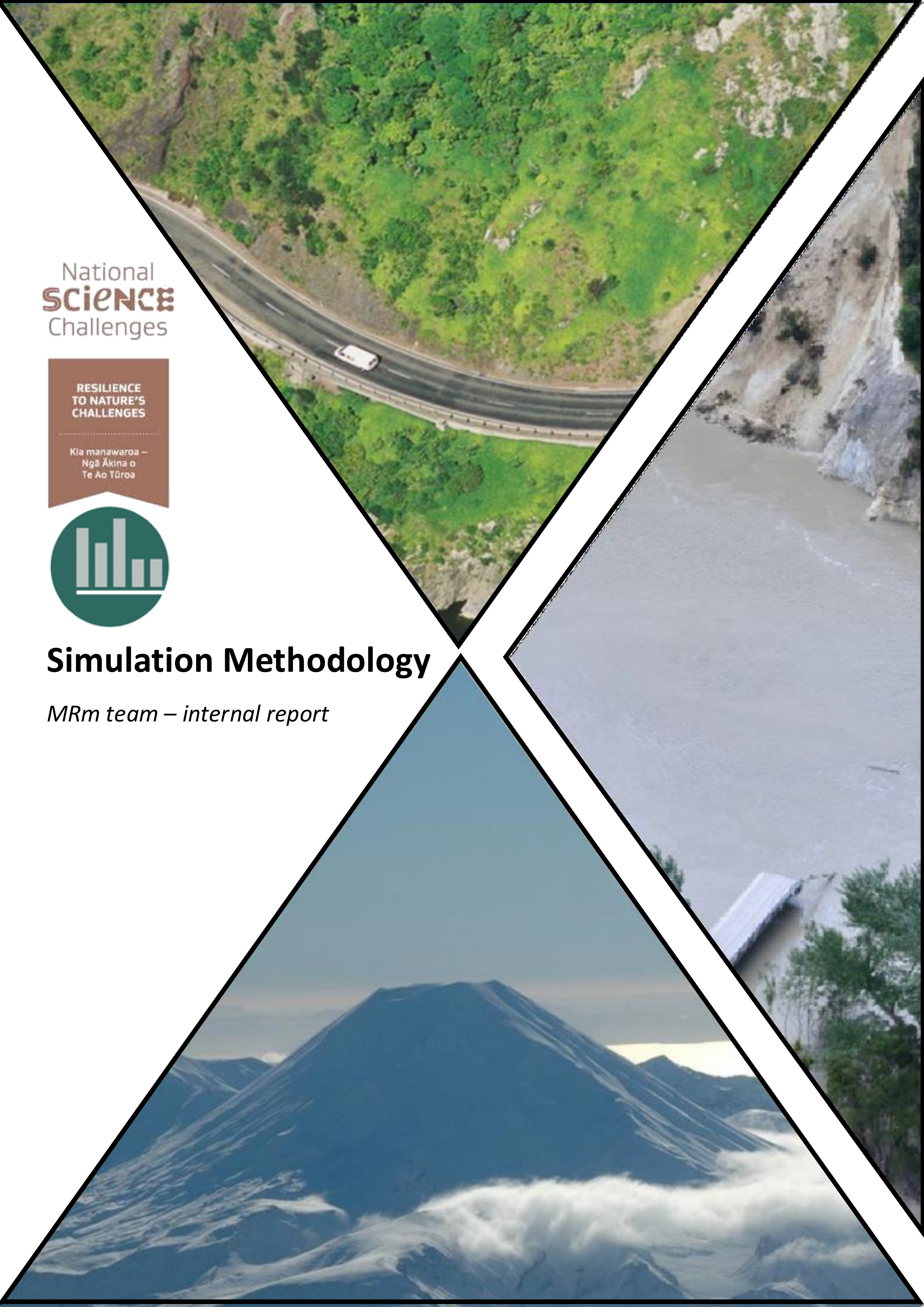

National SCIENCE Challenges

RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa – Ngā Ākina o Te Ao Tūroa

Simulation Methodology

MRm team – internal report

Resilience to Nature's Challenges 2

Simulation Methodology: Transfer of cascading hazard outputs to direct impact assessments

Whitehead, M.[1], McDonald, N.[2], Dowling, L.[2], Bui, N.[2], Grimson, D.[2], Bebbington, M.[1], Mead, S.[1], Harte, D.[3]

1. Massey University, 2. Market Economics, 3. Statistics Research Associates.

EXECUTIVE SUMMARY

A significant part of multi-hazard impact assessment is the translation from hazard output to direct impact. As part of the Resilience to Nature's Challenges 2 – Multi-Hazard Risk Model, this work goes one step further to translate hazard outputs into potentially indirect, downstream economic impacts. This is a short report that serves as deliverable 4.1.1: "Simulation methodology for direct physical and economic impact assessment developed to align with Case Study and testing database produced".

The bulk of this report describes the processes behind the selection of locations of interest at which hazard attribute information is required. Locations of interest include businesses deemed economically important to the region, productive land for dairy, forestry, or horticulture, and locations along road and power networks. The remainder of the report details the specifics around hazard attribute transfer. There are six hazards modelled across this Case Study: lava, tephra, lahars/debris flows, landslides/debris avalanches, floods, and earthquakes, each of which comes with a different set of required hazard attributes at the locations of interest.

Abbreviations

ACSTN	Alternating current (AC) station
COORD	Co-ordinates
CSV	Comma-Separated Variable
GXP	Grid Exit Point
LINZ	Toitū Te Whenua – Land Information New Zealand
MERIT	Modelling the Economics of Resilient Infrastructure Tool
MRm	Multi-hazard Risk model
RNC	Resilience to Nature's Challenges Kia manawaroa – Ngā Ākina o Te Ao Tūroa
UNISDR	United Nations Office for Disaster Risk Reduction

Figures & Tables

Contents

1. Introduction

A **hazard** is an event that *may have* negative impacts on society (UNISDR, 2009). A **multi-hazard** is the occurrence of multiple (>1) hazards partially or completely overlapping in space-time that may or may not be causally related (Whitehead et al., 2021). Here, **impact** is defined as the effect of a hazard, or multi-hazard on the region of interest.

Infrastructure is commonly used to translate spatio-temporal hazard outputs (e.g., thickness of tephra deposition or depth of flooding at location *x*, time *t*) into tangible effects for any downstream societal or economic model (McDonald et al., 2018; McDonald et al., 2020; Brown et al., 2023). For example, if a bridge is destroyed by a flood, then the road may be temporarily impassable, and this can then be translated into economic losses through shipment delays, or people not being able to get to work (McDonald et al., 2017).

For proof-of-concept for the Resilience to Nature's Challenges 2 - Multi-hazard Risk model case study, a set of infrastructure points was used to translate hazard outputs into the downstream economic model (MERIT). The overall methodology was an iterative procedure structured around a set of inter-team discussions. The two teams are referred to here as the *Hazard Modelling Team*, and the *Economic Modelling Team.*

Infrastructure types were primarily driven by the Economics Team, specifically the key businesses to include and a road network model that already interfaced with the MERIT dynamic model. Within these types, specific infrastructure points were initially proposed by both the Hazards Team, prioritising locations at higher risk of damage (e.g., located in the flood plain), and the Economics Team, concerned with productive land locations, and then discussed between teams to decide on the merged set.

