9.10. Otago Region Natural Hazards Exposure

Prepared for:	Safety and Resilience Committee
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Activity:	Governance Report
Author:	Tim van Woerden, Senior Natural Hazards Analyst Andrew Welsh, Spatial Analyst Jean-Luc Payan, Manager Natural Hazards
Endorsed by:	Tom Dyer, General Manager Science and Resilience
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PURPOSE

[1] To inform the Committee of the work on a region-wide natural hazards assessment programme, including presenting a report analysing natural hazards exposure within the Otago region.

EXECUTIVE SUMMARY

[2] The Otago Regional Council (ORC) Natural Hazards team have been progressing work on a regional-scale natural hazards assessment programme. The programme is aiming to work towards a comprehensive, regional-scale, spatial understanding of Otago's natural hazards and risks.

[3] This paper presents a recently completed natural hazards exposure analysis for the region, which is ORC's first iteration of analysis to quantify and map natural hazards exposure in Otago at a regional scale.

[4] The natural hazards exposure information will be an important input towards the ORC Natural Hazard team's region-wide natural hazards prioritisation process, which is planned to commence in 2025/2026, and the exposure analysis results are expected to also be of interest to other organisations in the region, for example Emergency Management Otago and territorial authorities.

RECOMMENDATION

That the Committee:

1) ***Notes** this report.*
2) ***Endorses** the report Otago Region Natural Hazards Exposure Analysis.*
3) ***Notes** the next steps in the work programme, including commencement of the natural hazards prioritisation workstream.*

BACKGROUND

[5] Since the 2021/22 financial year, the ORC Natural Hazards team have been progressing work on a regional-scale natural hazards assessment programme. The programme is aiming to work towards a comprehensive, regional-scale, spatial understanding of Otago's natural hazards and risks. The background to the work programme is outlined in a paper presented to the ORC Safety and Resilience committee in May 2023.[1]

[1] van Woerden T, 2023. Otago Region Natural Hazards Risk Assessment. Report to the Otago Regional Council Safety and Resilience Committee, 10 May 2023.

[6] Figure 1 outlines the key activities and programme sequencing in the natural hazards assessment and prioritisation programme.

[7] This paper presents the recently completed natural hazards exposure analysis, which builds on ORC's existing hazards datasets to provide further insights into the region's natural hazards setting. To introduce the exposure analysis report, this paper first provides a brief overview of the natural hazards information held by ORC.

[8] A natural hazards prioritisation approach for the region has been developed and was presented to the ORC Safety and Resilience Committee in a May 2024 workshop[1] and a November 2024 paper.[2]

[1] Otago Region Natural Hazards Exposure and Risk Analysis. Otago Regional Council Safety and Resilience Committee workshop, 9 May 2024.
[2] van Woerden T Welsh A and Payan J, 2024. Otago Region Natural Hazards Prioritisation. Report to the Otago Regional Council Safety and Resilience Committee, 7 November 2024.

