

The New Zealand Alpine Fault:

Are we prepared?

A major rupture of the Alpine Fault is likely, with current estimates at 75% within the next 50 years.

Any major rupture is expected to cause widespread structural damage to the region and cut off critical infrastructure, isolating parts of the South Island for several weeks to months.

Ongoing research, detailed hazard mapping and locally developed loss models are helping NZ become more resilient and better prepared for future events. A strong local collaboration between research, risk management and insurance sectors exist to help the country be more resilient and better prepared for any major rupture, leaning from recent experience (2010-11 Canterbury Earthquake Sequence and the 2016 Kaikōura Earthquake).



Executive Summary

The Alpine Fault is one of the most extensively studied and potentially destructive geological features in the Pacific Ring of Fire.

Running approximately 850 kilometres along NZ's South Island, this major geological fault forms the boundary between the Pacific and Australian tectonic plates.

Current estimates place the probability of a magnitude 8.0-8.2 rupture at approximately 75% within the next 50 years, with horizontal ground displacements of up to 8-9 metres and vertically 1-2 metres expected along the surface rupture^{1,2,3}. Such an event would deliver physical impacts to most of the South Island and the lower North Island.

The shaking alone, expected to last up to 2 minutes for those near the fault, could exceed the design levels of many existing buildings and infrastructure, resulting in widespread structural damage.

1. Berryman, K., Cooper, A., Norris, R., Villamor, P., Sutherland, R., Wright, T., & Biasi, G. (2012). Late Holocene rupture history of the Alpine fault in south Westland, New Zealand. *Bulletin of the Seismological Society of America*, 102(2), 620-638.

2. Howarth, J. D., Barth, N. C., Fitzsimons, S. J., Norris, R. J., & Langridge, R. M. (2021). Spatiotemporal distribution of paleoearthquakes on the Alpine Fault, New Zealand: Insights into rupture propagation and earthquake gates. *Geology*, 49(5), 522-527.

3. GNS Sciecne (n.d.) [Alpine Fault](#)

Seismic Hazards

A major rupture on the Alpine Fault is unlikely to be a single event, but rather a multi-hazard cascade of events that may produce physical and systemic shocks over several weeks or months. Understanding these interlinked hazards is essential to better understand their potential impact.

Ground Shaking

Severe (MMI 8-9+) shaking, lasting several minutes for those near the fault rupture (within 50 kilometres) is expected, resulting in widespread structural damage to vulnerable buildings.^{4,5} West Coast towns (Hokitika, Greymouth, Franz Josef) face particularly severe exposure due to their proximity to the fault and their underlying soil, expected to amplify shaking intensity. The Canterbury Plains is expected to experience strong (MMI 6-7) shaking despite being 100-150 kilometres away from the fault, with potential structural damage to weak buildings.

