CHRISTCHURCH MULTI-HAZARD ANALYSIS APPROACH

Tom Parsons – Innovate Consulting (CCC)

Water NZ Stormwater Conference May 2018

overview

- the challenge for LDRP
- approach
- early findings
- next steps

acknowledgements

- councillors, management, staff
- previous researchers
- consultants: Jacobs, Beca, HR Wallingford, University of Canterbury, NIWA, Mulgor, GHD



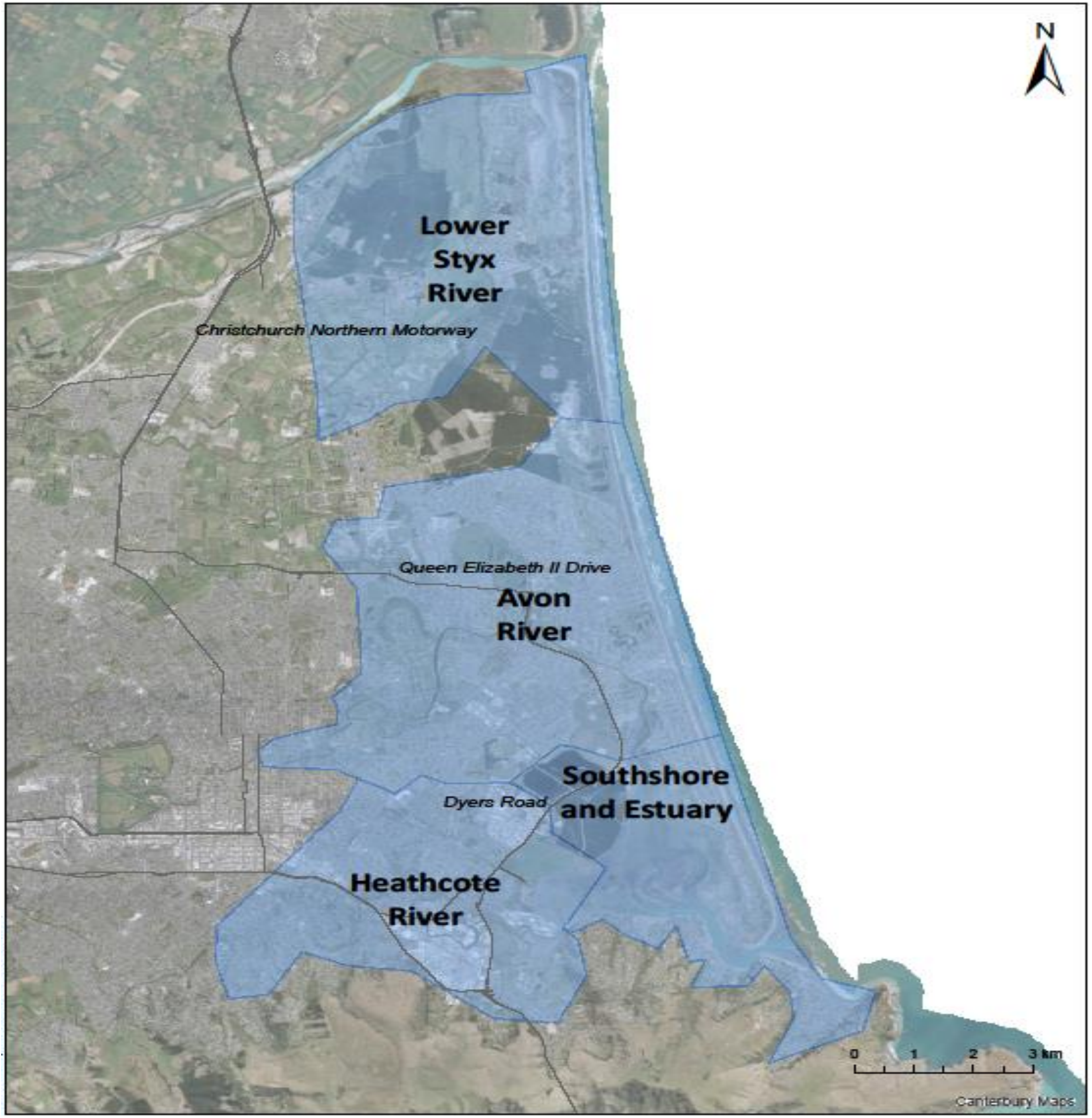

the challenge

- earthquake effects
- large infrastructure programme
- long term plan
- quick programme
- multiple overlying hazards