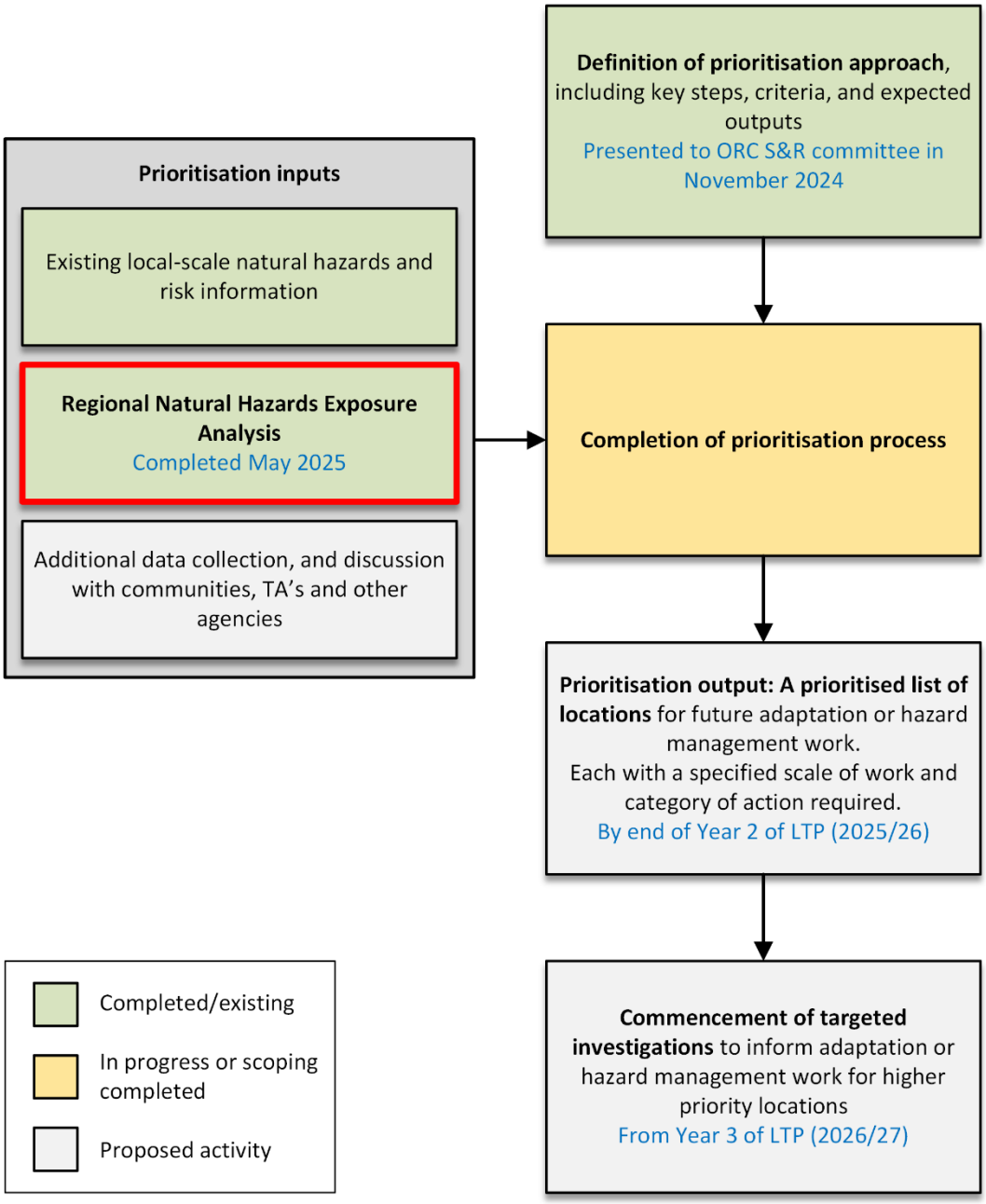


Figure 1: Flow chart showing key activities and programme sequencing in the natural hazards assessment and prioritisation programme. The regional natural hazards exposure analysis report presented in this paper is highlighted red.

LEGISLATIVE REQUIREMENTS

[9] The natural hazard information held by ORC enables the understanding and management of the risks associated with natural hazards in the region, required by legislation such as the Civil Defence Emergency Management Act (CDEMA) and the Resource Management Act (RMA).

[10] The RMA specifies that councils must, as a matter of national importance, recognise and provide for the management of significant risks,[1] and regional councils have specified

[1] Resource Management Act, 1991. Section 6(h).

functions[1] including the control of land for the purpose of the avoidance or mitigation of natural hazards.

[11] The CDEMA[2] states that a function of a Civil Defence membership group is to identify, assess, and manage natural hazards and risks.

[12] ORC is required to investigate and map potential natural hazards to meet the requirements of these legislations. The legislation does not provide any guidance on the precise approach or level of detail to be used in hazards investigation or mapping, this is developed based on ORC's requirements, industry good practice and with reference to national guidelines[3] where available.

ORC NATURAL HAZARDS INFORMATION

[13] ORC carries out investigations of natural hazards and their risks and holds a large amount of natural hazards information compiled over decades to identify, map and characterise natural hazards in the Otago region. Natural hazards information ranges from region-wide mapping datasets to targeted local-scale studies, and includes mapping or modelling datasets, technical reports, surveys and photographs.

[14] Much of ORC's natural hazards information is publicly available on the ORC Natural Hazards Portal, and other information can be provided on request. Data such as technical reports and hazards mapping are provided to key internal/external stakeholders for their reference and use, for example:

- For ORC Engineering team (e.g. for management of flood protection schemes).
- For Otago's territorial authorities (district and city councils) for use in landuse planning (District Plans, Spatial Plans) and for inclusion on Land Information Memorandum (LIM).
- For Emergency Management Otago for use in civil defence response planning.
- For infrastructure managers (e.g. lifelines organisations).

[15] The ORC Natural Hazards team regularly responds to public enquiries[4] for natural hazards information (approximately 100 enquiries per year).[5] For example, enquiries from a prospective purchaser of a property enquiring about what natural hazards information ORC holds for that location.

[16] The regional or district-scale natural hazards mapping datasets held by ORC cover all of the main types of natural hazards which may impact the region, including slope stability, flooding, coastal and seismic hazard types (Appendix 1).

[17] These regional mapping layers are often based largely on interpretation from aerial imagery and topographic information, supplemented by on-ground observations (e.g. flooding, landslides, alluvial fans, active fault mapping) or based on modelling approaches (e.g. storm surge and tsunami).

[1] Resource Management Act, 1991. Section 30(1)(c)(iv)
[2] CDEM Act, 2002. Section 17.
[3] e.g. the GNS Science landslide planning guidance (2024), and the MfE/MBIE guidance for potentially liquefaction-prone land (2017).
[4] NaturalHazards.Enquiries@orc.govt.nz
[5] 90 enquiries in the 2023/24 financial year, and 120 enquiries in the 2024/25 financial year (as of 9th May 2025).