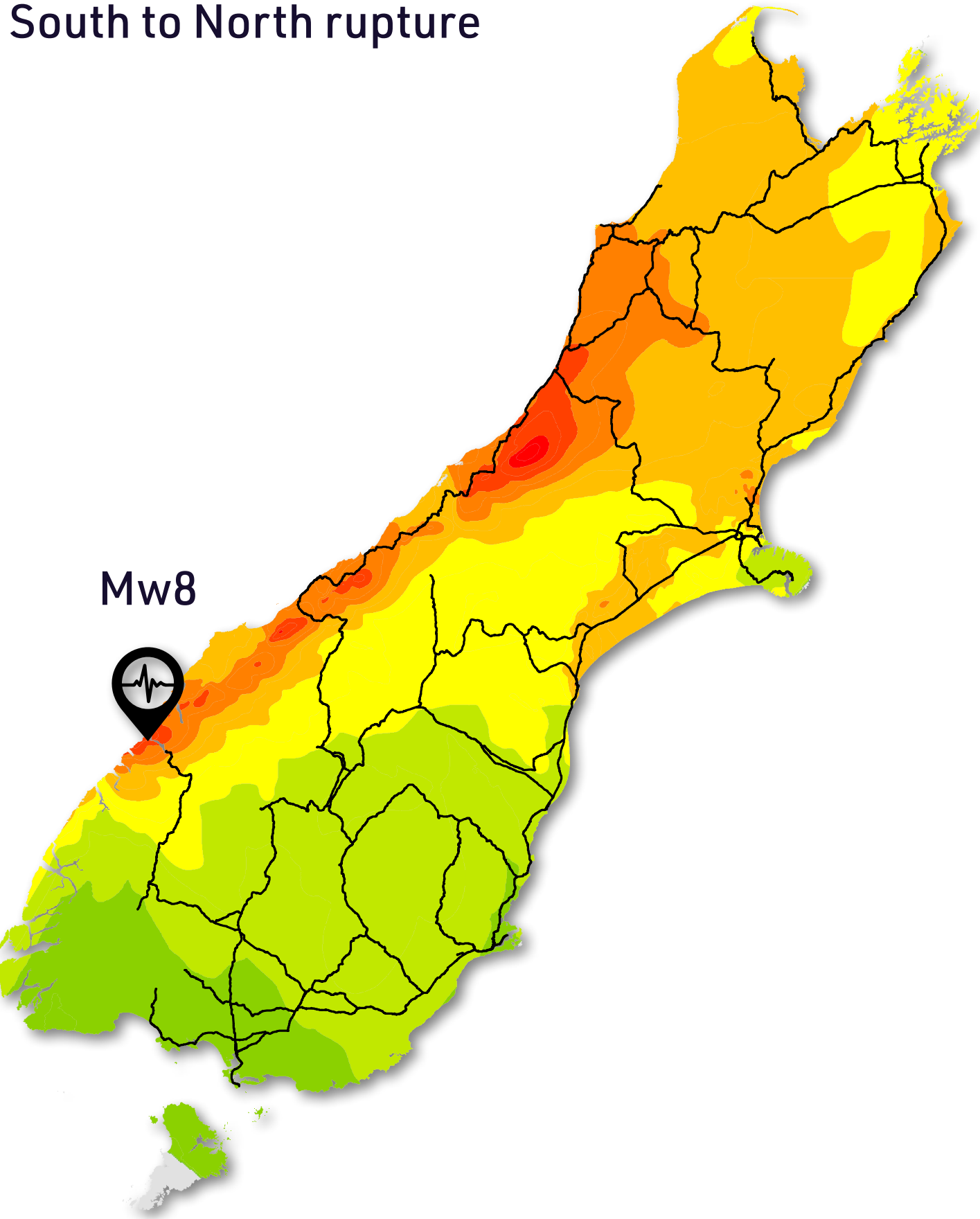
4. Bradley, B. A., Bae, S. E., Polak, V., Lee, R. L., Thomson, E. M., & Tarbali, K. (2017). Ground motion simulations of great earthquakes on the Alpine Fault: effect of hypocentre location and comparison with empirical modelling. *New Zealand Journal of Geology and Geophysics*, 60(3), 188-198.
5. Holden, C. (2014). Ground motion modelling of an Alpine fault earthquake and a Hope fault earthquake for main South Island cities (NZ). GNS Science Consultancy Report, 257, 24.



