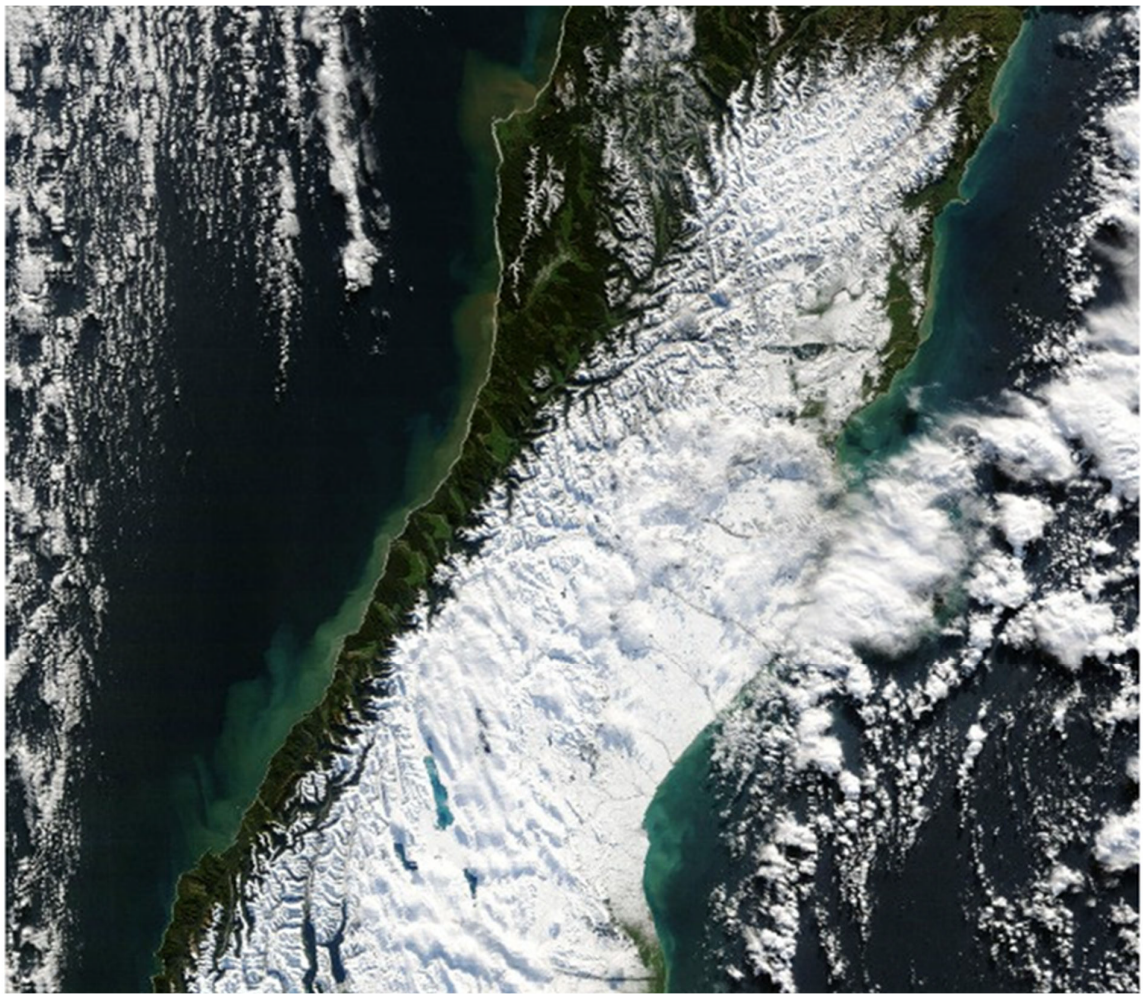
Risks and Resilience

Advancing the Maturity of Infrastructure Vulnerability and Resilience Investment Business Case Assessments

Milestone 4: Data Acquisition and Setup

Canterbury Civil Defence Emergency Management Group



Quality Information

Document	Risks and Resilience: Advancing the Maturity of Infrastructure Vulnerability and Resilience Investment Business Case Assessments – Milestone 4: Data Acquisition and Setup Report
Ref	
Date	28 February 2023
Prepared by	Mark Gordon
Reviewed by	Martyn Wooster

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
1	28 February 2023	Final Report	Mark Gordon	

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1.0 Introduction

1.1 Overview

This project seeks to "connect the dots" in relation to data, tools, resources, knowledge, and practice, with the aim of facilitating informed, up-to-date, and efficient vulnerability and resilience assessments using a lifelines GIS portal. A maturity-based approach has been developed and is to be tested along with a recommended data schema that can be nationally applied.

Engagement has to date largely focussed on the lifelines sector, universities, and research agencies. Drawing on research programmes and tools, an "intermediate" level approach that lies between the current methodology for vulnerability assessments and the more comprehensive "Wellington Regional Lifelines programme business case" approach[1] has been developed.

Using the North Canterbury region and Canterbury Lifelines Group as a pilot, this "intermediate" approach will also inform Phase 2 of the *Risks & Resilience* project, utilising the GIS portal and information documented in Phase 1 (Vulnerability Assessment).

This report covers the tasks associated with Milestone 4, i.e., Data Acquisition for GIS Portal Set-up and Intermediate Level Analysis.

1.2 Milestone 4 Tasks Summary

This report relates to Tasks 10, 11, 12 and 13. A status summary against each task is provided in the table below.

Table 1 Task Summary – Milestone 4

Task	Description	Summary
10	Populate the qualitative information from Canterbury's Risks & Resilience Phase 1 vulnerability stocktake into the GIS portal – this being current textual knowledge about each LLU's network assets and likely vulnerabilities.	This has not been progressed as the level of work involved has not been scoped, resources were not available, and also because the qualitative information involved needs to be reviewed and updated by lifeline utilities.
11	Obtain data as per schema and populate / update the data model in the Lifelines GIS portal for the pilot LLUs – this is expected to be a mix of "live" open source data feeds and subscribed feeds and include infrastructure, hazards and "community sites" data. Include climate change induced effects such as more intense rainfall, sea level rise, etc.	Workshop with lifeline utilities followed by a process of data acquisition as per the sector schemas. Flood and tsunami hazard layers obtained. North Canterbury Resilience Pilot GIS Portal created. Refer Section 2.0.
12	Set up the "Integrated Approach" with connections via the GIS portal to relevant tools and knowledge including MERIT and other resources as determined in the scanning stocktake.	Modelling approach confirmed. Urban Intelligence Resilience Explorer configured and linked to the GIS Portal. Format of data required for MERIT analysis confirmed. Refer Section 3.0.
13	GIS portal ready to be used, data compiled, produce report on implementing the "Integrated Approach".	This report summarises achievements under Milestone 4.

[1] Refer to https://www.wremo.nz/assets/Uploads/191111-Wellington-Lifelines-PBC-MAIN-20191009.pdf

2.0 Data Acquisition

2.1 Lifelines Sectors

A project workshop to introduce and explain the project to invited North Canterbury lifeline utilities was conducted in August 2022. The utilities that participated in this workshop and/or have subsequently provided data to be used in the modelling analysis are:

- Electricity Sector:
  - Transpower
  - MainPower
- Telecommunications Sector:
  - Enable
  - Vodafone
  - Chorus
- Three Waters Sector
  - Waimakariri District Council
  - Hurunui District Council
  - Kaikoura District Council
- Transport Sector
  - Waka Kotahi
  - KiwiRail
  - Waimakariri District Council
  - Hurunui District Council
  - Kaikoura District Council

This provides a good cross-section across several key sectors for the purposes of the proof of concept pilot.

2.2 Data Summary

2.2.1 Hazard Layers

Geospatial data were obtained from Environment Canterbury (ECan) for the following hazard types:

- River breakout flooding scenarios for a range of storm return periods across North Canterbury. This includes modelled water depth and flow velocity information for a range of return period events, 100, 200 and 500 years, some of these models included provision for climate change rainfall (e.g., RCP8.5 for 2081-2100). Scenarios including sea level rise have also been incorporated in some areas, in particular Kaikoura. These scenarios have been derived from both ECan and Waimakariri District Council modelling work.
- Tsunami Evacuation Zones and a tsunami scenario based on a possible Hikurangi Trench earthquake event. The coastal effects of a range of tsunami events has been the subject of recent ECan hazard assessments. Note that the Hikurangi scenario was not in a format that could be readily linked to the Lifelines GIS Portal at this time – this is an action for completion later.

These layers are captured in the Lifelines GIS portal described in Section 2.3 below, and subsequently accessed by the Urban Intelligence Resilience Explorer described in Section 3.3 for vulnerability assessment and visualisation.

2.2.2 Lifeline Utility Infrastructure Layers

Each of the lifeline utilities above were individually contacted following the August 2022 workshop and asked to provide data in accordance with the data schema for each sector.

Onsite Meetings

Onsite meetings were held with lifeline utilities to highlight the project objectives and outline data requirements. The visits provided a good opportunity to collectively review available asset data and discuss any related disaster resilience and risk reduction initiatives.

The sector specific data schemas from the Milestone 2 report were shared with the utilities as part of the formal data request. In some cases, this was the first time that an external request had been made for sensitive asset, location and attribute data.

