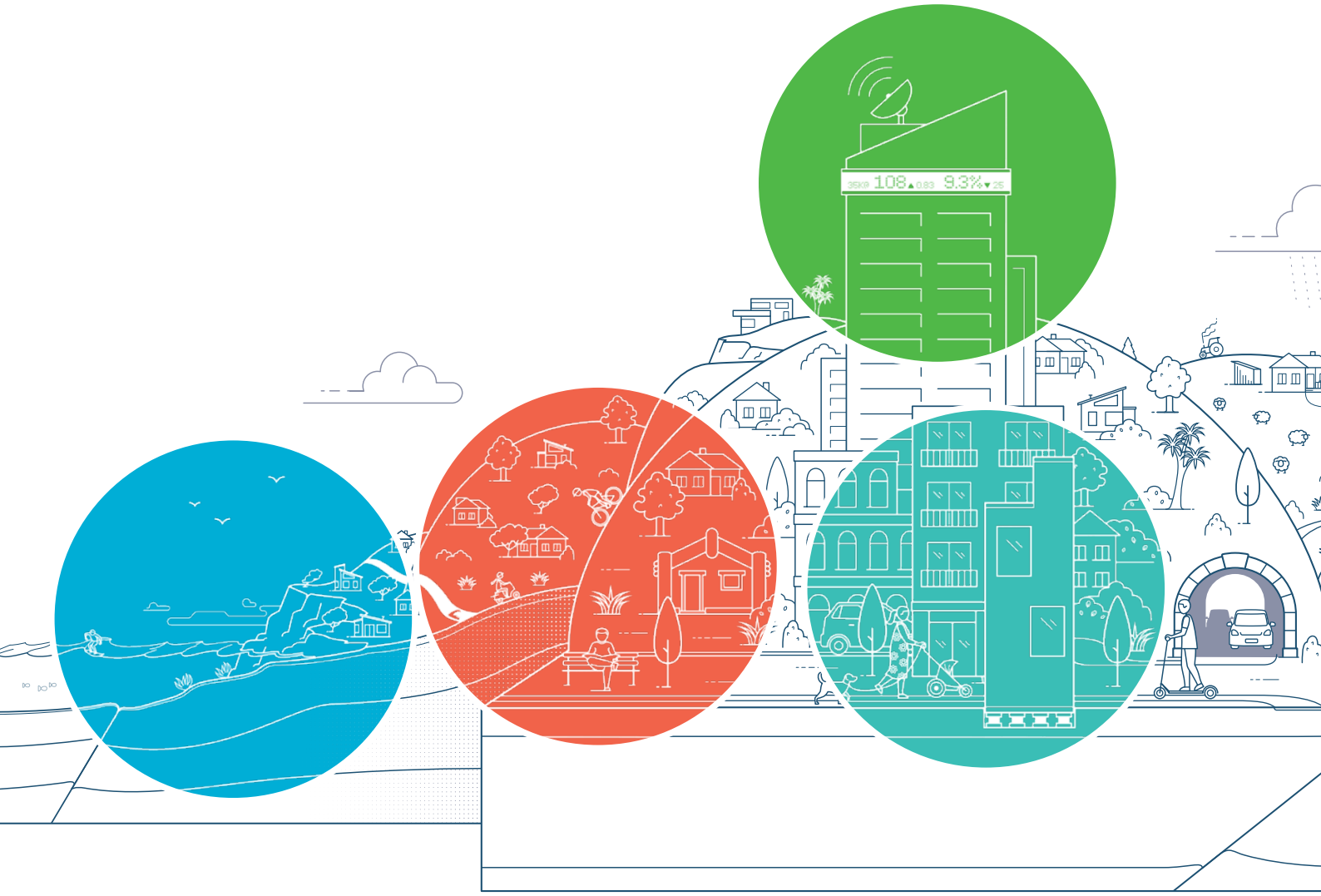
The foundation from which we stand strong, together

Resilience and Research Highlights Report

2022

Te Kāwanatanga o Aotearoa
New Zealand Government

Toka Tū Ake EQC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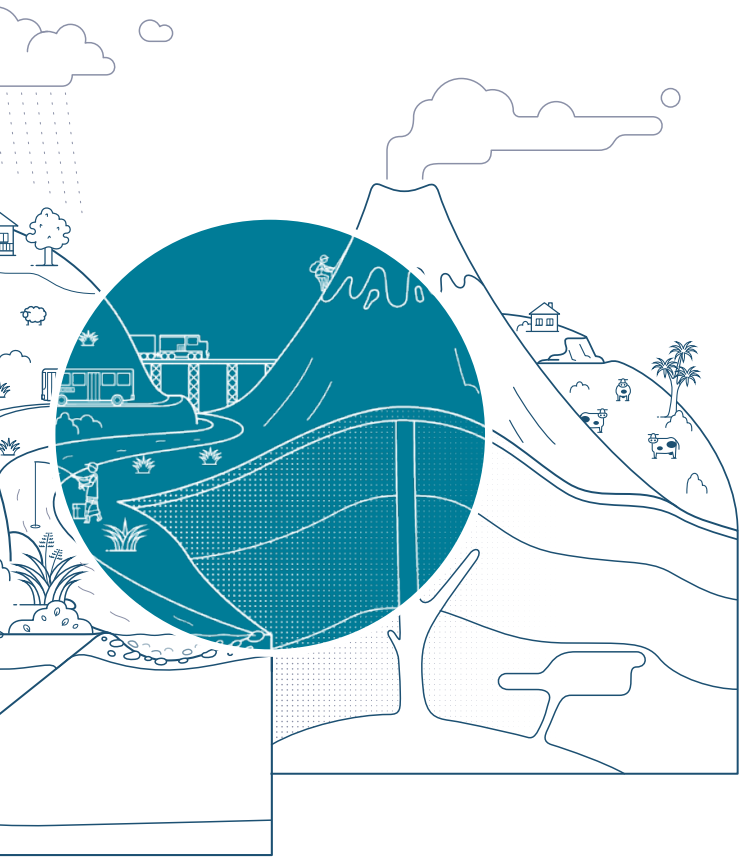

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April 2023
Toka Tū Ake EQC

EQC.GOVT.NZ

WELCOME TO OUR 2022 RESILIENCE AND RESEARCH HIGHLIGHTS REPORT

Like many other organisations in Aotearoa New Zealand, Toka Tū Ake EQC experienced another extraordinary year in 2022. The year began with a major volcanic eruption and tsunami in Tonga, the largest such event this century, and one whose impact was felt on our shores. Aotearoa experienced several flooding and landslide events throughout the year, alongside seismic and volcanic activity. The land we live on continues to remind us that we need to understand, respect, and manage these natural hazard risks in order to reduce their impact on people and property.

As well as natural hazards, the Covid-19 pandemic continued to dominate our operations. Our staff continued to work from home and in new ways, demonstrating agility and fortitude in the face of challenges. Scientific conferences, events and meetings slowly started to be held in-person again, although many were still postponed, or held in hybrid form.

In other ways it was the start of a new chapter for our organisation. We have implemented a new claims model in partnership with private insurers, saw legislation introduced to Parliament to modernise the EQC scheme, and adopted our new name – Toka Tū Ake EQC scheme, which means 'The foundation from which we stand strong, together'.

We work hard to ensure we are prepared as an organisation, including working with our partners to be ready to support impacted communities when a natural hazard event occurs, and managing the EQC scheme so financial resources are available to meet claims.

One of our core strategic outcomes is to improve the resilience of New Zealanders to natural hazards. We do this by investing in research, collaborating with others, and sharing information and knowledge about natural hazards with key stakeholders and the public. As this report shows, we have continued this work in 2022. I am pleased to share some of the highlights of what we have been doing over the past year to build a more resilient Aotearoa New Zealand.

