Coastal & flood inundation: hazard exposure and risk for the elderly

Rob Bell & Ryan Paulik

National Reference Group, Nov 2013

NIWA
Taihoro Nukurangi

Whitianga: August 1989

Also sizeable coastal inundation events in 1936, 1968, 1972, 1978

Auckland awash: 23 January 2011

NZTA

Kay Jones

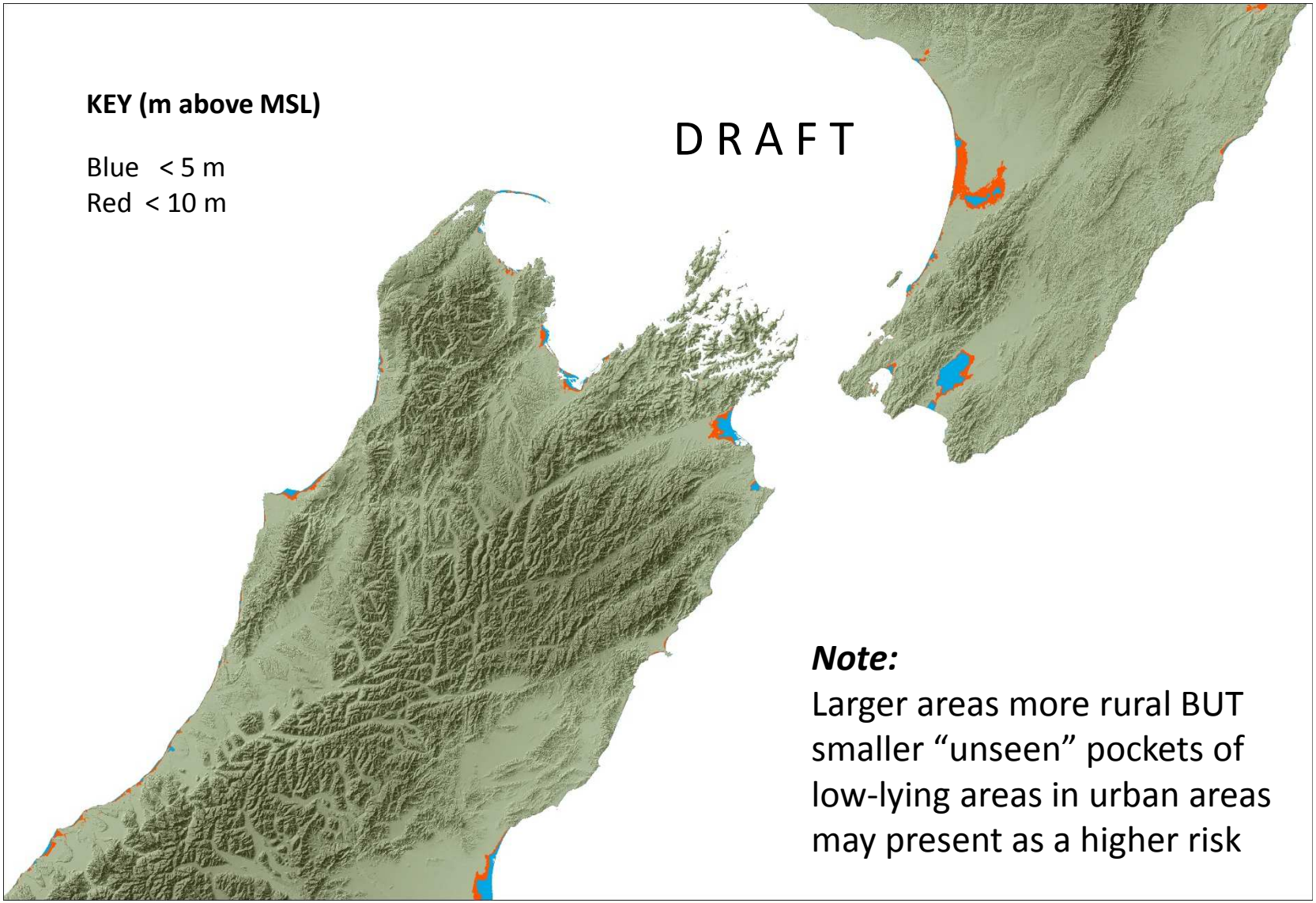
NZ coastal hazard susceptibility: national scoping index