The meetings were used to explain how the data would be handled and kept secure during the project to provide asset owners with some comfort around data risk management.

Data assurance is an area that is worth exploring by lifelines groups to help improve trust levels and facilitate the flow of infrastructure data. A formalised approach to data handling via an MOU or similar could help build trust and facilitate future stages of the project.

Engagement was positive overall, and the utility partners recognised the benefits that this project could enable for their own future adaptation planning work. Having visibility of other utility asset locations with interdependent relationships would help close a gap in current knowledge.

Data Request

The visits were followed by an email request for asset data and details of any criticality scoring work that might assist with ranking assets that carry a higher direct consequence of failure.

For distributed asset networks such as three waters and electricity, the request called for details of the supply / service zones to illustrate network connectivity and likely scale of impact when key upstream assets like substations or headworks fail.

Timing

Proactive coordination was necessary throughout the data gathering phase to provide clarifications to the utilities in support of the data schemas and keep the data request active.

National Liaison

Spark New Zealand asked that all data requests be made through the national lifelines group to improve regional coordination and avoid duplication of effort. This is a valid point and thought should be given to how best to interact with national entities in the future given the regional and somewhat independent nature of lifelines groups.

Tables

Refer to the following table for a summary of the GIS layers received by sector and lifeline utility. The Attributes (available) column offers an indication of the variation in attributes included within each data set.

Table 2 Asset Data supplied by Lifeline Utilities

Sector	Lifeline Utility	GIS Layer Name	Attributes (available)
Electricity	MainPower	MainPower HV MV Substations	Site Name; Name
		MainPower MV Cables	Cable type (overhead); Installation Date; Line type; Operating Voltage; Phase; Status (in service)
	TransPower	Transpower Spans	Status (in service)
		Transpower Structures	Status (in service); Construction Type
		Transpower Sites	Status (in service); Description
		Transpower Transmission Lines	Name
Telecoms	Chorus	Chorus Core Sites	Site Name
		Chorus Core Routes	-
	Enable	Enable Ducts	Service Type (distribution)
		Enable Cabinets	Status (in service)
	Vodafone	Vodafone Points	Site Name; Priority
		Vodafone Polylines	Name
Three Waters	Hurunui District Council	HDC Pumpsheds	Type; Subtype; Community; Short_Name; Installation Date
		HDC Pumpstation Service Areas	-
	Waimakariri District Council	WMK Water Supply Assets in Service	-
		WMK Wastewater Assets in Service	-
		WMK Stormwater Assets in Service	-
		WMK DatranSignals	
		WMK DatranSites	Status (in service); Classification (Water/Waste/Storm); Description (eg pump at XXX Road)
Solid Waste	Waimakariri District Council	WMK Solid Waste Sites	Name; Type
Transport	KiwiRail*	KiwiRail Locations	Name; Priority
		KiwiRail Tunnels	Tunnel Name; Line Name
		Kiwirail Bridges	Bridge Name; Line Name
		NZ Railway Network	-
		Kiwirail FibreOptic line	Files relate to third party assets only and are not carried through to UI Resilience Explorer.
		Kiwirail FibreOptic point	
		Kiwirail Colocated services polygons	
		Kiwirail Colocated services points	
		Kiwirail Colocated services lines	
		KiwiRail Locations	
	NZTA	NZTA One Road	Full Road name; ONRC Class; Surface Type; Width

Openly or publicly sourced data sets were used to offer supplementary asset location data for the telecoms, three waters and transport sectors. Feedback suggests that this information is available from utilities directly if more time was provisioned to process the request. Refer to the following table for details of the key supplementary GIS asset layers.

Table 3 Supplementary Asset Data – Open Source

Sector	Source	GIS Layer Name	Attributes (available)
Telecoms	Radio Spectrum Management	Mobile Network Towers	Carrier; Height above Sea Level
Three Waters	Canterbury Maps	Community Drinking Water Supply	Well Number; Well Type; Well Supply Name; Depth
	Water NZ	Wastewater Treatment Plants	Name; Treatment Level; Owner; Volume Treated
Transport	Land Information NZ	Bridges	Bridge Use
	Land Information NZ	Tunnels	Tunnel Use

2.2.3 Sector Specific Comments

Telecoms

Mobile network (cell) tower locations are published by Radio Spectrum Management NZ which includes details of all sites and carriers within New Zealand. More specific data for Vodafone cell towers has merged with this layer for completeness. The future objective is to engage with Spark NZ and 2Degrees to request their cell tower data directly with more detailed attribution.

Roading

The One Network Road Classification (ONRC) dataset maintained by Waka Kotahi does not currently hold bridge and tunnel location information. A supplementary data set has been utilised from LINZ for the project as an interim measure. This knowledge gap could be resolved with Waka Kotahi during the next phase of the project.

Local authority roading asset data is stored on the Think Project (formerly RAMM) asset management system and can be externally accessed with Council permission. This could be an easy way in the future to efficiently capture local roading data across Canterbury and other regions using a single login.

Three Waters

Publicly sourced community supply points and wastewater treatment plant locations were obtained from Canterbury Maps and Water NZ respectively and used to complement three waters data. It is envisaged that these will be replaced once the Council files are made available as a Feature Service (GIS format). This file type requirement will be included in the updated data schema specification for future reference.

Canterbury Maps includes three waters data from Councils for the piped network and above ground key sites albeit with limited attribution. This data set could provide a useful overview of three waters assets in Canterbury as a temporary measure while waiting on more comprehensive data from Councils directly. These layers have not yet been accessed for the Waimakariri District, an improvement action for future phases.

2.2.4 Asset Data Supplied

Results

Good representation of asset data was received across the five sectors with only two utilities not able to provide data within the project timeframe. This reflected the strong support observed from North Canterbury utilities for this project and recognition of the insights it can collectively offer to the region.

We received data sets from most of the invited utilities within the desired project timeframe. The files generally included asset location coordinates for the core sites and network components. This was sufficient to create layers in GIS for the core asset types of interest.

Several larger utilities publish data layers at a high level for selected asset types and locations. These data sets while being easy to access can hold limited specific attribute information. Most utilities queried their internal asset management systems and shared shapefiles and spreadsheets for sharing the requested asset data.

Provision of attributes was varied and usually centred on name, type and internal technical codes. This was a deviation from the data schemas and possibly reflected the limited time given for utilities to process the data request. Another potential factor is the level of trust necessary before asset owners are comfortable sharing more sensitive data.

Supply of the correct level of attribute data is essential if the impacts are to be accurately modelled and risk of failure better understood. Therefore, common factors preventing the supply of core attribute data will be further explored with utilities during the next phase of the project.

Asset data layers from national and regional level utility owners often extended beyond the project area of North Canterbury. These wider data sets offer a great platform to scale reach beyond North Canterbury during future phases.

Refer to the following table for a summary of how the GIS layers were mapped into the Urban Intelligence (UI) Resilience Explorer along with the status of analysis achieved.

In the UI Resilience Explorer Approach column:

- '**Assets Mapped**' indicates that the asset locations have been mapped in UI for high level comparison with the flood hazard zones. Outage and duration will be assessed using the knowledge of lifeline utilities.
- **'Fragility Relationship'** indicates a vulnerability assessment to be modelled using fragility information sourced from international literature. Duration of outage to be assessed using the knowledge of lifeline utilities.

Table 4 Mapping of asset data into Urban Intelligence

Sector	GIS Layer Name	UI Dashboard Name	UI Resilience Explorer Approach
Electricity	MainPower HV MV Substations	Electricity Distribution Substations	Fragility Relationship
	MainPower MV Cables	Electricity Distribution Cables	Assets Mapped
	Transpower Spans	-	Not Mapped
	Transpower Structures	Electricity Transmission Towers	Assets Mapped
	Transpower Sites	Electricity Transmission Sites	Assets Mapped
	Transpower Transmission Lines	Electricity Transmission Lines	Assets Mapped
Telecoms	Chorus Core Sites	Chorus Core Sites	Assets Mapped
	Chorus Core Routes	Chorus Core Routes	Assets Mapped
	Enable Ducts	Fibre Network Ducts	Assets Mapped
	Enable Cabinets	Fibre Network Cabinets	Assets Mapped
	Vodafone Points	Mobile Network Towers	Assets Mapped
	Vodafone Polylines	Vodafone Cables	Assets Mapped
Three Waters	HDC Pumpsheds	Reservoir Intake Pumpsheds	Assets Mapped
	HDC Pumpstation Service Areas	Yet to be populated	Not Mapped

Sector	GIS Layer Name	UI Dashboard Name	UI Resilience Explorer Approach
	WMK Water Supply Assets in Service	Yet to be populated	Not Mapped
	WMK Wastewater Assets in Service	Yet to be populated	Not Mapped
	WMK Stormwater Assets in Service	Yet to be populated	Not Mapped
	WMK DatranSignals	Yet to be populated	Not Mapped
	WMK DatranSites	Water Supply Pumps; Stormwater Pumps; Wastewater Pumps	Assets Mapped
Solid Waste	WMK Solid Waste Sites	Landfills & Solid Waste Facilities	Assets Mapped
Transport	KiwiRail Locations	Railway Stations & Yards	Assets Mapped
	KiwiRail Tunnels	Railway Tunnels	Assets Mapped
	Kiwirail Bridges	Railway Bridges	Assets Mapped
	NZ Railway Network	Railway Network	Assets Mapped
	NZTA	Roads	Fragility Relationship

It can be seen that there are currently only two asset types for which a fragility relationship derived from international research is to be used. Future enhancements of the platform should include additional relationships where available (e.g., future research outputs).