Tina Mitchell

Chief Executive

Titiro whakamuri
Whakarite ināinei, hei hāngai whakamua

See the past
Prepare now to shape the future

At Toka Tū Ake EQC, we're on a mission to reduce the impact of natural hazards on people and property. Contributing to reducing risk and building resilience is a big part of how we do this. We fund research and data to build our collective knowledge base on natural hazards, and ways to reduce the impacts from them. We 'translate' the science so it's easy to use, and we work to get the information to the people who need it: homeowners, communities, and decision-makers in both central and local government, and the design and construction industry.

Although we don't deal with climate change directly, we know it will intensify some of the risks that Toka Tū Ake EQC covers, such as landslides and floods (for land), and we are increasingly including this in our thinking.

We have been consolidating and growing our Resilience and Research group in order to better support these goals. Our aim is to be a leader in natural hazard risk reduction in Aotearoa New Zealand, based on credible science, research, education and strong stakeholder relationships.

This report provides a brief snapshot of some of the highlights from our work and research investments over the past year. We feature highlights from some of our innovative Biennial Grants and the larger University Research Programme grants. Guided by our partners and stakeholders to target our research investment more effectively, we supported more than 80 research projects this year, including a greater focus on incorporating mātauranga Māori, social science, and the effects of climate change.

Also featured in the report is some of the work we are doing ourselves to encourage risk reduction action, including through our *Resilient Homes* and *Buildings Action Plan* and *Smarter Land Use Action Plan for Risk Reduction*. We also take a look at some of our public education efforts and readiness activities.

For further information on these items and other work, please check our website: www.eqc.govt.nz/resilience-and-research/. And as always, if there is something you want to know more about or are keen to work on together, please don't hesitate to get in touch with me or one of the team at jhorrocks@eqc.govt.nz.

Dr Jo Horrocks

Chief Resilience and Research Officer

SECTION ONE

QUANTIFYING HAZARDS AND IMPACTS

We fund research to improve understanding of the size, severity and likelihood of natural hazards and their impacts for loss modelling and insurance.

By understanding more about the natural hazards in Aotearoa New Zealand, we can make better decisions, reduce risk and improve resilience. The research and data work includes updating models of hazards and their impacts, and developing consistent national approaches to mapping and modelling natural hazard risks.

GeoNet, Aotearoa New Zealand's national geohazards monitoring platform

Our biggest research investment is in GeoNet, a critical national service that monitors earthquakes, volcanic activity, large landslides and tsunamis; and collects essential data for research and providing information to educate the public.

Toka Tū Ake EQC was a founding partner of GeoNet and continues to be a major funder, contributing close to $12 million in 2022. The sensor network generates an ever-increasing stream of data about Aotearoa New Zealand's land and sea. It is hosted by GNS Science and funded by partners such as Toitū Te Whenua Land Information New Zealand; Ministry of Business, Innovation and Employment (MBIE); the National Emergency Management Agency; MetService (NEMA); and the Department of Conservation.

Databases for evidence

Besides GeoNet, we also support other important databases such as the New Zealand Geotechnical Database, the National Landslide Database and the historic New Zealand Tsunami Database. These databases are important tools for providing evidence to decision-makers.

GNSS MONITORING STATION MOUNT PRICE, WESTLAND.

PHOTO CREDIT: ASHTON MCGILL/GNS SCIENCE.

A revised earthquake hazard model for Aotearoa New Zealand

We reached a major milestone this year with the release of Aotearoa New Zealand's updated National Seismic Hazard Model (NSHM). This model is an important feature of Aotearoa New Zealand's science infrastructure and helps manage risks to safety and the economy from seismic events.

The NSHM provides an estimate of the likelihood and strength of earthquake ground shaking that might occur at any given site, and gives information about how different parts of the country might behave in large-magnitude earthquakes. Knowing how future earthquakes might affect our different regions helps us to understand the risks to our communities.

Led by a team at GNS Science, and co-funded by MBIE and Toka Tū Ake EQC, the revision has incorporated years of work and research by local and international scientists and academics from diverse research fields. Aotearoa New Zealand's previous seismic hazard model was first developed in the 1980s and was last updated in 2010.

The revised model estimated that ground shaking hazard has increased significantly in some areas to more than twice the level estimated in the 2010 model, emphasising the need for enhanced resilience strategies and preparedness.

The model is used by government and industry to help understand seismic hazard in Aotearoa New Zealand better and contribute to decision-making. It helps inform technical standards for earthquake engineering design as well as providing critical information for earthquake risk management relevant to infrastructure and emergency planning. Our primary interest in the model is for natural hazard risk and loss modelling for insurance and reinsurance purposes, but we are also keen to see it used in local government resource management and land use planning.

As well as incorporating the latest international science, it brought in data and knowledge from significant seismic hazard events of the last two decades, such as the Canterbury earthquake sequence and the Kaikōura/Hurunui earthquakes.

Throughout the revision project, technical advice on the development of the NSHM was provided by a panel of international scientists and engineers. An additional smaller international panel undertook an assurance review of the science process, noting that the project team did an outstanding job of incorporating the best available science, engaging the highest level of relevant expertise among numerous organisations worldwide and navigating the project through pandemic-related constraints.

For more information and detail on the NSHM go to: www.gns.cri.nz/research-projects/national-seismic-hazard-model/

JO HORROCKS (CENTRE) WAS PART OF THE PANEL ON ONE OF THE MANY JOINT-AGENCY WEBINARS TO EXPLAIN AND ANSWER QUESTIONS ON THE NEW NATIONAL SEISMIC HAZARD MODEL.

Understanding and managing risk in low seismic hazard zones

Many New Zealanders in 'lower seismicity' areas still need to be prepared for earthquakes. Southland and Otago are usually seismically quiet, but as experienced in Canterbury in 2010-11, large damaging earthquakes can happen unexpectedly anywhere in Aotearoa New Zealand.

Southland has a similar tectonic setting to the eastern South Island, but is thought of as having low seismic hazard. While this is justified from a plate tectonics perspective, the low hazard may also reflect the near absence of earthquake research in the region until now. Professors Mark Stirling and Caroline Orchiston at the University of Otago are leading a major research programme in the southern South Island, to better understand the seismic hazard levels and prepare communities to plan for and manage the associated seismic risk in those zones.

The project has the ambitious goal of going beyond the traditional methods of identifying earthquake faults from landforms, which are very limiting in lower seismicity regions where the faults cannot keep up with the rates of landscape change. The Canterbury earthquake sequence began with a big earthquake on a fault hidden under the young Canterbury Plains. We want to avoid a similar surprise in Southland by locating the faults ahead of time.

Southland has a growing resident population and a large number of tourists and seasonal workers, so it is important to understand the seismic hazard. The University Research Programme, funded by Toka Tū Ake EQC, with aligned funding from QuakeCoRE and Resilience to Nature's Challenges National Science Challenges, is addressing gaps in knowledge beyond current understanding of high-risk places in Aotearoa New Zealand.

THE UNIVERSITY OF OTAGO TEAM UNDERTAKING TRENCHING WORK IN SOUTHLAND.

The researchers have:

- reviewed existing literature to assess where earthquake sources are likely to exist,
- undertaken field studies and trenching at key sites to determine prehistoric earthquake activity,
- deployed a temporary seismic network to monitor small earthquakes in an effort to identify unknown earthquake faults, and
- provided input to the national seismic hazard model (NSHM).

In a parallel stream of work looking at seismic risk, preparedness and resilience, researchers have analysed Southland as a low seismic hazard zone in light of risk-based approaches to developing public policy, e.g. earthquake-prone building legislation.

The research is generating insights into the understanding of seismic risk by those who use the new risk-based legislation, including their perceptions of operating in lower seismic hazard zones relative to high-risk places.

Greywacke rock research unlocks secrets of earthquake faults

Research into Aotearoa New Zealand's most common type of rock, greywacke, is helping to build a picture of how, why and where earthquakes happen across the country. Faults in greywacke have caused havoc in places like Christchurch, Kaikōura and Edgecumbe in recent years, so it's important to understand this rock type.