[18] This ORC natural hazards mapping provides a regional overview and a general indication of locations where that hazard may be an issue or require further assessment but are not designed to be used at a more detailed project or property-specific scale. For mapping layers compiled through topographic interpretation, the accuracy is generally considered to be in the order of about ±100 metres at best.

[19] In addition to these broad-scale hazards datasets, ORC also holds a variety of other supporting data which enables natural hazards analysis, e.g. LiDAR[1] and other survey data, aerial imagery, environmental monitoring datasets such as lake level, river flow or rainfall records, and hazards photographs including historical images from the Otago Catchment Board archives.

[20] Many national-scale natural hazards datasets and information sources are also available, and which complement the regional or local-scale data held by ORC. These include:

- Spatial datasets of mapping or modelled natural hazards data, e.g., coastal inundation mapping,[2] location-specific sea-level rise projections,[3] and the National Seismic Hazard Model.[4]
- Information sharing platforms holding compilations of natural hazards of geotechnical data, e.g., the New Zealand Geotechnical Database for publicly available geotechnical information,[5] Natural Hazards Commission compilation of previous natural hazard damage claims.[6]

Local-scale targeted hazard and risk studies

[21] Local-scale targeted investigations are often carried out to add detail and spatial resolution beyond that available in regional or district-scale information. These targeted studies will generally be completed for a specific natural hazards issue in a defined geographic location, and for a specific purpose. Investigation purpose could be to inform decision-making (e.g. for the ORC Engineering team, or for an adaptation programme), or to inform landuse planning decision-making (e.g. supporting a territorial authority in District Plan review or spatial planning). Investigations may be reactive, in response to the occurrence of a natural hazards event, while others are undertaken proactively in response to identification of a potential hazard impact which requires further assessment.

[22] Local-scale investigations can be designed as either a natural hazard assessment or a risk assessment:

- A natural hazard assessment aims to understand the physical characteristics of the potential natural hazard event, such as the possible extent, behaviour, likelihood or severity of the event (e.g. a flood hazard or debris flow modelling study, or a geotechnical study for landslide or liquefaction susceptibility).
- A natural hazard risk assessment aims to understand and explain the event's impacts and consequences (i.e. possible harm), building on the available natural hazards information, but also information about the vulnerability of the people/community or assets exposed to the hazard (e.g. risk assessments recently

[1] Light Detection and Ranging, a remote sensing technique for capturing high-resolution topographic information.
[2] NIWA, Extreme coastal flood maps for Aotearoa New Zealand (https://niwa.co.nz/hazards/coastal-hazards/extreme-coastal-flood-maps-aotearoa-new-zealand).
[3] NZ SeaRise (https://www.searise.nz/).
[4] GNS Science (https://www.gns.cri.nz/research-projects/national-seismic-hazard-model/).
[5] NZGD (nzgd.org.nz).
[6] NHC Natural Hazards Portal (https://www.naturalhazardsportal.govt.nz).

completed for South Dunedin[1] and Glenorchy,[2] and in progress for debris flow hazard in the Roxburgh area [3]).

[23] Compared to the regional-scale natural hazards information described in paragraphs 16-20, these more targeted studies will typically involve more detailed data collection, analysis or hazards modelling. Although studies of this type may be completed at a relatively finer spatial resolution, they are generally not intended for use at an individual property-level.

OTAGO REGION NATURAL HAZARDS EXPOSURE ANALYSIS

Introduction

[24] In order to provide further insights into the region's natural hazards context, ORC has completed an analysis of natural hazard exposure for the region, which utilises information from the existing regional-scale natural hazards mapping datasets.

[25] "Exposure" is the people, infrastructure, buildings, the economy, and other assets that are exposed to a hazard.

[26] This is ORC's first systematic analysis of natural hazard exposure for Otago – the existing hazards mapping datasets have not previously been used for further analysis to understand or characterise natural hazards exposure in the region. The report provides a stocktake and baseline of the current understanding of natural hazard exposure for the region, and is a first iteration of analysis to quantify and map natural hazards exposure in Otago at a regional scale.

[27] Reporting and analysis were completed by the ORC Natural Hazards team, and externally reviewed by NIWA and GNS Science.

[28] The technical report is included as Appendix 2, and results are also available through an online data viewer at orc.govt.nz/naturalhazardexposure.

Methods

[29] Exposure analysis was completed for nine natural hazard types where region or district-wide hazard mapping coverage was available, aiming to give a region-wide understanding and broad-focus view, enabling a comparison across the region and between natural hazard types.

[30] The analysis methodology and input datasets used are more fully detailed in the appended technical report (Appendix 2).

[31] The analysis assesses the exposure of three elements at risk: population, buildings and 'critical community facilities' defined as facilities which have a post-disaster function (Saunders et al, 2013). These three elements are identified based on the approach to assessing hazard consequences in the proposed Otago Regional Policy Statement 2021

[1] South Dunedin Future risk assessment report, March 2025 (https://www.dunedin.govt.nz/__data/assets/pdf_file/0007/1124179/south-dunedin-risk-assessment.pdf).
[2] Glenorchy and Kinloch natural hazards risk analysis report. Beca Ltd, August 2024 (https://www.orc.govt.nz/media/hnlim52b/glenorchy-and-natural-hazards-risk-analysis-report_final-report-26aug2024-compres.pdf)
[3] Roxburgh natural hazards management. ORC committee paper, November 2024 (https://www.orc.govt.nz/media/ffqpudud/20241107-sr-agenda.pdf).

