

# Resilience to Nature's Challenges

## Kia manawaroa - Ngā Ākina o Te Ao Tūroa

### Lifetime Summary



# Tēnā koe,

As we bring the Resilience to Nature’s Challenges National Science Challenge to a close, we take this opportunity to reflect on ten years of mahi dedicated to enhancing the resilience of Aotearoa New Zealand to natural hazards. This document reflects on our journey, achievements, and enduring legacy as a National Science Challenge. It is both a record of what we have achieved and a testament to the partnerships and collaborations that have made our collective mahi impactful.

We would like to thank everyone who has contributed to this kaupapa. To our researchers, our partner organisations including our host GNS Science, and our numerous collaborators in hapū and iwi, community groups, government agencies, councils, and the private sector—ngā mihi nui ki a koutou.

Your contributions have deepened our collective knowledge about the hazards we face, created new tools, and helped bring about more resilient policies and practices. Equally importantly, they have fostered new relationships, capabilities, and ways of working that will continue to support the resilience mission.

As we reflect on our journey, we are guided by the whakataukī: He peka tītoki e kore e whati—The branch of the tītoki tree will not be broken.

This whakataukī embodies the resilience we have sought to foster through our Challenge, signifying strength, adaptability, and perseverance in the face of adversity.

While the National Science Challenges have ended, the Natural Hazards and Resilience Platform provides a new pathway for mission-led, collaborative resilience research. The Platform will build on the foundation of the Resilience Challenge, and we’re excited for the journey ahead.

Ngā mihi nui,

The Resilience Challenge Directorate.



Resilience Challenge Directorate 2023. Credit: Resilience Challenge.

# Lifetime Summary

2014 - 2024

**The Resilience National Science Challenge (RNC) has been a ten-year mission-led, multi-disciplinary research programme to accelerate New Zealand's resilience to natural hazards, involving hundreds of researchers from around the country, with expertise spanning physical sciences, social sciences, indigenous knowledge, economics, law, and engineering.**

As a mission-led research programme, RNC has sought to transform not just natural hazard and resilience science and research but also the way resilience research is done in New Zealand - by involving research users at the outset, building deep collaborations between disciplines and organisations, drawing on multiple knowledge sources, and addressing Māori, community, industry, and infrastructure resilience needs. The mission-led approach in RNC can be seen as goal-oriented towards public good, working across traditional boundaries, elevating relationships and collaboration, and creating system-wide value beyond new knowledge and capabilities.

## SECTION ONE:

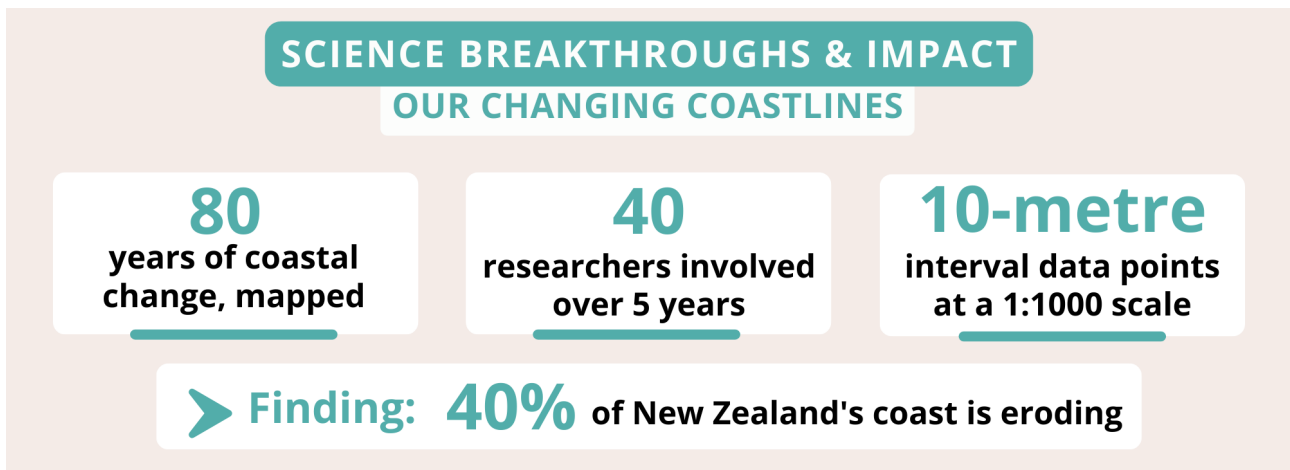
### CHALLENGE SCIENCE BREAKTHROUGHS AND THEIR IMPACTS

#### Challenge science breakthroughs and their impacts

We have developed a significant and diverse body of new knowledge over what has been a very disruptive decade, with RNC research capability drawn on for damaging earthquakes, a deadly volcanic eruption, the long-tail of the COVID-19 pandemic, and numerous big storms and floods, particularly the North Island severe weather events of 2023. Some examples of RNC science breakthroughs and achievements are summarised below.