The bulk of this report details how these infrastructure points were selected with subjective judgements noted where undertaken for transparency and repeatability. The final section outlines the process for using the infrastructure points for data transfer and translation between hazard model outputs and economic model inputs.

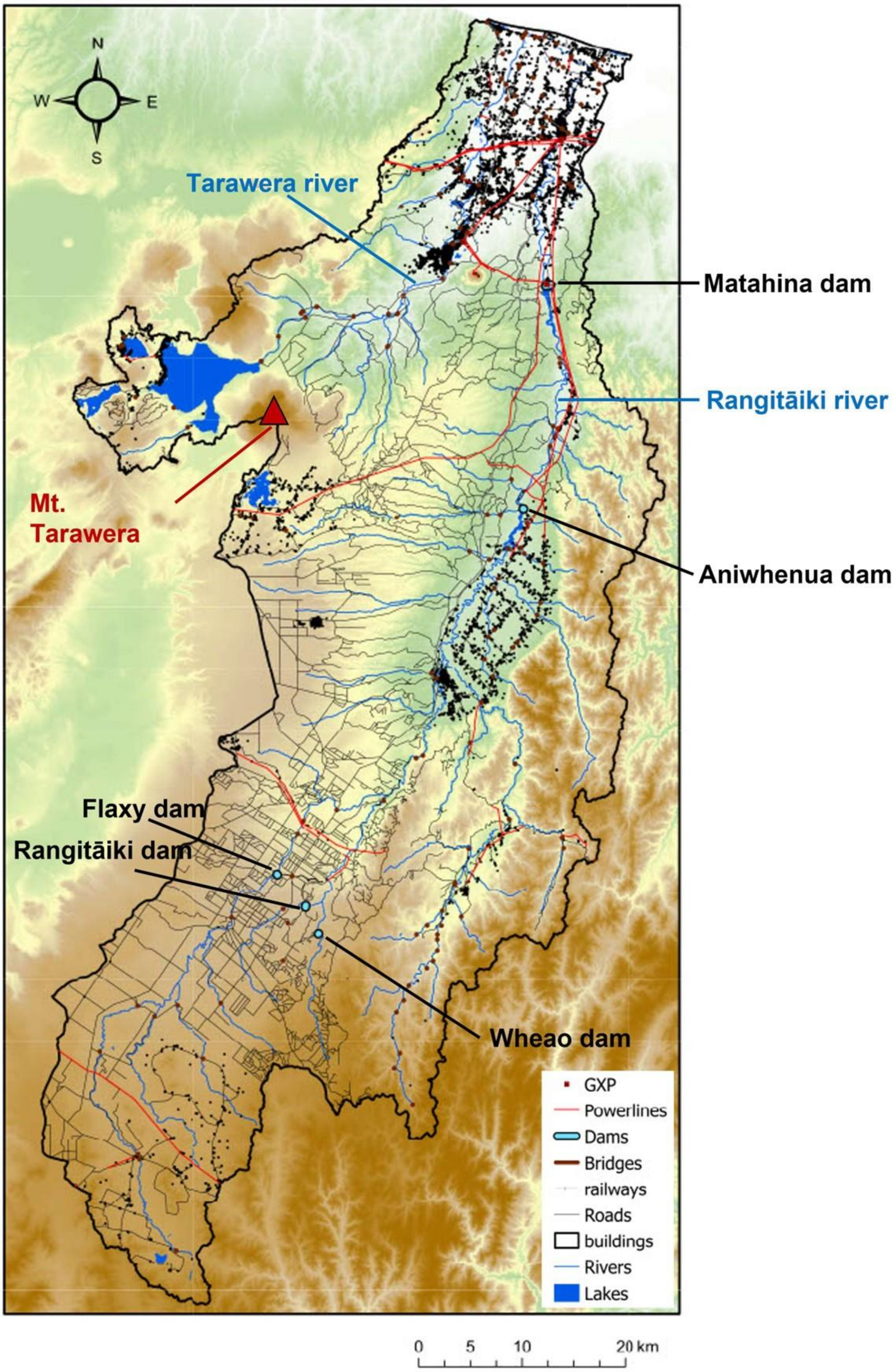

Figure 1: Potential Infrastructure types available across the Case Study

2. Infrastructure data

The Case Study is in the Bay of Plenty, New Zealand. Data for this region is freely available from Toitū Te Whenua – Land Information New Zealand, specifically, through the LINZ Data Service and licensed for reuse under the CC BY 4.0 licence. Data are available for the Cast Study region for approximately 120 infrastructure types, ranging from gas valves and dumping grounds through to helipads and racetracks.

For most of these infrastructure types in this Multi-hazard Risk model, any hazard interaction would not have any influence on the downstream economic model. Thus, through a series of discussions between the Hazards and Economics Modelling teams, potential infrastructure types were reduced to five options, with an additional two types "businesses", and "hazard points" provided directly by the Economics Team (Table 1, Figure 1).

Table 1: Potential Infrastructure types available across the Case Study region

Infrastructure	Source	Brief description
Businesses	Economics Team	Specific business geographic units identified as economically important for the Case Study Region
Hazard points	Economics Team	Specific locations of interest to the economic modelling team, examples include points within dairy farms and other productive land classes
Roads	Economics Team	Road segments from a road network model built for the Case Study
Bridges	LINZ	"A structure erected over a depression or obstacle to carry traffic or some facility such as a pipeline." https://docs.topo.linz.govt.nz/data-dictionary/tdd-class-bridge_cl.html
Railways	LINZ	"A permanent way having one or more rails which provides a track for trains or trams." https://docs.topo.linz.govt.nz/data-dictionary/tdd-class-railway_cl.html
Powerlines	LINZ	"A cable or cables supported by poles or towers for the transmission of electricity." https://docs.topo.linz.govt.nz/data-dictionary/tdd-class-powerline_cl.html
Pylons	LINZ	"A steel tower supporting high tension wires." https://docs.topo.linz.govt.nz/data-dictionary/tdd-class-pylon_pnt.html

The following sections provide a brief overview as to each infrastructure type and how specific infrastructure points were selected from these raw data.

2.1 Businesses

Modified Employment Counts (MECs)[1], provided by Market Economics' Business Directory, have been used to identify areas (SA1s) with significant employment levels. Simple Location Quotients (SLQs) have also been used to help inform relevant areas of employment within the Case Study Area. SLQs measure the relative concentration of an industry type within a specific area against the concentration of the same industry type across a wider region. This provides an approximation of the relative importance of a specific industry to a regional economy.

After identifying areas of significant employment, individual businesses have been matched to corresponding employment counts using Google Maps and Google Streetview. Given the size of the businesses and their importance to the regional economy, these identified individual businesses then form business infrastructure points. For the Case Study Area, business infrastructure points are concentrated in areas such as Kawerau, Edgecumbe, and Te Teko and include a range of industries grouped by ANZSIC06 classification. These include a range of manufacturing industries, education providers, and electricity generation. In total, 38 business infrastructure points are included.