(pORPS, ORC 2021b). The elements at risk considered are representative of socio-economic elements at risk to natural hazard impacts, and provide an indication of the magnitude of potential natural hazards exposure.

[32] Natural hazard exposure analysis was completed using RiskScape software,[1] with analysis completed for over the full Otago region for 351 distinct geographic units, termed 'community areas', based on Statistical Areas (SA's) defined by Statistics NZ.[2]

[33] The analysis approach is summarised in Figure 2. The natural hazard mapping and elements at risk information used in analysis is listed in Table 1.

[34] Exposure statistics are estimated for each element at risk within each community area, and aggregated by urban area/settlement, district, and over the full region. An exposure level classification is also developed for each community area, for each hazard type.

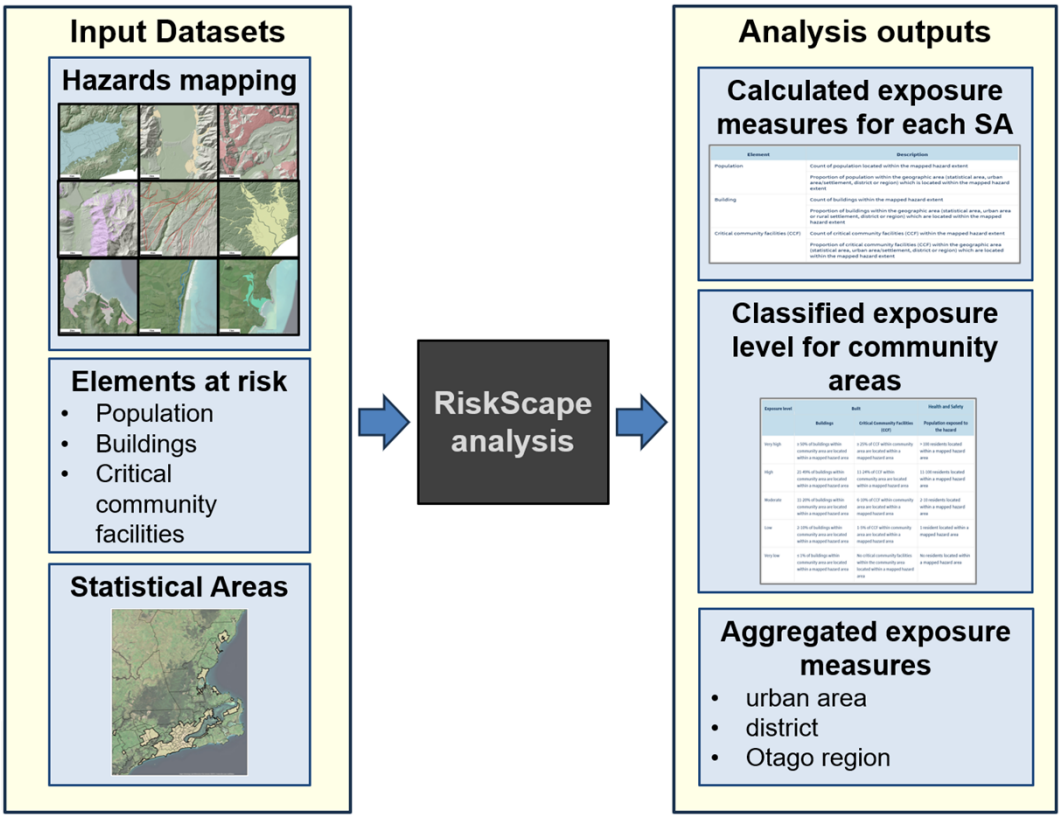
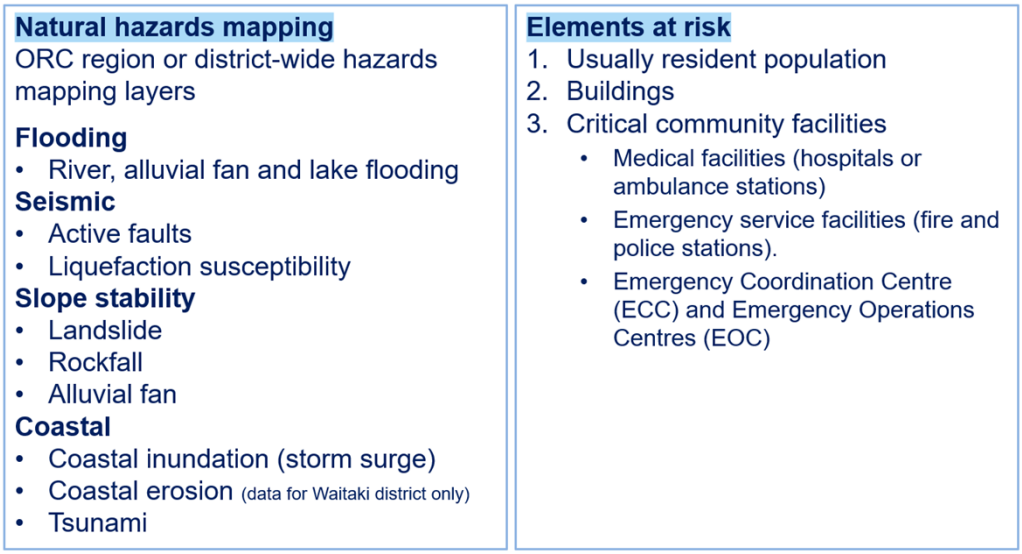