2.2.5 Improving Trust and Data Flow

Creating a digital infrastructure data platform for lifeline utilities in Canterbury had not previously been attempted. This project has revealed what could be achieved with perseverance and engagement with lifeline utilities.

Ultimately, a common risk assessment platform can provide benefits to individual utilities that outweigh perceived risks around data sharing.

Developing a comprehensive fit for purpose data set is going to be an iterative process. It is important to celebrate successes along the way by sharing data and insights within the GIS and risk assessment platforms.

The aspiration to develop a live asset data feed on a digital platform that facilitates agile analysis and updates remain sound.

Asset fragility relationships for different hazard events are not sufficiently documented to cover the core asset types of interest. This may improve over time as more natural hazard events occur and are studied by the international research community.

Practitioner workshops should be used to develop a framework of asset damage / service impact with varying levels of event severity. A generalised approach to estimating vulnerability levels for the main asset and hazard types is an effective way to bridge the gap in fragility information.

2.2.6 "Community" Sites

As part of the project Scanning Stocktake a wide range of stakeholder and Iwi sites across Canterbury were identified, although spatial attributes data has not been collated. These include sites across the following sectors:

- Age care
- Banks
- Business sector associations
- Central government agencies
- Construction supplies
- Contractors
- Education
- Emergency services
- Fast Moving Consumer Goods (FMCG)
- Food production
- Freight providers
- Funeral /crematoria
- Health
- Industry
- Insurance
- Iwi
- Military
- Rural sector
- Tourism
- Vineyards
- Welfare

While this information has not been incorporated in the North Canterbury Resilience Pilot GIS portal, this is an improvement for the future. This will allow the vulnerability assessment to also consider these sites, providing intelligence for both lifeline utilities and the CDEM sector generally.

In the meantime, the MERIT economic GDP-based analysis will assess the impact of hazard scenarios on industry sectors based on disruption to the lifelines services they depend on (e.g., electricity, roads, telecommunications, etc.).

2.3 North Canterbury Resilience Pilot – GIS Portal

ArcGIS Online from the GIS software company ESRI is a Software as a Service (SAAS) platform for discovery, storage, manipulation, sharing and publishing geospatial data. Use of this platform enables a wide range of capabilities because of the rich set of functional tools it offers, and because the use of the REST data format enables a highly functional way to publish geospatial data to and consume from other analytics applications.

In their 2018 MCDEM Resilience Fund report *National Information Infrastructure Framework for Emergency Management,* StratSim Ltd proposed that a well-structured catalogue of targeted geospatial data could support a variety of products across the four R's of emergency management: Reduction, Readiness, Response, and Recovery. Canterbury CDEM has subsequently developed an ArcGIS Online instance (The Portal) for storage and analysis of geospatial data as described in that report.

To date The Portal has been deployed for operational purposes so that Lifelines coordinators can understand the location of critical assets in relation to a range of local and regional response situations, however uptake of that data has been limited to occasional response usage only. The North Canterbury Pilot has now extended use of The Portal to include Research and, by inference, Reduction activities as well.

Starting with a list of core information requirements, geospatial information for key hazards and critical infrastructure has been gathered. Ensuring that data is only gathered from a "source of truth", a useful set of authoritative datasets was rapidly catalogued and missing data identified. Any missing spatial data to add to the data store was then gathered to augment the available geospatial data for the pilot area.

Referring to Figure 1 to Figure 6 below, Critical Infrastructure content has been collated into a web map for viewing and interrogating the attributes of that geospatial data. Most data is available as a nationwide coverage, however some datasets are for the study area only. Note the following features:

- Some layers are "live feeds" consumed directly from the infrastructure provider as owner of their assets, for example Kiwirail assets are published for use in their geospatial hub here: https://data-kiwirail.opendata.arcgis.com/
- Where a direct connection to hosted data is unavailable, static files have been obtained from the infrastructure provider and hosted on The Portal.
- Drop-downs for the data layers in each sector are located on the left hand side of the screen.
- Toggles are also included for the various hazard layers, including flooding, tsunami and AF8 shaking intensities at this stage.
- The ability to select and view asset specific layers, either individually or together, and overlay these with either single or multiple hazards.
- The ability to hover and click on an asset or hazard and obtain data specific to that link.
- The Portal also includes links to a StoryMap and technical reports for each flooding hazard, which link back to ECan or District Council hazards websites or document libraries.

Example screens showing this functionality are provided below:

- Figure 1 is a screenshot of the home page, showing available layers in the left side of the screen.
- Figure 2 shows examples of infrastructure layers along with the associated legend to the left.
- Figure 3 provides a zoomed in view of the area around Rangiora and Kaiapoi for the 500 year flood depth model and Figure 4 shows modelled flow velocities.
- Figure 5 shows a Transpower line providing data about it in the panel to the left, while Figure 6 provides details about the overlaid flood scenario. Within the panel are links to the "StoryMap" and the supporting Technical Report, shown in Figure 7 and Figure 8. The former provides a link to the District Council's Natural Hazards Interactive Viewer, the latter to a document library or published report.

- Figure 9 shows the currently available layers.

