Understanding Risk in Levee Systems

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Background

Flooding caused by Cyclone Gabrielle in Awatoto (AFP)

Aerial view of Temuka River May 2021
(John Bisset, Stuff New Zealand)

Background

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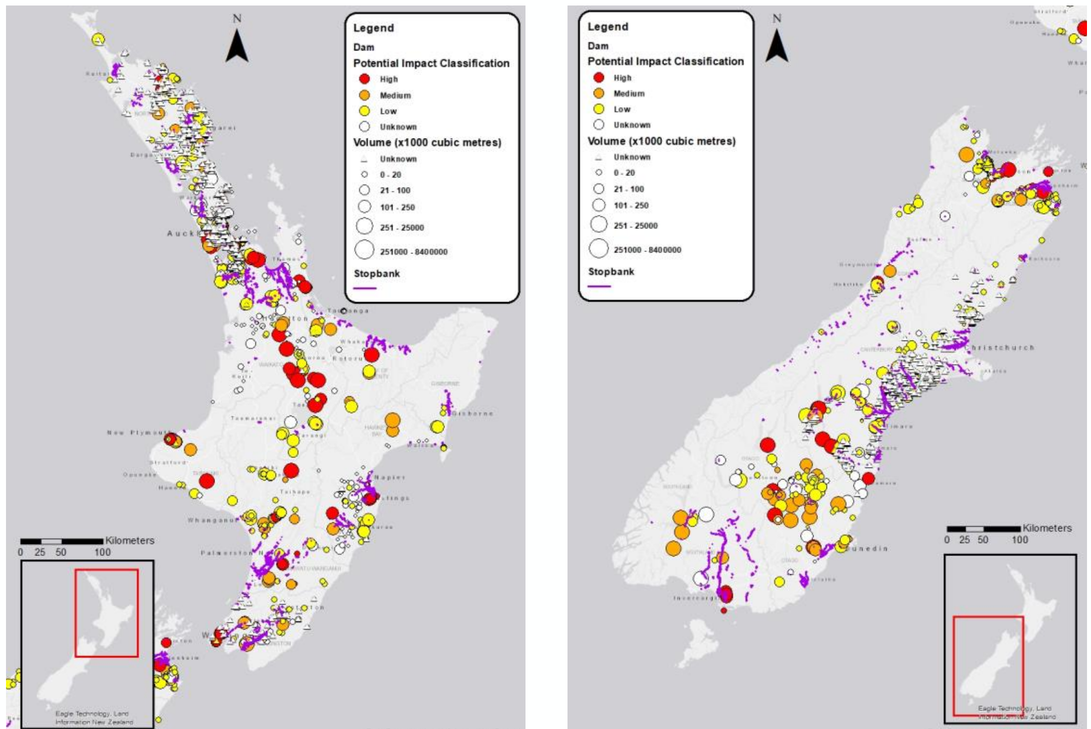
Cyclone Gabrielle – 6km of breaches in 250 km levee network, total of 30 breaches



New Zealand Inventory of Dams and Inventory of Levees

Objectives

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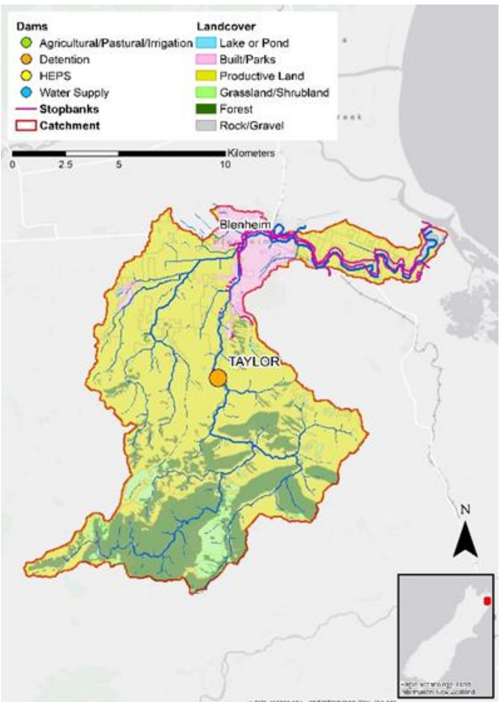
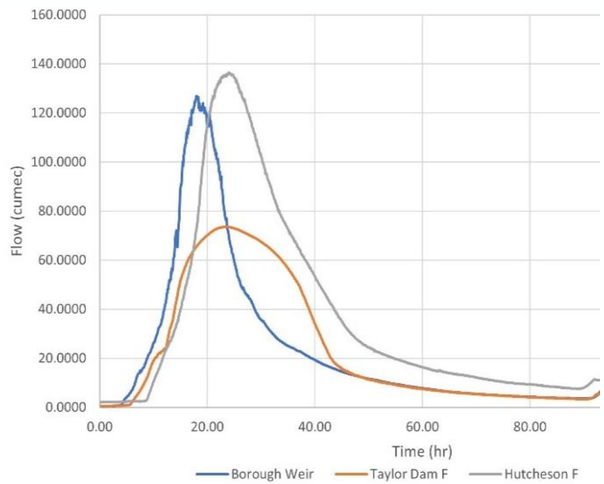
"This project aims to investigate how levee breaching affects flooding"