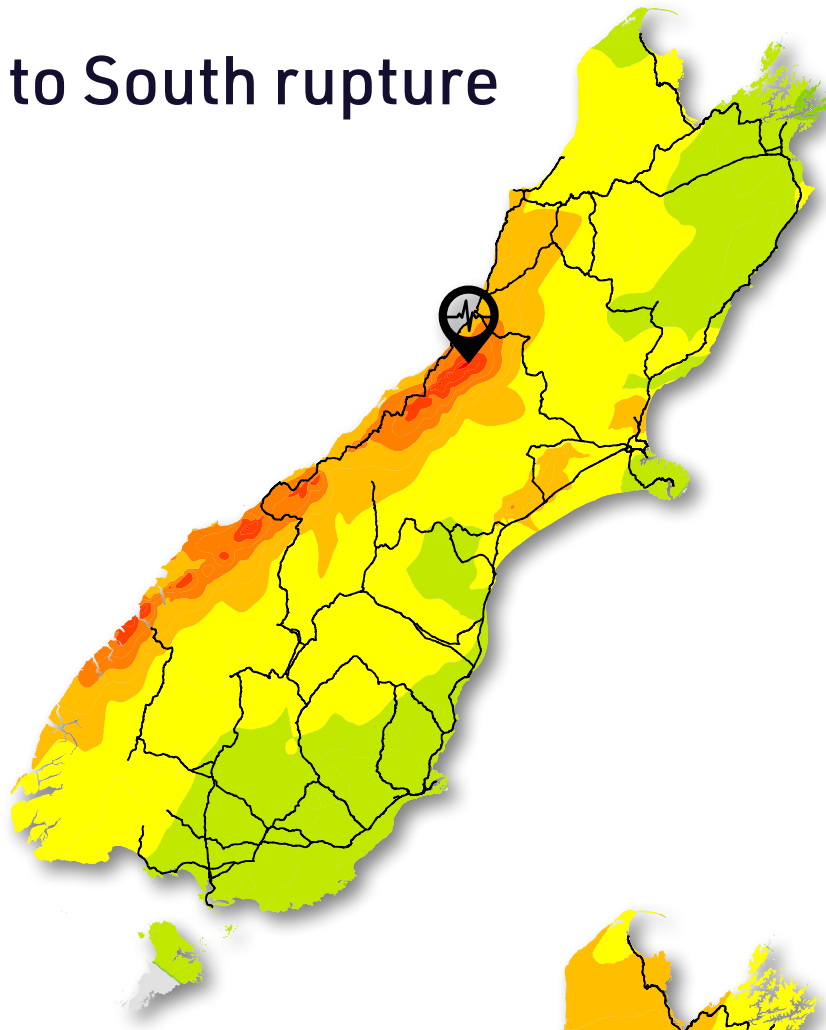
Seismic Hazards

AF8 hazard scenario ground-shaking intensity models

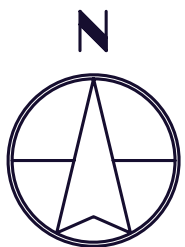
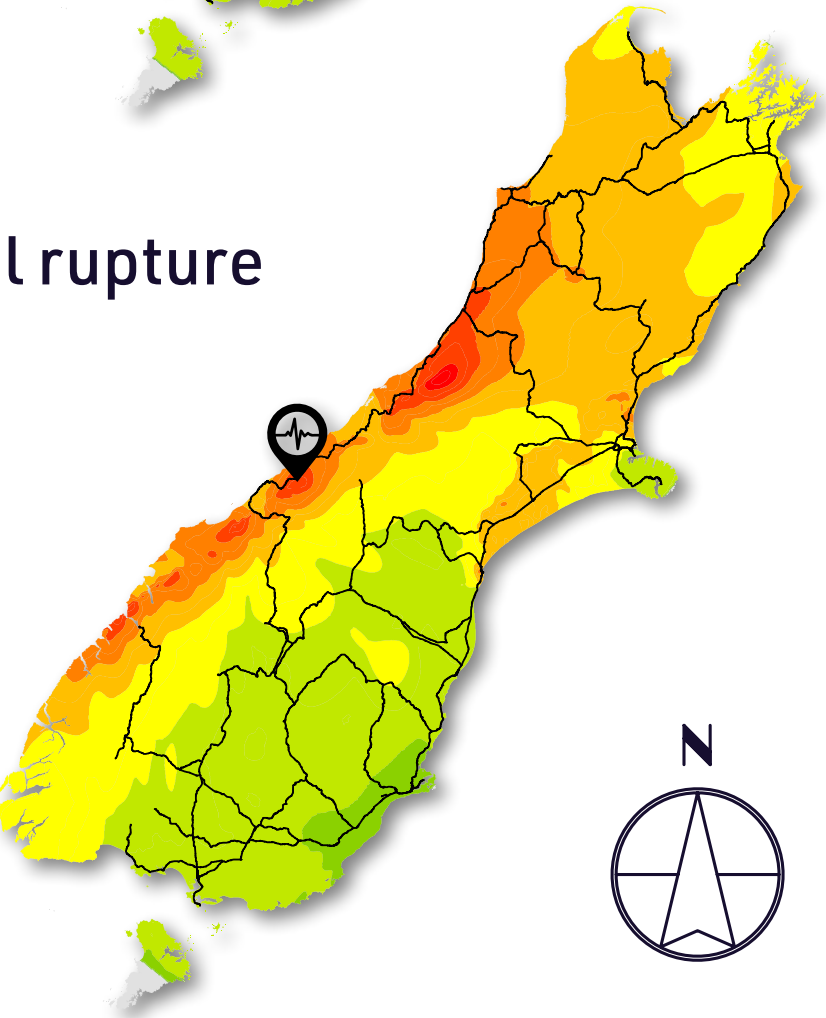
South to North rupture



North to South rupture



Central rupture



Modified Mercalli Intensity Scale

- | | |
|----|-------------------|
| 4 | Largely Observed |
| 5 | Strong |
| 6 | Slightly Damaging |
| 7 | Damaging |
| 8 | Heavily Damaging |
| 9 | Destructive |
| 10 | Very Destructive |

Source: GNS Science

Examples from the Alpine Fault 8 (AF8) initiative of a Mw 8 rupture along the Alpine Fault.⁶

6. Holden, C. (2014). Ground motion modelling of an Alpine fault earthquake and a Hope fault earthquake for main South Island cities (NZ). GNS Science Consultancy Report, 257, 24.

Seismic Hazards

Surface Rupture / Displacement

Up to 8m of horizontal and 2m vertical movement near the fault.^{7,8} This displacement is expected to cut off critical infrastructure such as transport, energy, water and telecommunications.

Aftershocks

The potential for tens or even hundreds of aftershocks (M6-7) for months to years following a major rupture would all have the potential to cause further structural damage and delay long term recovery efforts.^{9,10}

Landslides

Impact studies suggest up to 70,000 individual slope failures could occur along the Southern Alps following a major rupture.¹¹ Slope failures would likely isolate many West Coast communities through the closure of State Highways (6, 73, and 94), with limited alternative access routes. Major debris avalanches may dam rivers and potentially create outburst flooding or fjord tsunamis in areas such as Milford Sound or Lake Wakatipu, threatening waterfront property and infrastructure.^{12,13}

Liquefaction

Strong ground motion could induce liquefaction in alluvial and coastal soils up to 200 km from the fault, including at Greymouth, Westport, and Christchurch.^{14,15}

7. Nichol, S., Goff, J., Devoy, R., Chague-Goff, C., Hayward, B. and James, I. (2007) Lagoon subsidence and tsunami on the West Coast of New Zealand, *Sediment. Geol.*, 200, 248– 262, doi:10.1016/j.sedgeo.2007.01.019

8. Howarth, J. D., Barth, N. C., Fitzsimons, S. J., Norris, R. J., & Langridge, R. M. (2021). Spatiotemporal distribution of paleoearthquakes on the Alpine Fault, New Zealand: Insights into rupture propagation and earthquake gates. *Geology*, 49(5), 522-527.