2.2 Hazard points

There were two methods of hazard point identification - one for dairy farms, and one more general approach for other land uses.

2.2.1 Dairy

Dairy farming is a high-value land use and relies on daily milking at the dairy shed. Shed locations were used as the location for linking dairy farming land to the hazard models.

To create the dairy shed location data, the LINZ Data Service buildings dataset was filtered to include only those buildings within the case-study area. Metrics were calculated for each building and tested for predictive power for classifying buildings as dairy shed using a Random Forests model (Breiman 2001) in the R statistical programming language (R Core Team 2022). The calibration dataset included 97 identified dairy sheds and 564 non-dairy buildings.

Despite a range of metrics designed to identify dairy sheds, only the distance to a Resource consent with the recorded subtype of 'Discharge' and category 'Dairy' provided reasonable predictive power. Even with that, the result was a model achieving an out-of-bag R-squared of 0.26. Because that was considered poor, manual identification was used.

Manual identification started with buildings assigned high likelihood of being a dairy shed by the model. All sections of the case study area with some high-likelihood buildings were scanned manually looking for the dairy farm pattern of dairy races and high-productivity pastures evident in satellite and aerial imagery. Where dairy farming was identified, the races were followed to find the sheds. Following this semi-manual process systematically across the case study area areas the dataset of dairy sheds was created containing 210 dairy sheds (Figure 3).

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[1] Modified Employment Counts augment the standard Employment Counts provided by Stats NZ to include both all paid employees (e.g., staff paid through wages and salaries) as well as all unpaid employment (e.g., self-employed staff).

The result was cross-checked with the number of dairy businesses in each 2018 SA1 level area using data from Statistics New Zealand. The prediction of the number of dairy sheds within SA1 polygons resulted in an adjusted R-squared value of 0.86 and a residual standard error of 1.9 dairy sheds per SA1. The difference between our identified number of dairy sheds and the Statistics New Zealand data is likely due to some businesses running multiple dairy sheds, and others having their business locations registered outside the area they operate in, such as at an address in an urban area.

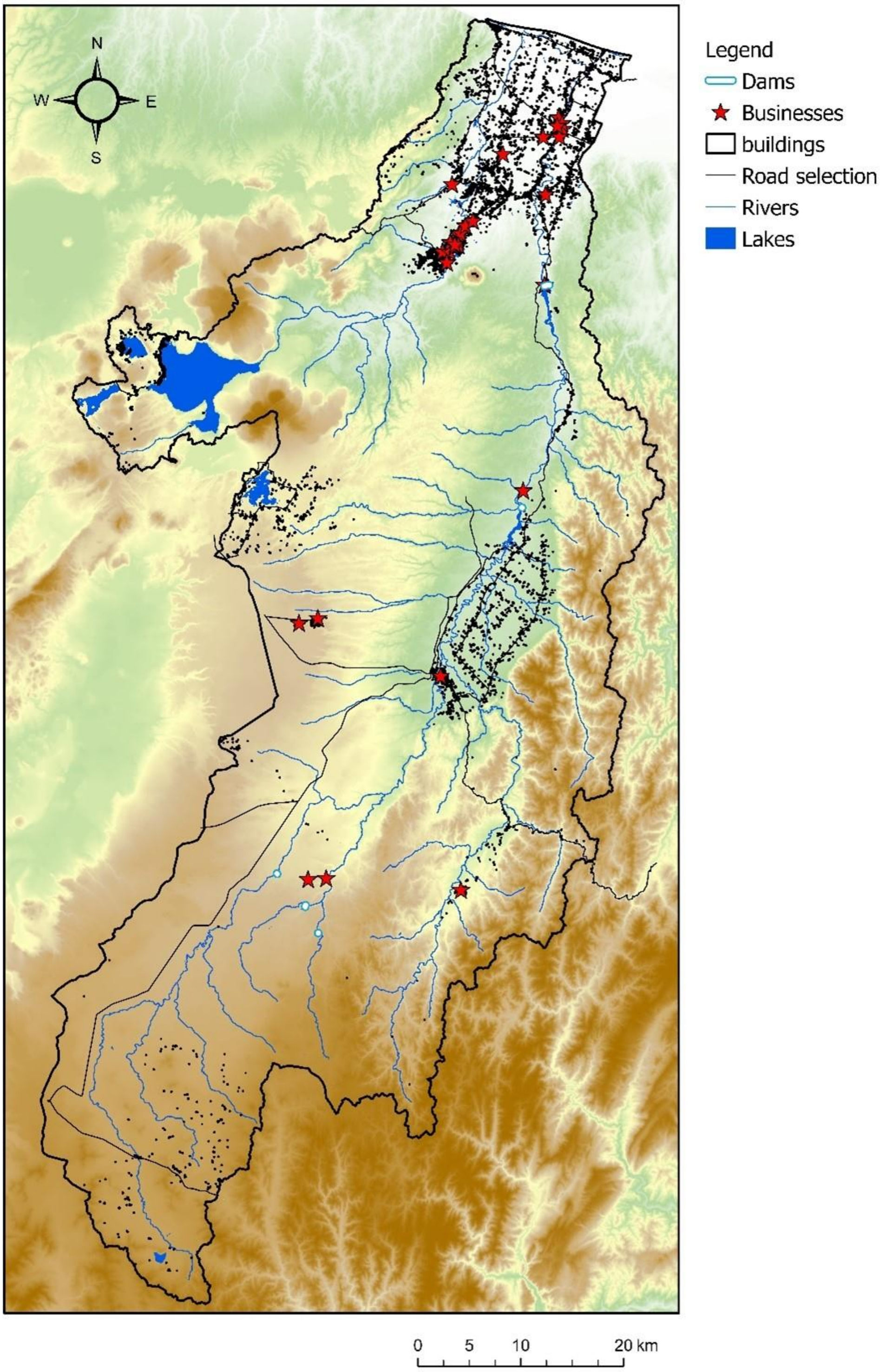

Figure 2: Business units identified as economically important for the Case Study Region