- Assumes topography above MSL in coastal margins is a broad nation-wide surrogate for exposure to coastal hazards (e.g. storm-tides, tsunami, sea-level rise)

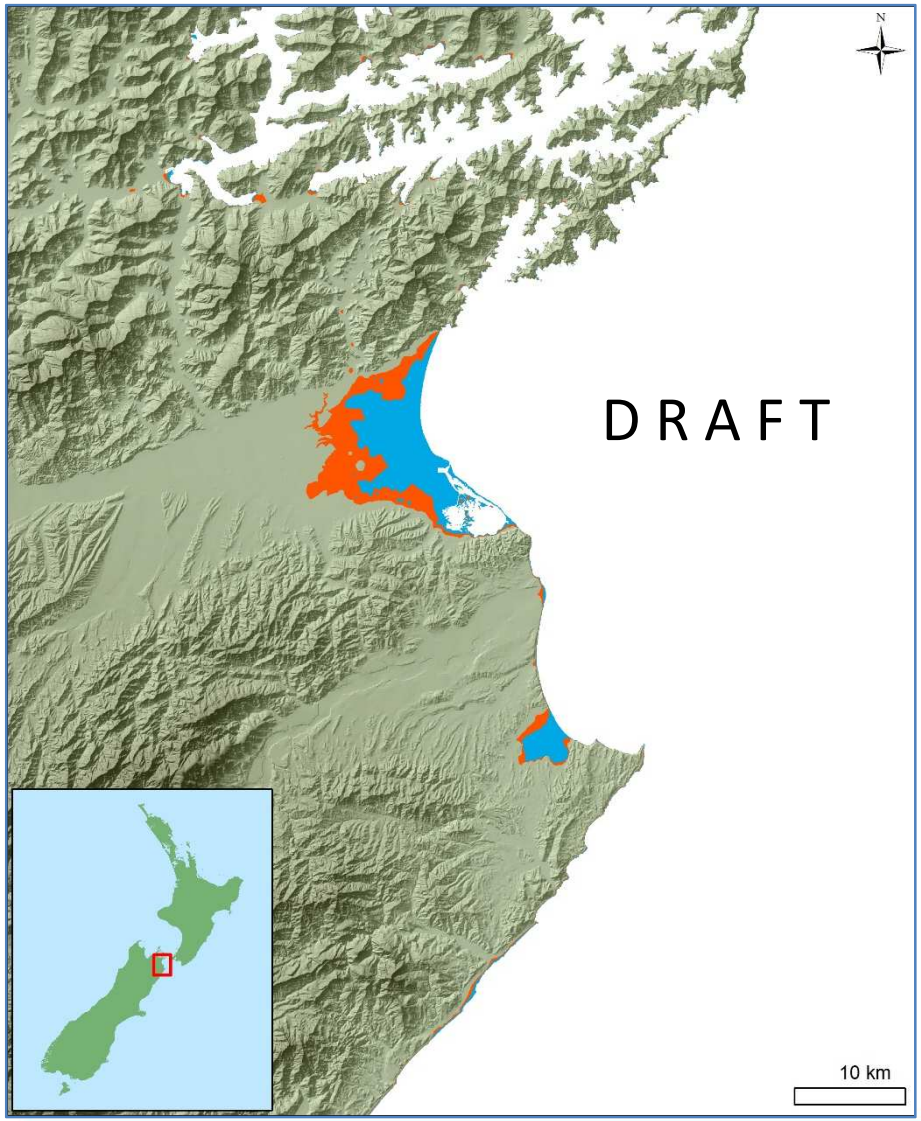
- Re-done NZ-wide 2008 analysis with best satellite land topography available to Govt Depts: Enhanced NZ SRTM/LINZ DEM database: vertical height accuracy only ~5 m
  - Note: high-accuracy (~0.15 m) LiDAR topography is available in pockets of NZ, especially urban areas – but no national coverage