Our Biennial Grant funding enabled Dr Carolyn Boulton from Te Herenga Waka—Victoria University of Wellington to look specifically at how greywacke rocks behave before, during and after earthquakes, as well as how faults communicate with each other.

The research team tested greywacke rocks in machines that create tiny earthquakes by simulating the high temperatures and pressures that exist where earthquakes begin. This included testing greywacke samples at Utrecht University in the Netherlands, which has a sophisticated apparatus that can measure the frictional properties of the rock at high temperatures and pressure. The experiments helped quantify the properties of a fault.

The researchers combined the laboratory data with a catalogue of real earthquakes around Wellington and built a physics-based model to calculate the temperatures underneath the region, to determine where seismic events are most likely to occur and why. Wellington is ideal because it has such a uniform rock type–greywacke–as well as a densely-spaced network of seismometer stations, giving high-resolution data on where the earthquakes are happening.

The results provided essential input data to build a simulated fault network to explain how faults interact and why Aotearoa New Zealand has 'multi-fault earthquakes'. They also contributed to models of how, why and where earthquakes happen across the country, and delivered essential modelling data to understand the likelihood and severity of earthquakes in Aotearoa New Zealand.

DR CAROLYN BOULTON RESEARCHING GREYWACKE ROCK.

Supporting research to understand Aotearoa New Zealand's tsunami risk

Toka Tū Ake EQC has supported GNS Science to combine hundreds of years of tsunami data and information into the New Zealand Tsunami Database, a public resource to help guide Aotearoa New Zealand's science and hazard risk management sector, including insurance, resource management and emergency planning and preparedness.

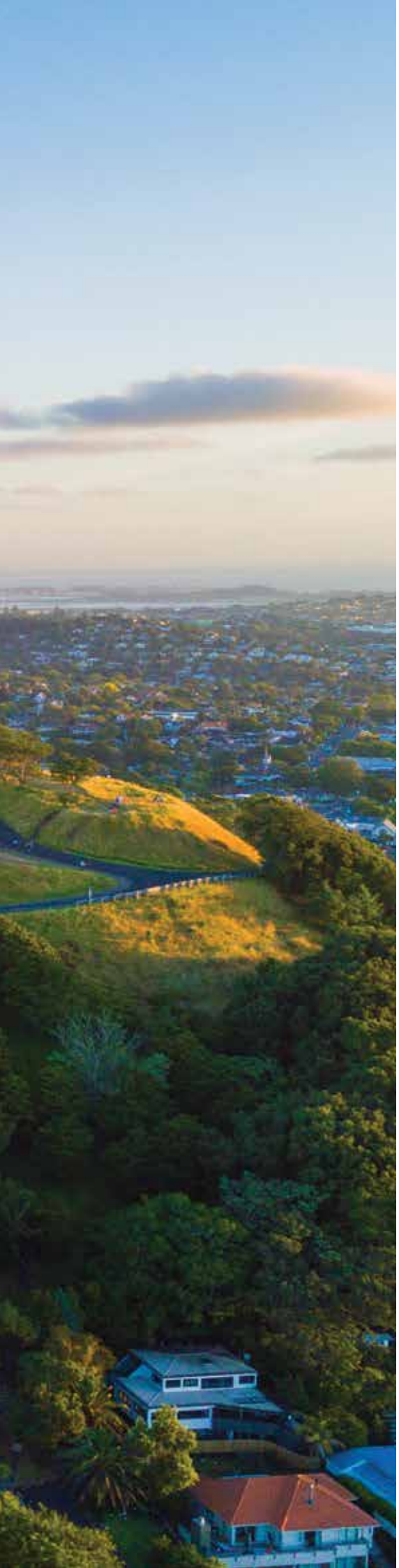
While Aotearoa New Zealand may not have experienced significant or damaging tsunami events as other countries have in recent years, this database shows there have been very large tsunamis here in the past. It's important to know what we could face in Aotearoa New Zealand. Each event is different, and scientists place huge value on understanding the characteristics of tsunami sources.

The database features more than 900 records from the early 1800s to the present. It is closely aligned with, and links to, NIWA's paleotsunami database, verifying what is seen in the ground against what has been observed in the past. To complement our modern-day assessment and modelling of tsunami hazard and risk, it's useful to collate and include data from historic newspaper articles, maritime records, personal diary entries and Māori oral records, as so much can be discovered by looking into these historical observations.

For example, in the 1940s, two large earthquakes happened near Gisborne. Historical records show these earthquakes were not widely felt, but generated two land-inundating tsunamis which have come to be known as 'stealth tsunamis'. These records have helped scientists to understand other locations in Aotearoa New Zealand where these types of events could occur, encouraging research that has led to further investment in Aotearoa New Zealand's tsunami monitoring and detection network.

SECTION TWO

TĀMAKI MĀKAURAU (AUCKLAND) CITY VIEW.



SMARTER LAND USE

Toka Tū Ake EQC is responsible for providing natural hazard insurance to residential property owners in Aotearoa New Zealand.

Aotearoa New Zealand's exposure to natural hazard risk is high and a large portion of this is carried by Toka Tū Ake EQC on behalf of the Crown. Claims are paid from the Natural Disaster Fund (NDF). These were previously capped at $150,000 per claim. For policies taken out or renewing after 01 October 2022, the cap doubled to $300,000. This increases Toka Tū Ake EQC's potential financial liability in an event. The NDF is primarily funded by levies collected from home owners taking out a residential house fire insurance policy. With the cap increasing, most home owners now have a higher proportion of their cover provided by Toka Tū Ake EQC instead of their private insurer.

Some natural hazards are also being exacerbated by a changing climate, and population growth is pushing development into higher risk areas, together increasing natural hazard risk for New Zealanders. As such, Toka Tū Ake EQC has a strong interest in reducing risk and increasing resilience to natural hazards in Aotearoa New Zealand.

In 2022, Toka Tū Ake EQC launched two complementary action plans, one to guide resilient construction of the built environment and the other to address land use planning.

Smarter Land Use Action Plan for Risk Reduction

We published the *Smarter Land Use Action Plan for Risk Reduction* to help understand the challenges and opportunities involved in avoiding or reducing exposure to natural hazards. This plan aims to help decision-makers in local and central government, as well as Māori, planners, communities and others to achieve smarter land use planning to reduce natural hazard risk.

To assist communities to reduce their risks, Toka Tū Ake EQC is focused on improving Aotearoa New Zealand's resilience, where the potential consequences of social and economic disruption by natural hazards are consciously considered, quantified, and included in everyday development decisions, based on the best knowledge available.

The goal of the *Smarter Land Use Action Plan for Risk Reduction* is to take a proactive approach to reduce our current and future risks through smarter, risk-informed land use planning.

Land use planning is a key method for reducing and preventing damage from natural hazards. But it is also a challenging policy area that must balance a range of often competing priorities. Our risk tolerance is informed by social norms, existing development, development intent, information availability, the availability of risk treatment measures, and sustainability.

For more information go to: Smarter Land Use Action Plan on the website: www.eqc.govt.nz/our-publications/smarter-land-use-action-plan/

Ensuring natural hazards are accounted for in national and local policy and planning

We have made several formal submissions this year on draft legislation, national policy direction, and local government plans, resulting in positive changes for Aotearoa New Zealand's natural hazard risk management.

Several local authorities this year were required to make (district) plan changes to implement the *National Policy Statement: Urban Development (NPS-UD)* and the *Medium Density Residential Standards (MDRS)* introduced in the *Resource Management (Enabling Housing Supply And Other Matters) Amendment Act 2021*. Toka Tū Ake EQC submitted on six proposed plan changes (Wellington City, Hutt City, Kāpiti Coast, Porirua, Tauranga City and Auckland City), one draft plan change (Upper Hutt), one regional policy statement change (Greater Wellington Regional Council), and made further submissions on Auckland, Wellington, Hutt City, Kāpiti Coast, and Porirua plan changes.

These submissions focused on recommending that development and intensification do not occur, or are limited, in areas that are at high risk from natural hazards.