1. Develop a framework for **simulating levee breaching** within 2D flood models where site specific data is limited or absent
2. Determine the **exposure of infrastructure and communities** to inundation as a result of changes in breach location
3. **Determine the critical sections** of levees so they may be targeted for additional reinforcement of monitoring during an event
4. Provide **alternative flood strategy recommendations** to improve flood management and reduce the downstream flood risk.

Today's Catchment



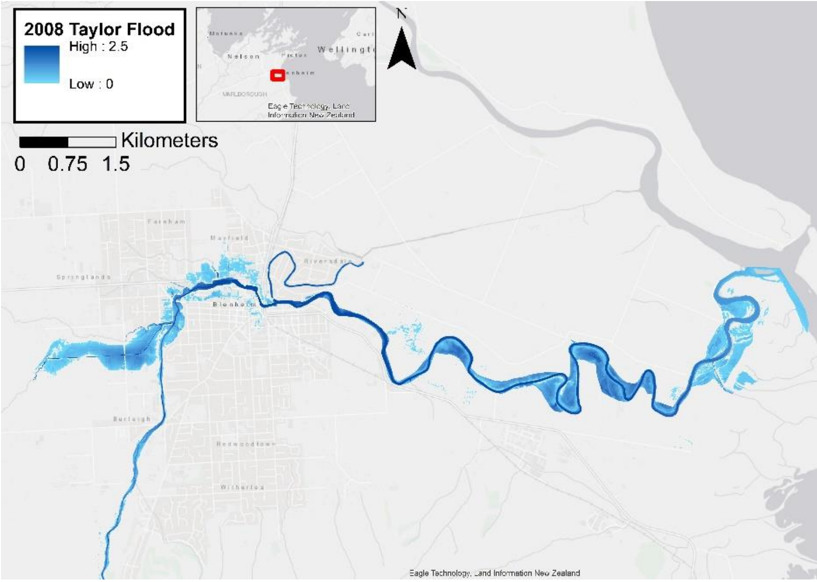
Taylor Catchment Map



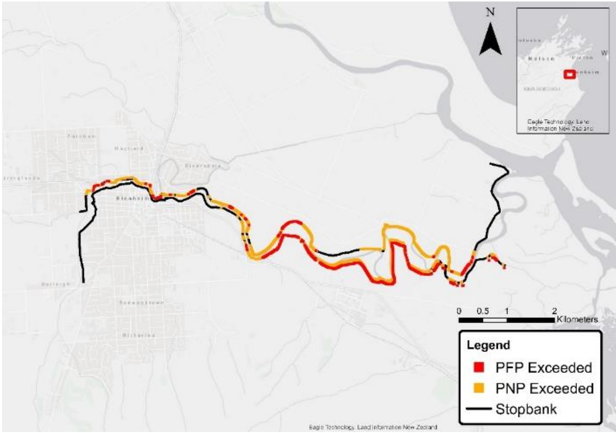
Hydrograph of 2008 flood event
~25 year event