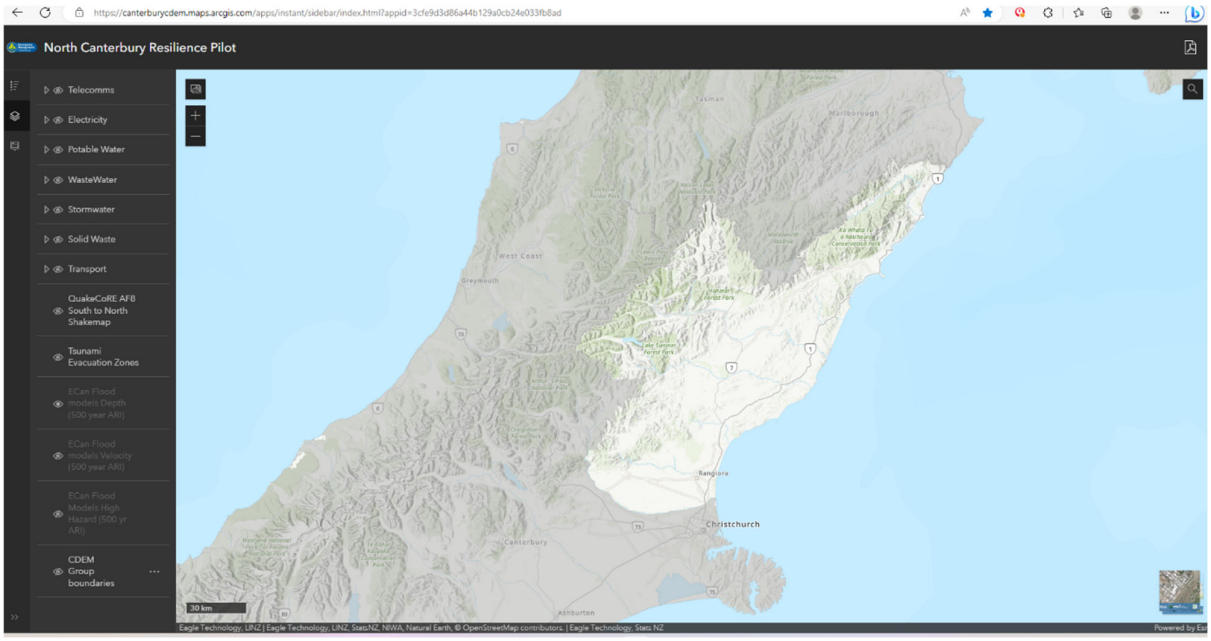

Figure 1 North Canterbury Resilience Pilot – GIS Portal Home Screen

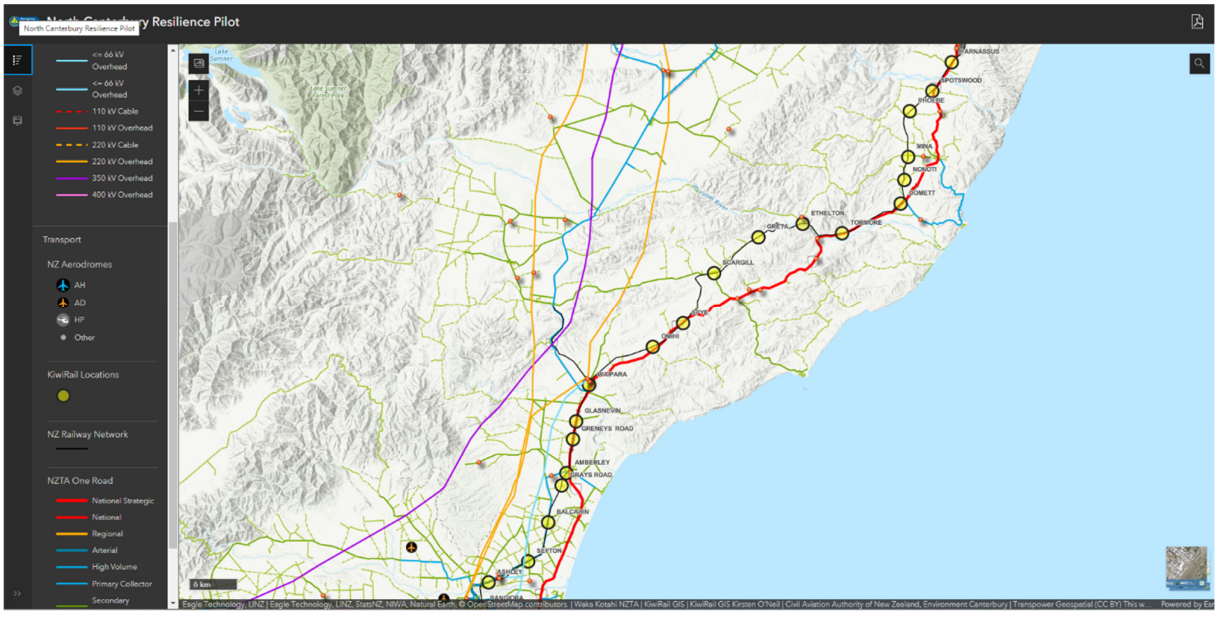

Figure 2 Example of Lifelines Data Layers – Transpower, Road Network, KiwiRail

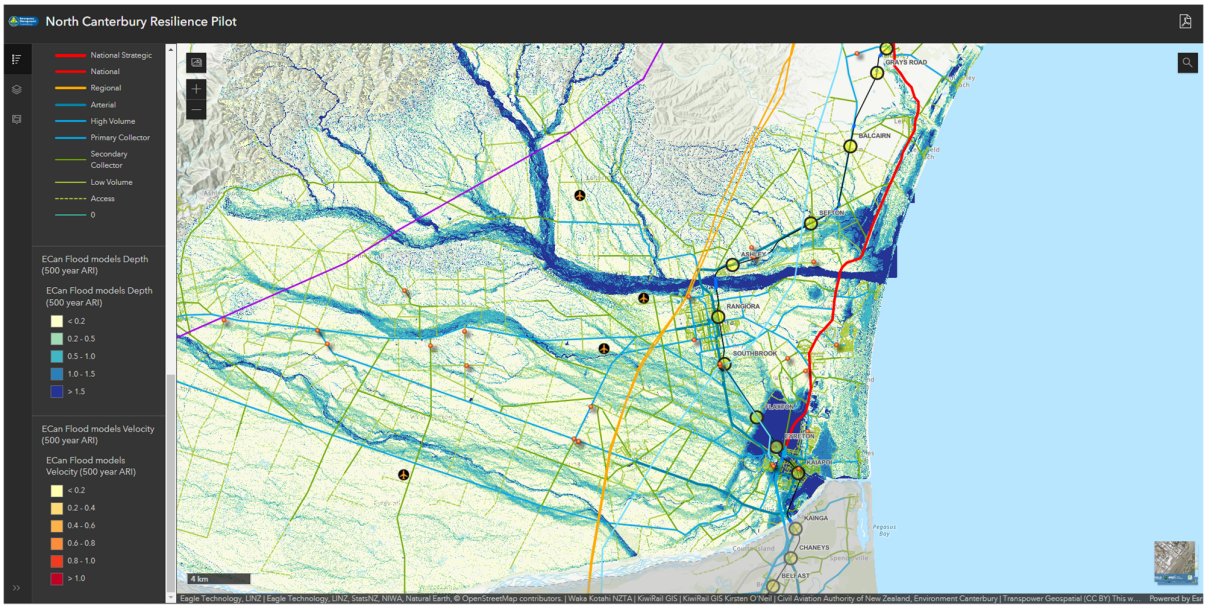

Figure 3 Example of Lifelines Data Layer Overlaid with 500 Year Flood Model - Depth

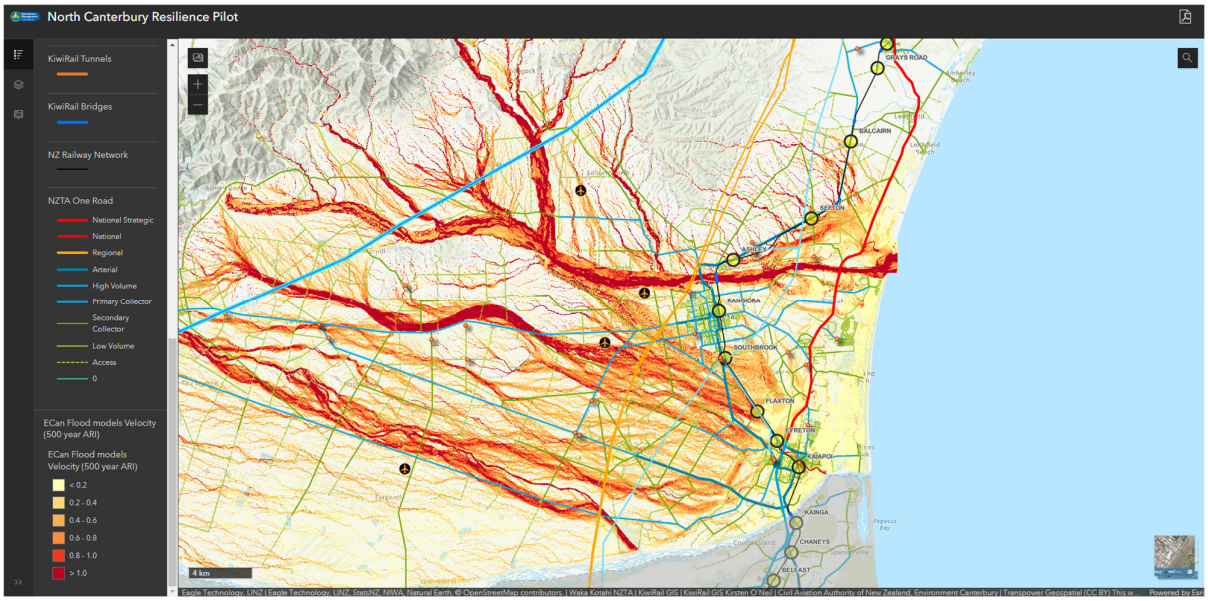

Figure 4 Example of Lifelines Data Layer Overlaid with 500 Year Flood Model - Velocity

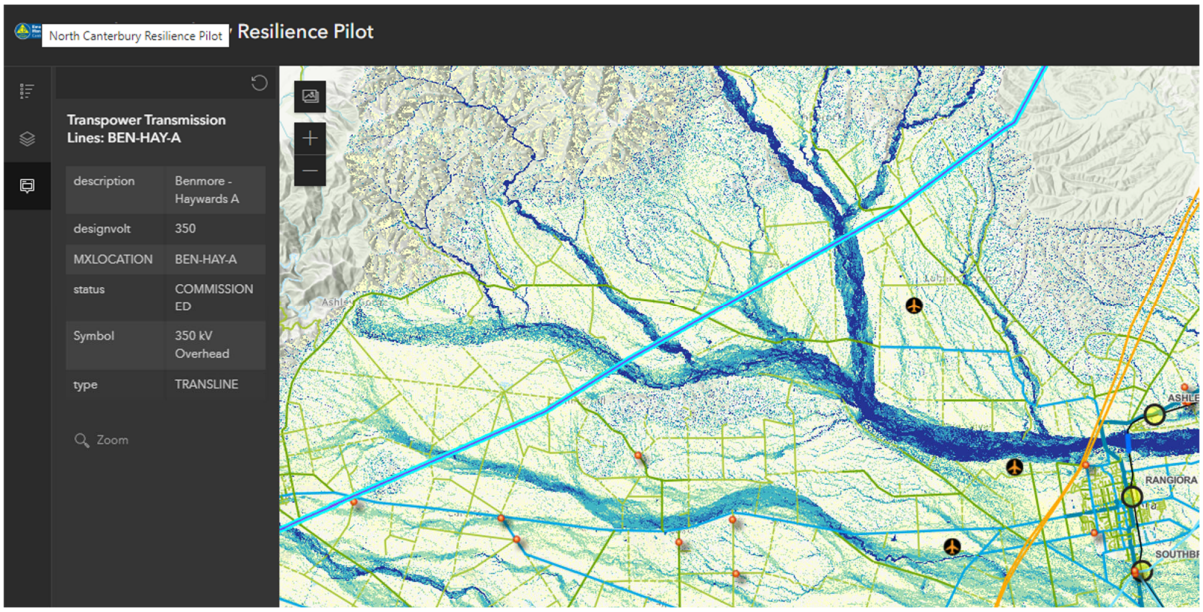

Figure 5 Transpower 350 kV Transmission Line Overlaid with 500 Year Flood Model - Depth

