UNDERSTANDING THE OPERATIONAL VULNERABILITIES AND SYSTEMIC RISK IN INTEGRATED STOPBANK-DAM CATCHMENTS

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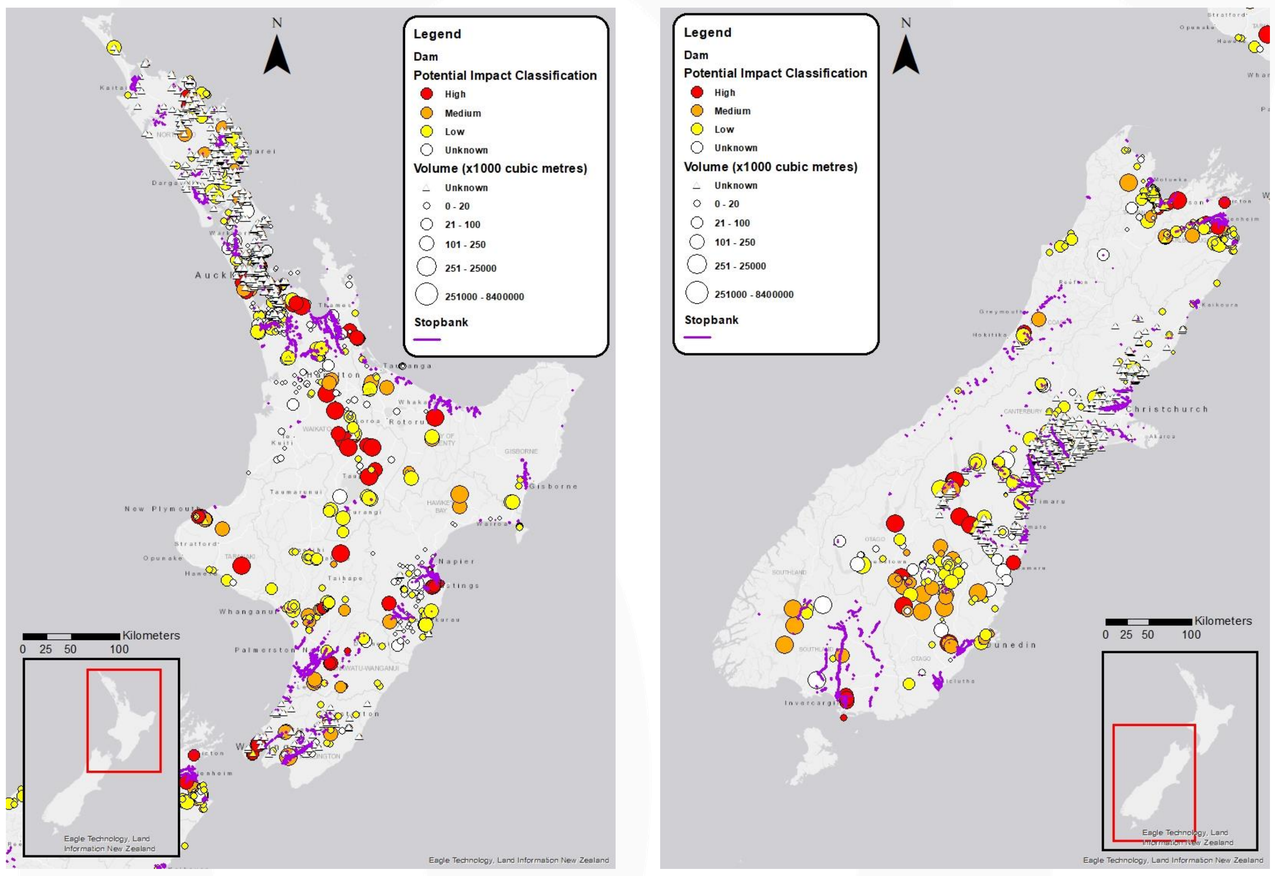
BACKGROUND

There is a growing need for greater flood protection globally as flood risk increases. The three main strategies employed within New Zealand are: (1) structural defences (2) planning measures to ensure people and infrastructure are out of harm's way, and (3) emergency management, including preparation (MfE, 2008). Despite the implementation of these strategies **there is, and always will remain, a flood risk** in some areas.

In New Zealand, dams and stopbanks **are primarily managed as individual elements despite being part of a larger connected flood protection system**. A non-integrated approach has contributed to inconsistencies in the construction, maintenance, and management of structures between regions. Despite the importance of stopbanks and dams, these differences have led to **varying levels of resilience which may not be proportional to the relative importance of the structures**

A broader systems approach to flood management can provide many benefits over a non-integrated approach through greater collaboration among stakeholders and a shared understanding of potential hazards. A systems approach may help to **reduce systemic risk by addressing operational vulnerabilities**. For this research, operational elements are those that can influence the functioning of a structure during a high-intensity weather event. Systemic elements are elements that involve interactions between multiple aspects of a flood protection system.

Currently there are knowledge gaps regarding the **prevalence and potential consequences of operational systemic vulnerabilities** on flooding as well as **methods to assess** the operational systemic elements maturity in integrated stopbank-dam catchments.



Documented dams and stopbanks in New Zealand (Blake et al., 2018; Crawford-Flett, Pascoal, & Wilson, 2018)

This project aims to move flood management of stopbanks and dams away from an individual view to a systems perspective. This will be achieved through assessing system maturity of operational elements in stopbank-dam management. The potential consequences of operational vulnerabilities will be determined through probabilistic breach flood modelling to highlight the importance of recommendations made to reduce flood risk.