the goal

- sound science
- long term strategy
- informed decision making

study area


N
Lower
Styx
River
Christchurch Northern Motorway
Queen Elizabeth II Drive
Avon
River
Southshore
and Estuary
Dyers Road
Heathcote
River
0 1 2 3 km
Canterbury Maps

objective

Develop **flood management plans** for the study area, involving developing a range of sustainable and resilient flood mitigation options including engineering, planning and policy responses.

- influences of other natural hazards
- long term changes (e.g. climate change)
- magnitude, frequency and extent of flooding
- sustainable and resilient interventions

floodplain management plans

In undertaking a multi-hazard approach to the flood management planning, it is the:

- **Spatial co-existence**
- **Temporal coincidence**
- **Cascading impacts**

of the hazards that is required to be assessed.

multi-hazard interactions

- coastal storm events (storm surge and extreme waves)
- coastal erosion
- tsunami
- regional flood (Waimakariri River)
- earthquake and liquefaction
- mass movement (co-seismic and aseismic)
- climate change and sea level rise
- future increases in groundwater levels
- nature of precipitation (e.g. snow and hail)

Interested in: Spatial co-existence, Temporal coincidence, Cascading impacts

multi-hazard interactions

Table 13-1 Anticipated likelihood and consequence of co-incidence of hazard types with FPF events

Hazard	Likelihood of Temporal Co-incidence with FPF Event	Consequence of Co-incidence for Exacerbating Flooding
Coastal Storm	High	High
Snow and Hail Event	Low	Moderate (blocked drains, change antecedent conditions)
Extreme Wind Event	Low (except for coastal storms)	Low (except for coastal storms)
Future Coastal Erosion	High	High
Future Coastal Inundation	High	High
Distant Source Tsunami	Low	High
Regional Source Tsunami	Low	High
Local Source Tsunami	Low	High
Local Christchurch Earthquake	Low	High
Regional Canterbury Earthquake	Low	High
Distant Southern Alps Earthquake	Low	High
High Ground water Levels	High	High
Hill slope Instability	Moderate (erosion in extreme rainfall event)	Low
Waimakariri Flood – stopbank contained	Low	Moderate (mouth migration)
Waimakariri Flood – stopbank breached	Low	High

http://christchurch.infocouncil.biz/Open/2017/08/CNCL_20170803_AGN_1294_AT.PDF

multi-hazard interactions

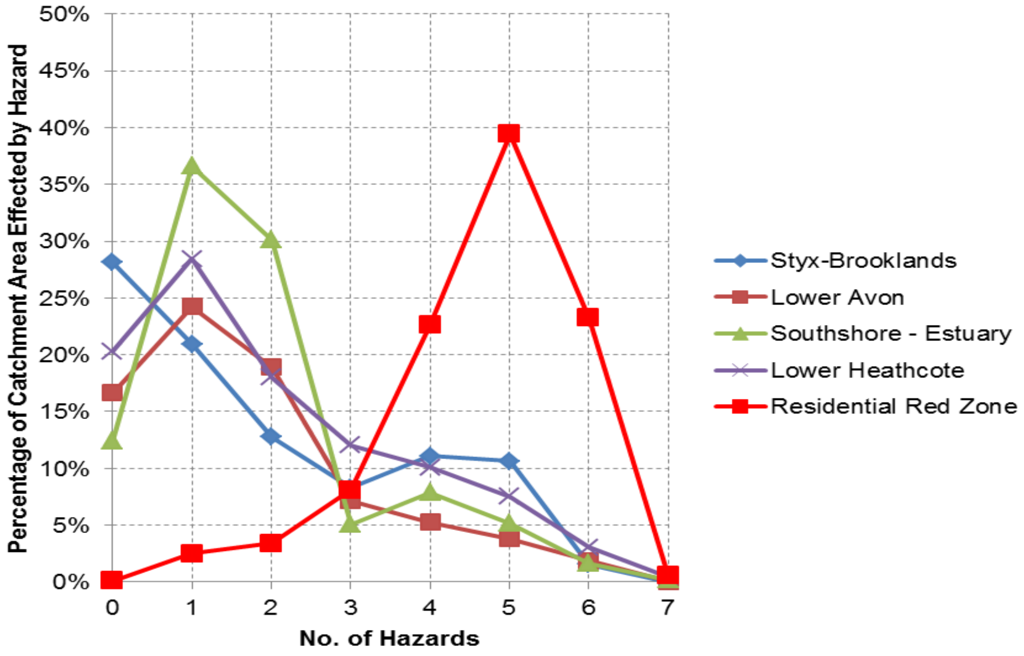
Table 13-2 Anticipated likelihood and consequence of cascade of hazard types to FPF events