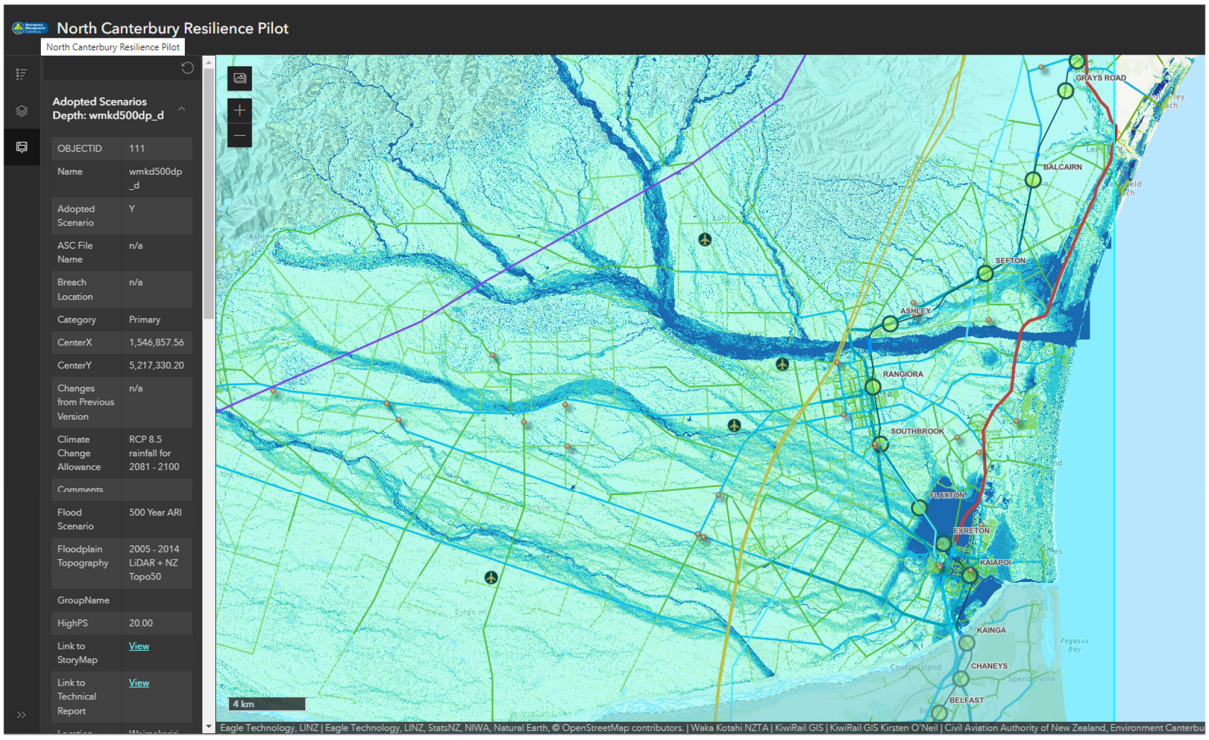

Figure 6 500 Year Flood Depth including Associated Data

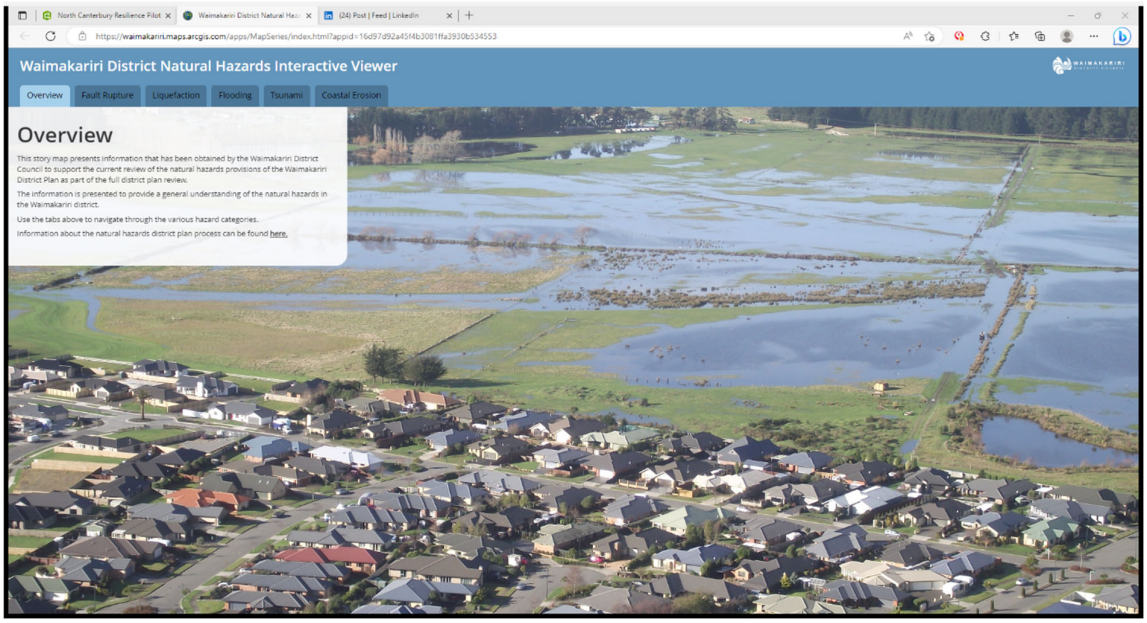

Figure 7 StoryMap for Waimakariri District Flooding Scenario

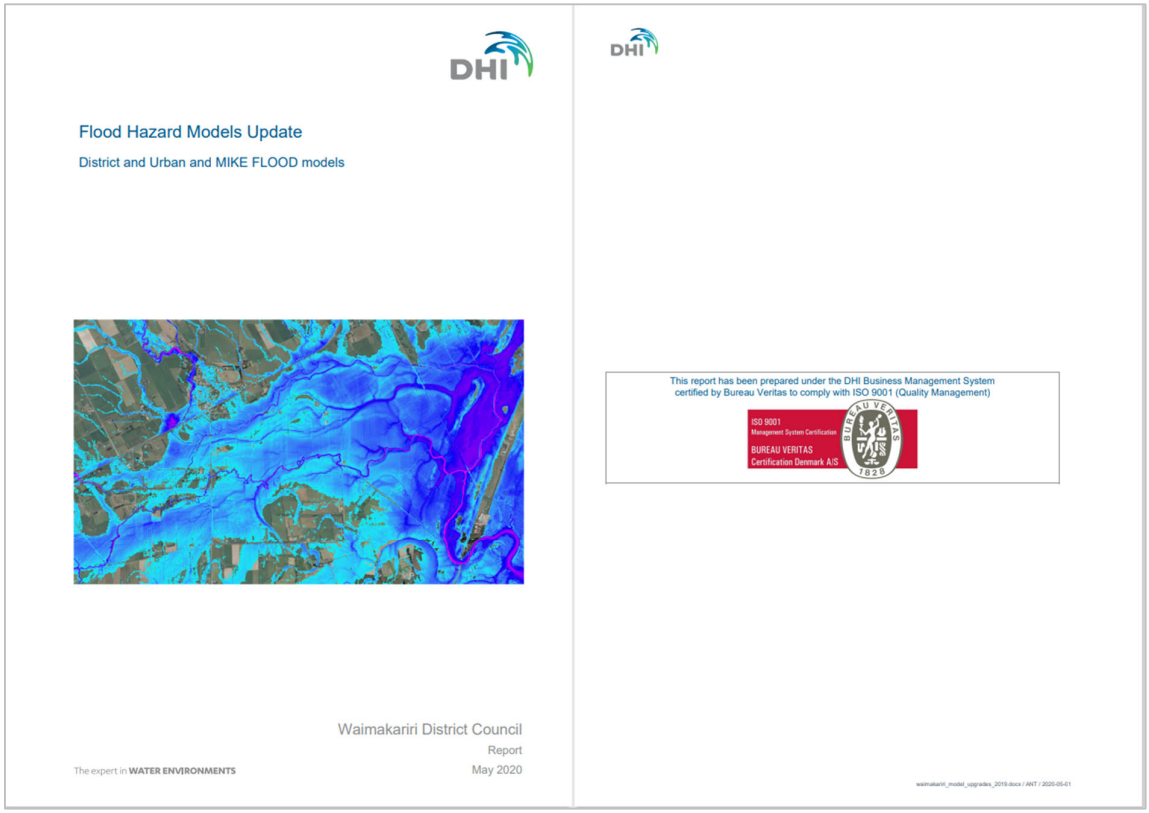

Figure 8 Technical Report – Waimakariri District Flooding

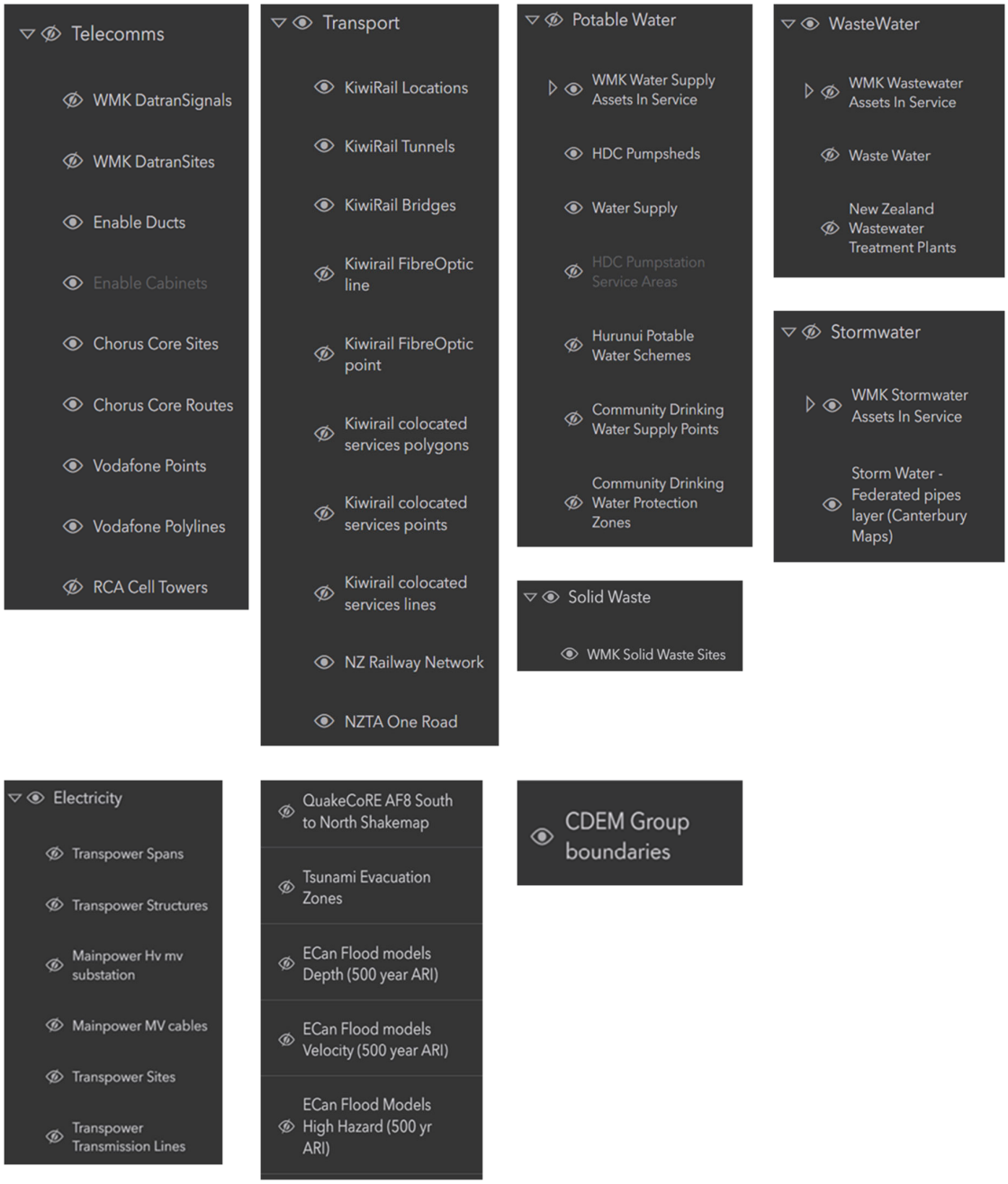

Figure 9 Available Asset and Hazard Data Layers

3.0 Modelling Approach

3.1 Maturity Pathway

3.1.1 Overview

The following figure provides an overview highlighting the modelling / analytic tools that support the pathway from "core" towards "advanced" maturity – the Urban Intelligence Resilience Explorer, MERIT, and RiskScape. Underpinning the use of these tools is the Lifelines GIS Portal, hazards and infrastructure data, and the outputs of research.

In the bottom left corner is the qualitative approach adopted for describing infrastructure networks and potential vulnerabilities to natural hazards. The arrow moves practice towards a highly quantitative approach embodying fragility relationships or thresholds in vulnerability analysis, service level disruption and outage, loss modelling and economic modelling in determining and evaluating potential mitigation investment strategies. The Wellington Programme Business Case to the right side of this diagram currently represents "best practice" in the NZ lifelines context, taking economic evaluation into the assessment of alternative investment scenarios for improved resilience.

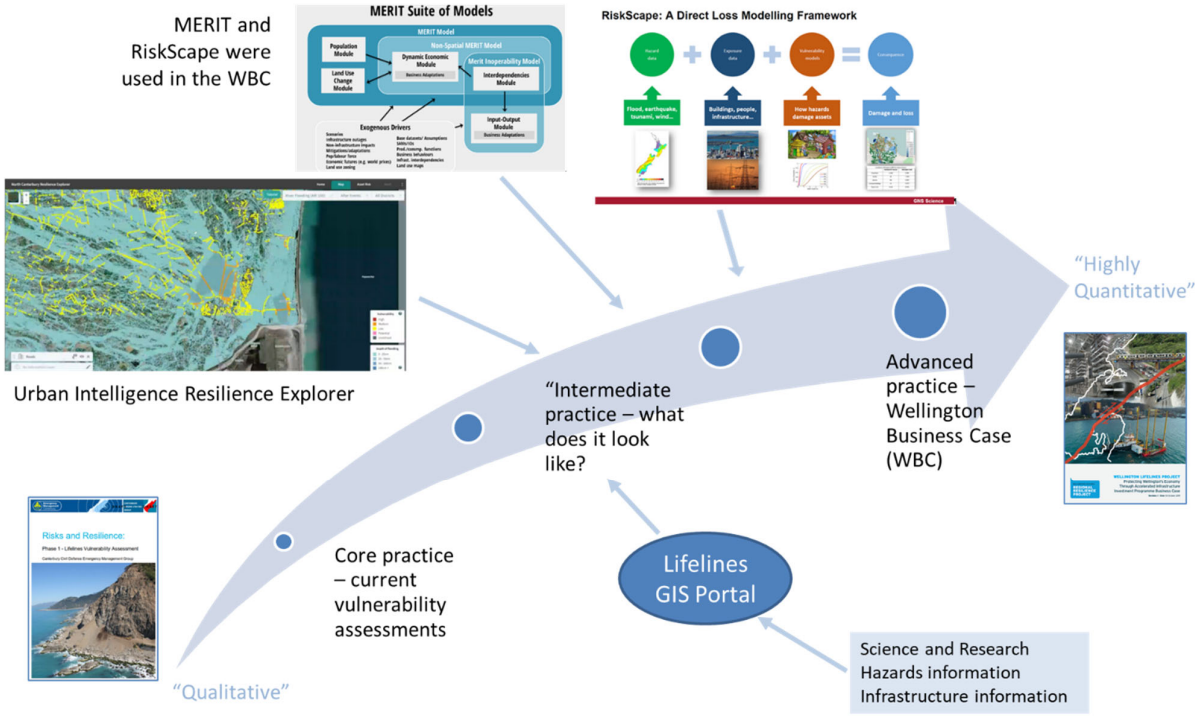

Figure 10 Maturity Pathway

3.1.2 Pilot Approach

Steps in the Maturity Pathway are illustrated below. This report particularly covers the first two steps – improving hazard understanding by providing visual and technical information in a "one-stop" shop GIS-based lifelines application along with asset data layers aligned with the data schema described in the Milestone 3 report.

Table 5 Maturity Pathway Steps being utilised in North Canterbury Pilot

Step	Features of Intermediate to Advanced Practice	Approach Adopted
1	Improve understanding of hazards and climate change and their impacts	AF8 earthquake shaking, river flooding, and tsunami hazard data layers have been sourced reflecting current research-based knowledge. This includes climate change induced impacts on rainfall and thus river flows.
2	Enhance and expand the application of GIS and the level of detail captured / reported	Development of the North Canterbury Resilience GIS portal enables infrastructure layers to be overlaid with hazards layers. Data that is recorded in the portal can be interrogated.