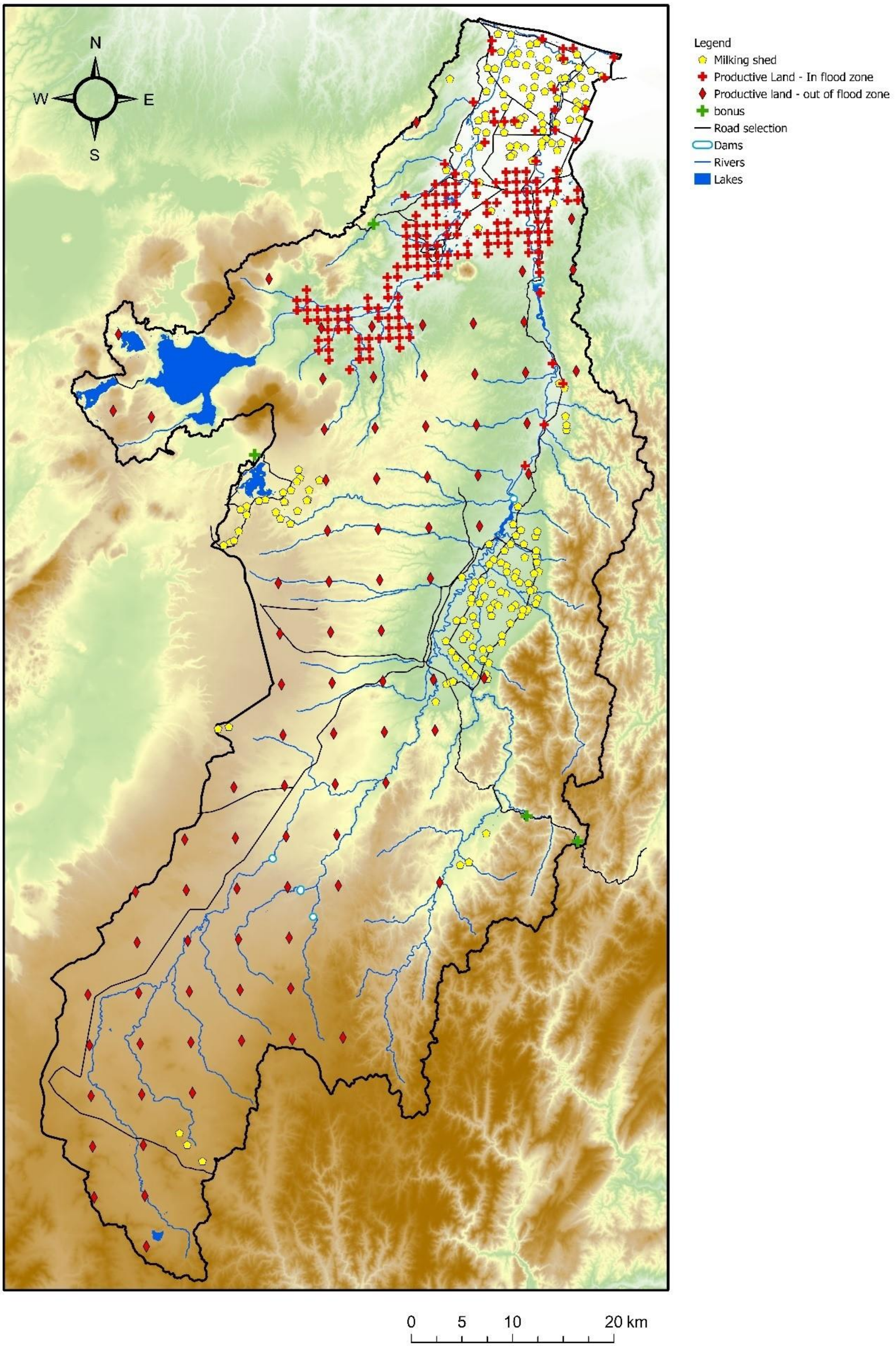

Figure 3: Specific locations of interest to the economic modelling team

2.2.2 Other land use

Other land uses, in contrast to dairy, do not rely on specific locations for production. As such a regular grid of points was used to link those productive areas to hazard models.

Other land uses included dry-stock farming, horticulture, cropping, forestry, and various others. The land use was determined based on the New Zealand Land Cover Database (LCDB v5.0; LRIS, 2021). All areas were included for point allocation other than indigenous forests and other non-productive land covers. The study area was divided into two categories: low-lying flatter ground and higher ground, with low-lying flat ground serving as a proxy for higher flood risk. To ensure appropriate linkage with the flood modelling, a denser spatial sample was taken where flood risk was considered higher. Higher flood risk areas were sampled on a 1 km grid, while low flood risk areas were sampled on a 5 km grid. The starting points for both grids were selected randomly. The result was 179 productive land points in the high-risk flood zone, and 86 points in productive land out of flood zone (Figure 3).

2.3 Roads

The road network model used in the study was built using Python and a library called 'OSMnx' (Boeing, 2017). We downloaded OpenStreetMap data regarding the driving network for the Bay of Plenty region in New Zealand. After that, the data was reprojected to New Zealand Transverse Mercator (NZTM), with the addition of columns for speed and travel times along the road segments. Once processed, we visualised the road segments (edges) of the road network and stored the data in the GeoPackage format.

The model classifies roads into several categories, drawing from the 'highway' variable detailed by OpenStreetMap as follows (categories range from most to least important): motorways (restricted access major divided highways), trunk (major roads not categorized as motorways), primary (important roads often linking larger towns), secondary (also significant, usually connecting towns), tertiary (connecting smaller towns and villages), unclassified (minor roads serving purposes other than access to properties), and residential (roads providing access to housing).

Given the intended use of our model, we focused on roads classified as tertiary level or higher, as well as trunk links. By retaining these, we ensured optimal flow of movement around the case study region and between all key businesses, as described in Section 2.1. This careful selection of roads in the model allowed us to prioritise efficient connections within the broader network.

The road network model comprises road segments and road nodes (junctions between the segments). All road nodes between segments classified as tertiary or above were selected as locations of interest (n = 220). To include road segments (n = 437), each segment was paired to its closest hazard point (Section 2.2), four road segments were located far from existing hazard points so four bonus hazard points were created to accommodate these (Figure 3). The pairing of these road segments to hazard points can be found in Appendix B.