Hazard	Cascade Likelihood	Cascade Geomorphic Permanence	Cascade Consequence for Exacerbating Flooding
Coastal Storm	High	Moderate (estuary/river mouth migration)	Moderate (estuary/river mouth migration)
Snow and Hail Event	Low	Nil	Low (only if very short term cascade of events)
Extreme Wind Event	Moderate	Nil	Nil
Future Coastal Erosion	High	High	High
Future Coastal Inundation	High	High	High
Distant Source Tsunami	Low	High (estuary/river mouth, estuary infrastructure)	High (estuary/river mouth, estuary infrastructure)
Regional Source Tsunami	Low	Moderate (less likelihood of permanent impacts)	Moderate

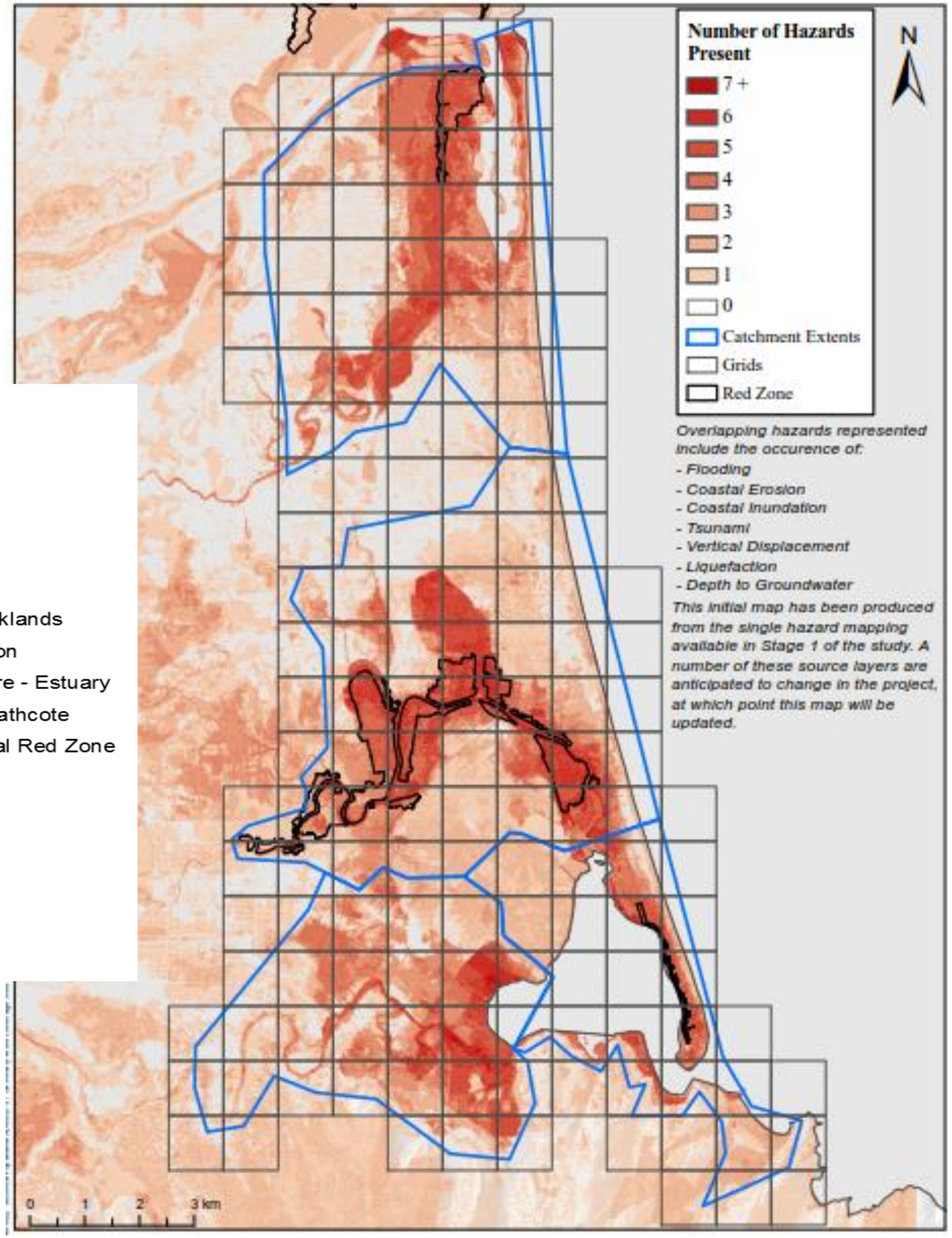
multi-hazard interactions

Hazard	Cascade Likelihood	Cascade Geomorphic Permanence	Cascade Consequence for Exacerbating Flooding
Local Source Tsunami	Low	Uncertain	Uncertain
Local Christchurch Earthquake	High	High (liquefaction, vertical displacement)	High
Regional Canterbury Earthquake	High	Moderate (liquefaction, vertical displacement)	Moderate
Distant Southern Alps Earthquake	High	Moderate (liquefaction, vertical displacement)	Moderate
Future High Ground water Levels	High	High permanent high water table	High
Hill slope instabilities	Moderate	High	Low limited ability to get in river channel/estuary
Waimakariri Flood-stopbank contained	Moderate	Moderate (mouth migration)	Moderate mouth migration)
Waimakariri Flood –stopbank breached	Low	Moderate	Moderate

