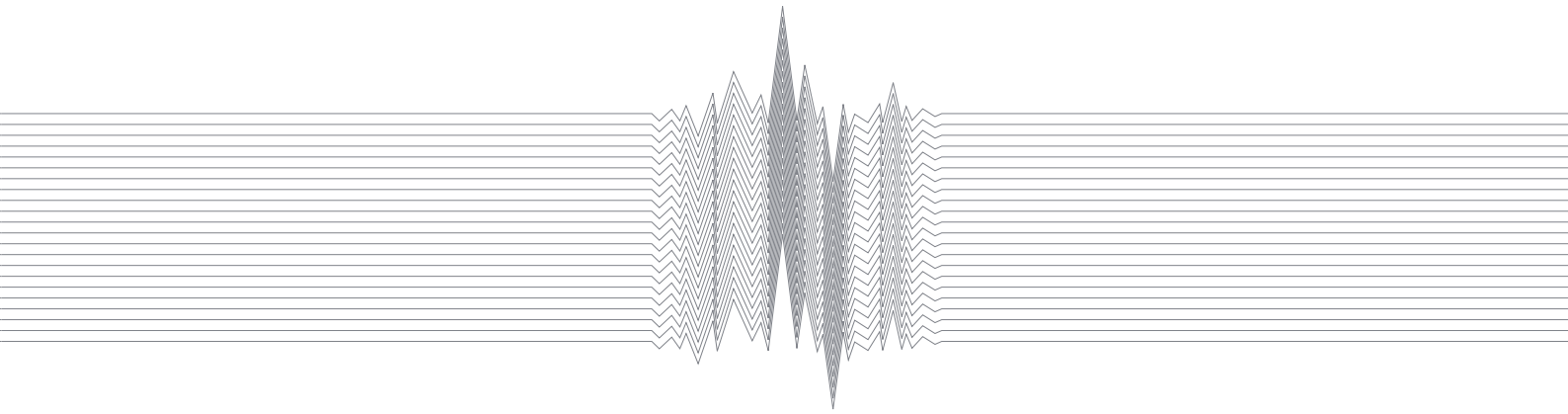
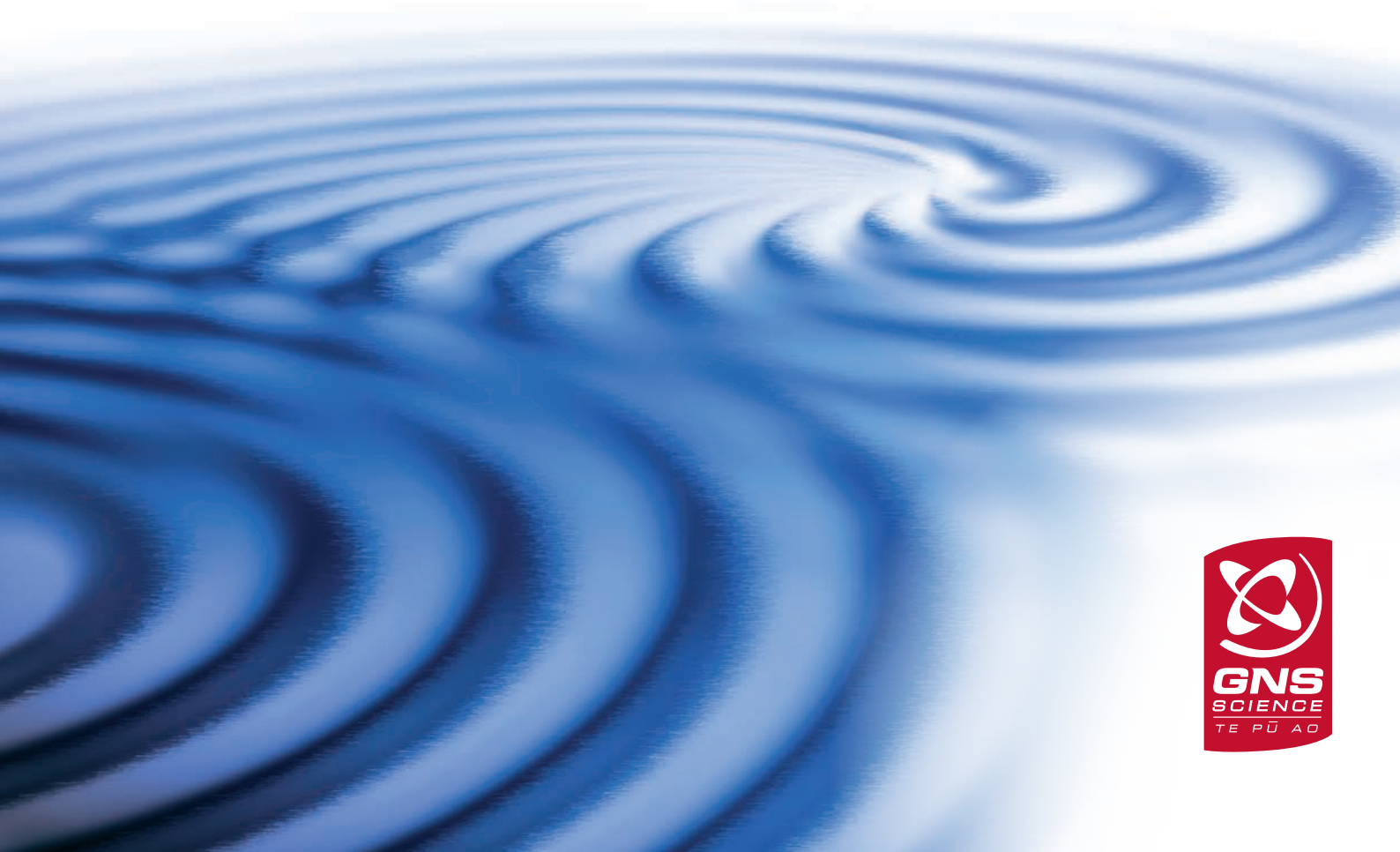