Example of Blenheim Levee

Historical Flood



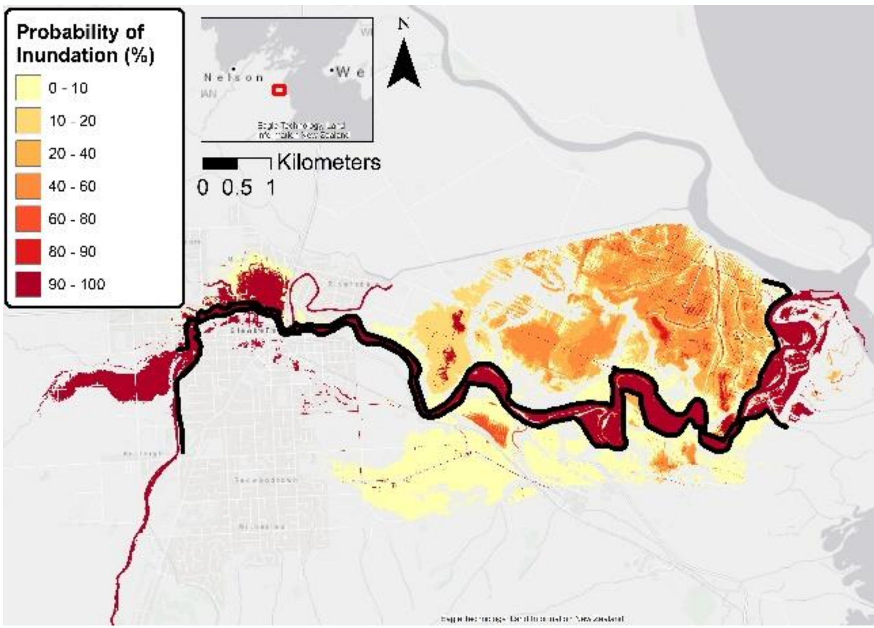
2008 Historic Flood



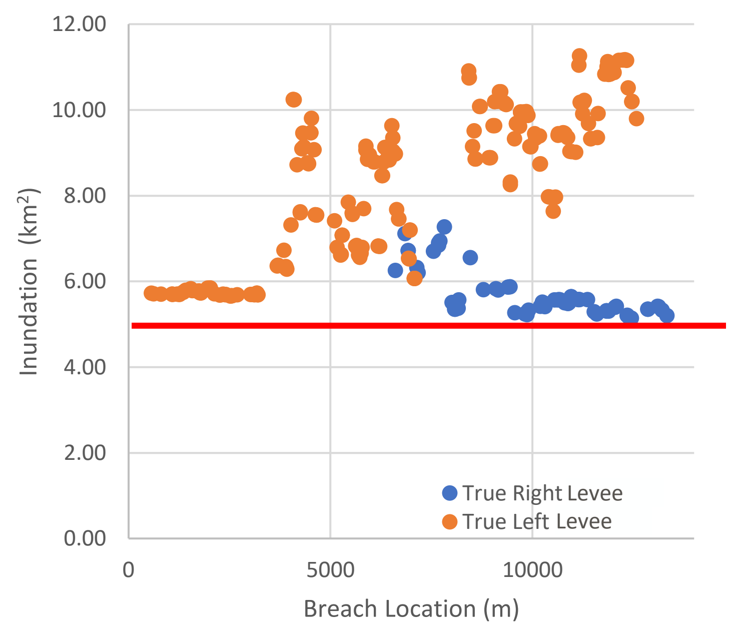
PNP & PFP thresholds were exceeded during 2008 flood

	Length (km)	Length (%)
Total	27.8	-
Probable Non-failure Point (PNP)	14.1	50%
Probable Failure Point (PFP)	5.9	21%