co-location

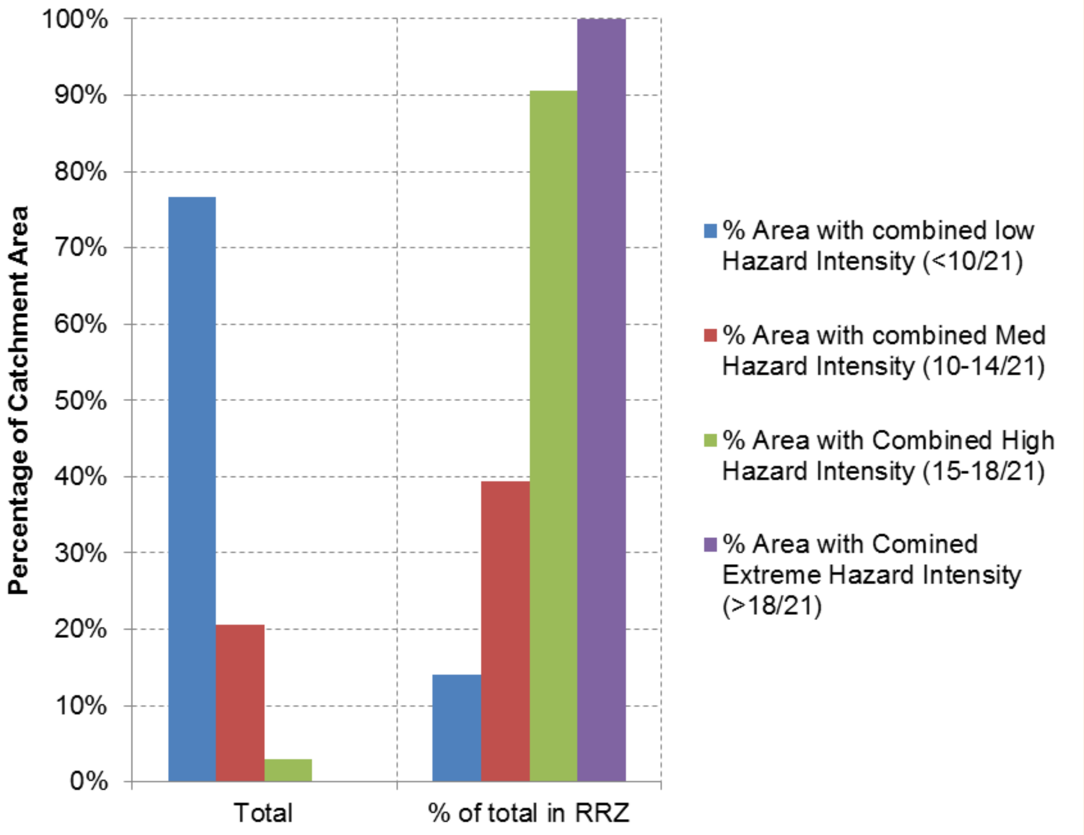


Percentage of Catchment Area Effected by Hazard
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0
1
2
3
4
5
6
7
No. of Hazards
Styx-Brooklands
Lower Avon
Southshore - Estuary
Lower Heathcote
Residential Red Zone