3	Improve assessment of physical damage to infrastructure	Good data attribution in Step 2 facilitates a systematic approach to vulnerability assessment, based on factors such as asset type, material type, exposure to the hazard (e.g. depth of flooding). While not consistent across all sectors, sufficient data has been acquired to demonstrate "proof of concept".
4	Quantify / model hazard impacts on interdependent infrastructure networks	By adopting a "Statistical Area" basis for the economic evaluation, interdependencies within each such area can be spatially identified. For example, if an electricity substation has an outage, any reliant facility such as a water pumping station or telecommunications site can also be assumed to be out (unless it has an alternative power supply source).
5	Assess how damaged infrastructure disrupts levels of service	The modelling approach will use known fragility relationships sourced from research alongside the results of expert elicitation from lifelines providers. For modelling purposes, service outages are assumed to be on an On/Off basis, expressed on a daily basis for the economic analysis period. This could be refined in future to represent partial loss of service on a % basis.
6	Describe infrastructure recovery pathways over time	This is linked to the assumed service outage pattern over time described above. The better these pathways can be described the more robust will be the outcome of the analysis. Pathways also need to be linked to interdependencies – e.g., restoration of electricity supply to restore water, telecommunications, etc.
7	Assess social and cultural impacts due to service disruptions	This step is not part of the pilot. However, it is planned to explore possible approaches in future work.
8	Assess economic impacts of service disruption to communities	MERIT will be used to assess the impacts of one event – a 500-year river flooding hazard – in particular, the Business Behaviours Module. Some functionality (e.g., Population Relocation Module) has yet to be considered.
9	Loss modelling to determine infrastructure financial losses and recovery costs	This step will not be carried out in the pilot. One approach is to use infrastructure valuation data and expected damage ratios to estimate the financial costs of recovering / restoring each network.
10	Integrated economic evaluation – service disruption and loss modelling	Due to Step 9 not being carried out, only the GDP economic impacts are to be assessed. This will however be sufficient to demonstrate the feasibility of the pilot's "end-to end" process.
11	Business case development - mitigation scenarios, analysis, programme case	The pilot will not produce a full business case as such, however, it is intended that potential mitigation measures be identified with broad indicative investment needs. These will then be compared to the economic impacts of a major flooding event.