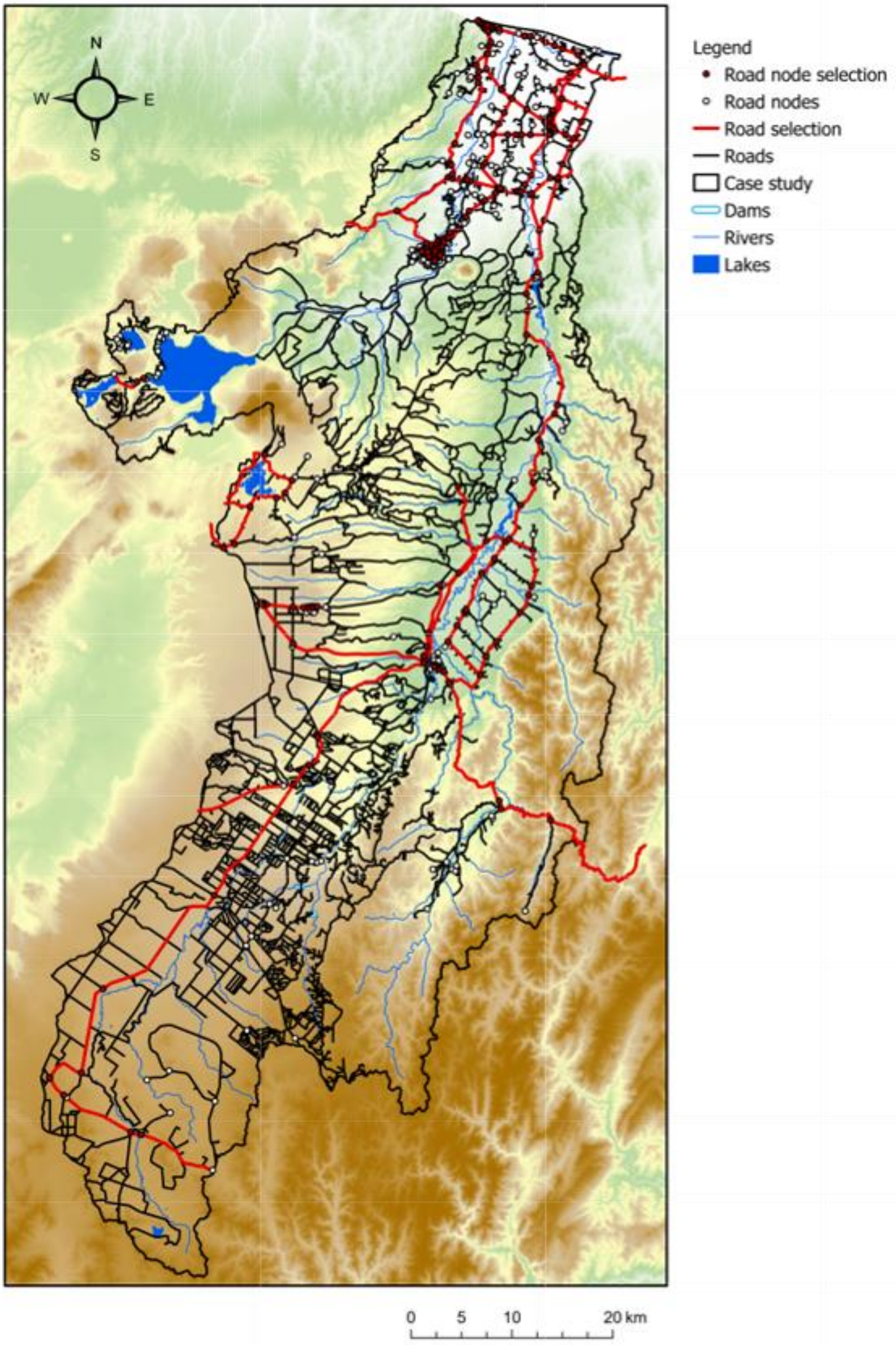

Figure 4: Road network and the road subset used for the Case Study

2.4 Bridges & Railways

Bridge data from the LINZ Data Service for the Case Study (n = 137) are classified by usage into vehicle, farm, or train. Farm bridges (n = 5) were removed from the data set as impacts would not reach the economic model (see Farm bridge example, Figure 5). Train (n = 10) and vehicle (n = 122) bridges were retained conditional on the fact that they intersected with the road network as described above (2.3). The railway network across this region is the East Coast Main Trunk with terminals in Kawerau (in Case Study) and Hamilton (outside of Case Study), currently operating for freight only (Joyce, 2019). Discussions between the hazard and economic modelling teams resulted in the decision to remove railways from the infrastructure list. The hazard to railways is flooding, with elevated rail lines they are unlikely to be damaged. Thus, the additional hazard to railways is negligible compared to those of the train bridges. In this region, train bridges consistently run parallel to vehicle bridges, and where they span water, all are located upstream of the vehicle bridge. Coupled to the fact that some of these train bridges are no longer used, and therefore no longer maintained, it was thought feasible that the destruction of an upstream train bridge may block or damage its downstream vehicle counterpart (see Edgecumbe bridge example, Figure 5).

The above resulted in 56 bridges selected for use as infrastructure points (train: n = 7; vehicle: n = 49). These bridges can vary substantially in both size and construction (Figure 5).

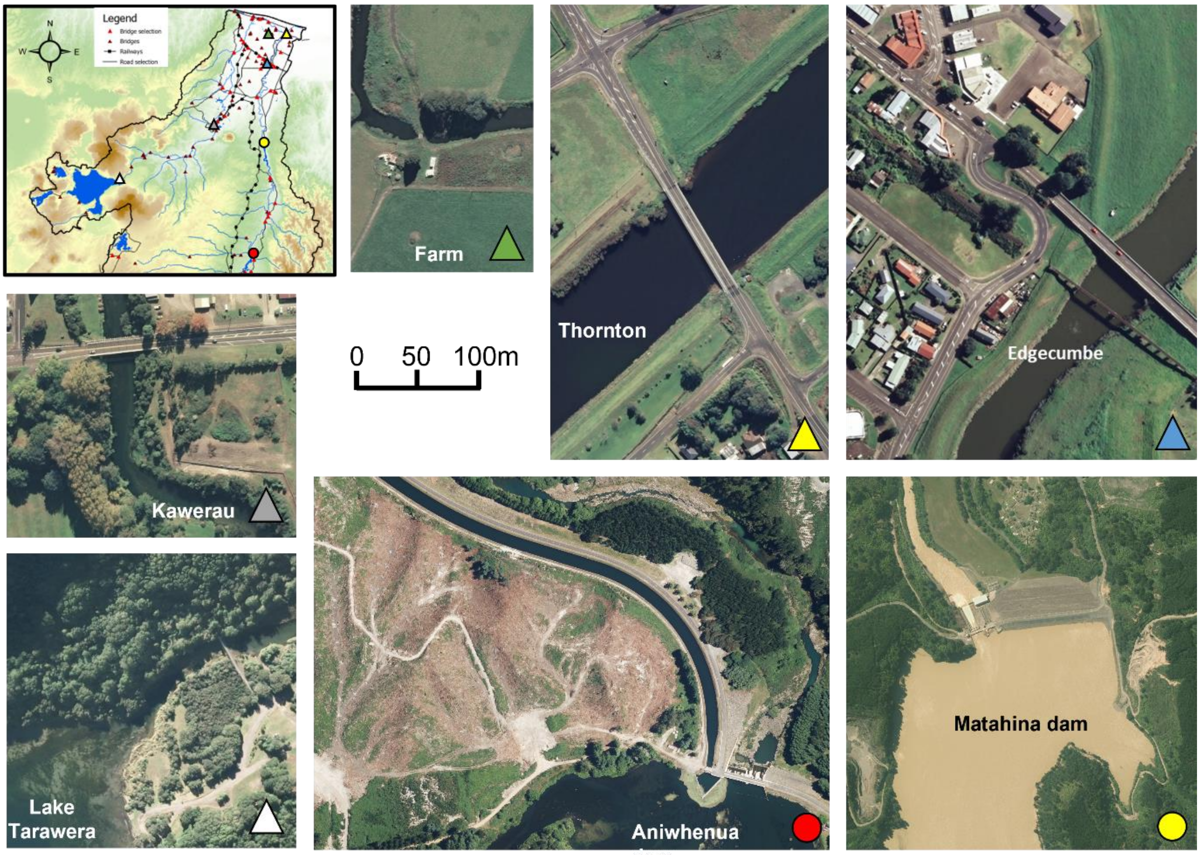

Figure 5: Bridge examples from across the Case Study

2.5 Powerlines & Pylons

Electricity across the Bay of Plenty is distributed by Horizon Networks, with supply coming in at four grid exit points from Transpower: Edgecumbe and Kawerau (in Case Study) and Waiotahi and Te Kaha (outside of case study). The Matahina hydroelectric power station also feeds into the Transpower grid at Kawerau GXP. The Aniwhenua hydroelectric power station feeds into the horizon network (important for the Galatea region), with any excess going back into the Transpower grid also at Kawerau GXP (Horizon Networks, 2019).