9. Robinson, T. R., & Davies, T. R. H. (2013). Potential geomorphic consequences of a future great (M w= 8.0+) Alpine Fault earthquake, South Island, New Zealand. *Natural hazards and earth system sciences*, 13(9), 2279-2299.

10. Orchiston, C., Davies, T., Langridge, R., Wilson, T., Mitchell, J., & Hughes, M. (2016). Alpine Fault magnitude 8 hazard scenario. Report Commissioned by Project AF8, Environmental Southland, Invercargill, 45.

11. Robinson, T. R., Wilson, T. M., Buxton, R., Cousins, W. J., & Christophersen, A. M. (2015). An Alpine Fault earthquake scenario to aid in the development of the Economics of Resilient Infrastructure’s MERIT model. ERI Research Report 2016/04.

12. Dykstra, J. (2012). The role of mass wasting and ice retreat in the post-LGM evolution of Milford Sound, Fiordland, New Zealand, Ph.D. thesis, University of Canterbury, New Zealand.

13. Nobes, D. C., Jol, H. M., & Duffy, B. (2016) Geophysical imaging of disrupted coastal dune stratigraphy and possible mechanisms, Haast, South Westland, New Zealand. *New Zealand Journal of Geology and Geophysics*, 59(3), 426-43

14. Cubrinovski, M., Bradley, B., Wotherspoon, L., Green, R., Bray, J., Wood, C., ... & Wells, D. (2011). Geotechnical aspects of the 22 February 2011 Christchurch earthquake. *Bulletin of the New Zealand Society for Earthquake Engineering*, 44(4), 205-226.

15. Van Ballegooy, S., Malan, P., Lacrosse, V., Jacka, M. E., Cubrinovski, M., Bray, J. D., ... & Cowan, H. (2014). Assessment of liquefaction-induced land damage for residential Christchurch. *Earthquake Spectra*, 30(1), 31-55.



Seismic Risk

The consequences of a major Alpine Fault rupture would be felt through much of the South Island and into the lower North Island. Severe local physical damage would be expected to compound broader disruption in infrastructure and economic activity. While the physical rupture may only impact a defined region, the entire country would feel impact due to the interdependence of transport, utilities, communications, and services.



The Immediate Aftermath: Physical Damage

The built environment and critical systems are exposed to direct failure from shaking, landslides, and fault rupture, and are vulnerable to cascading effects when interdependent lifelines collapse:

Buildings

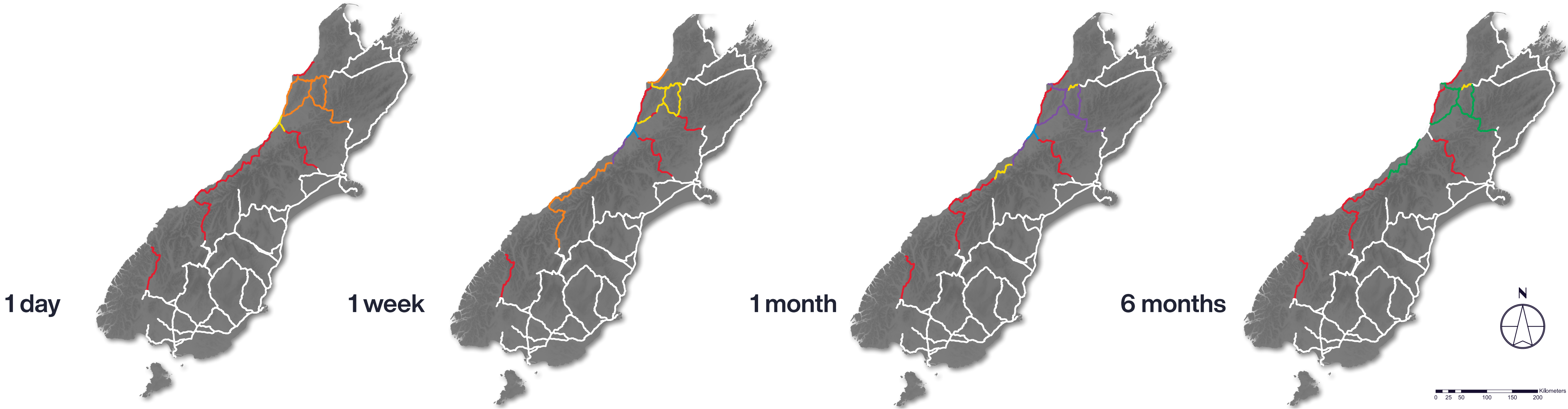
Severe shaking intensities near the fault would cause widespread structural damage to residential, commercial, and public buildings, particularly older building stock. Even structures built to code may require demolition due to exceeding economic repair thresholds.^{16,17}