Figure 2: Schematic illustration of the process used for natural hazards exposure analysis. A more detailed illustration of the analysis process is included in the technical report as Figure 4.1.

Table 1: Natural hazards mapping and elements at risk information used in natural hazards exposure analysis

[1] RiskScape is an open-source software designed for multi-hazard risk analysis, developed by GNS Science, NIWA and the Natural Hazards Commission Toka Tū Ake (https://riskscape.org.nz/). RiskScape is widely used for natural hazards analysis, and provides a robust, replicable analysis framework.

[2] Rural community areas are defined by SA1 (100-200 residents), while urban community areas are defined by SA2 (1000-4000 residents) and rural settlements by SA1 (100-200 residents.



Limitations

[35] The most significant constraint on completion of a regional-scale natural hazards exposure assessment is the availability and consistency of data for natural hazards and elements at risk. A selection of key limitations in exposure analysis are summarised in paragraphs 36-37, the analysis limitations are explained more fully in the technical report (Appendix 2).

[36] The natural hazards mapping data used in this analysis is the best natural hazards information with region-wide coverage currently available, however a number of key limitations are identified, including:

- Only ORC's regional or district-scale hazards mapping datasets were used in analysis. More detailed natural hazard information is available in many locations (e.g. local-scale flood hazard modelling or geotechnical investigations) but was not used for this initial analysis to maintain consistency of data resolution across the full region.
- Some datasets include consideration of climate change or sea level rise (e.g. coastal inundation, tsunami and coastal erosion), but climate change effects are not accounted for in other datasets such as flood hazard mapping or landslides.
- Several hazard mapping datasets (e.g. flooding, landslides) have been compiled from a range of composite sources or using differing methodologies, leading to variation in the precision and quality of information within a specific mapping dataset.

[37] The key limitations of the elements at risk are associated with the development of the population and building datasets used in analysis. For example:

- The spatial distribution of the population was estimated by modelling population allocation into building types likely to represent dwellings, and is therefore an approximation.

Results

[38] Natural hazards exposure analysis results are presented in tabular form in the technical report (Appendix 2), and can be viewed spatially through a digital data portal (accessible at orc.govt.nz/naturalhazardexposure). Two high-level results tables are reproduced in this paper:

- Table 2 is a summary of natural hazard exposure in the region for each hazard type considered.
- Table 3 identifies the 'Top 10' urban areas or rural settlements with highest exposure (by population count) for each hazard type.

[39] Selected findings from this natural hazard exposure analysis for the Otago region are summarised in paragraphs 40-44.

[40] The highest exposure for the natural hazard types considered is for river and lake flooding, and liquefaction. Totals of greater than 30,000 people and buildings, including >10,000 residential dwellings, within the Otago region are located in areas identified as potentially subject to each of these hazards. There is also a notable spatial overlap between the geographic extents of flooding and liquefaction hazards exposure, because flood-prone areas typically comprise geologically-recent sediment deposits which may also be susceptible to liquefaction.

[41] The majority of exposure to flooding hazards in the region is located within the Dunedin City district, including the floodplains receiving flood mitigation from ORC's Leith and Lower Taieri flood protection schemes. Population and buildings located within the 'protected' areas of ORC's flood protection schemes are considered to be potentially exposed to the hazard, as these areas could still be exposed to flooding in the case of a super-design flood event or a failure of flood protection infrastructure.[1]

[42] The majority of exposure to slope stability hazards (landslide, rockfall and alluvial fan hazard) is located within the Queenstown Lakes and Dunedin City districts, with much of the exposure to these hazard types within the urban areas of Queenstown, Dunedin city and Wanaka.

[43] The majority of exposure to seismic hazards (active faulting and liquefaction) is located within the Dunedin City district, where the highest exposure is for the urban areas of Dunedin and Mosgiel.

[44] The exposure to coastal hazards (storm surge, tsunami, and coastal erosion) is much less relative to the other hazard types considered, with exposure of up to ~500 people and ~1100 buildings for each of storm surge and tsunami.

[1] i.e. there is an exposure to residual risk, where residual risk is the risk that remains after risk treatment (e.g. flood protection works) has been applied to reduce the potential consequences.

Table 2: Natural hazards exposure summary for the Otago Region, showing the estimated count and percentage of those elements within Otago potentially exposed to impact from the named natural hazard types.