The focus of the economic modelling for the Multi-hazard Risk model is principally on the primary sector (dairy, sheep and beef, horticulture, and exotic forestry). Inter-team discussions concluded that electricity network modelling was not a priority for the primary sector given the ability to utilise on-site back-up generators for operations where necessary (e.g., for milking sheds) which in turn are dependent on the resilience of the road network for maintaining fuel supply. Thus, a full-scale (generation to customer) model of the power network was considered superfluous, and powerlines dropped from the infrastructure list.

The pylons dataset consisted of 380 pylons within the Case Study area on both the national (Transpower) and local (Horizons) grid. This dataset was supplemented with pole data (n = 289) for the national grid (Transpower, 2023).

As the loss of any one pylon along a powerline results in loss of power along that line, a representative subset was selected such that the resolution along a powerline is minimum one pylon or pole per km. Practically, this is about one in every six poles or pylons on Lines A, B, C and D, and one every three poles or pylons on Line E. Additional pylons were added to connect Aniwhenua to the national grid at Matahina, as well as several deemed to have a greater likelihood of being impacted by flooding. Grid eXit Points (GXPs) were also added to the infrastructure points list. (Table 2; Figure 6).

The WRK-WHI-A line (F) runs along the southern part of the Case Study (Figure 6) and does not link up with any of the national grid exit points in the region. We assumed any impact to this section could be bypassed using lines outside the region, and this section was ruled out.

Table 2: Transpower assets in Case Study, grouped by proximity (lines run parallel)
(data sourced from Transpower, 2023)

Asset type (Ref)	**Name**	**Description**
Line (A)	EDG-TRK-A ARI-EDG-A ARI-EDG-B	Edgecumbe - Tarukenga A; Design voltage 220 kV Arapuni - Edgecumbe A; Design voltage 110 kV Arapuni – Edgecumbe B; Design voltage 110 kV
Line (B)	EDG-WAI-B	Edgecumbe - Waitoahi B; Design voltage 110 kV
Line (C)	OHK-EDG-A	Ohakuri - Edgecumbe A; Design voltage 220 kV
Line (D)	EDG-KAW-A EDG-KAW-B	Edgecumbe - Kawerau A; Design voltage 110 kV Edgecumbe - Kawerau B; Design voltage 110 kV
Line (E)	KAW-MAT-A KAW-DEV-A	Kawerau - Matahina A; Design voltage 110 kV Kawerau - Deviation A; Design voltage 220 kV
Line (F)	WRK-WHI-A	Wairakei - Whirinaki A; Design voltage 220 kV
GXP (EDG)	Edgecumbe	Site ID: EDG, Type: ACSTN, Lines: A, B, C, D
GXP (MAT)	Matahina	Site ID: MAT, Type: ACSTN, Lines: E
GXP (KAW)	Kawerau	Site ID: KAW, Type: ACSTN, Lines: E, D

The WRK-WHI-A line (F) runs along the southern part of the Case Study (Figure 6) and does not link up with any of the national grid exit points in the region so was ruled out. Four additional pylons located not on Transpower lines but linking the Wheao and Flaxy Hydro Power Scheme to the local network were also included, as they connect an important electricity generation asset for the region. This resulted in 182 points associated with the power network across the region comprising 157 national grid structures (3 GXPs, 95 pylons, and 59 poles), and 25 local grid structures (all pylons).

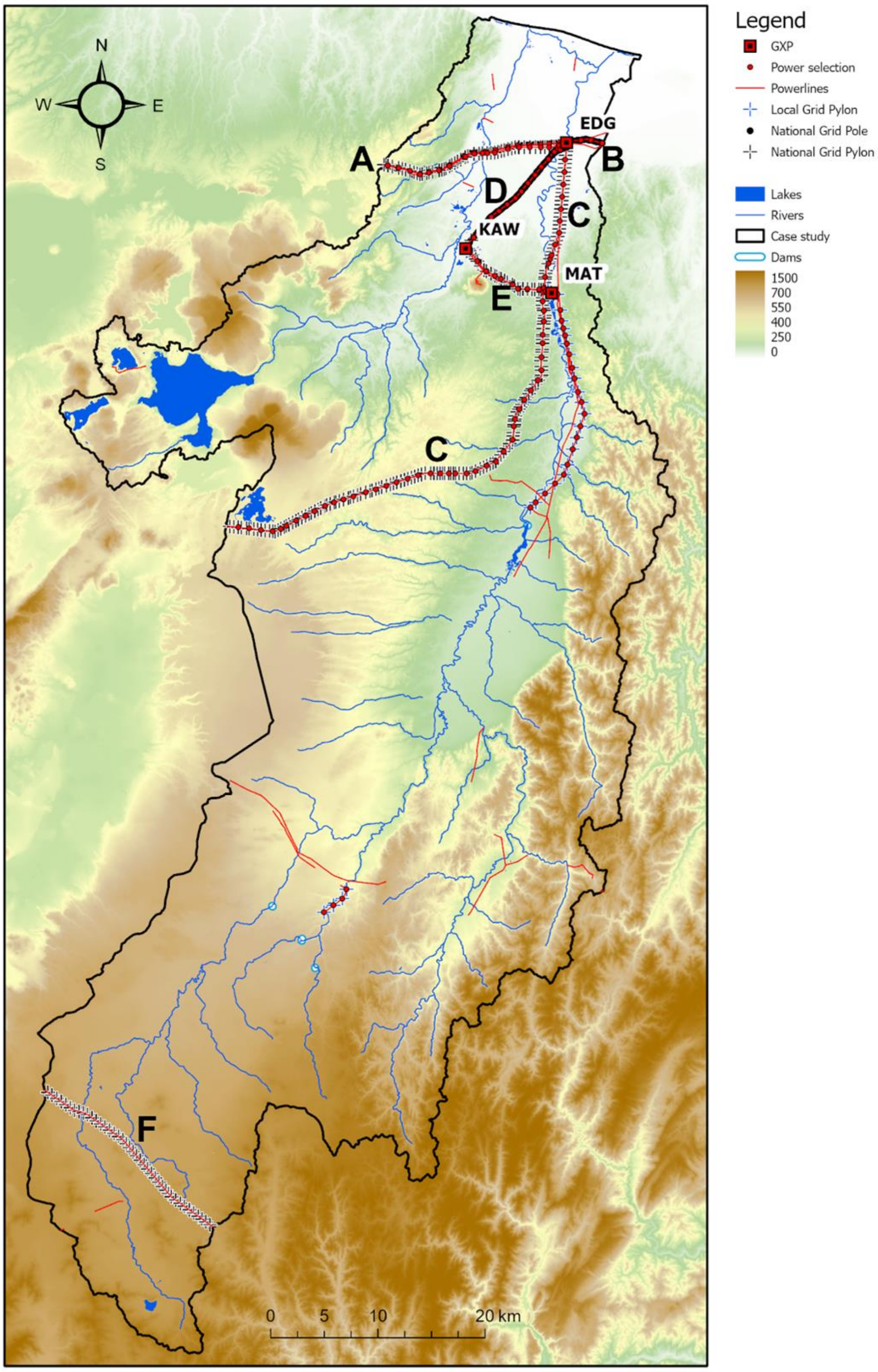

Figure 6: Power network and the power subset used for the Case Study, letters A:F correspond to lines in Table 2

3. Infrastructure points

There are 980 infrastructure points in the final set (Figure 7; Appendix A), with attributes according to infrastructure type (Table 3). Each point represents a location at which hazard attributes will be extracted (e.g., flood depth) and funnelled through to the economic modelling team.