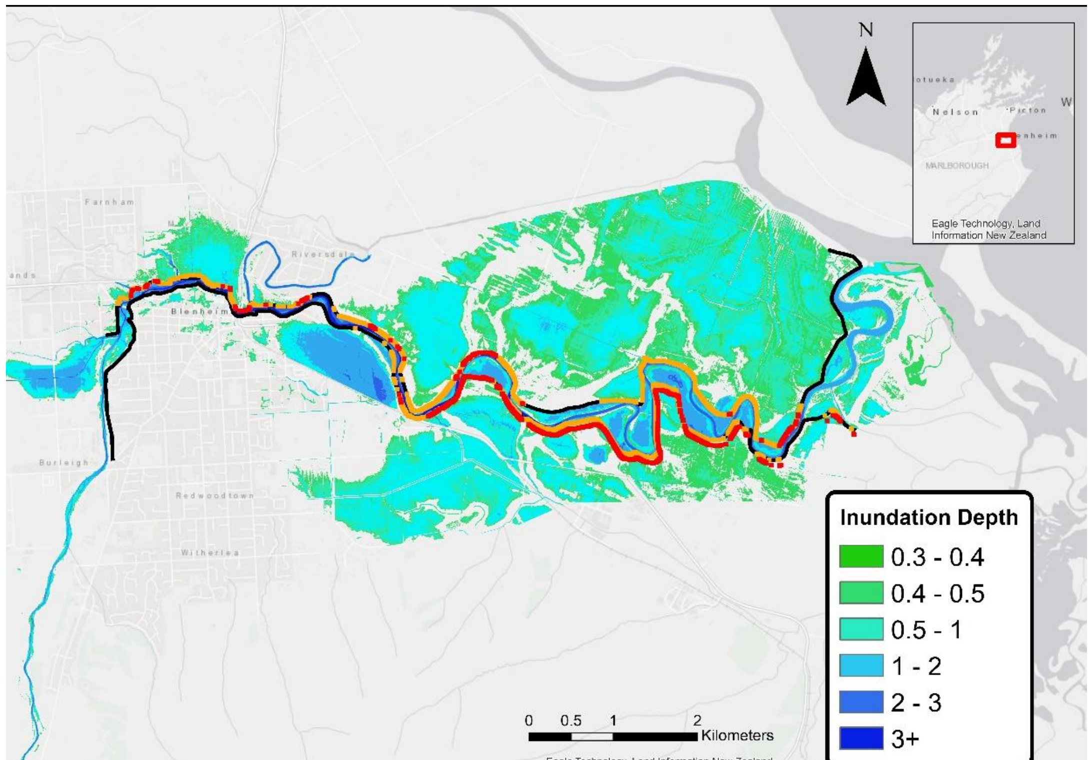
Breach Flood Map



Breach flood map given a breach occurs



Breath Depth Map



Preliminary Breach Flood Map (given a breach occurs, using PNP threshold locations)

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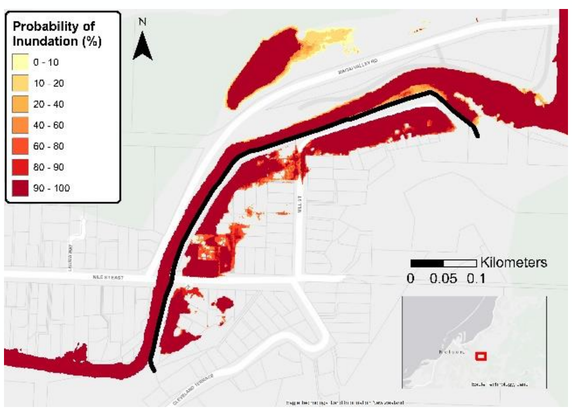
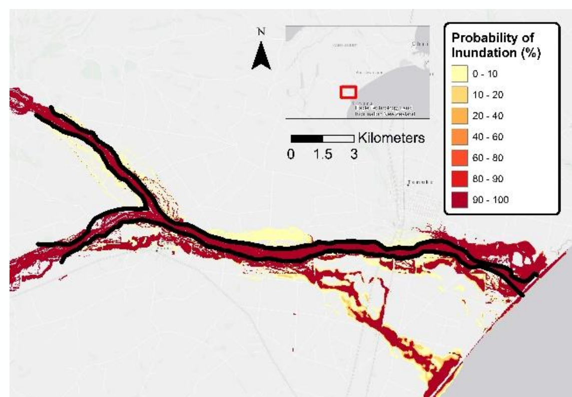
Additional Breach Maps

CATCHMENT	RETURN PERIOD	HISTORIC FLOODING (km^2)	INUNDATION INCLUDING BREACHING (%)		
			Average Increase	Max	Minimum
Taylor	25	5.1	48.2%	120.3%	0.7%
Maitai	10	0.85	0.7%	1.6%	0.3%
Opuha	50	48.8	1.5%	10.8%	-2.1%
Rangitaiki	25	24.2	9.0%	35.3%	-12.3%