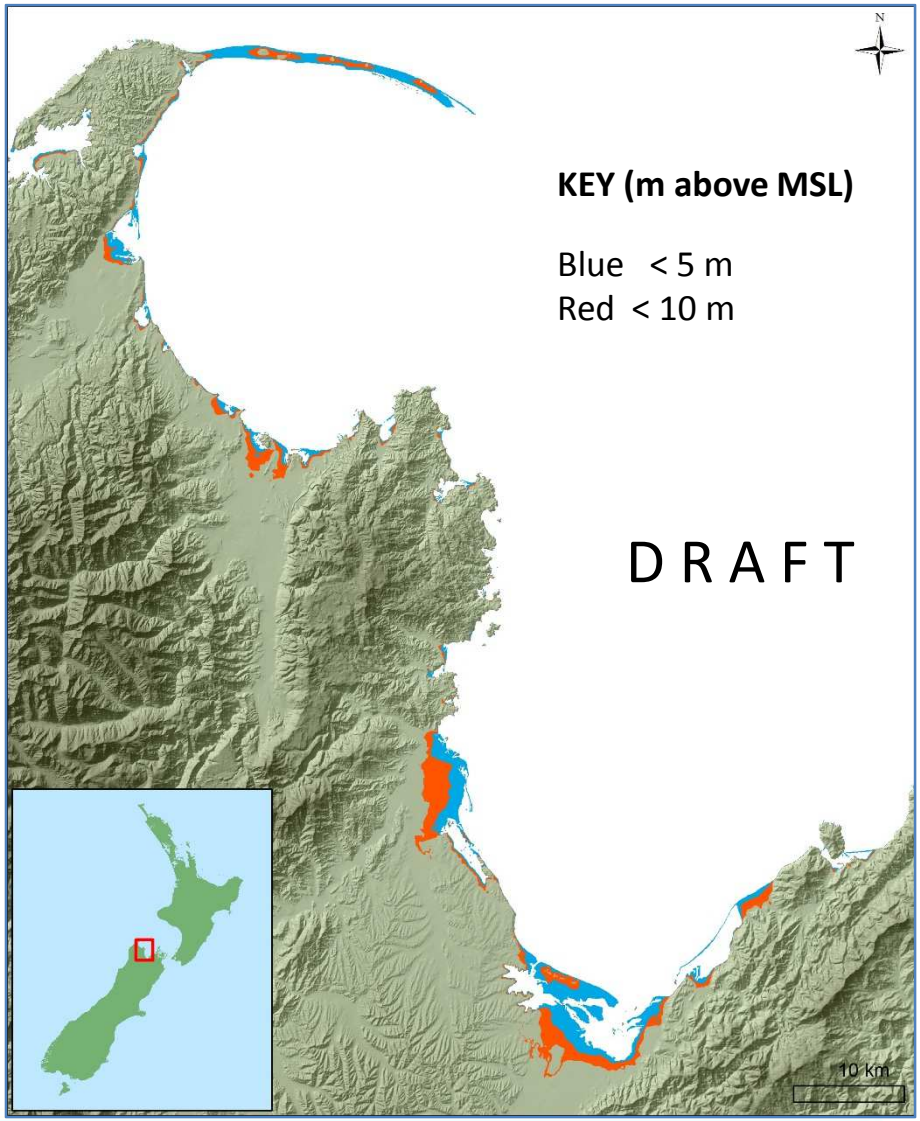
- GIS shape files of < 5 m MSL & < 10 m MSL will be mapped onto Census mesh blocks and demographics of the aged (to represent relative exposure to coastal hazards and climate change)