From our **Earthquakes & Tsunami** programme, innovative computational science to understand the earthquake cycle for all known active New Zealand faults is providing the basis for next-generation seismic hazard assessment. The physics-based earthquake-cycle simulator, a first for New Zealand, has created a catalogue of synthetic earthquakes going back hundreds of thousands of years, enabling seismologists to identify patterns of potential future earthquake behaviours such as how ruptures of deeper faults may trigger shallower faults, or how earthquakes can cluster in time. These insights make it possible to better constrain scenarios of damaging earthquakes, making preparedness planning and risk reduction actions more compelling and cost-effective. An exciting additional spinoff of this work is that it provides the statistical rigour needed to build, for the first time, a national probabilistic local-source tsunami hazard model, and allows for future probabilistic multi-hazard modelling.

A major achievement from our **Coastal programme** has been the completion of the first comprehensive assessment of coastal change (erosion and accretion) since the 1970s. This concerted effort provides a nationally consistent baseline against which future coastal change can be assessed, and also identifies erosion hotspots where decision-making is most urgent. The dataset is already being used by several councils and their consultants to inform adaptation planning for the coast.



**“For the first time in decades, we have a comprehensive, nationwide baseline that will aid in better decision-making and planning for coastal hazards and climate change adaptation.”**

*Prof Mark Dickson, Coastal Change team, The University of Auckland*

Our **Volcanoes programme** has focused on development of new numerical models, which provide a basis for better impact forecasting across the diverse range of volcanic hazard types (like surges, flows and lahars) typical of the cone volcanoes in Taranaki and the Central Plateau. These models have been verified through innovative physical testing and are helping communities and infrastructure providers to better define likely areas and types of disruption, guiding better-targeted avoidance and loss mitigation efforts, and will inform more effective risk communication in future eruptions. The team have also developed strong relationships with iwi who whakapapa to the cone volcanoes, in particular with Ngāti Rangi near Ruapehu maunga. Scientists and kaitiaki have worked together to deepen their shared knowledge of volcanic risk, and establish verified datasets based on traditional observations and volcano science.



*Jon Procter and RNC Volcanoes team members, stakeholders at Ruapehu, 2021.  
Credit: Delia Tamsen*

The **Weather & Wildfire** programme established new models of potential cyclone tracks across Auckland to enable better assessment of severe weather hazards for our largest city. This modelling has identified realistic scenarios of cyclonic severe weather events and quantified, for the first time, physical impacts for Auckland City. Additionally, engineering modelling looked at the vulnerabilities of high-rise buildings in the central business district to severe wind, which provides a quantitative basis for mitigation efforts to reduce future damage and disruption in our biggest city.

Fire researchers have led community-based work in the subdivision of Mt Iron, Wānaka to identify mitigation actions that householders, councils and other agencies can take to reduce wildfire risk in the growing rural-urban fringe. The recommendations have been published to inform authorities on ways they can reduce risk in wildfire-prone communities.

This programme also advanced world-leading practice for impact-based hazard forecasts that help people and agencies better understand the implications of forecasted events such as severe weather. The team's research has shown forecasts and warnings that describe impacts (loss of power or blocked roads, for example) are more meaningful to people, and are more likely to drive preparedness actions than forecasts that describe hazard intensities like rainfall or wind speed. Through international collaborations, the team's work is contributing to global best practice, and with their support, MetService has shifted towards issuing impact-based warnings and forecasts in New Zealand.

Our **Whanake te Kura I Tawhiti Nui** programme harnessed kaupapa Māori research methods to address Māori resilience needs. Collaborative projects in the top of the South Island have deepened understandings of past tsunami and future risk by bringing together oral histories of tsunami with geoscience drilling techniques and analysis of sediment cores. An engineering project has shone a light on the complex issues facing marae communities with buildings deemed ‘earthquake-prone’, and identified widely applicable and affordable techniques that hapū and whānau can use to upgrade their buildings using their own workforces.