Hazard type	Population exposed		Buildings exposed				Critical Community Facilities (CCF)		Count of community areas in each exposure class					Count of community areas in region
	Count	Percent of population in region	Count (all buildings)	Percent of total buildings in region	Count (Dwellings)	Percent of total dwellings in region	Count	Percent of total CCF in region	Very Low	Low	Moderate	High	Very High	
River and lake flooding	38,778	16.1	33,898	16.1	12,776	14.4	23	25.6	121	26	45	99	60	351
Liquefaction	46,047	19.1	43,029	20.4	17,459	19.7	37	41.1	142	18	45	68	78	351
Active Faults	21,949	9.1	20,096	9.5	8,371	9.4	10	11.1	203	19	21	68	40	351
Landslide	8,038	3.3	6,592	3.1	2,844	3.2	3	3.3	225	14	51	41	20	351
Alluvial fan	5,473	2.3	5,904	2.8	1,996	2.3	3	3.3	272	10	18	38	13	351
Rockfall	1,234	0.5	1,056	0.5	377	0.4	0	0	290	14	29	14	4	351
Tsunami	504	0.2	1,130	0.5	266	0.3	0	0	327	4	7	12	1	351
Storm surge	504	0.2	1,122	0.5	230	0.3	0	0	325	7	8	10	1	351
Coastal Erosion (Waitaki)	37	0	111	0.1	19	0.0	0	0	346	1	3	1	0	351

Table 3: Natural hazards exposure summary for the Otago Region, showing the 'Top 10' urban areas or rural settlements with highest exposure for each hazard type, identified and ordered by the estimated population exposed to the hazard within that urban area/settlement. The population exposed within each urban area/settlement is indicated by the cell shading (see legend). Coastal erosion hazard is not included in the table, as there is insufficient data to provide a region-wide comparison across the full Otago coastline.

Hazard type							
River and lake flooding	*Liquefaction*	*Active Faults*	*Landslide*	*Alluvial fan*	*Rockfall*	*Tsunami*	*Storm surge*
Mosgiel	Dunedin	Dunedin	Dunedin	Queenstown	Queenstown	Pounawea	Dunedin
Dunedin	Mosgiel	Mosgiel	Wanaka	Dunedin	Dunedin	Taieri Mouth	Waikouaiti
Oamaru	Wanaka	Alexandra	Warrington	Wanaka	Arrowtown	Purakaunui	Purakaunui
Queenstown	Queenstown	Wanaka	Queenstown	Roxburgh	Wanaka	Brighton	Pounawea
Balclutha	Milton	Lake Hawea	Mosgiel	Palmerston	Roxburgh	Waikouaiti	Taieri Mouth
Outram	Balclutha	Roxburgh	Moeraki	Waikouaiti	Aramoana	Karitane	Waitati-Doctors Point
Milton	Outram	Kaitangata	Roxburgh	Glenorchy	Purakaunui	Waitati-Doctors Point	Brighton
Luggate	Kingston	Waihola	Brighton	Arrowtown	Lake Roxburgh	Kaka Point	Karitane
Glenorchy	Glenorchy	Allanton	Karitane	Kingston	Oamaru	Kaitangata	Kakanui
Waihola	Brighton	Queenstown	Waitati-Doctors Point	Harington Point	Moeraki	Kakanui	Moeraki

Legend
Population exposed
>5,000
1000-5000
500-1000
100-500
20-100
≤20

DISCUSSION

[45] The natural hazards exposure analysis presented in this report is ORC's first iteration of analysis to quantify and map natural hazards exposure in Otago at a regional scale. The analysis enables comparison of natural hazards exposure between natural hazard types, and between geographic locations.

[46] The natural hazards information used as the basis for analysis has been available for many years, but this new analysis of hazard exposure provides significant added value beyond the existing mapping, to improve understanding of the potential scale of impact of those natural hazard events.

[47] Although the analysis is generally based on relatively broad-scale hazards mapping information, the findings are useful to identify where more detailed hazards or risk assessment may be required, or as a prompt to check if more detailed information is available.

[48] Many of the locations identified as being of relatively higher exposure have been the previous focus of detailed hazard/risk investigations, adaptation work programmes or hazard mitigation works (e.g. engineered flood protection). This exposure analysis therefore confirms the justification for targeting of those work programmes.

[49] For the ORC Natural Hazards team, the exposure information will inform the region-wide natural hazards prioritisation process which is planned to commence in 2025/2026.

[50] The exposure analysis is expected to also be of interest to other organisations in the region, for example Emergency Management Otago and territorial authorities, both of whom have already been briefed on the work programme purpose and approach in February-March 2025. The full natural hazards exposure dataset will be publicly available, so can be interrogated by others based on interest and perspective.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[51] The information in the natural hazards exposure analysis report aligns with Council's Strategic Directions, where the 'Resilience' focus area has the aspiration that "*Otago builds resilience in a way that contributes to community and environmental wellbeing through planned and well-managed responses to shocks and stresses, including natural hazards*".