We have also submitted on changes to the *Taupō District Plan* and *Te Tai o Poutini Plan* (Buller, Westland and Grey districts' combined plan) which are not related to NPS-UD or MDRS requirements. These submissions relate to how the councils are using natural hazard risk information to inform decisions on development in at-risk areas.

As well as local government plans and policies, we make submissions on Central Government policy. In the last year this has focused heavily on the passage of the *Natural and Built Environment Bill* and the *Spatial Planning Bill*, the future successors to the Resource Management Act, through the legislative process. This culminated in an appearance before the Environment Select Committee in February 2023, where we made our case for a higher priority being placed on natural hazard risk management in the legislation.

Toka Tū Ake EQC makes these submissions because we want to see positive changes in Aotearoa New Zealand's natural hazard risk management, and a more risk-informed approach to policy and planning generally. While there are always trade-offs and competing priorities involved in these policies and plans, we think it is important to be a voice for a resilience approach, as well as to use the research and data Toka Tū Ake EQC has invested in over the years, to make an evidence-based case for change.

We have had some significant successes. For example, in 2021 we provided a detailed submission on the draft *Rautaki Hanganga o Aotearoa – New Zealand Infrastructure Strategy 2022-2052*, which we believed did not adequately address the risks from natural hazards. The final strategy includes 'Strengthening resilience to shocks and stresses' as one of its five main objectives, which includes two recommendations focused on natural hazards resilience. In the Government's response to the strategy, both of these recommendations were accepted in full. While Toka Tū Ake EQC was likely not the only one making such a submission, we were certainly very pleased to see the final result.

Understanding Auckland's volcanic hazards and risks

Toka Tū Ake EQC tries to ensure broad coverage of different hazards in the research we invest in. One of our longstanding investments is in the DEVORA (Determining Volcanic Risk in Auckland) programme. Alongside the Auckland Council we co-fund this programme, which is led by volcanologists at the University of Auckland and GNS Science.

DEVORA brings together scientists with emergency managers, planners and infrastructure providers to work together on reducing the impact of volcanoes on Auckland. A good understanding of the likely risks and impacts is important, not just for Auckland, which is built on a potentially active volcanic field and vulnerable to ashfall from other North Island volcanoes, but also for the rest of Aotearoa New Zealand.

Through DEVORA, scientists look to understand key questions such as how often and how fast magma rises to the surface in the Auckland Volcanic Field, what patterns there have been in previous eruptions, and what the likely impacts of different eruptions could be in the future.

In August 2022, some of our Resilience and Research group members attended the 15th annual forum of the DEVORA programme. They shared and heard about the latest research, and discussed ways to use it in policy, implementation and preparedness to assess the volcanic risk and hazard and improve resilience in the Auckland region. For more information, go to: www.devora.org.nz/

Liquefaction risk on Wellington's waterfront

Research into the impact of the 2016 Kaikōura earthquake on reclaimed land in Wellington is providing engineers with invaluable new information for building and infrastructure design on the capital's waterfront.

University of Canterbury (UC) researcher Ribu Dhakal has been part of a team researching liquefaction and the behaviour of reclaimed soils along Wellington Harbour. His research identified how the different areas around the harbour were affected in 2016. His work is part of one of our University Research Programmes – on assessment and mitigation of liquefaction hazards – led by UC Professor Misko Cubrinovski.

The ground motion from the Kaikōura earthquake was relatively minor in Wellington, compared to what would occur in an earthquake on the Wellington fault, but the damage to the ground and consequent effect on buried structures and building foundations was still significant, and more severe than we would have historically expected.

RIBU DHAKAL TESTS SOIL SAMPLES IN THE UNIVERSITY OF CANTERBURY GEOMECHANICS LABORATORY.

The research is possibly one of the most well-documented liquefaction case histories of reclaimed soils anywhere in the world. The team conducted over 100 cone penetration tests in a small 0.5 km^2 area at the Port of Wellington, as well as drilling dozens of soil samples which were tested at the UC geomechanics lab.

The team discovered that the liquefaction in the southern part of the harbour had been severe, including in gravelly soils where experts historically may not have expected it to occur.

As a result of the liquefaction, some of the land area settled by half a metre and experienced more than a metre of lateral movement.

The research is providing great insights for Aotearoa New Zealand geotechnical engineers for designing buildings that will cope with the seismic hazards on parts of the reclaimed land. Engineers working in this area will now have a much better understanding of where they can expect liquefaction and how much ground movement may occur. This research will help with the goal of improving Aotearoa New Zealand's resilience to natural hazards by understanding what is happening under the surface of the earth.

SIGNIFICANT GROUND DAMAGE OCCURRED ON THE WELLINGTON WATERFRONT AFTER THE 2016 KAIKŌURA EARTHQUAKES.

SECTION THREE

RESILIENT HOMES AND BUILDINGS

Toka Tū Ake EQC has a strong interest in the resilience of the built environment, especially of Aotearoa New Zealand residential homes and buildings.

In 2022 we published a five-year action plan–the *Resilient Homes and Buildings Action Plan*–to guide our activities. This plan is complementary to the *Smarter Land Use Action Plan for Risk Reduction* outlined above. *The Resilient Homes and Buildings Action Plan* sets out where and how Toka Tū Ake EQC views the biggest opportunities to improve the built environment, and how we can be most effective in working towards those goals with other key partners. The plan identifies three main objectives:

- New homes and buildings are designed and built for resilience.
- Existing buildings are managed and assessed so they are safe and resilient.
- Aotearoa New Zealand's built environment 'system' is fit for purpose.

The main focus areas in the plan include:

- supporting fundamental research to improve the way we build
- capturing data and information on our built environment at a national scale
- safeguarding infrastructure and services that support our built environment
- developing effective, economical retrofit solutions and investigating directly subsidising building owners to reduce their risk, such as removing chimneys and fixing houses to foundations, as well as promoting low-damage design for new buildings
- refining national building regulation and policies
- how to decrease the level of embodied carbon in buildings while increasing natural hazard resilience
- understanding and improving building performance.

For more information, check the website: www.eqc.govt.nz/our-publications/resilient-homes-and-buildings-action-plan/

Understanding societal expectations of buildings

Continuing important research to understand what society expects from buildings in Aotearoa New Zealand, the Resilient Buildings Project team has been working to define tolerable impacts in the built environment.

This multi-stage project is helping to define a new way of designing buildings for Aotearoa New Zealand that will lead to reduced impacts in future earthquakes, and better overall outcomes for people. Current Aotearoa New Zealand building standards prioritise 'life safety' in design, but do not focus on other considerations for societal function or wellbeing.

The most recent part of the project explored societal expectations and tolerance towards seismic risk. The findings revealed the importance to Aotearoa New Zealand communities of restoring building functions following an earthquake, and therefore highlighted the performance of non-structural elements as a key determinant of outcomes.

The multi-agency team, with representatives from NZ Society of Earthquake Engineering (NZSEE), Resilient Organisations, University of Auckland and others, has taken significant steps to outline the range of impacts to society in an earthquake, encompassing physical, social, cultural, environmental, and economic outcomes. The project benefits from the diverse backgrounds of its steering group, which includes leaders from engineering design, social science, economics, and policy.

Ultimately, this programme of work will inform future performance objectives for the design of new buildings, and may help guide the development of future *Building Code* improvements.

THE RESILIENT BUILDINGS RESEARCHERS RAN A WORKSHOP ON ELEMENTS OF THE RESEARCH AT THE 2022 QUAKECORE CONFERENCE.

WORKING WITH GROUPS TO EXPLORE EXPECTATIONS OF BUILDINGS.

Appointment of joint agency Chief Engineer role to increase collaboration and improve resilience

Strengthening our partnerships is key to getting results. The partnership between Toka Tū Ake EQC and MBIE has been strengthened through establishing a joint Chief Engineer role.