risk ready

hazard and risk modelling



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As populations and cities grow on to hazard prone land, our communities become more at risk

risk aware – ready for action

Complex forces can impact our world dramatically and at any time. We live with the ever-present threat of natural hazards: earthquakes, volcanic eruptions, tsunami and landslides. And as our population, cities and infrastructure grow, we become more at risk.

Modelling is a powerful tool to estimate the risk of future economic loss and social impact from natural hazards. Modelling allows Civil Defence, local authorities, engineers and numerous others to prioritise mitigation measures, plan hazard response, prepare communities, and develop warning and evacuation systems.

At GNS Science we offer you our diverse team of seismologists, geodesists, earthquake geologists, engineering geologists, GIS experts, risk engineers, tsunami scientists and social scientists – working together to provide a comprehensive solution.

We have modelled diverse hazard scenarios in New Zealand, Australia, Japan, Mexico, Turkey, Spain, Peru, Mongolia, Hong Kong, Indonesia, Vietnam, Philippines and the USA.

Whatever your natural hazard modelling requirements – we can help you to be aware of your hazards and risks and be ready for action.

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hazard and risk modelling

GNS Science is at the forefront of developing effective and innovative hazard simulation and risk modelling tools. Using large-scale computing clusters and comprehensive scientific databases we can estimate your risk of economic loss and the social impact of natural hazards.

We focus on four natural hazards: earthquake, volcano, landslide and tsunami, and the communities' vulnerability to each. Each project is designed to fit your specific needs – from providing catalogues of data, producing inputs for models, through to in-depth hazard and risk analyses.