[52] The proposed Otago Regional Policy Statement June 2021, notified in late March 2024, states that ORC specifically is responsible for "identifying areas in the region subject to hazards and describing their characteristics" and including hazard maps on a natural hazard register or database.[22]

Financial Considerations

[53] The forward work programme is included in the 2024-34 Long-Term Plan budget, with a total proposed budget for the 2024/25, 2025/26 and 2026/27 financial years of $150,000.

[22] HAZ-NH-M1 (2b)

[54] The work programme includes completion of the regional natural hazards prioritisation, revision/updating of natural hazards exposure analysis (if required), and targeted investigations for higher priority locations (see Figures 1, 3).

Significance and Engagement

[55] Initial engagement has been undertaken with territorial authorities and Emergency Management Otago to ensure they are aware of this natural hazards exposure analysis and the wider work programme.

[56] We will also discuss this work programme and exposure analysis with others such as the Insurance Council of New Zealand (ICNZ) and the Natural Hazards Commission.

[57] Engagement with territorial authorities, communities, and other stakeholders will form a key component of the prioritisation process, to be completed over the financial next year.

Legislative and Risk Considerations

[58] The work described in this paper helps ORC fulfil its responsibilities under sections 30 and 35 of the RMA.

[59] As part of the Government's Resource Management Act reform programme, a national direction on managing natural hazard risk is being developed. Targeted changes to this national direction will be consulted on from mid-2025.

Climate Change Considerations

[60] Climate change and sea level rise effects are considered in the coastal hazards data (tsunami, storm surge and coastal erosion) used in natural hazard exposure analysis.

[61] For some other hazards which may be exacerbated by climate change (e.g. flooding), the regional-scale hazard mapping used in exposure analysis reflects only the present-day hazards extent, however this present-day regional exposure is useful to highlight areas of possible future impacts. Climate change effects are considered in local-scale targeted natural hazard and risk assessments, such as those for river flooding or coastal hazards.

Communications Considerations

[62] A digital data viewer has been developed which presents the spatial data outputs from the natural hazards exposure analysis. This viewer can be accessed at orc.govt.nz/naturalhazardexposure.

[63] This data viewer will be linked or embedded in a web page on the ORC website, which also includes plain language summary information explaining the project purpose and approach, and a link to the supporting technical report.

[64] A media release providing an outline of the project has been prepared, to be distributed at the time this meeting agenda is made public. This may be supplemented by other communications methods such as social media posts or news updates on the ORC website.

NEXT STEPS

[65] The completion and publication of this exposure report is not the end-point for ORC's regional natural hazards analysis, rather a useful information source which will then feed into further analysis such as natural hazards prioritisation.

[66] Following completion of this regional natural hazards exposure analysis, there are two main next steps in ORC's region-wide natural hazards risk programme:

a. Natural hazards prioritisation for the Otago region.
b. Review and possible revision of this region-wide natural hazards exposure analysis.

[67] Natural hazards prioritisation will be completed using the approach presented to the committee in November 2024, and is intended to enable a systematic identification and definition of key projects and allocation of work within the Natural Hazards work programme. Figure 3 is a schematic timeline of the work programme, showing the natural hazards prioritisation scheduled for completion in mid-2026 (by end of Year 3 of the LTP, 2025/26).

[68] Review and revision of this region-wide natural hazards exposure analysis will be completed as required. The exposure analysis approach and RiskScape workflow are now well-established, and it is now possible to re-run the analysis to include additional elements at risk data, or new/revised natural hazards information as it becomes available.

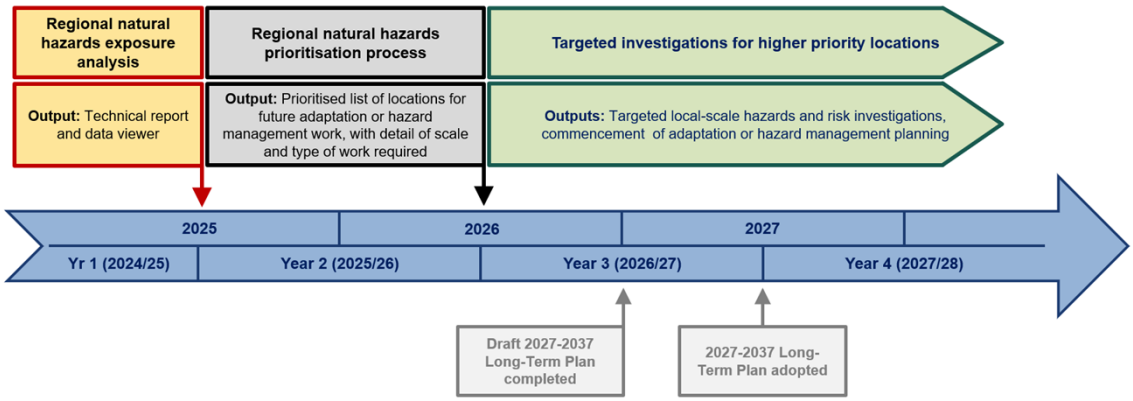


Figure 3: Schematic timeline of the work programme work, showing the completion of the regional natural hazards analysis, and the proposed work to follow. The timing for development of the 2027-2037 Long-Term Plan is also shown, to illustrate that the outcomes of the prioritisation process can be used to inform plan preparation.