The first person appointed to the role is Professor Ken Elwood from the University of Auckland. In this role, Professor Elwood can help broker knowledge sharing and collaboration from science to policy to practice, helping to produce practical standards and guidelines that improve building resilience in the real world. He hopes to bring the right people together to address critical challenges, work on solutions and initiatives, and better position Aotearoa New Zealand's construction environment for the future. Improving building resilience needs more than just best practice or minimum guidelines.

This appointment is a big step towards that for the industry. Toka Tū Ake EQC and MBIE have a shared objective to increase the resilience of Aotearoa New Zealand buildings and reduce the impact of natural hazards on people and property. Collaboration between the two entities on previous building resilience projects has been successful, including revising the National Seismic Hazard Model (NSHM).

Science is always evolving, but researchers, policy-makers and engineers understandably concentrate on their individual areas.

The new role will help support the resilience of the built environment, bringing key aspects of science, policy and engineering practice together, and strengthen relationships between industry, academic and research organisations.

KEN ELWOOD DURING TESTING OF CONCRETE BUILDING IN UNIVERSITY OF CANTERBURY LABORATORY.

A collaborative approach will inform and drive risk-reduction activities to get natural hazard resilience embedded in all aspects of decision-making for our communities. A top priority for Prof Elwood and team is the Seismic Work Programme, which involves working with earthquake engineering experts to assess possible changes to the Building Code and supporting documents.

Low-cost, low-damage seismic engineering wins 2022 Ivan Skinner Award

The 2022 Ivan Skinner Award was won by Dr Shahab Ramhormozian, a senior lecturer at the Auckland University of Technology (AUT), whose work focused on low-cost and low-damage seismic engineering. The award is jointly funded by Toka Tū Ake EQC and NZSEE and awarded each year at the annual NZSEE conference.

An innovative friction sliding hinge system was first developed many years ago by Aotearoa New Zealand researchers in response to the Northridge and Kobe earthquakes in the mid-1990s when buildings suffered much more damage than expected. The original technology was innovative but required more work to overcome design and construction accuracy and other precision issues, as well as post-earthquake loss of strength.

NZSEE PRESIDENT HELEN FERNER PRESENTS THE 2022 IVAN SKINNER AWARD TO DR RAMHORMOZIAN.

Dr Ramhormozian addressed these shortcomings in his PhD research when he developed an optimised sliding hinge joint, now being researched and used across Europe, China and here in Aotearoa New Zealand.

The optimised joint has different components installed in a different way, resulting in a highly accurate and resilient system without the necessity to repair the joints after an earthquake. Before Dr Ramhormozian's changes, buildings were designed to save lives but not able to deal with stronger earthquakes.

Engineers and academics around the world have been quick to adopt and replicate the optimised technology, which is currently being used by several groups, including BECA engineers in three Hamilton CBD buildings under construction by Hawkins for Tainui Holdings Group.

Using traditional Māori construction methods to rebuild and strengthen historic wharenui

A Toka Tū Ake EQC 2022 Biennial Grant was awarded to Professor Anthony Hoete (Ngāti Awa, Ngāti Rānana) and his team to research, co-design, rebuild and test the seismic resilience of a historic Bay of Plenty wharenui.

The University of Auckland team is working alongside, and co-designing the wharenui with, the Ōpōtiki community, particularly Ngāti Ira o Waioweka, who in the 1860s built the original Tānewhirinaki wharenui, which was destroyed in the M7.8 Napier earthquake in 1931.

They will incorporate traditional Māori construction methods, using endangered knowledge called mīmiro, to build a prototype full-scale timber structure and test its seismic resilience.

The origins of mīmiro can be traced back to the ships and strong sail lashing that ancestors used to travel across the Pacific. The team wants to try to recreate those lost techniques of building, creating strength and tension in structures to give the wharenui greater seismic resilience. The team will replicate mīmiro techniques, but use modern metal wiring for the lashings instead of the flax that their ancestors would have used.

TE WHARE RANGITUPU WHAKAIRO.

The timber structure uses interlocking compression joints instead of bolting parts together, and tensile elements will pull the structure to the ground, like a tent. The next stage will be to pull the vertical portals sideways using a winch from a jeep to test the horizontal strength required for seismic resilience, while vertical strength will be tested by water weights.

The research, which is also supported by QuakeCoRE, the Centre of Research Excellence for seismic resilience, and the Endangered Wooden Architecture Programme at Oxford Brookes University in the UK, combines mātauranga Māori knowledge with modern science and building techniques to test and improve seismic resilience.

PROFESSOR HOETE (AT RIGHT) AND SOME OF THE RESEARCH TEAM.

Research with impact – making homes stronger

An engineering breakthrough by Dr Angela Liu at BRANZ is starting to show results in strengthening homes, and may soon become part of many current building designs.

Dr Liu and others observed that many new or architecturally designed modern homes with mixed bracing had suffered significantly more damage in the 2010-11 Canterbury quakes than older, more traditionally built houses. She examined the causes of the substantial damage to these houses by using existing testing data and carrying out desktop studies.

Dr Liu's research, originally funded by an EQC Biennial Grant in 2014 and published in 2015, identified the bracing issues and led to formal guidance for specifically designed bracing systems in light timber-framed residential buildings. The published guidance from her research is having a wide impact, having been taken up by professional engineers and authorities across Aotearoa New Zealand, resulting in stronger homes and providing greater resilience against damage from natural hazards.

The 2015 guidance has gradually become the informal compliance pathway for seismic design of houses with specifically designed bracing systems. In 2020, it was also used to develop the good practice document *Residential Portal Frames: An Engineer's Perspective*, published by Engineering NZ and the Engineering General Practitioners Group. This has further helped the industry to make use of the guidance, and it is also likely to feature in the *NZS 3604* document used to design homes. It sets out the compliance pathway, which is currently being updated, for many of Aotearoa New Zealand's timber-framed buildings.

It is rare for research to be adopted into practice and compliance in such a short time, due to complexities in connecting research to policy and practice, but this science is a great example of engineering research already having a tangible impact on protecting Aotearoa New Zealand properties and people.

DR LIU ONSITE IN A HOUSE BEING CONSTRUCTED USING THE NEW BRACING SYSTEM.


SECTION FOUR

GOVERNANCE, ECONOMICS AND FINANCE

This theme is about understanding the governance and economics of disasters and disaster risk management, and investigating financial mechanisms and incentives for reducing risk and building resilience. Toka Tū Ake EQC has good relationships and works well with reinsurers and insurers, who demonstrate strong confidence in us. This is partly due to our investment in quality research and data and our loss modelling capability.

Reviewing the pros and cons of cash settlement as a claims settlement mechanism

Toka Tū Ake EQC has commissioned research to assess the impacts of cash settlement of EQCover claims in the Kaikōura/Hurunui earthquake, including the longer-term impact on the quality of the housing stock, and the wellbeing of claimants.

Repairing and rebuilding damaged homes following large-scale natural hazard events is a key component of disaster recovery. Insurance plays a significant role in enabling recovery in Aotearoa New Zealand. Cash settlement of insurance claims is, and has been, the preferred approach of Toka Tū Ake EQC and private insurers in Aotearoa New Zealand, except for after the Canterbury earthquake sequence in 2010-11, where the process of 'managed repair' was used. In March 2020, the *Report of the Public Inquiry into the Earthquake Commission* was published, with recommendations related to the process for settling EQCover claims, including investigating the impact of cash settlements on the quality of housing following the Kaikōura/Hurunui earthquake.

In 2021, Toka Tū Ake EQC commissioned independent research to assess the impacts of cash settlement following the Kaikōura/ Hurunui earthquake. The research team assessed the impacts on housing quality, but also impacts on mental health, building sector capacity, and community capacity.

The research, to be released in 2023, looks at advantages and disadvantages of cash settlement, to understand the consequences of different approaches to claims, and inform the best way to respond to future events in Aotearoa New Zealand, in particular in the post-disaster repair process and recovery.

Contributing to hazard policy and planning

Toka Tū Ake EQC supports the advancement of hazard policy and planning. Over the last year, we have actively contributed to numerous policy development processes, such as the development of the resource management system reform, including the *Natural and Built Environment Bill*, *Spatial Planning Bill*, and *Climate Adaptation Bill*, the update to the *Building Code 2022*, and the review of the *Land Information Memorandum* process.