Through wānanga, early career researchers from our Whanake te Kura and Coastal teams have worked together with Māori planners, researchers and kaitiaki from across the motu to gather solutions and provide advice to Parliament and agencies working on policy and legislative reforms on climate adaptation.



*Above: Programme co-lead Kristie-Lee Thomas presents at ‘Te Tai Whanake’ RNC Conference, May 2024. Credit: Dave Allen Photography*

Using managed retreat as a case study, our **Resilience, Policy and Governance** team has explored initiatives that can take some of the risks (political, reputational, financial) out of resilience decision-making. The goal is to make it easier for decision-makers to use evidence-based resilience knowledge as the basis for policy and investment choices. The team has successfully trialled new processes bringing policymakers and researchers together for innovative policy development on climate adaptation. Another highlight has been the development of a framework and mapping tool for planning ‘emergency levels of service’ for critical lifeline services such as drinking water, power, and communication.

The **Rural Resilience** team has developed a significant body of knowledge on tourism and disasters. This work was sparked by a case study examining social and economic recovery following the 2016 Kaikōura earthquake. Researchers have developed innovative methods for better understanding tourist exposure to disaster risks, plus lessons and recommendations to improve event preparedness, risk communication, response, and recovery in tourism hotspots like Milford Sound. The Kaikōura earthquake also provided an opportunity to study food resilience and food security following disruptive events. Researchers identified regulatory changes that could enable other cut-off regions to ‘unlock’ their local food resources to feed the community and prevent wastage. This work on food security, food resilience, and disasters has been continued in both our Rural programme and Enhancing Resilience and Wellbeing workstream. Researchers identified the social return on investment for food rescue, showing that for every \$1 invested in food rescue, \$4.50 of social value is created in return.

Our **Built Environment** team (and our Phase 1 Infrastructure team) were heavily involved in post-event response and research on critical infrastructure disruptions following the 2016 Kaikōura earthquake, and numerous storm and flood events including the 2023 North Island severe weather events. This work has led to improved understanding of the performance of critical infrastructure

networks in response to various natural hazard impacts, and in particular, their dependencies on one another. The research has resulted in new, improved approaches for design, assessment and repair, and guidance to inform decision-making and investment. The team has developed strong relationships with stakeholders including government agencies and infrastructure providers.

The Built team provided underpinning science to the New Zealand Seismic Risk Working Group as it developed proposed changes to MBIE's earthquake loading requirements for buildings. Māori students in the Built team have led work to understand hazard risks facing marae across the motu, and potential avenues and collaborations to mitigate risk.



Above: Cyclone Gabrielle Hawke's Bay damage.  
Credit: GNS Science

In collaboration with Massey University's CRISiSLab, the Urban team worked with households, community groups and schools to roll-out affordable technology devices such as seismometers and low-cost earthquake early warning sensors, providing useful community education, while also developing citizen science trials of new tools to boost community resilience. Another Urban team focused on governance aspects of disaster recovery, and developed recommendations for use of legislation to support recovery, using an Auckland Volcanic Field case study. This team also developed a multi-capitals tool, ReCap, to support decision-making for disaster recovery, which was promoted as guidance in local recovery efforts following Cyclone Gabrielle and the Auckland Anniversary floods, and has been endorsed by recovery practitioners in Australia and the United States.

The **Multi-hazard Risk** team have advanced new statistical methods for integrating the cascading and compounding effects of different hazard types, which is enabling new ways of quantifying the complex mix of physical, social and economic consequences of multiple natural hazard risks. Their case-study project in the Bay of Plenty examined the interplay between frequent flood hazards and less frequent but often catastrophic volcanic hazards. and has also established a first of its kind framework for integrating Te Ao Māori perspectives on hazard risks that make risk assessments more actionable by communities.

Our impact case-studies provide more detail across four main themes of impact, available [here](#).