3.1.3 Application in Other Regions

The above steps can be adopted by any other region or Lifelines group in New Zealand. What is important is to be able to develop maturity at each step progressing towards alignment with the pathway at a level appropriate to the region and the resources that are available.

The Milestone 2 report provides further information in relation to these maturity steps, including a discussion of various tools and resources that can be utilised for each. Note that some of these resources were in development at the time of writing. For example, the Urban Intelligence North Canterbury Resilience Explorer was developed as part of this project.

The Milestone 2 report also describes in matrix form what “core”, “medium”, “high”, and “advanced” maturity look like for each step (or theme).

3.2 GIS Portal

3.2.1 Overview

The GIS Portal introduced in Section 2.3 has been configured with the available hazard and infrastructure data layers provided. It can now be used to supply this data to the Urban Intelligence Platform for vulnerability analysis and visualisation purposes.

It is noted that keeping the GIS Portal up to date with research outputs will need to be an ongoing task as research is completed and the results translated into a GIS-consumable format. Research outputs could include new understanding in relation to the nature and scale of hazards, the ways in which infrastructural assets can be damaged or affected by such hazards, through to the social and cultural implications to communities. Milestone 1 and 2 project reports provide more detailed information on these topics.

Note that The Portal itself is not configured to carry out detailed vulnerability assessment using specific fragility relationships or thresholds but is the conduit for providing core data layers to analytical platforms such as Urban Intelligence, RiskScape and MERIT. Planned as a future improvement is the ability for the outputs from the Resilience Explorer to be exported back into The GIS Portal to improve insights and visualisation.

3.2.2 Application in Other Regions

The Portal can be readily utilised by other regions as it has a national basis. Live data feeds from some national lifeline utilities are already captured, with local or regional layers able to be added to their own versions of The Portal by lifelines groups.

3.3 Urban Intelligence (UI) Resilience Explorer

3.3.1 Overview

This project has leveraged the advanced capabilities of ArcGIS Online by providing a diverse set of analysis-ready data to Urban Intelligence's third-party application. This means that the Urban Intelligence platform holds no data, instead it will access relevant data from The Portal and perform analytics on the fly as the user demands.

The ArcGIS implementation of the REST format has become a de-facto standard for local and regional government to publish and receive geospatial information. This functionality allows compatible applications to receive data hosted from another source and perform analysis tasks on that incoming service. This "loosely coupled" system can now be seen to be successfully working as Urban Intelligence use the data stored and delivered from The Portal to perform analysis tasks within their own platform.

This represents a radical departure from the previous paradigm, where large amounts of resource can be spent on gathering and storage of suitable data prior to the analysis being performed, proving the hypothesis that "A well-structured analysis-ready set of geospatial data can enable innovative solutions to a diverse range of problems".

The introduction screen to the Urban Intelligence Resilience Explorer is shown below.

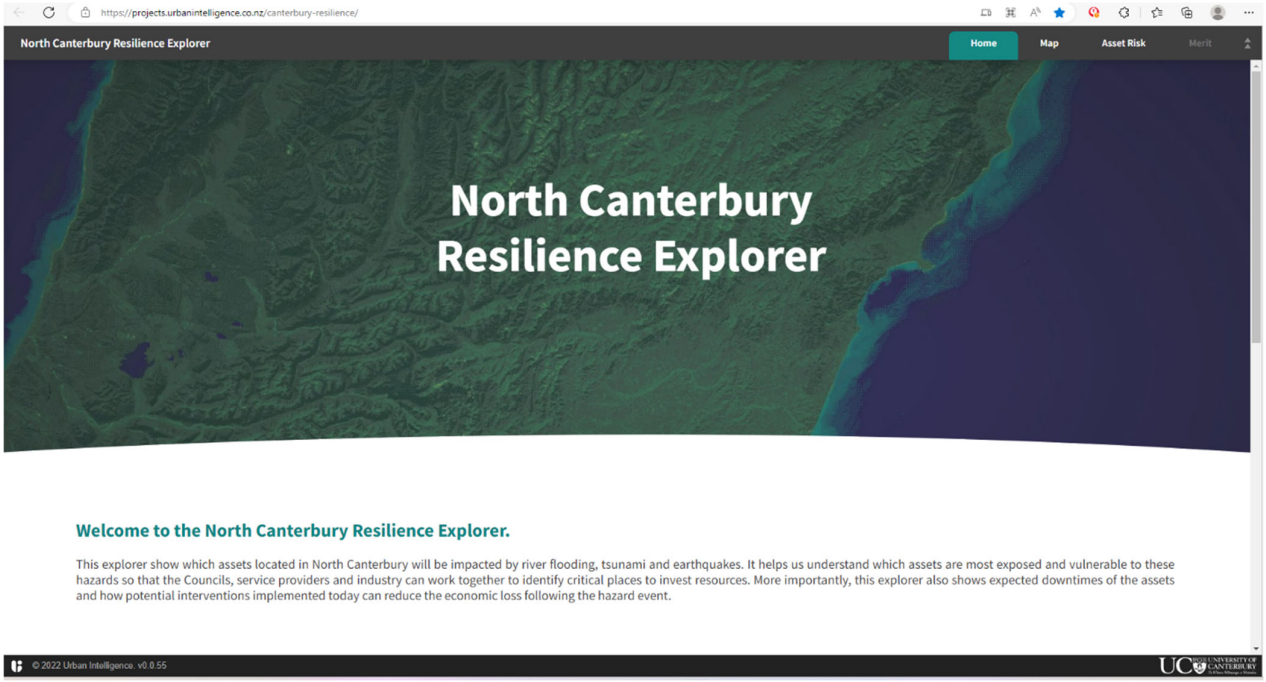

Figure 11 North Canterbury Resilience Explorer

The application has been configured to demonstrate the following functionality:

- Mapping and selection of hazard events, for the pilot these are flooding (100-500 year return periods) and the Hikurangi tsunami – see Figure 12 below.
- Selection of lifelines asset layers using a menu – see Figure 13 and Figure 14 below.
- Vulnerability assessment utilising fragility relationships or nominated threshold levels for disruption.

In future, it is proposed to include the mapping of economic impacts from MERIT within the platform.