In a collaboration with the New Zealand Planning Institute, we have continued to support 'planning for non-planners' courses. These courses are especially designed for people with a non-planning background who would like to gain a better understanding of how the planning system works in Aotearoa New Zealand. For example, they could empower natural hazards researchers to use their research to inform planning policy. These courses have been regularly over-subscribed and well-received.

As a result of a request from the Ministry for the Environment (MfE), Toka Tū Ake EQC is providing one of our principal advisors to assist with developing the *National Planning Framework for Natural Hazards*, a key instrument that will operationalise parts of the new *Natural and Built Environment Act* and *Spatial Planning Act* for local authorities. This collaboration supports implementing safer land use planning for natural hazards within the Framework, and is further strengthening our relationship with MfE.

Understanding risk tolerance

Understanding how much risk people can tolerate with respect to natural hazards forms a critical part of the risk management process, yet Aotearoa New Zealand does not have an agreed local, regional, or national regulatory framework for risk tolerance or risk thresholds. This includes being able to define and compare acceptable, tolerable, and intolerable risks across hazards.

Toka Tū Ake EQC is now leading the development of a risk tolerance framework for Aotearoa New Zealand, in collaboration with the Hazard Risk Board, a sub-committee comprising central government agencies, which looks at the implications of hazards for Aotearoa New Zealand. Robust and transparent risk tolerance frameworks are important for effective risk management and implementation of risk reduction initiatives.

Toka Tū Ake EQC has completed a literature review and drafted a discussion paper and policy framework. This work is being used by the Hazard Risk Board to inform the development of a national framework, and is also being used by central government agencies to inform policy development. The next steps are to test the findings of this paper and progress the national conversation on determining risk tolerances and setting risk threshold criteria.

SECTION FIVE

EMPOWERING PEOPLE

Working with communities, understanding how people perceive and manage risk, and learning from others and from the past are all key to our work.

Toka Tū Ake EQC continues to support people making decisions for the resilience of homes, towns and cities with sound evidence about natural hazard risk and risk reduction.

A Natural Hazards Portal

Natural hazard impacts can be very costly both in terms of repairs and on the wellbeing of our communities. Local authorities, central government, insurers, and all New Zealanders carry the costs of natural hazard events. To drive long-term change in the management of natural hazard risk in Aotearoa New Zealand, we need to access, translate, and apply the natural hazard risk data we hold. Therefore, Toka Tū Ake EQ is developing and building a Natural Hazards Portal to make it easier for people and communities to access and understand hazard risk information, and be empowered to make risk-based decisions and take action to build their resilience.

The content and structure of the Natural Hazards Portal is now nearing completion, and the build of the website is underway. Our first phase of delivery will be displaying nationwide EQCover claims information from previous natural hazard events (event type, event date, and claim type). The Portal's functionality will be developed and released over time.

Communicating volcanic risk more effectively

Clear communications about natural hazards are crucial to keep the public informed and safe. Communication of volcanic risk is challenging due to the unpredictability of eruptions, and it varies over time, depending on the volcano's state and the population at risk.

Aotearoa New Zealand experiences a wide range of volcanic activity and eruption types. The eruptions of Mt Ruapehu (1995-96), Te Maari Crater (2012), and events overseas, such as the Hunga Tonga-Hunga Ha'apai eruption (2022), provide opportunities to learn more.

A Biennial Grant research project led by Associate Professor Julia Becker (Massey University) is aiming to drive fundamental changes to the way agencies communicate and respond to volcanic risk. The research team from Massey University and GNS Science will work alongside the Department of Conservation, local iwi, advisory groups and agencies responsible for volcanic risk management in Aotearoa New Zealand.

ASSOCIATE PROFESSOR JULIA BECKER.

The researchers are exploring how agencies have communicated risk during times of inactivity, unrest, and eruption, and after an eruption in previous volcanic events, to create an effective approach for future events. They will learn from previous responses to volcanic events, ensuring important past lessons are not lost, and use the results to help communicate volcanic risks more effectively in the future, improving Aotearoa New Zealand's preparedness, resilience, emergency management and warnings.

Although the focus is on volcanic risk communication, the researchers will also explore aftershock communication approaches used during the Canterbury earthquake sequence, which could be transferable to a volcano context. An integrated approach could help us understand ways to effectively communicate volcanic risk and provide advice for decision-making, so people can better plan and prepare for these events.

TALKING WITH COMMUNITY GROUPS ABOUT VOLCANIC RISK COMMUNICATION.

Communicating science

Toka Tū Ake EQC needs to ensure that the research we fund is communicated so that it can be useful to individuals and organisations. Thus, in 2022 we started developing a programme to support researchers to communicate their science more effectively.

Initially, a survey was delivered to our funded researchers to assess their existing communication skills and interests. We explored their experience, self-assessment of capability, resource awareness, communication barriers, and training needs. From the responses, the research team identified a range of potential training activities. Due to the ongoing pandemic limiting in-person meetings, activities in 2022 were centred around three 90-minute online webinars.

The first focused on communication skills to get science into practice, the second on communicating science to the media, and the third on policy perspectives of science communication. Each webinar consisted of a panel of speakers, followed by smaller kōrero question and answer discussions in breakout rooms.

All sessions were very well attended, with enthusiastic, interesting, and provocative discussions.

The plan is to continue this series this year to address our researchers' needs, as we seek to enhance their science communication skills. This will help us move towards our Resilience Strategy's goals for science that is useful, useable, and used, where complex information is effectively synthesised, translated, and shared with diverse audiences to enhance decisions.

SECTION SIX

BETTER TOGETHER

We fund research and data to build an evidence base for decisions, translate science so it's easy to use, and work with others to get the right information out to decision-makers, whether they're homeowners, in central or local government, or in the design and construction industry.

We're involved in several large science programmes, such as DEVORA, as well as 'It's Our Fault', a collaborative programme focused on Wellington earthquake resilience. Toka Tu Ake EQC also works with many organisations, and sponsors a range of events such as the NZSEE, QuakeCoRE, the annual National Lifeline Utilities Forum, Geoscience Society of New Zealand Annual Conference, and Disastrous Doctorates annual symposium, to continue to advance the research and share knowledge within different communities. We also work with many others in different partnerships, to provide education and outreach, with a big public education programme.

MEMBERS OF THE RESILIENCE AND RESEARCH TEAM AT THE 2022 QUAKECORE CONFERENCE.

The right message at the right time – public education campaigns

Toka Tū Ake EQC's public education campaigns play a vital role in connecting key audiences with our hazard awareness and preparedness messages. 2022 saw the completion of a planned suite of campaign material outlined in our Public Education Strategy. Each campaign has a defined purpose and objective, aiming to communicate with people when they are likely to be most receptive to our messages – and more likely to take action. Some of our key campaigns are featured below:

After Quake 'Double Take'

Have you ever had one of those moments just after a quake, when you swear to yourself that you'll get onto making your home safer for everyone–this time? After going live in 2021, our After Quake campaign continued to be rolled out across 2022, using the window of opportunity presented by people's experiences of moderately or strongly felt earthquakes. The campaign uses GeoNet felt report data to determine where people have felt a quake most strongly, with the goal of inspiring preparedness actions that will make homes safer and stronger for earthquake events.

THE CREATIVE USE OF DATA AND MEDIA FOR OUR AFTER QUAKE CAMPAIGN WAS RECOGNISED WITH FIVE TROPHIES AT THE 2022 NEW ZEALAND AXIS ADVERTISING AWARDS, INCLUDING GOLD FOR USE OF DATA IN DIGITAL.