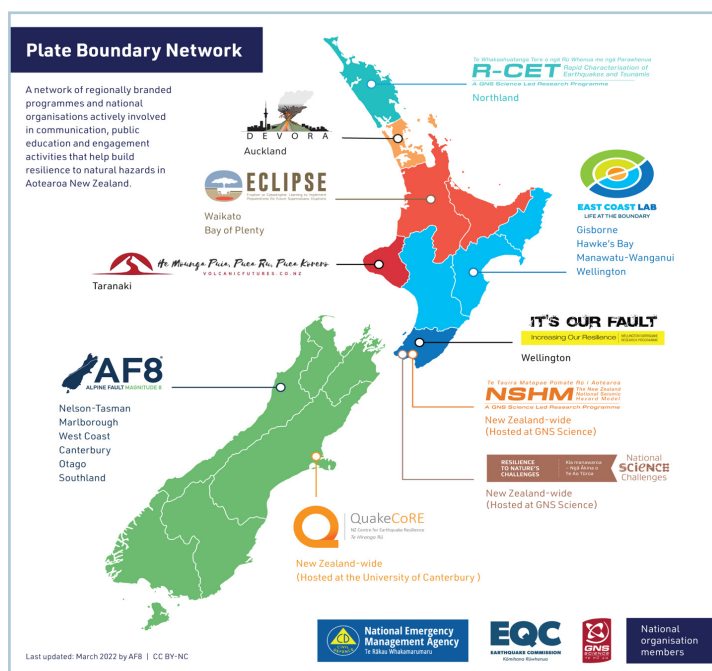
## Engagement for System Cohesion

Another element to supporting wider mission impact has been the role RNC has played as system facilitator, working across the boundaries of disciplines and organisations, often where a need exists but no one group has a clear mandate or resources. RNC saw this as enabling of enduring, system-wide impact for mission-led science, which has included creating opportunities across our ten research programmes, harmonising with research activities outside the Challenge, and connecting across the resilience policy and practice interfaces. While not explicitly part of our mandate as an NSC, there were important benefits from such coordination, including reduced gaps and overlaps across research, a less-fragmented science system for users, and added value for both new research and generating impact. This approach took the form of leadership across an area, topic or discipline, such as our Volcanoes programme which acted as a national hub across multiple research interests in volcanic hazards, including three Endeavours, CRI SSIF programmes, the Natural Hazards Commission, and the Auckland Council-funded DEVORA programme. In a similar way our Built Environment programme has acted as a hub across RNC and QuakeCoRE, for integrated connection with the engineering sector and government agencies. This coordination brings together researchers across these multiple programmes creating a community of practice, a forum for aligning objectives and identifying opportunities, and a unified culture for engagement with users and provision of advice. Working collectively in this way also builds the trust essential to successful coordination during high-stress responses to natural hazard events.

Another approach to expand RNC's reach has been partnerships with 'boundary organisations' focused on disaster resilience. A boundary organisation typically comprises a collective of scientists, decision-makers and practitioners that work to a set of shared objectives. RNC has a close partnership with the Alpine Fault earthquake preparedness and response planning programme AF8, providing direct support for science participation by our Rural, Urban, and Built Environment programmes. We are similarly engaged with East Coast LAB, DEVORA, and It's Our Fault, which operate in similar ways in other regions.

The value of well-coordinated, multi-disciplinary resilience science came to the fore in response to the severe weather events of January and February 2023. RNC researchers mobilised in the immediate aftermath to support science needs for the official and community responses, and to undertake time-critical data collection.

This included our Coastal programme scientists applying their new techniques to map coastline changes to inform hazard assessments for recovery planning, our landslide scientists contributing to the GNS Science field deployments to assess landslides as well as providing a recently-developed tool



Above: The Plate Boundary Network map highlighting the different natural hazards research programmes underway across Aotearoa New Zealand. The Network aims to strengthen relationships between programmes to improve information sharing and and public engagement with natural hazard science.

Credit: AF8, as at March 2022.



to forecast the likely extent of rainfall-induced landslides, our Built Environment team responding in support of council and lifeline utility providers such as NZTA and Transpower to understand impacts and enable restoration of services, and our social scientists providing commentary and advice on community needs, response and recovery challenges, and best practice risk communication.

In addition to RNC researchers' provision of advice, RNC as a collective was asked to contribute to national processes to identify post-event science needs and prioritise new research investments by MBIE. As part of this process the Extreme Weather Research Platform (EWRP) was established and RNC was asked to lead coordination for the new Platform projects.