16. Bradley, B. A., Bae, S. E., Polak, V., Lee, R. L., Thomson, E. M., & Tarbali, K. (2017). Ground motion simulations of great earthquakes on the Alpine Fault: effect of hypocentre location and comparison with empirical modelling. *New Zealand Journal of Geology and Geophysics*, 60(3), 188-198.

17. ICNZ (2022). *Canterbury Earthquakes: Insurance Council of New Zealand industry data*.

Physical Damage: Roads

AF8 South Island State Highway levels of service



Roads

State Highways 6, 7, and 73 are expected to be blocked by a major rupture, with extensive landsliding occurring for weeks to months after the rupture.¹⁸ The NZ Lifelines Council (2020) identifies these specific State highway routes as the most vulnerable and highly exposed, with limited alternatives available for restoring inland freight and emergency access.

Modelled levels of service for State Highways following an Mw8 rupture, provided by the Alpine Fault 8 (AF8) initiative.

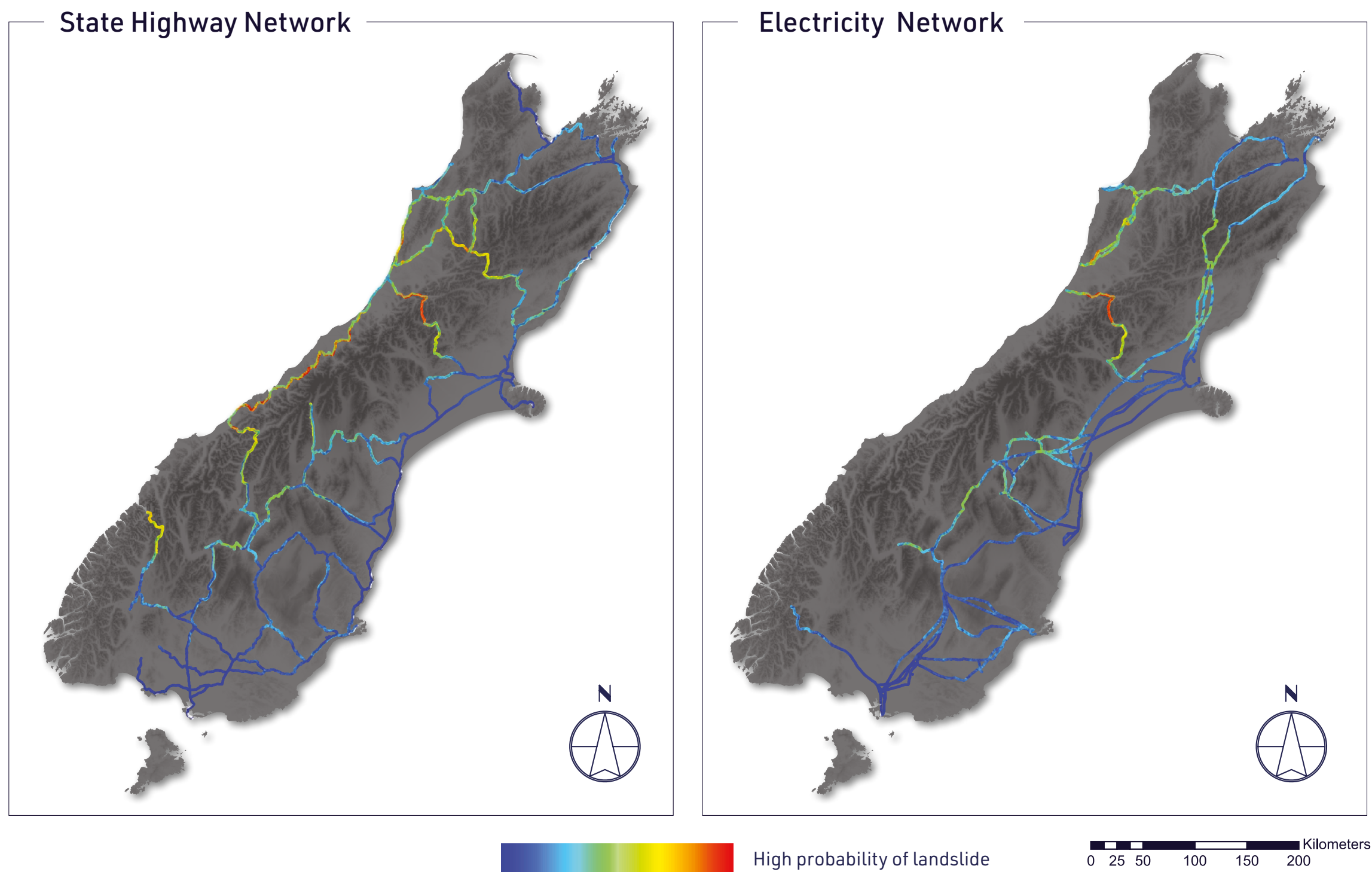
- Full access
- Access, 1-2 days per week
- Access, daytime
- Access, emergency only
- No access, working to open
- No access, reconnaissance
- No access