GNS Science offers you proven expertise in:

- Identifying possible events
- Quantifying the impact on infrastructure and people
- Assessing the probability of risk
- Managing multiple hazards

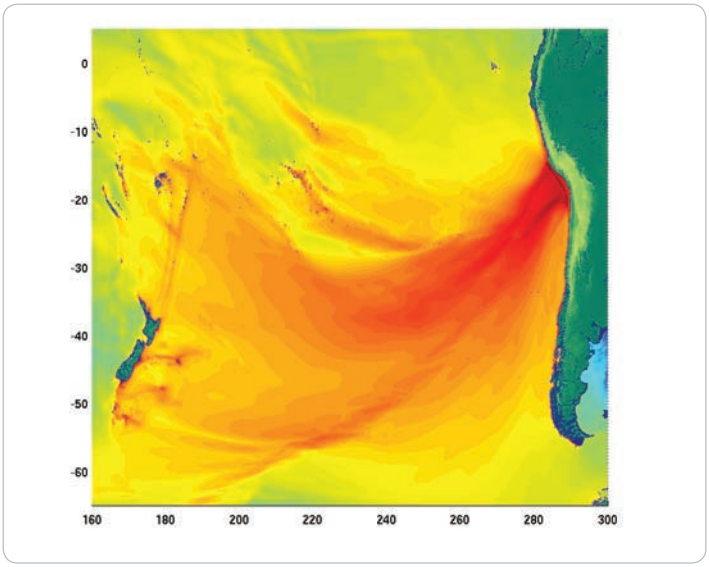
What events are likely?

Historical records of large earthquakes, eruptions, landslides and tsunami over the past 150 years provide a guide as to what may happen in the future. However, this information only provides part of the story. To determine what events are likely it is necessary to consider the much larger events that have occurred further back in our past, over many thousands of years.

It is important to take account of these large events to give a realistic picture of maximum possible future hazards and their frequency. These results can be used for:

- Land-use planning
- Designing and assessing emergency responses, e.g. evacuation routes and simulation practices
- Insurance
- Mitigation options
- Building codes

Earthquakes: Our simulations assist the development of design requirements and engineering solutions to mitigate earthquake hazards. Earthquake sources are accounted for using a database of active faults and background seismicity models. By modelling strong quakes, the severity and characteristics of strong ground motion can be determined and designed for.



Tsunami scenario for magnitude 9.5 earthquake in northern Chile. The red colour represents elevated water levels greater than 1 metre.

Landslides: We forecast the magnitude and frequency of new landslides occurring in a specified area, or the future movement of pre-existing landslides, in response to scenario events of varying intensity (e.g. rainstorms and earthquakes). If assets or lives are vulnerable to a landslide, the landslide risk can be calculated for the current situation and for different mitigation solutions to help communities identify their best option by considering both risk-reduction and cost-effectiveness.

Tsunami: Our hydrodynamic models estimate the propagation of tsunami waves away from their source, and the impact of those waves when they reach the coast. Our expertise in characterising tsunami sources allows us to go beyond modelling individual scenarios to producing quantitative estimates of the probability of tsunami impact that can be used to inform land-use and evacuation planning.

Volcanoes: We can analyse past historic and geologic data of a volcano and assess the likelihood of size, frequency and location of future eruptions. Coupled with GeoNet monitoring data, we can provide a dynamic assessment of risk, based on the current level of unrest of a volcano.

Loss modelling

Having established the basis for modelling large, rare events, we apply engineering expertise to quantify the impact on infrastructure and people.

Loss modelling provides realistic estimates of likely damage and loss of assets, infrastructure and casualties, should an event occur. We rely on historical data from actual losses and we consider building types and their likely response to imposed forces from natural hazards. This information is essential for risk managers, hazard planners and for insurance, in order to assess the impact of natural hazards.

Examples

Earthquake: Earthquakes can cause major damage and loss of life, not only near the epicentre but also much further afield. We have realistic procedures for estimating how much damage and disruption would be caused, and how this compares with the effects of earthquakes elsewhere, as well as other types of natural hazard events.

Post-earthquake fire: Fires after earthquakes in urban areas can sometimes account for more damage than ground shaking. We can model how far uncontrolled fires are likely to spread and which fires are likely to cause the most damage. Varying the parameters of the model and simulating the effects allows authorities to plan accurate fire-fighting strategies, and inform insurance and business continuity purposes.

With water mains broken, post-earthquake fires can spread uncontrollably.

Aftermath of 2004 Indian Ocean Tsunami in Banda Aceh, Indonesia.