## EXTREME WEATHER RESEARCH PLATFORM

FEBRUARY 2023 - JUNE 2024

The Resilience Challenge and Climate Sigma coordinated urgent scientific research and data collection as part of the ongoing response to extreme weather events in the North Island

**14**  
Projects

**5**  
Reports



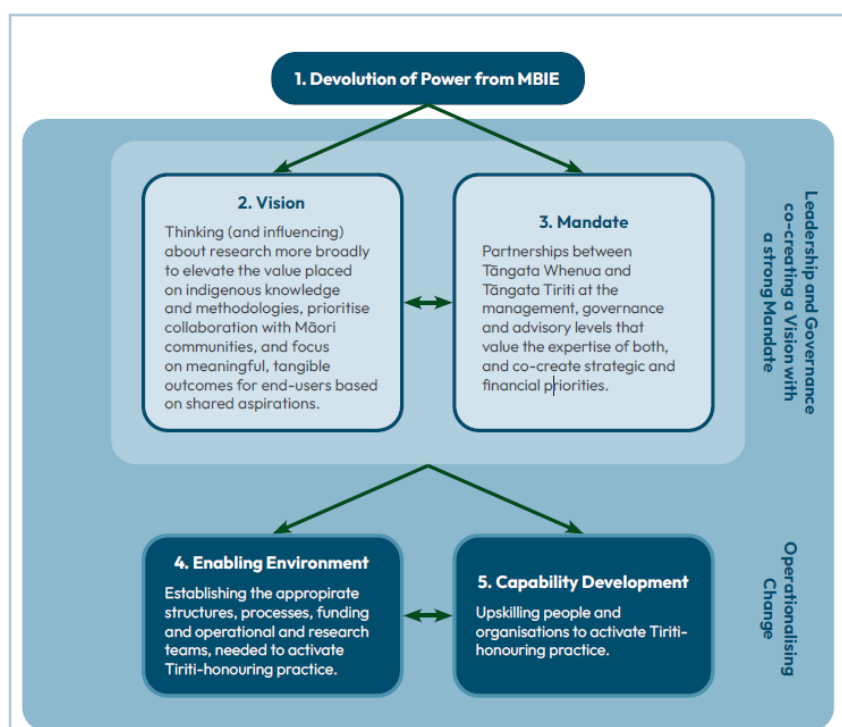
**5**  
Newsletters

**3**  
Policy Briefs

## The NSCs and Partnership with Māori

A defining feature across all the NSCs has been the stance taken on Māori partnership and participation in the science, and a focus on supporting Māori aspirations. An evaluation of the evolving approach across the ten-year history of the NSCs has been published jointly. The key enablers identified include:

- The devolved nature of funding and independent governance which allowed each Challenge to make their own decisions on how research was conducted
- The opportunity to create alternative visions of research that elevated the value placed on indigenous knowledge and methodologies, prioritised collaboration with Māori communities and focused on meaningful, tangible outcomes based on shared aspirations
- Establishing a mandate for change based on partnership at the governance, management and science leadership levels that jointly determined strategic priorities
- Investing in an enabling environment through structures, processes and resources and by upskilling people and organisations to activate Treaty of Waitangi-honouring practices



Above: Activating VM and Tiriti-honouring Practice within the National Science Challenges  
Credit: Te Tiriti O Waitangi Partnerships Enhances Research, Science and Innovation Report, National Science Challenges.

## SECTION TWO: CHALLENGE PERFORMANCE AND INVESTMENT SUCCESS

### Our Challenge-specific and common key performance indicators have all been met or exceeded.

#### Science Impact

The performance indicators to gauge our research impact were selected based on a jointly developed outcomes framework. This intervention logic linked Challenge activities and outputs with resilience-related impacts, through to their contribution to system-level outcomes such as reduced losses in future disasters.

RNC-specific measures for Science Impact (all achieved or exceeded) reflected the ability to quantify research contributions to shorter term impacts such as improved understanding of hazards and risks, development of tools and guidance to support better decision-making in management of risks (including in response and recovery), serving the aspirations of our Māori partners, and accelerating the take-up of research. These measures focused on the tangible development and utilisation of new knowledge by users through tools, methods and guidance. Examples include:

1. Improved understanding of natural hazard processes and their physical, economic and social consequences, thereby reducing uncertainty for scenario planning and development decisions;
2. Analysis of social and economic benefits and costs of resilience initiatives giving government agencies and infrastructure providers improved economic rationale for investment decisions;
3. Incorporation of new engineering design and retrofit solutions to make buildings and infrastructure more resilient; and
4. Development of processes to facilitate the incorporation of resilience science into risk-informed policy development (at the national level) and new practices (at the local level) that will avoid or reduce future losses from hazard events.