18. Davies, A., Zorn, C., Wotherspoon, L., Beaven, S., Davies, T., Matthew, H., & Wilson, T. (2021). Infrastructure failure propagations and recovery strategies from an Alpine Fault earthquake scenario: Establishing feedback loops between integrated modelling and participatory processes for disaster impact reduction.

19. [New Zealand Lifelines Council \(2020\). National Vulnerability Assessment.](#)

Physical Damage: Networks

South Island Infrastructure network exposure to Alpine Fault co-seismic landslide scenario



Modelled exposure of infrastructure to co-seismic landslides following an Mw8 rupture, provided by the Alpine Fault 8 (AF8) initiative.²²

Energy

High-voltage transmission lines crossing the Southern Alps are at high risk of tower collapse due to shaking, slope failure, and snow-line exposure. Hydroelectric stations, which supply the bulk of the South Island's electricity, may require a temporary shutdown due to access loss or structural damage.^{19,20}

Water

Thousands of breaks in buried infrastructure are anticipated, particularly in liquefaction-prone areas or near the fault. Some networks may require full replacement, as observed post-Canterbury events.²¹

Telecommunication

Major fibre routes across the Southern Alps are expected to fail at multiple locations due to ground deformation and power outages. Cell towers reliant on mains power and microwave links are likely to go offline for days to weeks without backup generation.¹⁹

19. [New Zealand Lifelines Council \(2020\). National Vulnerability Assessment.](#)

20. [MBIE. \(2020\). Energy in New Zealand 2020. Wellington: Ministry of Business, Innovation & Employment.](#)

21. Van Ballegooy, S., Malan, P., Lacrosse, V., Jacka, M. E., Cubrinovski, M., Bray, J. D., ... & Cowan, H. (2014). Assessment of liquefaction-induced land damage for residential Christchurch. *Earthquake Spectra*, 30(1), 31-55.

22. Robinson, T. R., Wilson, T. M., Buxton, R., Cousins, W. J., & Christophersen, A. M. (2015). An Alpine Fault earthquake scenario to aid in the development of the Economics of Resilient Infrastructure's MERIT model. ERI Research Report 2016/04."

Consequences to Key Sectors

Sector	Impacts
Tourism	Isolated destinations (e.g. Fiordland, West Coast, Queenstown); extended recovery times; visitor downturn. ²³
Primary Production (agriculture, horticulture, viticulture)	Production loss from access delays, irrigation failure, sediment damage, cold chain risk, seasonal workforce disruption. ²⁴
Forestry	Export disruption due to road/rail closure, mill down time, port access constrained by sedimentation. ²⁵
Retail / SME	Business interruption from access loss, power outages, depopulation, recovery tied to infrastructure repair. ²⁵
Freight / Logistics	Inter-island and inland freight delays, severed corridors, fuel and aviation supply disruption. ²⁶

23. [AF8. \(2022\). AF8 Hazard Scenario.](#)

24. [New Zealand Lifelines Council \(2020\). National Vulnerability Assessment.](#)

25. [ICNZ \(2022\). Canterbury Earthquakes: Insurance Council of New Zealand industry data.](#)

26. McDonald, G. W., Smith, N. J., Kim, J. H., Brown, C., Buxton, R., & Seville, E. (2018). Economic systems modelling of infrastructure interdependencies for an Alpine Fault earthquake in New Zealand. Civil Engineering and Environmental Systems, 35(1-4), 57-80.



Risk Management and Preparedness

National resilience is shaped not only by its seismic history, but also by deliberate policy, planning, and financial risk-sharing measures. The Alpine Fault represents a well-known hazard with high consequences and because of this, is an actively managed risk.

Scientific Research and Engagement

NZ leads the world in scientific research into earthquake hazard and risk, with major initiatives ongoing including:

- **AF8 (Alpine Fault Magnitude 8):** A South Island-wide scenario programme bringing together science, emergency management, and community outreach. The initiative developed the SAFER Framework to coordinate response across multiple regions and is supported by the Natural Hazards Commission, universities, and local governments.
- **NSHM22:** The 2022 update to the National Seismic Hazard Model provides an enhanced probabilistic view of shaking hazards across NZ, integrating new fault data, including the Alpine Fault, updated global and regional earthquake science and configured to leverage the latest computational resources.²⁷
- **QuakeCoRE:** A Centre of Research Excellence focused on seismic resilience in the built environment, linking engineering, planning, and social science.