Table 3: Final locations of interest used for hazard attribute transfer

Infrastructure	**Attribute(s)**		
Bridges *(n = 56)*	Use:	Vehicle	*(n = 49)*
		Train	*(n = 7)*
Power *(n = 182)*	Grid:	Local	*(n = 25)*
		National	*(n = 157)*
	Structure:	Pylon	*(n = 25)*
		GXP	*(n = 3)*
		Single Circuit Steel Tower	*(n = 57)*
		Double Circuit Steel Tower	*(n = 38)*
		Single Circuit Pi Pole	*(n = 59)*
Dams *(n = 5)*	Name of dam		
Business *(n = 38)*	Name of business		
Roads *(n = 220)*	-		
Hazard point *(n = 479)*	Class:	Milking shed	*(n = 210)*
		Productive land – in flood zone	*(n = 179)*
		Productive land – out of flood zone	*(n = 86)*
		Bonus	*(n = 4)*

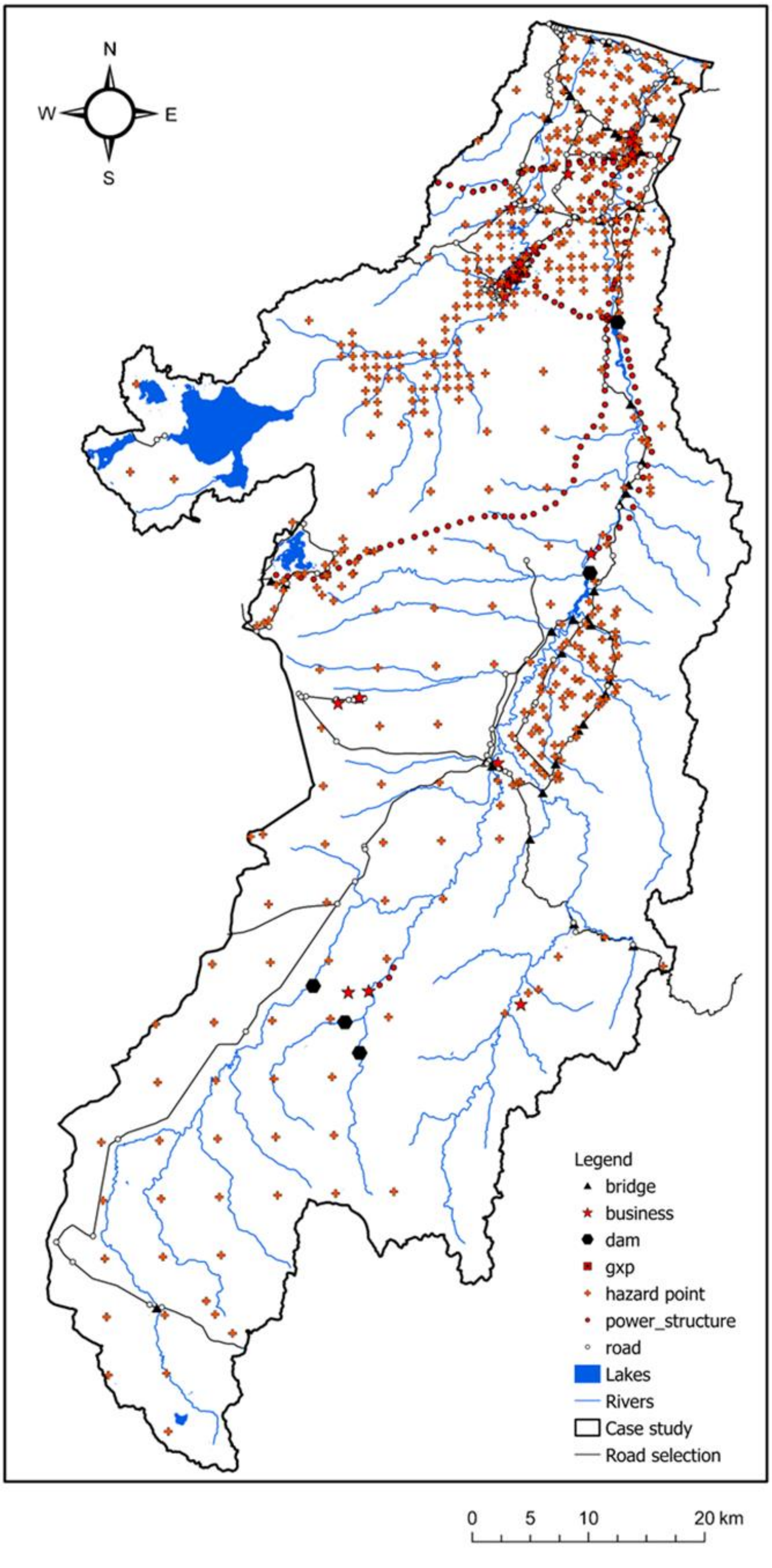

Figure 7: Final locations of interest used for the Case Study

4. Hazard to Economics model transfer

The Multi-hazard Risk model will be run over the Case Study region with a duration of 20-30 years (Davies et al., 2020). During this time, a variety of hazards will be simulated, including earthquakes, landslides, flooding, and a volcanic eruption with associated potential ashfall, lava, lahars, and debris flows. These hazards may occur independently, coincidentally, or through triggering conditions (Davies et al., 2020). All hazard models will be run probabilistically thus it is feasible that there will be extended periods within the 30 years of no hazard occurrence. The internal time steps of the hazard models vary from seconds (sediment transport and flooding) to hourly (weather). The data are output quasi-instantaneously (landslides), through to hourly to daily (flooding), and daily (tephra).

The MERIT Dynamic Economic model (DEM) operates on time step of approximately two days. It does not, however, require inputs to necessarily be provided at this fine spatial scale. The important information is identification of where there is a change in the magnitude or trend of an input parameter, and the model will interpolate the inputs for time periods between these changes. For the most part, no data from the Multi-hazard Risk Model is utilised directly within the DEM. The DEM model traces stocks and flows through an economic system, all recorded in monetary terms whereas the Multi-hazard Risk Model provides output information in physical metrics. Interfacing models are thus required to translate between the physical metrics to monetary metrics. In some instances, a series of interfacing models are required.