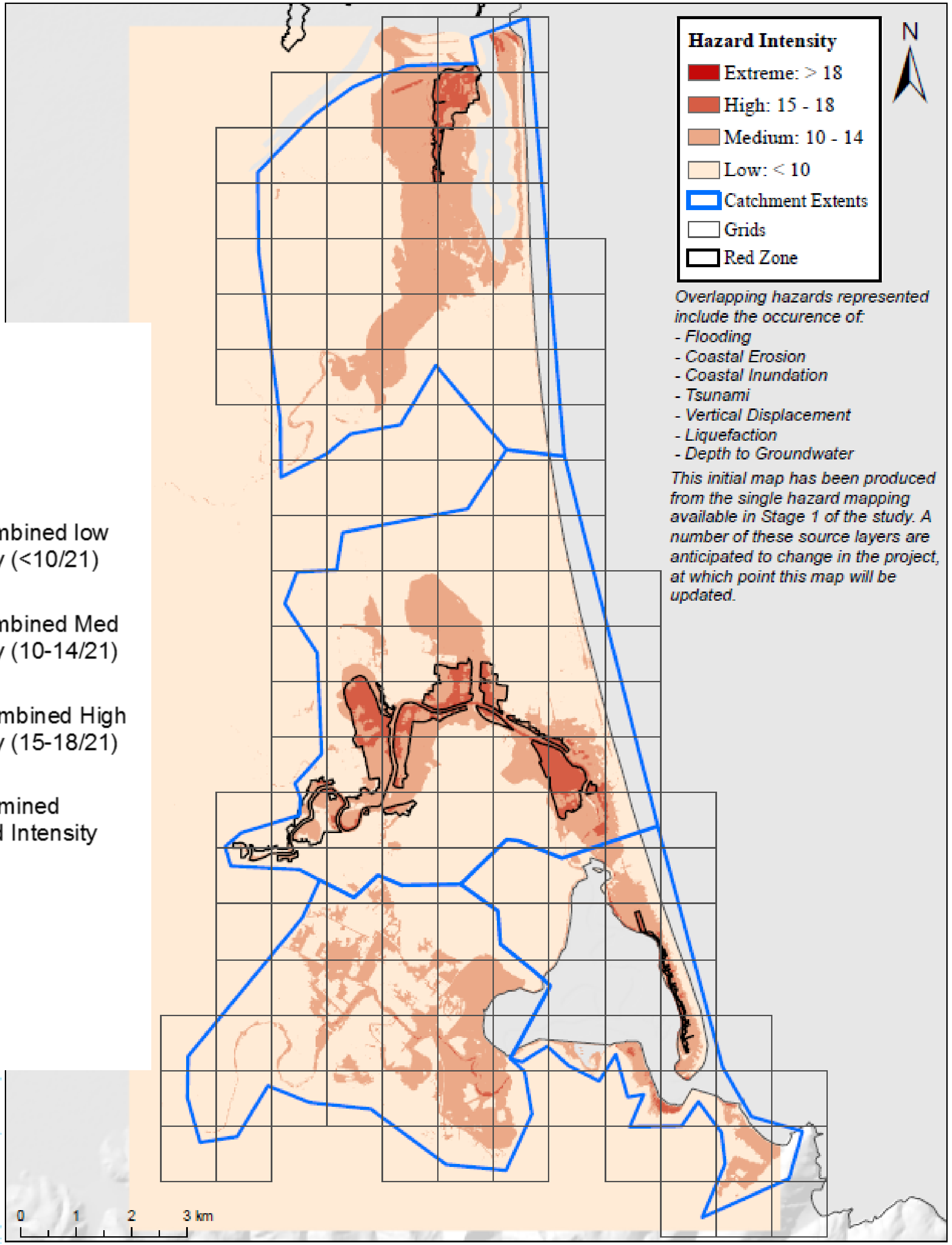


Number of Hazards Present
7 +
6
5
4
3
2
1
0
Catchment Extents
Grids
Red Zone
N
Overlapping hazards represented include the occurence of:
- Flooding
- Coastal Erosion
- Coastal Inundation
- Tsunami
- Vertical Displacement
- Liquefaction
- Depth to Groundwater
This initial map has been produced from the single hazard mapping available in Stage 1 of the study. A number of these source layers are anticipated to change in the project, at which point this map will be updated.
0
1
2
3 km

co-location



Percentage of Catchment Area
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Total
% of total in RRZ
% Area with combined low Hazard Intensity (<10/21)
% Area with combined Med Hazard Intensity (10-14/21)
% Area with Combined High Hazard Intensity (15-18/21)
% Area with Comined Extreme Hazard Intensity (>18/21)



Hazard Intensity
Extreme: > 18
High: 15 - 18
Medium: 10 - 14
Low: < 10
Catchment Extents
Grids
Red Zone
N