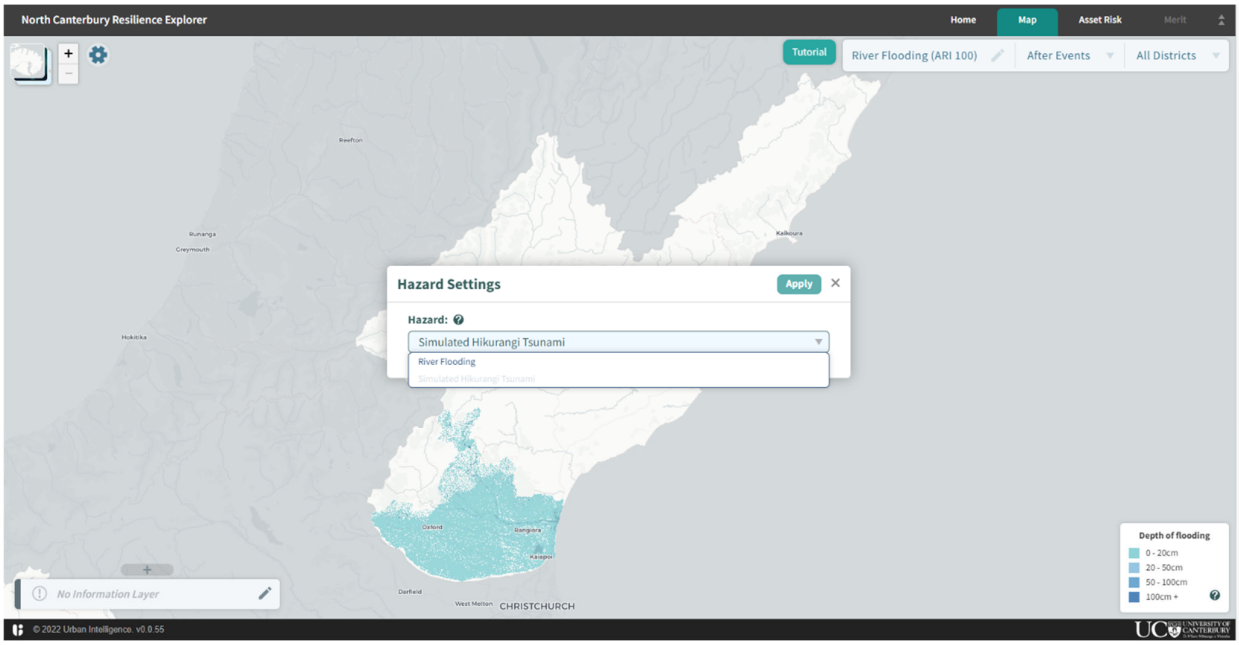

Figure 12 Hazard Mapping

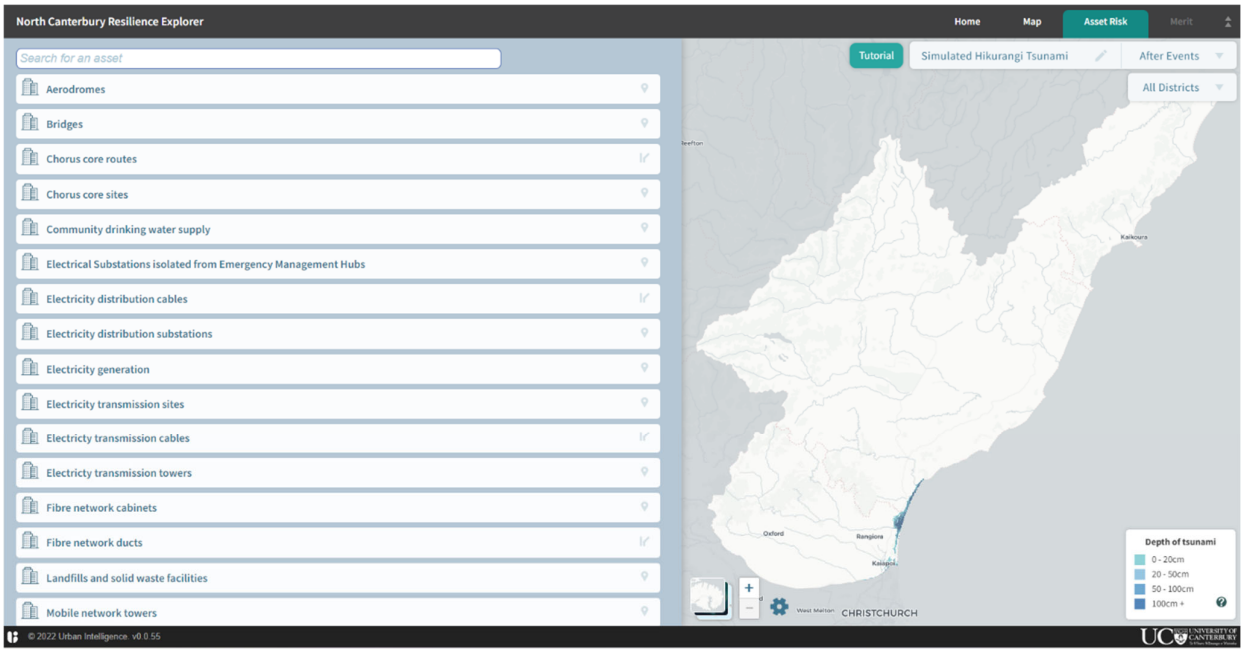

Figure 13 Asset Risk

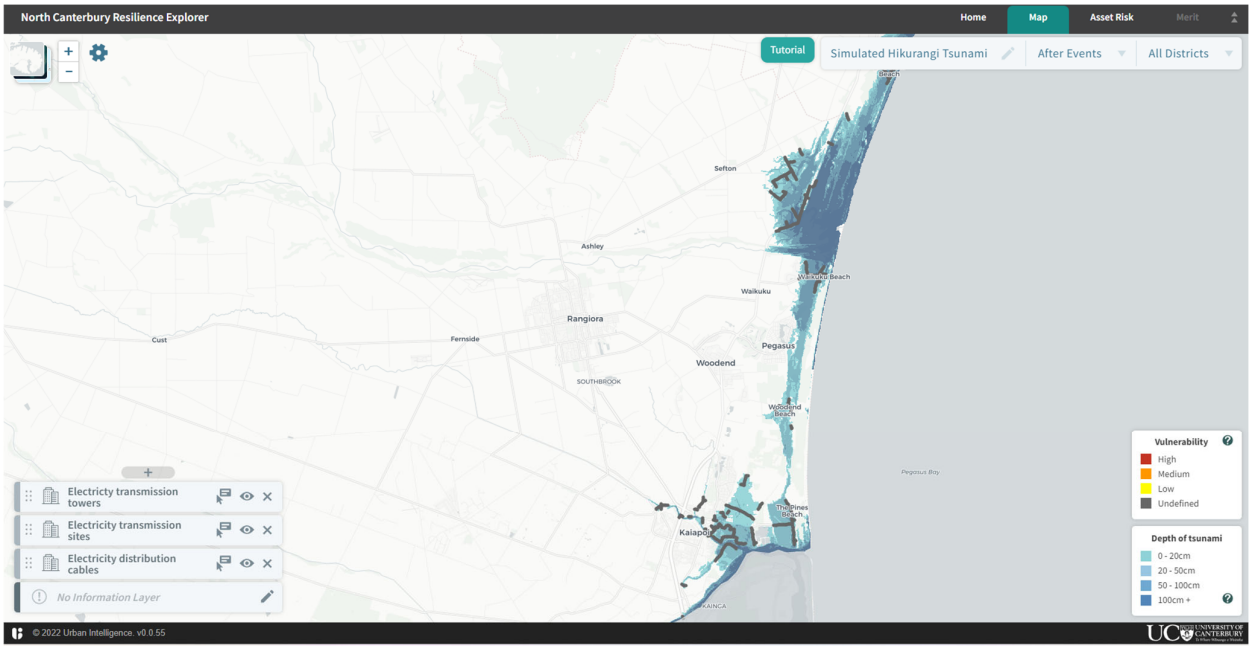

Figure 14 Selection of Multiple Mapped Asset Types for Vulnerability Analysis

3.3.2 Application in Other Regions

The architecture of this platform is configurable to any part of New Zealand. A seamless approach has been developed to facilitate the take-up of hazard and infrastructure data from The Portal for use in the Urban Intelligence Resilience Explorer. It would also be possible to bring in other data layers, such as "community sites" referred to in Section 2.2.6, for analysis purposes.

3.4 MERIT

3.4.1 Overview

MERIT is depicted as a modelling pipeline with a range of components shown in Figure 15[2]. Not all of these are being implemented for the North Canterbury pilot, with those shown in yellow selected. The focus here will be Business Behaviours Modelling and Freight Margin / Travel Cost Analysis.

In future, with additional data inputs the impacts on people (Evacuation Scenarios) and Farms (Farm Functionality Modelling) can also be covered. Wider social impacts can be addressed through the Population Relocation Module and Cordon Analysis.

[2] Courtesy Market Economics, 2023

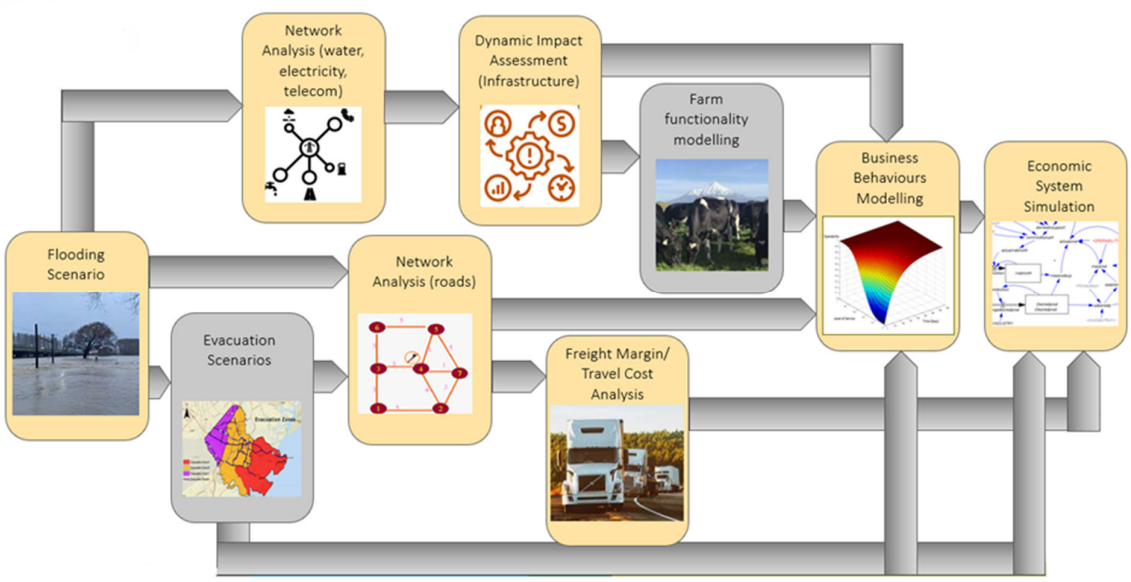

Figure 15 MERIT Modelling Pipeline

Disruption data will be provided to the modelling platform through a spreadsheet based data template provided by Market Economics and covering the following:

- Electricity
- Water
- Telecom data cell
- Telecom data landline
- Telecom voice cell
- Telecom voice landline
- Road – defined as segments with unique ID derived from either LINZ centreline data or Open Street Map data

Each of the above tabs provides for outages (service on/off) to be recorded on a daily basis within each statistical area (except for roads which is segment based). This will be populated by the Urban Intelligence team following the vulnerability analysis process, where outage and duration data by utility is available.

Compiled information will then be imported to MERIT for economic analysis.

3.4.2 Application in Other Regions

The MERIT modelling process can be readily configured for any region or area selecting the modules as desired. The outage vs duration data template needs to be populated on the SA basis as described for each lifelines sector being considered.