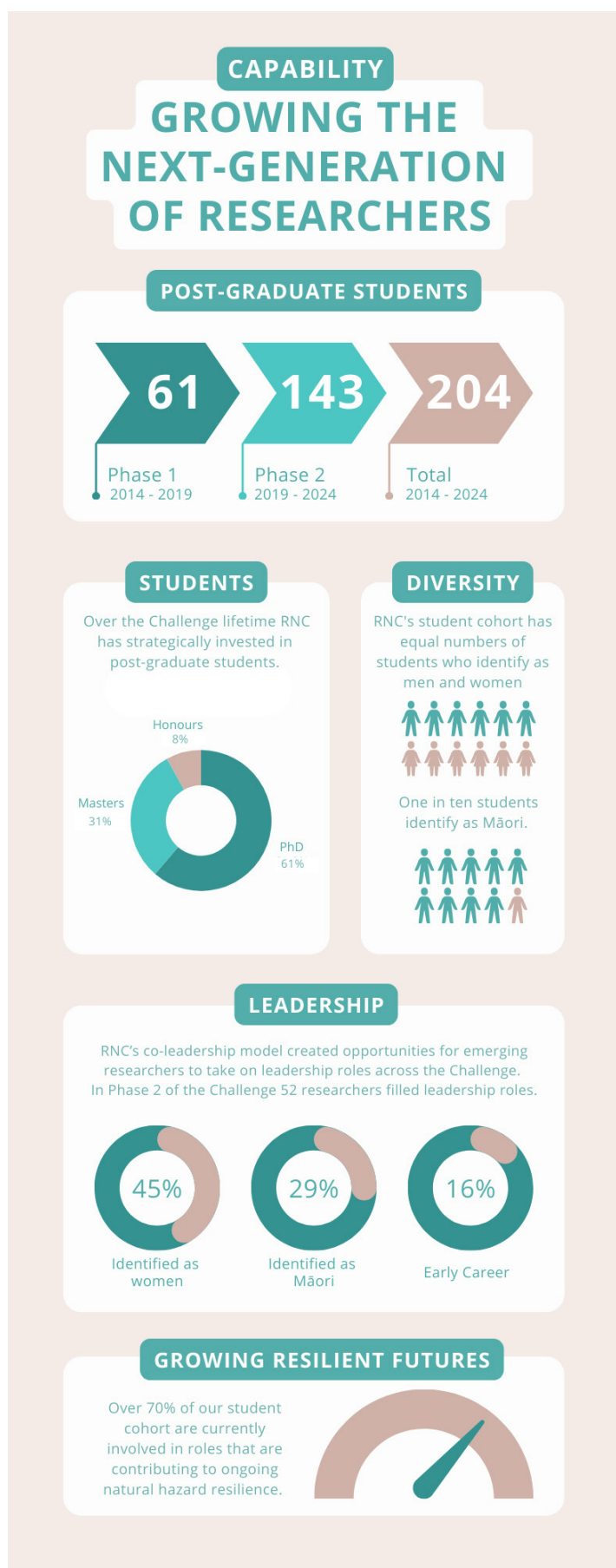


Above: View of Auckland skyline featuring the Nelson Street Cycleway. Credit: Stock.

## Capability – growing the next generation of resilience research leaders

A defining feature of RNC has been a strategy of investing in post-graduate students, with much research activity driven through the collective efforts of 61 post-graduate students in Phase 1 (39 PhD, 22 MSc), and 143 post-graduate student projects (89 PhD, 57 MSc) in Phase 2. With this diverse cohort, RNC has demonstrably grown national and international collaborative research capability in a variety of multi- and trans-disciplinary areas that support the national and global disaster resilience mission. By developing postgraduate research projects in close cooperation with end-user agencies, RNC has also lifted the knowledge and capability among policymakers and practitioners associated with these projects.