Probabilistic modelling

The estimated loss caused by a particular event is only one aspect of the risk; we combine this with the likelihood that the event will occur by undertaking probabilistic modelling. The result is a complete assessment of the risk: the probability that any given loss level will be experienced. This is essential to manage natural hazard risk for community decision makers and insurers.

Examples

Earthquake: We assessed the risk of earthquake damage to property in the Wellington Region for the Presbyterian Church of Aotearoa New Zealand.

"As a result of the information provided, the Group were able to reduce the maximum earthquake cover required for property in the Wellington Region, with a consequential saving in premium cost."

Doug Langford, Secretary – Insurance Group, Presbyterian Church of Aotearoa New Zealand.

Tsunami: We have developed methodologies for statistical modelling of tsunami risk, which combine source, propagation and inundation effects to produce probabilistic estimates of likely wave heights, damage, financial loss, injuries and deaths.

Volcano: A full risk assessment for damage from volcanic ash is achieved by combining the source modelling of each volcano, ashfall dispersion estimates and the engineering assessments of the fragility of buildings and infrastructure under ash loading and lahar inundation.

case study

Multihazard risk assessment

A multihazard risk assessment provides the full picture of likely damage – economic loss, injuries and deaths – in such a way that you can compare your vulnerability to the various hazards that can occur. We draw on event scenarios and probabilistic risk assessments that take into account the built environment and population demographics.

Multihazard risk models enable you to make decisions that will save lives and minimise disruption by:

- Informing district and city planning to reduce or avoid habitation in high-risk areas
- Guiding prioritisation of specific mitigation measures that reduce vulnerability e.g. earthquake strengthening of buildings, upgrading stop-banks
- Improving response capability based on informed evacuation plans and realistic scenarios for emergency management training exercises

Example

Regional Riskscape Model: New Zealand's continued economic growth has resulted in communities expanding on to hazard prone land such as river floodplains, earthquake fault zones and coastal land. The Regional Riskscape Model is currently under development to analyse risks from a range of natural hazards.

The model is being developed by GNS Science and our sister organisation NIWA, and focuses on the impact of five of the most commonly encountered natural hazards – earthquakes, tsunami, volcanic eruptions, landslides and floods. Comparisons between risks posed by each hazard are proving vital in prioritising mitigation strategies at local, regional and national levels.

Trenching across faults reveals their earthquake histories.