As a broad summary, the process for translating information from the Multi-Hazard Risk model into inputs for the DEM involves the use of fragility functions to translate hazard intensity (e.g., depth of ash deposited) and impact information (e.g., road network outage) into qualitative impact states for farms and forestry. An important requirement for much of the impact information is that it requires a time dimension. This mean it is necessary specify the length of time over which each infrastructure service is disrupted by including information on infrastructure recovery. Various approaches could be utilised to incorporate infrastructure recovery, ranging from expert elicitation through to sophisticated models that account for infrastructure interdependencies, recovery priorities, and available resources for recovery. For electricity, we utilise expert elicitation to set general parameters around the length of service outages. For the road network, we model recovery based on a set of simple assumptions around the rate of road recovery and then a network model determines the level of service available at locations around the study area.

Utilising the qualitative impact states, a be-spoke agriculture model then translates these impacts into changes in farm and forestry financials across time. The agriculture model takes into consideration changes in outputs or revenues from land uses (e.g., raw milk, kiwifruit harvest, logs by log-grade), changes in input or farm/forestry expenditures (e.g., blanking costs for foresters, extra feed purchased by farms) and any capital expenditures required particularly for repair and recovery.

Although hazard intensities and infrastructure impact information may be changing constantly, it is necessary to simply this complex reality for the purposes of the agriculture modelling by generating impact states at each location only for each ‘event’. An event is period over which hazard intensities are related to the same set of causal physical characteristics in the environmental system – for example an eruption, flooding following intensive rainfall, and so on. In some cases, post processing of the outputs of the Multi-hazard Risk model is necessary to enable the data to be ordered around an event classification.

Table 4: Hazard attributes required at each location of interest for each hazard

Hazard	MERIT required attributes at each infrastructure point	Units
Tephra	(1) total ash deposition *(at end of explosive phase of eruption)*	mm (total)
Flood	(2) maximum flood depth (3) time spent under water	mm (maximum) hours (total)
Lahar / debris flow	(5) inundation footprint at end of event *(area where lahar exceeded > 0.5 m of height)*	Y/N Spatial extent (.shp file)
lava	(8) hit or not *(at end of effusive phase of eruption)*	Y/N
Landslide / Debris Avalanche	(7) hit or not *(at end of event)*	Y/N
Earthquake M > 5.5	(6) Peak Ground Acceleration (PGA)	m/s^2 (maximum)

Thus, for this Case Study, information transfer is governed at the event level, rather than with variations in attributes on a quasi-continuous time basis. Exemplars for each of the hazards in Table 4 are shown in Table 5 with four theoretical infrastructure points (1:4).

Table 5a: Hazard attributes transfer exemplar – Tephra. *At each infrastructure point, the total tephra depth in mm is provided at the end of the event. Start date: start of explosive phase of eruption, End date: end of explosive phase of eruption (i.e., all end and start dates are consistent for a Tephra event) Tephra events are numbered sequentially (based on start time), with the prefix "Te_". Note: all infrastructure points are included in the table, total tephra depth == 0 if point is not hit.*

ID	Event ID	hazard	start date	end date	total tephra depth (mm)
1	Te_1	Tephra	1/05/2024	31/07/2024	0.05
2	Te_1	Tephra	1/05/2024	31/07/2024	0.3
3	Te_1	Tephra	1/05/2024	31/07/2024	1.2
4	Te_1	Tephra	1/05/2024	31/07/2024	0

Table 5b: Hazard attributes transfer exemplar – Flood. *At each infrastructure point, the maximum water depth in mm is provided at the end of the event. Start date: Start of flood water at infrastructure point, End date: End of flood water at infrastructure point. Time an infrastructure point spends under water is calculated from end date – start date. Flood events are numbered sequentially (based on start time), with the prefix "Fl_". Note: all infrastructure points are included in the table, maximum water depth == 0 if point is not hit.*

ID	Event ID	event	start date	end date	max. water depth (mm)
1	Fl_1	Flood	30/04/2024	2/05/2024	2.1
2	Fl_1	Flood	30/04/2024	2/05/2024	0.9
3	Fl_1	Flood	30/04/2024	2/05/2024	1.8
4	Fl_1	Flood	30/04/2024	2/05/2024	0

Table 5c: Hazard attributes transfer exemplar – Lahar / Debris Flow. *At each infrastructure point, whether the lahar or debris flow exceeded a height of 0.5 m at any time during the event. Start date: Start of lahar or debris flow, End date: End of lahar or debris flow. Lahar / Debris Flow events are numbered sequentially (based on start time), with the prefix "Lh_". Note: This will also be accompanied by a shape file of the spatial extent of the lahar/debris flow.*

ID	Event ID	event	start date	end date	Hit > 0.5 m at any time during event (Y/N)
1	Lh_1	Lahar / Debris Flow	6/06/2024	6/06/2024	Y
2	Lh_1	Lahar / Debris Flow	6/06/2024	6/06/2024	N
3	Lh_1	Lahar / Debris Flow	6/06/2024	6/06/2024	N
4	Lh_1	Lahar / Debris Flow	6/06/2024	6/06/2024	Y

Table 5d: Hazard attributes transfer exemplar – Lava. *Only at infrastructure points that are hit by the hazard (lava) at or during the event. Start date: Start of effusive phase of eruption, End date: End of effusive phase of eruption. Lava events are numbered sequentially (based on start time), with the prefix "La_".*

ID	Event ID	event	start date	end date	Lava at point at end of event (Y/N)
1	La_1	Lava Flow	6/06/2024	10/06/2024	Y
4	La_1	Lava Flow	6/06/2024	10/06/2024	Y

Table 5e: Hazard attributes transfer exemplar – Landslide / Debris avalanche. *Only at infrastructure points that are hit by the hazard (mass flow) at or during the event. Start date: Start of landslide or debris avalanche, End date: End of landslide or debris avalanche, noting that landslides / debris avalanches are assumed quasi-instantaneous. Landslide/debris avalanche events are numbered sequentially (based on start time), with the prefix "Ls_".*

ID	Event ID	event	start date	end date	Mass at point at end of event (Y/N)
1	Ls_1	Landslide/Debris Avalanche	7/06/2024	7/06/2024	Y
4	Ls_1	Landslide/Debris Avalanche	7/06/2024	7/06/2024	Y

Table 5f: Hazard attributes transfer exemplar – Earthquake. *At each infrastructure point, the maximum Peak Ground Acceleration (PGA) reached during the event. Start date: Start of earthquake, End date: End of earthquake, noting that earthquakes are assumed quasi-instantaneous. Earthquake events are numbered sequentially (based on start time), with the prefix "Eq_". Note: only LARGE (M > ~5.5) magnitude earthquake hazard attribute data will be transferred.*

ID	Event ID	event	start date	end date	PGA (m/s^2)
1	Eq_1	Earthquake	6/06/2024	6/06/2024	0.02
2	Eq_1	Earthquake	6/06/2024	6/06/2024	0.1
3	Eq_1	Earthquake	6/06/2024	6/06/2024	0.12
4	Eq_1	Earthquake	6/06/2024	6/06/2024	0.001

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