National coastal-hazard susceptibility index



National coastal-hazard susceptibility index

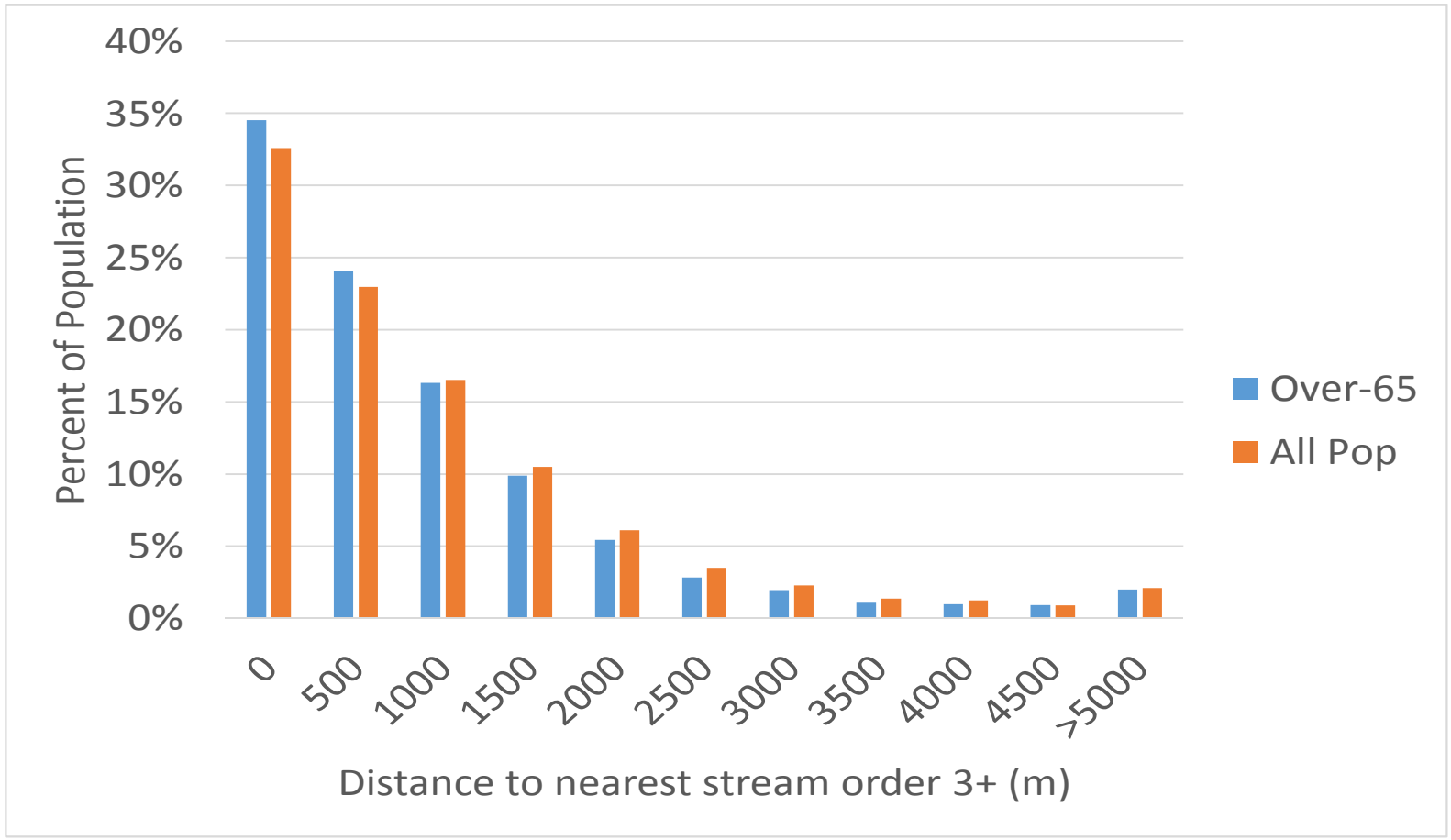




River floodplain hazard susceptibility

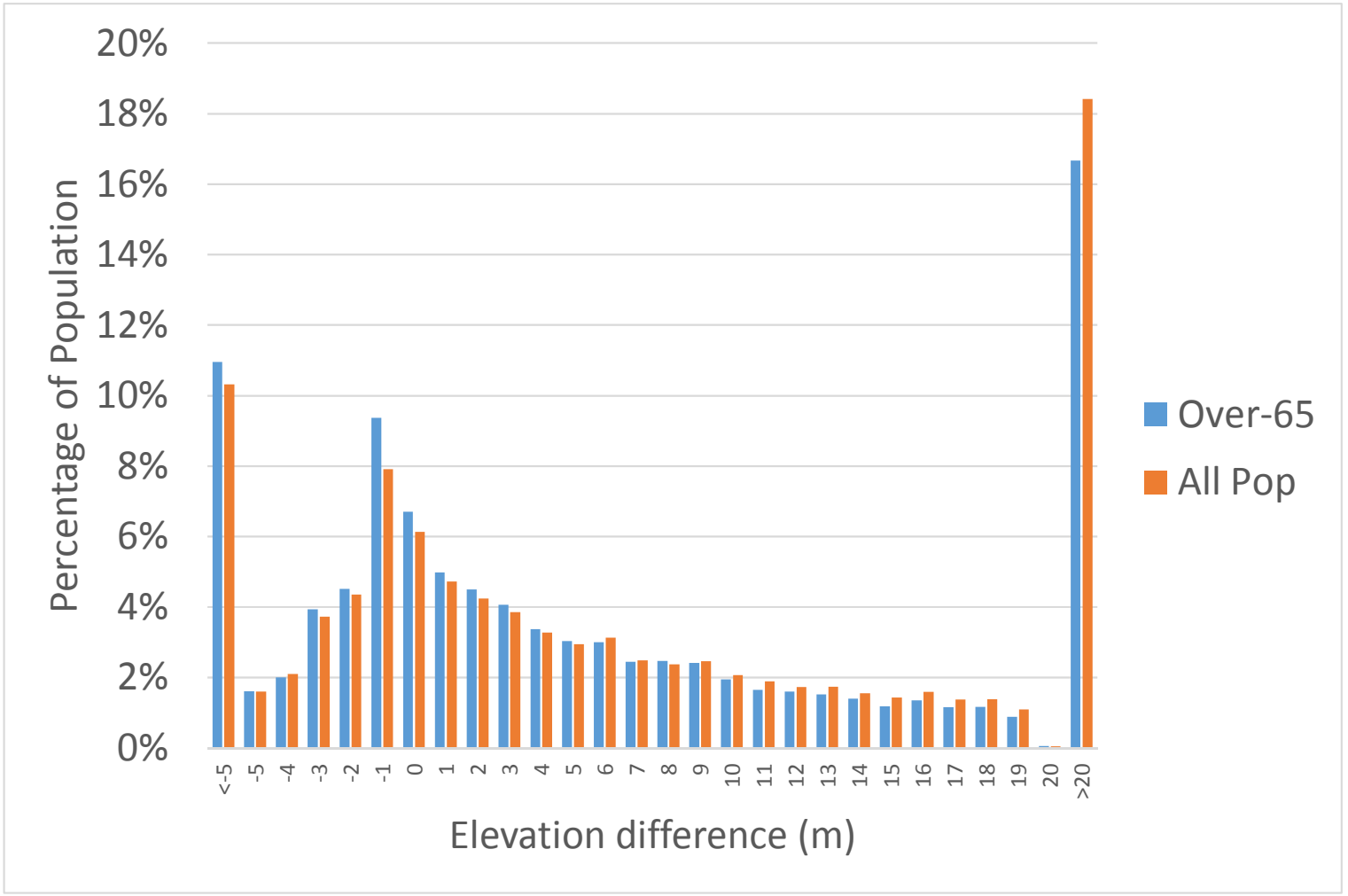
- Much more difficult to do for NZ:
  our rivers produce relatively short-term peaks (hrs to a day) compared to Europe and Australia – where bath-tub flood maps can easily be produced from historic floods
- No national susceptibility map exists for NZ river flooding
- Flood defences (presence or absence) makes it more challenging to provide realistic results. Also "safety" and risk around flood defences and community reliance/trust a separate issue!
- Approach was to develop a geographically-based surrogate e.g. within 0.5 km intervals of a river and in 1 m land height intervals above the river
- Only developed for rivers in populated census mesh blocks and irrespective of flood defences. Doesn't incl. stormwater.

River floodplain hazard susceptibility



Proximity to rivers of 3rd order or greater: slight bias towards elderly

River floodplain hazard susceptibility



% of population in 1 m height intervals of land above rivers - slight bias towards elderly

Note: national topography is only accurate to within +/- 5 m in elevation, hence –ve Nos.

Local case studies: RiskScape

Six districts/regions provisionally identified earlier in 2013 as case study areas to model weather-related natural hazard impacts.

- Tasman District, Nelson City, Marlborough District, Wellington City, Kāpiti District, Kawerau District.

Three districts/regions are selected (so far) for case studies due to the availability of flood and/or storm-tide inundation models.

District/Region	Case Study Location	Hazard Type	Hazard Model Availability	Building Asset Module	Impact and Loss Calculation
Tasman	Takaka/Golden Bay	Flood	Available	Yes	Yes
	Wakefield/Brightwater	Flood	Under Review - December (possibly)	Yes	No
Nelson	Maitai River Catchment	Flood	Under Review - Early November	Yes	No
	Nelson City	Storm-tide	Available	Yes	Yes
Kapiti	Waikanae	Flood	Under Review - Early November	Yes	No
	Otaki	Flood	Under Review - Early November	Yes	No

- Access to Maitai River Catchment, Waikanae and Otaki flood inundation scenarios for this study currently being pursued from the respective councils.