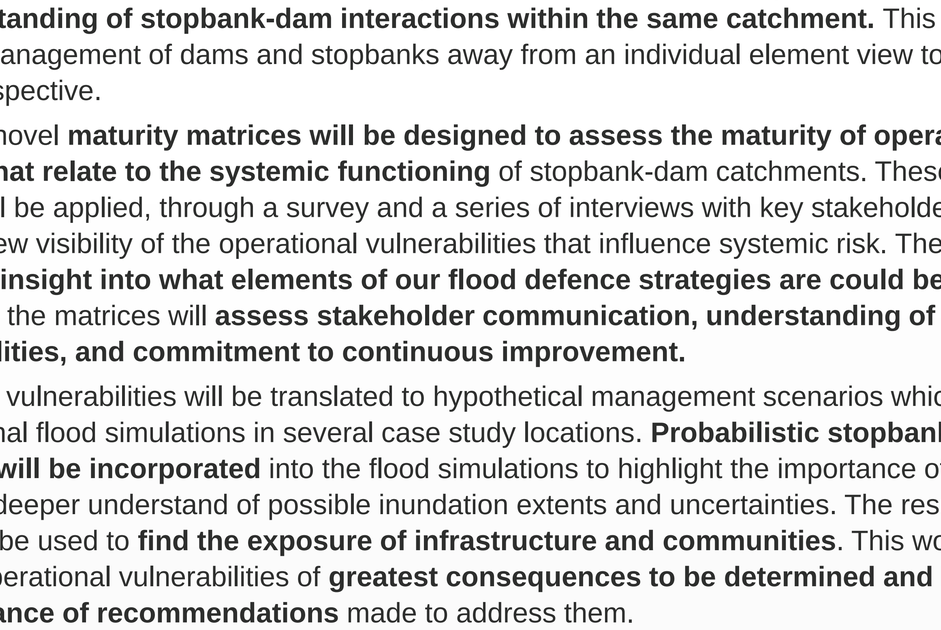
PROJECT SCOPE

This project aims **to reduce flood risk through improved system management by furthering the understanding of stopbank-dam interactions within the same catchment.** This will help to move the management of dams and stopbanks away from an individual element view to a broader system perspective.

A series of novel **maturity matrices will be designed to assess the maturity of operational elements that relate to the systemic functioning** of stopbank-dam catchments. These maturity matrices will be applied, through a survey and a series of interviews with key stakeholders, to provide a new visibility of the operational vulnerabilities that influence systemic risk. The matrices will provide **insight into what elements of our flood defence strategies are could be improved**. Specifically, the matrices will **assess stakeholder communication, understanding of roles & responsibilities, and commitment to continuous improvement.**

Operational vulnerabilities will be translated to hypothetical management scenarios which will affect computational flood simulations in several case study locations. **Probabilistic stopbank breaching will be incorporated** into the flood simulations to highlight the importance of structures and gain a deeper understand of possible inundation extents and uncertainties. The resulting flood extents will be used to **find the exposure of infrastructure and communities**. This work will allow the operational vulnerabilities of **greatest consequences to be determined and highlight the importance of recommendations** made to address them.

To summarise, this project aims to: (1) develop the understanding of maturity in operational systemic elements in stopbank-dam flood systems, (2) use the identified operational vulnerabilities to undertake probabilistic breach flood modelling and determine the flood exposure of communities and infrastructure, and (3) recommend alternative operational strategies to reduce exposure and improve resilience. **Ultimately, this project aims to move flood risk management towards a broader system-wide view** to improve resilience and safety in downstream communities.



Preliminary proof of concept work for probabilistic breach flood modelling with 10 stopbank breaches

OUTPUTS – WHAT DOES THIS MEAN FOR NEW ZEALAND

Technical communities will benefit from the development of techniques for determining the prevalence and consequences of operational vulnerabilities such as the maturity matrices and probabilistic breach flood modelling techniques

New Zealand hazard and embankment engineering communities will benefit from a better understanding of the infrastructure and communities exposed to flooding

Regional authorities & embankment owners will gain an improved nationwide understanding of system maturity at an operational level and recommendations to help improve flood management.

Stakeholders will benefit from the improved management of catchment systems and therefore safer flood protection networks.

Elements	Sub-elements	Maturity Level Descriptors				
		1. Needs Development	2. Intermediate	3. Good Practise	4. Best Practice	5. Leading Edge
Communication	Timely	-	-	-	-	-
	Complete	-	-	-	-	-
	Accurate	-	-	-	-	-
	Relevance	-	-	-	-	-
Roles & Responsibilities	Clarity	-	-	-	-	-
	Consistency	-	-	-	-	-
	Expectations	-	-	-	-	-
Continuous Improvement	Activities	-	-	-	-	-
	Reviews	-	-	-	-	-

Preliminary maturity matrix framework for assessing operational systemic elements

TIMELINE

Stage 1 – Maturity Matrices – late 2021: Development of maturity matrices and survey to assess operational systemic elements with guidance from expert reviewers

Stage 2 – Operational Vulnerabilities – early 2022: Analysis of survey results and interviews to determine potential operational vulnerabilities in selected case study locations

Stage 3 – Probabilistic Breach Flood Modelling - mid 2022: Translation of vulnerabilities to hypothetical management scenarios and application of these to probabilistic stopbank breaching in a computational flood model

Stage 4 – Exposure Assessments - late 2022: Determining exposure of infrastructure and communities to flooding

Stage 5 – Recommendations – early 2023: Alternative management scenarios to address the operational vulnerabilities to improve resilience

REFERENCES

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