RNC capability building has also emphasised supporting emerging researchers, with many of our early-career Phase 1 researchers stepping up for leadership roles in Phase 2 of the Challenge. This was enabled through our co-leadership model for the ten Phase 2 RNC programmes. This provided diversity of thought across the science leadership, and also created development pathways for emerging leaders to take on more responsibility, supported by a more experienced senior research leader. Skill development for all our research team members has included effective science communication and user engagement, tikanga-based partnership with Māori, and the confidence to work collaboratively across the boundaries of disciplines and domains. Many of these promising early- and mid-career researchers are now well placed to step up for leading the continuation of collaborative resilience efforts beyond the Resilience Challenge.



## Science Excellence

All Challenge performance measures relating to science excellence have been achieved or exceeded, including the number of Challenge publications accepted by the top 25% of journals, the overall citation score of Challenge publications, and the number of publications ranked in the top 10% of citations. Science excellence was managed initially through the close involvement of an international science panel to inform the research objectives of the Challenge programmes, and through Phase 2 by the peer-review process associated with acceptance of over [700 RNC research articles](#) by international research journals.

## Best Research Teams

All Challenge KPIs relating to this performance area have been met or exceeded, including the proportion of publications resulting from international and domestic collaboration. Our science leaders and teams were selected on their acknowledged expertise relevant to the RNC mission, but also importantly, their ability to collaborate across the boundaries of disciplines and institutions, and work in partnership with users of our research. Feedback from stakeholders noted the high-standing of our researcher leaders valued for their public service contributions as well as academic success, as endorsed by the plethora of awards, and honours bestowed.

## Stakeholder Engagement

All Challenge KPIs relating to this performance area were met. Effective engagement with our research users has been integral to the success of the RNC mission. It ensured the research was supporting outcomes relevant to current and future needs, and that outputs could be used to deliver benefit for New Zealand. A focus on elevating relationships has also been a driver of the wider influence we have achieved across the research and resilience systems, the catalyst for new opportunities, and the impetus for accelerating research uptake.

## Vision Mātauranga

In addition to our quantitative performance measures in this area (all met or exceeded), RNC established additional strategic goals for serving Māori aspirations in resilience, and for building Māori research leadership capability. These goals included a focus on mana-enhancing partnership with hapū participating in RNC research, supporting leadership development and networks for RNC Māori researchers, and building capacity among RNC non-



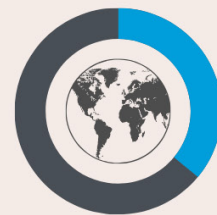
**47%**

of publications were in the top 25% journals  
(Baseline: 11)



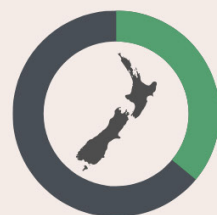
**23%**

of publications were in the top 10% most cited.  
(Baseline: 3.2)



**36%**

average international collaboration  
(Baseline: 28.1)



**47%**

average domestic\* collaboration  
(Baseline: 32.8)

*\*minimum of two NZ institutions represented*

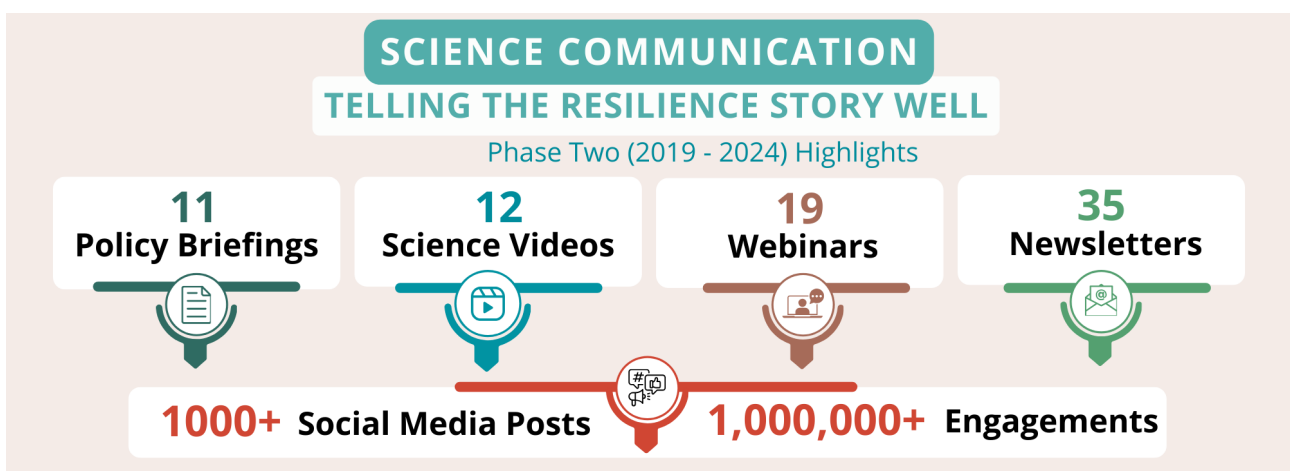
Māori researchers to partner effectively with mana whenua. Through the second phase RNC also moved toward shared decision-making through increased representation of tangata whenua on the RNC Governance Group. These strategies built trusted connections resulting in richer research outcomes and capability building which will endure and benefit all communities that are at the front-line of local responses to disaster events.