Case Study: Takaka/Golden Bay

- Tasman District Council have provided 20, 50, 100 and 200 year annual recurrence interval (ARI) flood inundation models

- Building asset module was developed for Tasman District based on data from a range of sources including; Quotable Value, EQC, Statistics NZ, RiskScape.

- Flood hazard impact and loss calculated for:
  - building damage state
  - building reinstatement costs (asset repair cost, content repair cost, clean-up cost, business disruption costs, vehicle costs)
  - human casualties and displacement (from buildings)
  - roads (damage state)

- For each flood inundation model the above impacts and losses were calculated for daytime and night-time scenarios along with 4 flood warning intervals:
  a) no warning (<10 mins); b) inadequate warning (10 mins to 1 hour);
  c) partial evacuation (1 – 6 hours); d) full evacuation (>6 hours).

- All impacts and losses aggregated to a suburb level.

Case Study: Takaka/Golden Bay

Impact and Loss Summary

- Building Damage State:
  - Number of damaged buildings increases from 246 in the 20-yr ARI to 342 in the 200-yr ARI flood.
- Building Reinstatement Costs:
  - For all events, asset (building structure) repair costs range between $21–$30M and content repair costs between $5–$16M depending on warning time, time of day and flood ARI.
- Human Casualties:
  - Up to 5 moderate (requires treatment) may occur in a 200-yr ARI flood.
- Human Displacement:
  - On average, for all events just over 2/3 of affected buildings will experience >1 month displacement of its occupants.
- Roads:
  - 43–53% of roads will experience structural damage.

Case Study: Nelson – Storm-tide

- Nelson City Council have provided 5, 20, 50, 100 and 200 year ARI storm-tide inundation models which were plugged into RiskScape as hazard modules. Additional models incorporating future sea level rise values were also provided but have not been used in this study. NO combined Maitai River flood

- Building asset module was developed for Nelson City based on data from a range of sources including; Quotable Value, EQC, Statistics NZ, RiskScape.

- Storm-tide hazard impact and loss calculated for:
  - building damage state
  - building reinstatement costs (asset repair cost, content repair cost, clean-up cost, business disruption costs, vehicle costs)
  - human displacement (from buildings).

- For each flood inundation model the above impacts and losses were calculated for daytime scenarios along with 4 flood warning time: full evacuation (>6 hours).

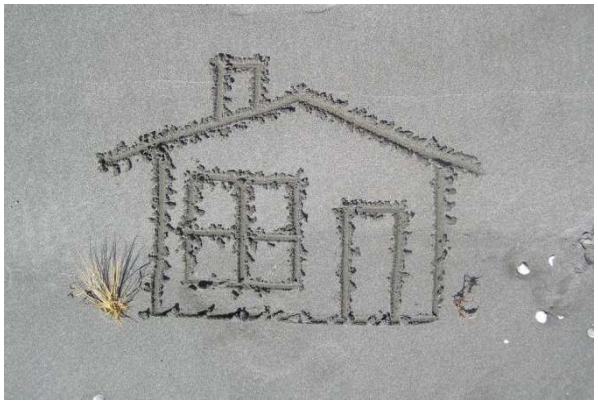
- All impacts and losses aggregated to a suburb level.

Case Study: Nelson – Storm-tide

Impact and Loss Summary

- Building Damage State:
  - No. of buildings suffering structural damage: 47 in the 5-yr ARI up to 89 in the 200-yr ARI storm-tide
  - The Wood suburb shows biggest increase for larger events (not so much for smaller events)
- Building Reinstatement Costs:
  - For all events, asset (building) repair costs: $7–$9M and content repairs $3–$4M.
- Human Displacement:
  - 45% to 60% of affected building will experience human displacement >1 month.
  - Unlike the Takaka flood case study, the relative proportion of buildings with human displacement >1 month declines as storm-tide ARI increases which suggests extra affected buildings are exposed to lower storm-tide inundation depths.

Summary points & where to?



National scale hazard susceptibility

- Broad measures of hazard exposure
  - ✓ Coastal hazards (storm-tide, tsunami, sea-level rise)
  - ✓ Flood plains (floods, drainage)

Local-scale case studies of risk

- Using RiskScape to determine potential losses and disruption for inundation hazards (Tasman, Nelson, Kāpiti Coast)

Demographics of the elderly (CRESA)

- Combine census demographics with hazard exposure at national scale and risk at the local case study sites to establish the extent of the risk