- **Resilience to Nature's Challenges (RNC):** A government-funded programme supporting multi-hazard resilience science, including long-term recovery planning.

The AF8 initiative in particular is a great example of putting science into practice, reaching thousands of South Island residents through community roadshows, public resources, and multi-agency coordination exercises to better prepare for a major Alpine Fault rupture.



AF8 is reducing risk and improving disaster planning, response and resilience in NZ through a co-created scenario-based approach to Alpine Fault earthquake risk.

It's award-winning outreach and engagement activities position AF8 among the world leaders in disaster risk reduction and response, by building awareness in communities, and response capability within Civil Defence Emergency Management and partner agencies.



27. Gerstenberger, M. C., Bora, S., Bradley, B. A., DiCaprio, C., Kaiser, A., Manea, E. F., ... & Wotherspoon, L. M. (2024). The 2022 Aotearoa New Zealand national seismic hazard model: Process, overview, and results. *Bulletin of the Seismological Society of America*, 114(1), 7-36.

Regulation and Planning

NZ employs a layered regulatory framework to reduce seismic risk:

Land-use planning: Local councils apply fault avoidance zones using guidance from the Ministry for the Environment to discourage development near active fault traces.

Building codes: NZS1170.5²⁸ sets seismic design standards that prioritize life safety. Updates following the Canterbury sequence and Kaikōura have improved performance expectations and introduced performance-based design for critical infrastructure.

Emergency management: The Civil Defence and Emergency Management Act (2002) underpins the national framework, supported by the National

Emergency Management Agency (NEMA). The SAFER Framework, designed specifically for the Alpine Fault, enables early coordination across all South Island Civil Defence groups.

Lessons from past events have driven improvements in engineering standards, better geotechnical mapping, and mandates for inter-agency rehearsals. Additionally, given the engagement between the research and practitioners, there is a responsive turnaround to apply the latest research on seismic hazard into improvements in regulation to improve resilience.²⁸

28. Hulsey, A., Elwood, K., Horspool, N., Gerstenberger, M., & Sullivan, T. (2025). Assessing the life-safety risk for the proposed Technical Specification (TS) 1170.5. Bulletin of the New Zealand Society for Earthquake Engineering, 58(2), 118-132.



Insurance and Risk Transfer

NZ benefits from one of the highest rates of residential earthquake insurance globally and has a unique public-private insurance framework for natural hazards.

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The Natural Hazards Commission Toka Tū Ake (NHC), funded by levies on home insurance policies, reinsurance, and a Crown guarantee, provides a first layer of cover for residential property damage from specified natural hazards, including earthquakes.²⁹

The cover (NHCover) includes buildings (up to a financial cap, recently increased to \$300,000 plus GST per dwelling) as well as some defined areas of residential land, is a globally unique offering.

Private insurers provide top-up residential cover above the NHC cap (top-up cover), and comprehensive cover for commercial properties and business interruption. Insurance penetration post-CES was ~80% of households³⁰ and remains similarly high under the current model.

29. [Natural Hazards Commission \(2024a\). About natural hazards cover.](#)

30. [ICNZ \(2022\). Canterbury Earthquakes: Insurance Council of New Zealand industry data.](#)



Insurance and Risk Transfer

One of the country's greatest advantages in improving resilience is the close partnership between researchers and decision-makers, particularly with NHC, which allows for the latest hazard and risk science to be readily incorporated into risk insight. This science includes funded projects for the national seismic hazard model update, as well as the multi-year programmes to produce high-resolution national liquefaction and landslide hazard models, incorporating detailed geotechnical investigation datasets and improved triggering characterisation, thereby improving the understanding of two of the largest secondary-peril gaps in risk models.^{31, 32}

A product running on the same research pipeline to the NSHM is the high-resolution loss-modelling suite comprising RiskScape³³ and NHC's insurance-tailored derivative, the Portfolio Risk Underwriting Engine (PRUE).³⁴