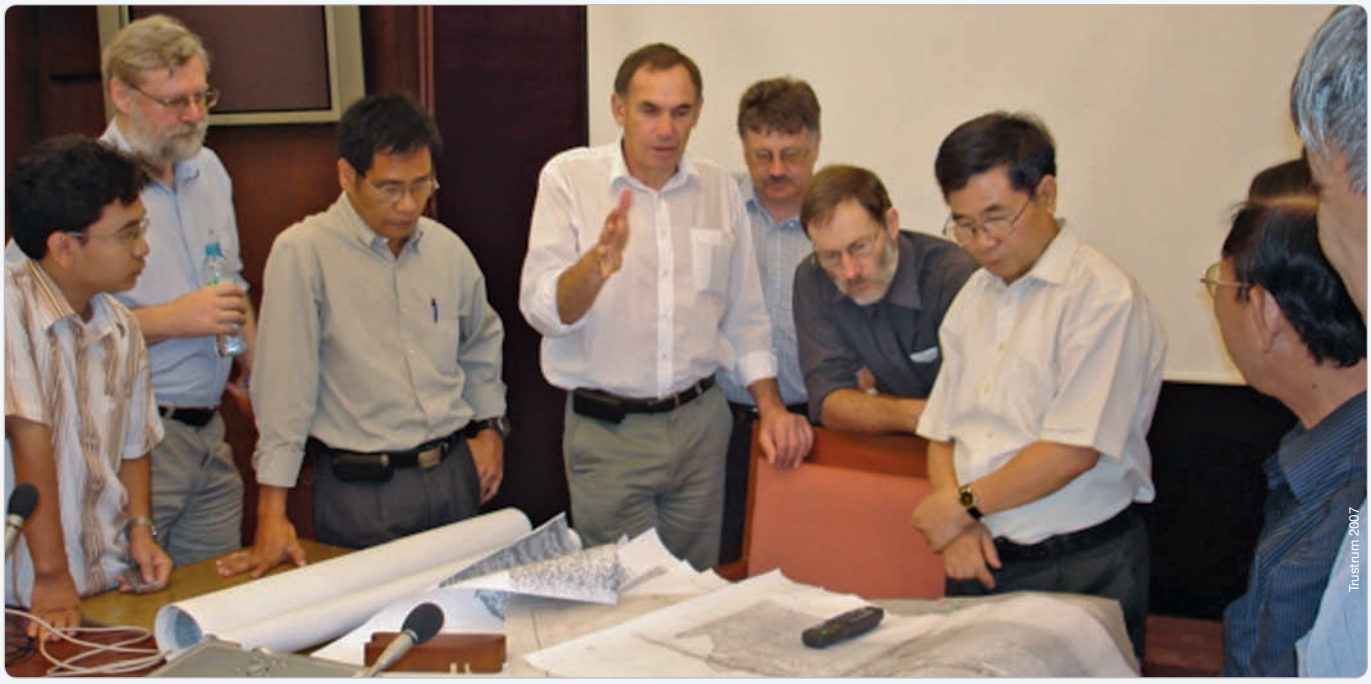
It's Our Fault

This GNS Science-led project aims to make the Wellington region more resilient by better quantifying the likelihood of large earthquakes and their effects on the community. The region has four major faults, a number of secondary faults and is situated above the subduction zone, all capable of producing earthquakes that are expected to cause major damage.

The research will determine the likelihood and frequency of future large earthquakes, their expected size, and the physical, social and economic impacts. Field investigations have determined the earthquake history of the faults, and a realistic computer model of earthquake occurrence and fault interaction is being developed to statistically assess interactions between the faults. A range of modelling work will provide better understanding of the likely physical effects, including the way in which seismic waves travel and spread during an earthquake, so that the level of strong shaking can be predicted at various locations and the impacts on structures determined.

The project is supporting better decision-making, protecting assets, and will minimise casualties in the event of a major earthquake. The project is designed so that information can be used in civil engineering, infrastructure planning, emergency management, and by the insurance industry.

case study



GNS Scientists, Vietnamese partners and a Filipino geophysicist examine marine maps to evaluate the earthquake and tsunami potential of faults that could affect Vietnam.

Proven tsunami expertise builds the capacity of Vietnamese scientists

Following the 2004 Indian Ocean Tsunami, GNS Science was commissioned by the New Zealand government to review New Zealand's level of tsunami risk and preparedness, and recommend measures for improving management of risk at both a national and regional level.

We reviewed current and historic knowledge of tsunami and used that knowledge to assess risk of distant, regional and local source tsunami. Datasets of historic and pre-historic information, together with numerical modelling and risk calculations were used. These base data enable realistic modelling of the maximum probable wave heights over a range of time frames, at multiple locations around New Zealand. Using inundation, asset and population models we were able to model mean probable financial losses, deaths and injuries.

Our work identified crucial gaps in current knowledge and provided clear recommendations for improving national and regional management of tsunami risk in New Zealand.

Vietnam is also at risk from occasional tsunami which could potentially bring chaos and economic hardship to the communities living in low-lying coastal areas. Like New Zealand, Vietnam needed a highly targeted and scaled solution. GNS Science's experience in assessing risk and setting up a national seismic and tsunami monitoring network is highly applicable to the Vietnamese situation.

Our scientists worked with Vietnam's Institute of Geophysics (IGP) to strengthen the capacity of Vietnamese scientists, enabling them to assess tsunami risk and develop early warning systems for Vietnam. We held workshops on various aspects of risk assessment, such as how to identify earthquake sources and determine vulnerability of communities. We also initiated effective data sharing between various Vietnamese agencies and provided recommendations for design needs for a seismic and tsunami operations centre.

contact us

To know more about how our hazard and risk modelling expertise can assist you, please visit:

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