Campaigns aimed at home buyers and renovators

Buying a home is a critical time when we make risk-based decisions about a property – including possible natural hazard impacts. Home buyers have been a key Toka Tū Ake EQC public education audience for several years, and 2022 saw the development of new home buyer campaign material, which uses simple yet striking visuals of different hazards to inspire home buyers to view a prospective property through a natural hazard lens. Our message of "Before you buy a home, find out how natural hazards might affect it" encourages buyers to be more risk-aware and seek more information on our website.

Renovators

Home resilience actions that are more complex and expensive can be difficult to inspire at any given time. But encouraging homeowners to incorporate these larger resilience steps as part of an existing renovation was identified as an important opportunity to communicate about increasing resilience.

Our new renovators campaign reframes features of a home that could become big problems in a disaster – the 'elephants' in our roofs, our walls, or our floors. Delivered across multiple media channels, this campaign first went live in November 2022 with the primary goal of increasing visits to the Building or Renovating section of the Toka Tū Ake EQC website.

Quake Safe Your Place video series

In mid-2021 a new series of 'how to' videos sharing quake safe tips was completed, for Toka Tū Ake EQC's website, covering off information for various audiences around important preparedness actions for earthquakes. The videos have had a strong presence in media across the past year, in another layer of activity to grow awareness of important preparedness messages.

Five Min Fix

Not all hazard preparedness actions are time-consuming or expensive. Many steps are quick and easy but could still make a big difference when disaster strikes. To share some of these actions, some 'Five Min Fix' videos were created for social media in the lead-up to the ShakeOut earthquake drill in October 2022. Each short video focuses on easy steps such as securing breakables, fastening tall furniture and using proper hooks for hanging pictures and mirrors.

OUR CAMPAIGNS BY THE NUMBERS*

25,815,588

impressions of Toka Tū Ake Tū Ake EQC's messages delivered to the Aotearoa New Zealand public

3,044,081

full plays of Toka Tū Ake EQC video content

114,403

visits generated to the Be Prepared section of the Toka Tū Ake EQC website

*Figures for the 2022 calendar year.

Marking 10 years of ShakeOut

Over the past decade, Aotearoa New Zealand's annual ShakeOut has seen more than a million Kiwis come together to 'Drop, Cover and Hold', and practise their tsunami hīkoi evacuation route in coastal areas.

Toka Tū Ake EQC once again co-sponsored ShakeOut in 2022 in partnership with the NEMA, marking the 10-year anniversary of ShakeOut drills in Aotearoa New Zealand.

The official ShakeOut event took place on October 27 and was live-streamed from Waimea Intermediate in Nelson as hundreds of students participated in the drill.

2022 also reintroduced the Kid's Challenge, with schoolchildren completing a number of preparedness tasks to enter the draw for a range of prizes.

Fifty-three schools nationwide entered the challenge, with an estimated 1,000 kids taking part across the motu. Registration numbers for ShakeOut increased across all categories compared to 2021, with overall participant numbers increasing for the first time since 2015. Overall, 700,695 people registered for ShakeOut in 2022, with schools, businesses and early childhood education centres signing up too. In addition, 134,319 participants signed up to take part in a tsunami hikoi.

Inspiring future careers and building awareness of natural hazards – tsunami impact on the Chatham Islands

Toka Tū Ake EQC works to help grow the next generation of hazard-aware New Zealanders by funding education programmes, such as LEARNZ online field trips which it has sponsored since 2009.

Helping young New Zealanders understand the natural forces which have shaped our land will inspire future careers, while building awareness of hazards and their impacts. LEARNZ has allowed thousands of students to access the inaccessible and be digitally transported to remote locations all over Aotearoa New Zealand and beyond.

More than 2,300 students from across Aotearoa New Zealand took part in the 2022 LEARNZ virtual field trip, which explored the impact of tsunamis on Rēkohu Wharekauri/ Chatham Islands. The islands would be the first place in Aotearoa New Zealand to be affected by a tsunami generated by earthquakes in the South American subduction zone.

GNS Science Principal Scientist, Dr Graham Leonard, Massey University's Professor David Johnston, and Senior Research Fellow, Kelvin Tapuke, provided scientific expertise and guidance. The team spent a week on Rēkohu Wharekauri/Chatham Islands filming content and conducted live chats with students.

This trip allowed students and teachers to discover more about the geological history of the islands and their link to the rest of Aotearoa New Zealand, and see how past events can help us to prepare for future tsunamis. Past events of specific interest included the 1868 tsunami, which resulted from a magnitude 8.5-9.5 earthquake off the coast of Chile and caused significant damage and loss of life on the islands.

Out of the trip came detailed content pages, a series of videos, live 'Connect with Experts' sessions, a Google Earth for Web tour and a quiz to test the students' knowledge. These resources are easy for educators to use, and fun and interactive for children all around the country. View content from the Tsunami: Lessons from the Chathams virtual field trip and access the curriculum at www.learnz.org.nz/tsunami223.

FILMING DR GRAHAM LEONARD ON THE CHATHAMS.

Students tackle earthquake problems in the CRISiSLab Challenge

An annual competition, organised by CRISiSLab at the Joint Centre for Disaster Research of Massey University and funded by Toka Tū Ake EQC, demonstrates how technology can support disaster management, and encourages young people into science, technology, engineering and maths (STEM).

Top prize in the 2022 CRISiSLab challenge went to students from Wellington High School for a unique earthquake alert system which could launch their careers in disaster management. The students produced a disaster response model which used seismometer data to trigger drones to warn residents and capture their whereabouts after an earthquake to help rescue efforts. They took extremely complex science and communicated it from start to finish as well as doing some problem-solving during their presentations.

The winners, who earned a month-long internship with CRISiSLab, faced stiff competition from fellow finalists, who impressed the judging panel with their innovative solutions to real-life earthquake challenges: St Patrick's College picked up the Endeavour Award, Taita College won Best Dashboard Award and Te Kura Māori o Porirua got the award for Best Alerting Device, as well as integrating mātauranga Māori into their presentation and alerting device.

CRISISLAB CHALLENGE WINNERS: WELLINGTON HIGH SCHOOL STUDENTS LEV PETERSEN, BRENDAN SHAW AND ANTHONY SMITH.

CRISiSLab is a research and learning laboratory that conducts transdisciplinary socio-technical research at the human-technology interface. Dr Marion Tan, who leads the CRISiSLab Challenge, says we need more young people in science and disaster management, working as the next generation of scientists and linking innovation with future preparedness.

Toka Tū Ake EQC supports this initiative, which gives young students access to some of Aotearoa New Zealand's most renowned experts. Head of Research, Dr Natalie Balfour, says it's important to give young people this kind of exposure, experience, and opportunity to learn about the technology behind the science.

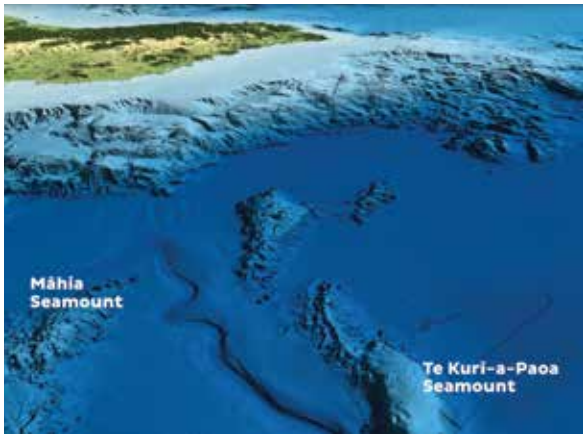
Videos connect communities with risk posed by Aotearoa New Zealand's largest and most active fault

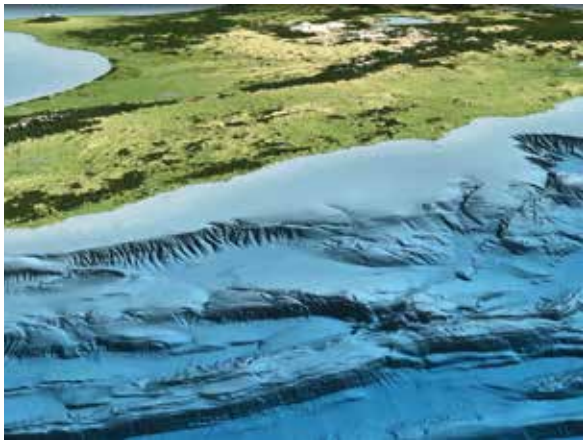
The Hikurangi Subduction Zone is where Aotearoa New Zealand's two tectonic plates meet offshore from the East Coast of Te Ika-a-Māui/North Island. Recent scientific research forecasts that there is a 25% chance of a major event on the fault in the next 50 years. With local education partner, East Coast LAB's planned 2022 community roadshow unable to go ahead due to Covid-19, Toka Tū Ake EQC funding was reallocated to produce several region-specific videos focused on the Hikurangi Subduction Zone hazard. The videos were co-funded by GNS Science.

