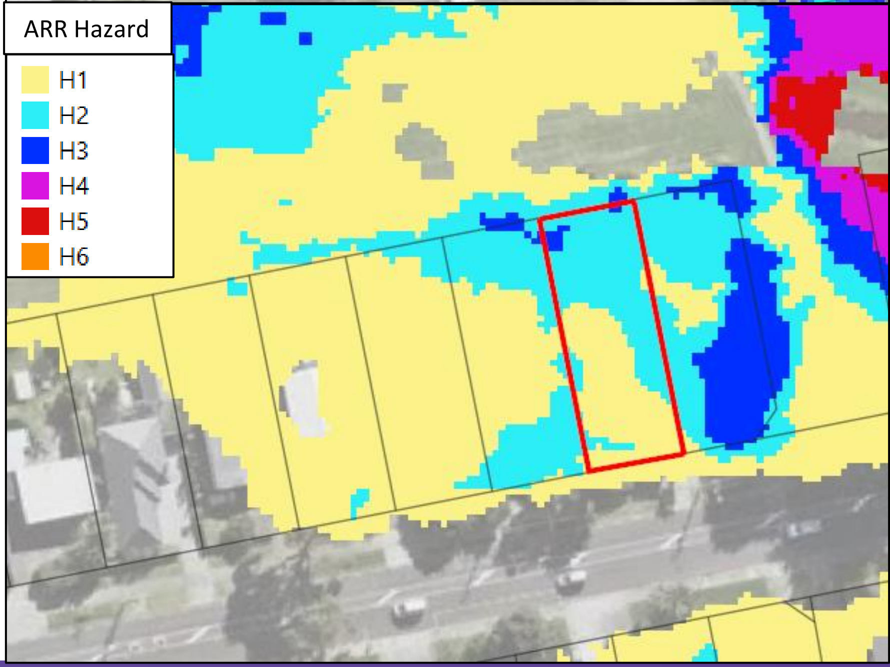
- Correlate flood fragility curves and flood hazard definitions to understand –
  - How bad is the flooding?
  - How risky is it for people and property?
  - How much damage is caused?
  - How long it will take to repair all of this?
- From a modelling perspective we answer these questions by –
  - Develop a flood model and RUN it for various storms
  - Determine flood extents, flood depths, velocities and the depth times velocity
  - Determine the likelihood of damage to each building
  - Classify the flood hazard for each building and create a damage index

Case Study 1 - Property flooding

- Model predicts 260mm-530mm of flooding for a 100yr event inclusive of climate change
- Analyse flood extents, flood depths, velocities as well as the depth * velocity
- Under the ARR guidelines, this property is to expect a flood risk level of H1, H2 and H3.

Location	Max Depth	Max Velocity	D*V	Hazard Vulnerability
Point 1	0.53 m	0.15 m/s	0.07	H3
Point 2	0.34 m	0.11 m/s	0.03	H2
Point 3	0.26 m	0.06 m/s	0.02	H1
Point 4	0.26 m	0.11 m/s	0.03	H1



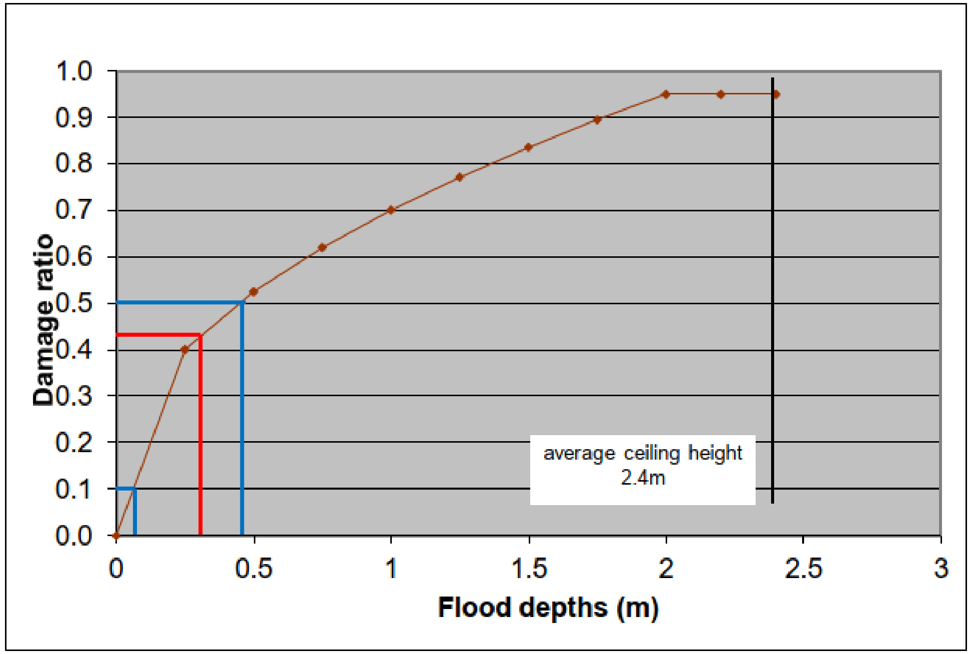


Case Study 1 – Habitable floor flooding

- Under the ARR 2019 guidelines, this property is to expect a flood risk level of H1, H2 and H3.
- Rain gauge data shows rainfall of 190mm recorded over 24hrs
- Flood Depths approximately 300mm
- Floor levels were above peak water level and have freeboard

Case Study 2 – Internal Damage using fragility curves

- Approximately 300mm of flooding
- Damage ratio of 0.43
- Damage categorised in damage state 2
- Moderate repairable structural damage



Legend

- Damage State 2
- Case Study

Key Findings

- Vulnerability curves provide more of a holistic flood risk analysis at a catchment level
  - Analysis of hazards in conjunction with flood extents can be used to identify critical infrastructure and more at risk properties
- Fragility curves can be used to analysis internal damage to specific sites more in depth
  - Assess the extent of damage and the expected repair actions with relation to flood depth

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Thank you!
Questions? Patai?