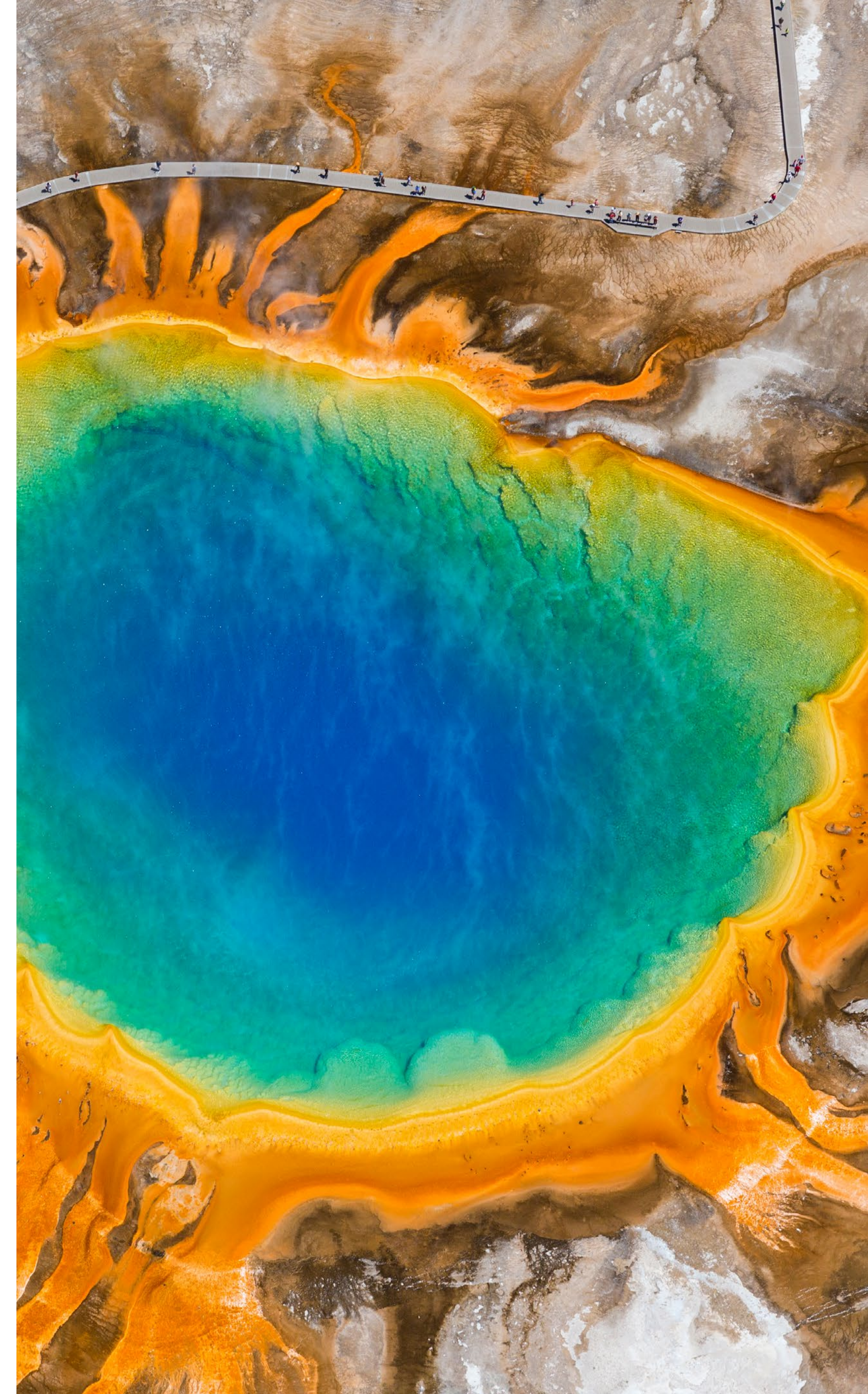
Developed jointly by Earth Sciences New Zealand (formerly GNS Science and NIWA), with funding support from NHC and national government research programs, these platforms ingest the latest hazard layers and NZ-specific vulnerability curves to model the impacts of natural catastrophe events, quantify direct financial losses and stress-test alternative resilience strategies. Their asset-level granularity, down to individual building typologies and soil conditions, provide valuable insights for decision-making at all levels, from life safety and risk management investment through to insurance loss limit levels. All projects and applications illustrate the value of close collaboration between research institutions and the insurance sector, translating cutting-edge science into practical risk-management decisions.

31. [GNS Science \(2023\). Sliding Lands | Hōretireti Whenua.](#)

32. [Natural Hazards Commission \(2024b\). Resilience and Research Highlights Report.](#)

33. Paulik, R., Horspool, N., Woods, R., Griffiths, N., Beale, T., Magill, C., ... & Garlick, R. (2023). RiskScape: a flexible multi-hazard risk modelling engine. *Natural Hazards*, 119(2), 1073-1090.

34. [RiskScape \(2024\). Powering loss modelling tool PRUE.](#)



The Alpine Fault represents one of the region's most potentially destructive natural hazards with a major rupture expected to occur within our lifetime and has severe consequences.

As a result, robust, transparent, and collaborative risk management processes are in place with ongoing efforts nationally to help reduce risk and improve resilience. NZ's proactive investment in resilience across research, engineering, emergency planning, and insurance currently sets the global standard.

The Alpine Fault will one day again deliver a severe rupture, causing widespread impacts. Our job is to ensure that when it does, we are collectively ready in order to ensure its impacts are as limited as possible by what we can proactively control.



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