Above: RNC co-chairs, Jessica Hutchings (left) and Melanie Mark-Shadbolt (right) make opening addresses at 'Te Tai Whanake' RNC's end-of-challenge conference in May 2024. Credit: Dave Allen Photography.

## Science Communication

Another important factor for creating impacts for all NSCs was including mission-led science communication and engagement throughout the life of the research. Rather than focusing only on translation of science outputs, mission-led science communication sought to build a bridge between knowledge and context, translating in both directions between researchers and users, thereby increasing understanding for all participants and the likelihood of real-world impacts. Mission-led science communication and engagement expertise deepened and developed over the course of the NSCs, with a multiplier effect on impact across the work of the NSCs.



## SECTION THREE: HAS YOUR CHALLENGE ACHIEVED ITS OBJECTIVES?

### Resilience Mission

RNC's mission was to enhance New Zealand's resilience to disasters caused by natural hazards. Natural hazards (like earthquakes) are inevitable in New Zealand due to our active geological setting. However, disasters from these hazards can be averted if we make a choice to build resilience to minimise the worst social and economic distress. Inherent in the concept of disaster resilience is a combination of resistance, absorption, and adaptation. Progress towards enhanced disaster resilience requires understanding the nature and consequences of hazards, quantifying potential impacts and losses, developing cost-effective tools and solutions, and, crucially, having risk-aware governance at all levels that optimises treatment of risks across the options of avoidance (through land use choices), control (through engineering), transfer (through insurance) and acceptance of risk (through emergency preparedness). The contribution that research makes to enhancing resilience is naturally limited to evidence-based insights and solutions to help decision-makers understand the options and take well-informed actions with confidence. Science and engineering alone cannot lift New Zealand's disaster resilience, but collaborative, multi-disciplinary research is an essential ingredient to a resilient nation.

The severe weather of 2023 revealed (again) that New Zealand is highly vulnerable to natural hazards that destroy lives and livelihoods, leaving a legacy of social and economic disruption. The damage across the North Island reflects the baked-in vulnerability of our communities from decisions taken decades ago about what we built, where we built, and how we built, as well as an intergenerational failure to learn from past events. The ten years of RNC research has made tangible contributions to national resilience through the building of new knowledge and capabilities. This new knowledge is being applied to new developments (and rebuilding in post-disaster recovery), resulting in stronger buildings and infrastructure which will mean lower losses and less disruption in future events. Other RNC research is being applied now by agencies for faster and clearer communication of hazard warnings, and action messages in preparedness campaigns, contributing to measurable improvements in societal resilience. RNC research is also providing fresh insights and reduced uncertainty about disaster risks for individuals and organisations, increasing the value of investing in resilience for the long-term societal benefits of fewer disasters.

Beyond new knowledge, another measurable RNC contribution enhancing national resilience is the growth of a unified community of multi-disciplinary scientists, driven to work collaboratively with policy-makers and communities, on jointly developing local and system-wide solutions. The value of this capability for addressing current and future challenges from natural hazard threats is reflected in the new investment in a natural hazards and resilience platform which will build on the strong legacy of RNC and further progress the mission of enhanced resilience for New Zealand.



*Tamariki at Te Kura ā-Iwi o Torere practicing "taka, uhi, mau tonu" (drop, cover hold) nā Cassino Akuhata, Ngāti Haka-Patuheuheu, 2023. Overseen by Kelvin Tapuke, Massey University, Wency Rewi – Tumuaki, Te Kura ā-Iwi o Torere and Elsa Kupa – Kaiako, Te Kura ā-Iwi o Torere. Photo credit: David Johnston, March 2024.*



## Contact us

Resilience to Nature's Challenges

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