Four separate videos were produced, a 12-min main video and three regional variations for the Tairāwhiti, Hawkes Bay and Wellington communities, to connect communities with the latest research and hazard information regarding the Hikurangi Subduction Zone.

Local Civil Defence and Emergency Management staff were interviewed for the regionally targeted videos, to ensure each had a local and familiar voice.

The videos were well-received by the public as well as science partners. The main video has been viewed more than 1.2 million times on the *Out There Learning* YouTube channel. Comments on social media show that people have watched to the end of the video and found the Toka Tū Ake EQC and Civil Defence messaging valuable. The main long video, and the Hawkes Bay video are being played in The LAB – East Coast LAB learning space at the Aquarium.





MEET THE TEAM

Dr Jo Horrocks

Chief Resilience and Research Officer

Jo joined Toka Tū Ake EQC in mid-2019, following 13 years in the Ministry of Civil Defence and Emergency Management, in the Department of the Prime Minister and Cabinet. There she led development of the National Disaster Resilience Strategy, as well as other strategic national policies and programmes. Jo is a geoscientist by background, completing a PhD in central North Island volcanic ash deposits. She is now more motivated by the social science side of life, including tackling complex social issues and progressing improved outcomes for New Zealanders.

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Dr Natalie Balfour

Head of Research

Natalie has a PhD in seismology and a strong interest in generating and using research and data to understand natural hazard risk. She came to Toka Tū Ake EQC from GNS Science, where she was involved in the management of GeoNet. Earlier in her career, she helped build the Australian Seismometers in Schools Network and has lectured at universities. She is currently an associate editor for Seismological Research Letters, and a Fellow of the Higher Education Academy in the United Kingdom.

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Sarah-Jayne McCurrach

Head of Risk Reduction and Resilience

Sarah-Jayne McCurrach is a dedicated leader in hazard risk management. With a focus on risk reduction, she leads the program, advocating for evidence-based coordination and smarter decision-making. Passionate about science-based decision-making, she strives to empower communities and enhance policies. Sarah-Jayne's leadership roles include chairing national working groups and representing New Zealand internationally. She initiated the development of New Zealand's first tsunami monitoring network and led the creation of a multi-hazard national risk assessment framework. Committed to building strong, knowledgeable communities, she fosters team growth within Toka Tū Ake EQC.

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Hamish Armstrong

Public Education Manager

Hamish leads some of Toka Tū Ake EQC's most visible programmes of work from advertising campaigns to work with schools and museum partners. Hamish monitors public awareness of what to do to reduce natural hazard risk, and is always looking for new ways to motivate people to reduce their risk at home.

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RESEARCH PROJECTS COMPLETED IN 2022

Explicit incorporation of uncertainties in ground motion simulations and their use in NZ probabilistic seismic hazard analysis, Professor Brendon Bradley, University of Canterbury.

Flat land fragility scenario modelling, Eric Bird, Tonkin & Taylor Ltd.

Site characterisation and liquefaction potential of Blenheim gravelly sandy deposits, Associate Professor Gabriele Chiaro, University of Canterbury.

Rauoterangi Fault Trenching, Jeff Graham, Manawatu District Council.

Delineation of landslide hazard and development of mitigation tools in a vulnerable city, Associate Professor Martin Brook, University of Auckland.

Upgrading New Zealand's Historic Tsunami Database, Dr Kate Clark and Dr Finn Scheele, GNS Science.

Improved constraint on past Hikurangi subduction earthquake rupture dimensions using a locally derived marine reservoir correction, Dr Kate Clark, GNS Science (2020 Biennial).

Volcanic Loss modelling and impact forecasting in Auckland, Dr Graham Leonard, GNS Science.

Application of AI to Advance Structural Performance and Resiliency Quantification, Dr Max Stephens, University of Auckland (2020 Biennial).

Geometries and slip of historical surface-rupturing earthquakes in New Zealand and their application to seismic hazard analysis, Professor Andy Nicol, University of Canterbury (2016 Biennial).

Towards real-time probabilistic ash deposition forecasting for Aotearoa New Zealand, Dr Yannik Behr, GNS Science (2020 Biennial).

Countdown to eruption - Timescales of magmatic processes in the crust, Dr Michael Rowe, University of Auckland.

Physics-based ground-motion modelling for the urban Wellington region: Basin-edge effects and implications for seismic design, Professor Brendon Bradley, University of Canterbury (2020 Biennial).

A fuzzy approach to understanding multi-fault earthquakes, Professor Timothy Stahl, University of Canterbury.

Delineation of landslide hazard and development of mitigation tools in a vulnerable city, Professor Jan Lindsay, University of Auckland. (2020 Biennial).

The Resilient Buildings Project - Stage 2b, Helen Ferner, New Zealand Society of Earthquake Engineering (NZSEE).

Seismic performance of multi-storey cross laminated timber shear walls with high-capacity anchoring systems, Dr Minghao Li, University of Canterbury (2020 Biennial).

Level 3 Tsunami Modelling in Hawke's Bay, Ian MacDonald, Hawke's Bay Regional Council.

Risk Based Planning Review, James Beban, Urban Edge Planning Ltd.

High resolution basement mapping beneath Wellington City based on gravity anomaly and borehole data, Professor Tim Stern, Te Herenga Waka—Victoria University of Wellington (2020 Biennial).

National Seismic Hazard Model (NSHM), Dr Matt Gerstenberger, GNS Science.

Geodetic and hydrological controls on seismic velocity changes after large earthquakes (WellVel), Professor Martha Savage, Te Herenga Waka—Victoria University of Wellington (2020 Biennial).

Guide on post-earthquake assessment, Dr Nicholas Brooke, Compusoft Engineering.

Guidelines for Cost-Benefit Analysis for Building Code Changes that Decrease Seismic Risks, Professor Ilan Noy, Te Herenga Waka—Victoria University of Wellington.

Updating the NZS1170.5 Parts and Components Approach, Professor Timothy Sullivan, University of Canterbury.

GNS Loss Modelling Liaison and Support, Virginie Lacrosse, Tonkin & Taylor Ltd.

ILEE - Robust Building System Testing, Professor Gregory MacRae, University of Canterbury.

Community-led low-cost micro-seismic (MS) sensor network applications for Earthquake Early Warning (EEW), Dr Raj Prasanna, Massey University.

Paleoseismology of the newly discovered Te Puninga Fault, Hauraki Plains, Dr Pilar Villamor, GNS Science.

Seismic Design of Low-Rise and Mid-Rise Hybrid Residential Buildings, Dr Angela Liu, BRANZ.

Seismic strengthening of reinforced concrete walls in existing buildings with fiber-reinforced polymer materials, Dr. Enrique del Rey Castillo, University of Auckland.

New Zealand Geotechnical Database, Tonkin & Taylor Ltd.

Sponsorships

- Disastrous Doctorates 2022.
- QuakeCoRE 2022 Annual Meeting.
- NZLC Annual Forum 2022, New Zealand Lifelines Council.
- Understanding Risk Forum - Wellington Satellite Meeting 2022 GNS Science.
- CRISiSLab Challenge 2022, Massey University.

Te Kāwanatanga o Aotearoa
New Zealand Government

Toka Tū Ake EQC