ATTACHMENTS

1. Otago regional or district-scale natural hazards mapping datasets [**9.10.1** - 5 pages]
2. Otago Region Natural Hazards Exposure Analysis [**9.10.2** - 107 pages]

Appendix 1: Otago regional or district-scale natural hazards mapping datasets.

Hazard Type	Hazard Mapping Dataset	Data coverage	Description	Reference for mapping dataset	Considers climate change or sea level rise
Flooding	River and lake flooding	Otago region	A dataset representing flood-prone areas. Most mapping is based on observations of historical flooding, and interpretation from aerial imagery and topographic datasets (e.g. LINZ Topo50 mapping or LiDAR). This mapping dataset does not include pluvial flooding (surface flooding from rainfall runoff where stormwater systems are overwhelmed). Note that mapping of 'floodwater- dominated' alluvial fan surfaces is included within the alluvial fan dataset (Grindley et al, 2009)	ORC (1999a, b, c; 2002; 2025).	No
Seismic	Active faults	Otago region	Mapped active faults, generally based on regional geologic mapping and air photo interpretation. 'Active' faults are those which have undergone at least one ground-deforming rupture within the last 125,000 years, or at least two ground-deforming ruptures within the last 500,000 years (Barrell, 2021).	Barrell (2016, 2019b, 2021)	n/a
	Liquefaction susceptibility	Otago region	Mapping of areas which are potentially subject to liquefaction hazards, based on regional-scale geologic mapping (QMAP), and interpretation from aerial imagery, LiDAR topography, and borehole information. Equivalent to a basic desktop assessment as defined in the MBIE/MfE (2017) guidance.	Barrell *et al* (2014), Barrell (2019a)	n/a

Hazard Type	Hazard Mapping Dataset	Data coverage	Description	Reference for mapping dataset	Considers climate change or sea level rise
	Ground shaking	Otago region	Spatial distribution of earthquake ground shaking hazard (in Modified Mercalli Intensity, MMI) expected to be exceeded, on average, once within a specified timeframe (100, 2500 years), and as isoseismals (contours of equal shaking intensity) for selected active faults (Akatore, Alpine, Dunstan North, Dunstan South)	Murashev and Davey (2004)	n/a
Slope Stability	Landslide	Otago region	Mapping of interpreted locations of past landslide movements, generally based on interpretation from aerial imagery. This dataset does not represent landslide susceptibility (i.e. slopes which may fail in future), or areas which may be impacted by the runout of landslide debris.	Compiled from various sources, including; Barrell *et al* (2017), Forsyth (2001), Turnbull (2000), Turnbull and Allibone (2003)	No
	Rockfall	Otago region (excludes catchments devoid of buildings or roads, or with only very sparsely distributed buildings).	Rockfall 'awareness areas' which may be susceptible to rockfall. Developed based on RAMMS modelling from source areas defined by slope-angle analysis.	Easterbrook-Clarke *et al* (2022)	No
	Alluvial fan	Otago region	Mapped alluvial fan surfaces which have been classed by activity (i.e. active, inactive) and dominant depositional process (floodwater-dominated, debris-dominated, or composite).	Grindley *et al* (2009)	No

Hazard Type	Hazard Mapping Dataset	Data coverage	Description	Reference for mapping dataset	Considers climate change or sea level rise
Coastal	Coastal inundation (storm surge) and sea level impacts	Otago region	Modelled extents of potential inundation due to extreme sea level events (storm surge) with return periods of up to 500-year ARI.	Lane *et al* (2008)	Yes. Sea level rise scenarios of 0.3 and 0.5 m considered. These scenarios could be reached in approximately 2065 and 2095 under SSP2-4.5 (MfE, 2022).
	Coastal inundation (storm surge) and sea level impacts	Waitaki District (for the populated coastal areas of Moeraki, Hampden, Kakanui and Oamaru)	Modelled extents of potential inundation due to extreme sea level events (storm surge) with return periods of up to 500-year ARI.	Bosserelle *et al* (2019)	Yes, up to an upper bound of 1.3 m sea level rise by 2115.
	Coastal erosion	Waitaki District	Modelled future shoreline position for a range of outlook timeframes (50, 100 years) and risk levels (5%, 50% probability of erosion extending up to or landward of this line over the relevant outlook period).	Bosserelle *et al* (2019)	Yes, up to an upper bound of 1.3 m sea level rise by 2115.
	Tsunami	Otago region	Numerical modelling findings showing the maximum area affected by a modelled tsunami from near and far-field sources, for events up to a 500-year ARI.	Lane *et al* (2007)	Yes. Sea level rise scenarios of 0.3 and 0.5 m considered. These scenarios could be reached in approximately 2065 and 2095 under SSP2-4.5 (MfE, 2022).

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