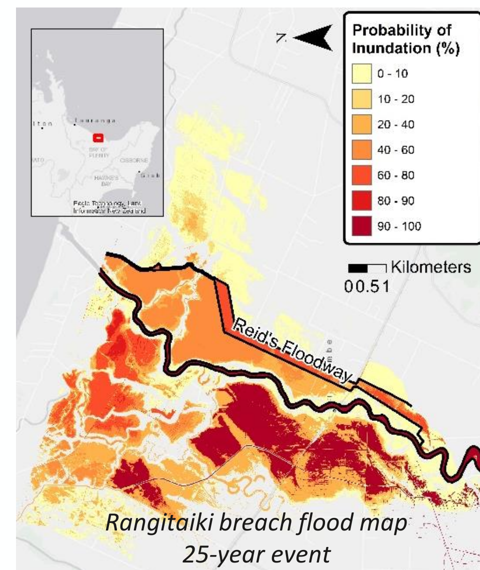
Average increase, maximum, and minimum changes in inundated area)



Maitai breach flood map
10-year event

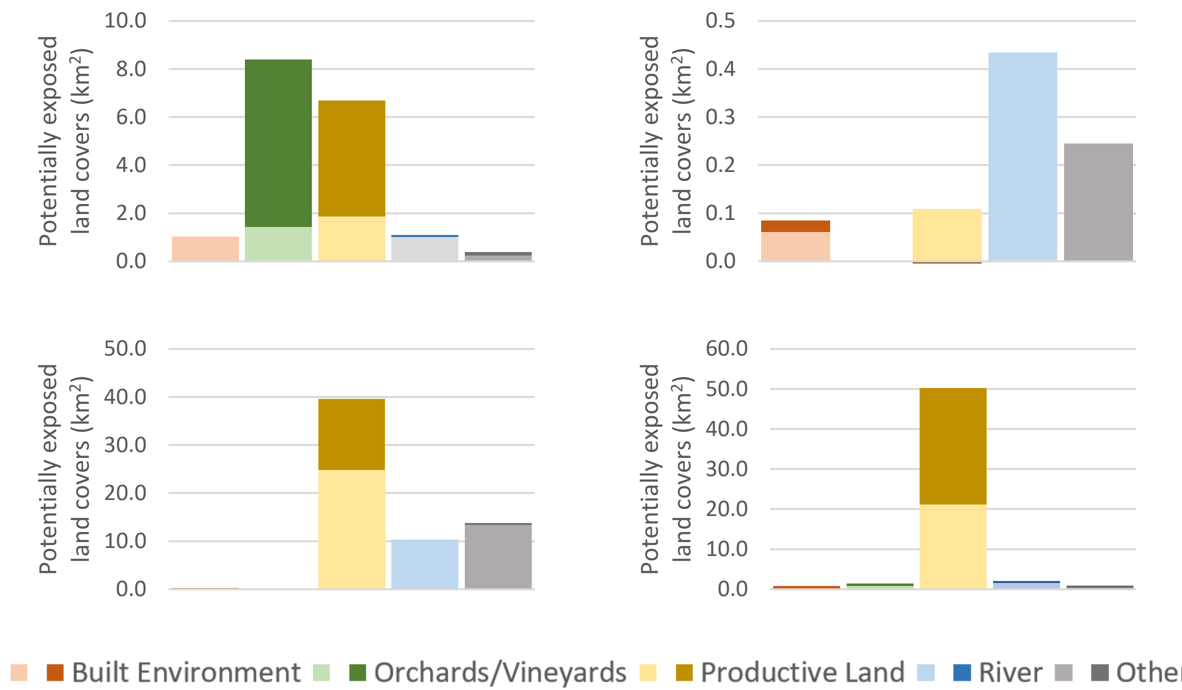


Opuha breach flood map
50-year event



Rangitaiki breach flood map
25-year event

Affected Landcover



Potentially exposed land covers (historically exposed in lighter, additionally exposed in darker)
(a) Taylor catchment, (b) Maitai catchment, (c) Opuha catchment, and (d) Rangitaiki catchment

Conclusions

- Novel method of simulating breaching with limited information in a 2D model
  - may be adapted to existing models
- Breaching increased flooding up to 48%
- Breaching highlights critical sections
- Breaching decreased flooding up to 12%
  - adopt fuse-plug /floodway strategies
- Flooded land is mostly paddocks that may be developed
- Prudent to act strategies now

Wairoa, Hawke's Bay during Cyclone Gabrielle
(Hawke's Bay CDEM Group)

THANK YOU

To develop recommendations to improve our flood protection systems

To reduce flood risk

Breached Floodwall in Edgecumbe
(Chris McKeen, Fairfax New Zealand, 2017)