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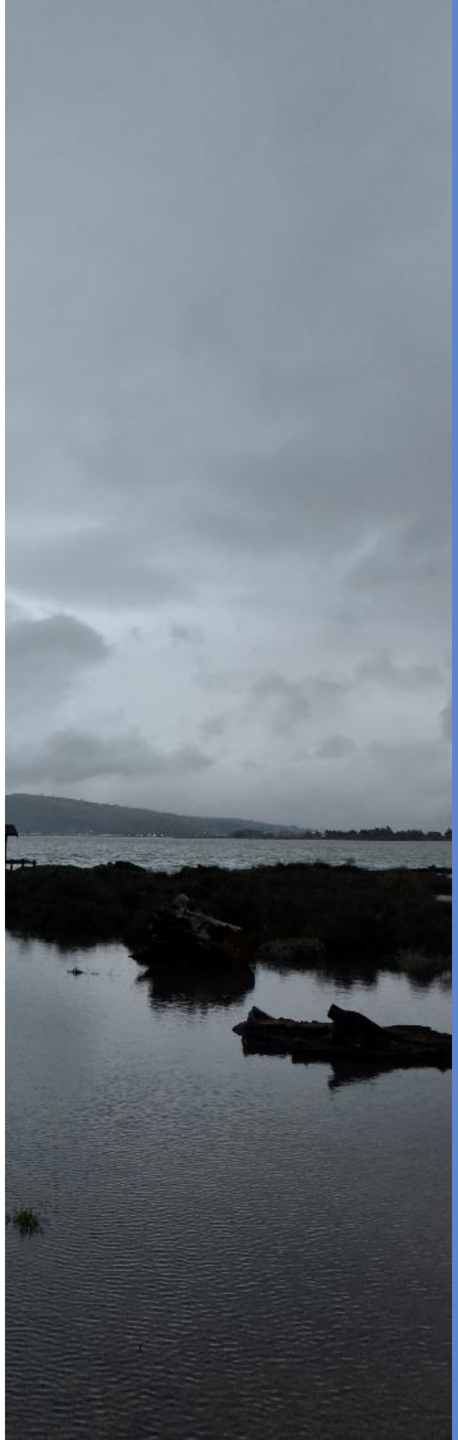
0 1 2 3 km

limitations / gaps

- data and spatial coverage gaps
- varying frequencies of hazards
- inconsistency in intensities



gap studies identified

- co-incidence of fluvial, pluvial and coastal flooding events, and the extreme weather causing these events
- groundwater levels to flooding from rainfall run-off/percolation;
- frequent tsunami events
- vertical ground displacements from future earthquakes
- coastal sediment budget and coastal erosion / accretion (sediment deposition)
- CCC assets valuation for the economic analysis of the multi-hazard assessment
- design guidance for CCC infrastructure in floodplains

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All three studies are being delivered by NIWA

next steps

- baseline modelling
- options assessment

Christchurch City Council

innovate
CONSULTING

JACOBS

Beca

HR Wallingford
Working with water

UC
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND