Strategic Science Investment Fund (SSIF) Case Study 2019-20
Platform 2 – Geological Processes and Hazards

Understanding a 'sleeping giant': research on the Hikurangi subduction zone

High-impact research into the past and present behaviour of Aotearoa New Zealand's largest and most active fault – the Hikurangi subduction zone – is producing invaluable information. The aim is to provide more reliable risk and hazard forecasts and drive better community preparedness.

The Hikurangi subduction zone is where the Pacific tectonic plate dives beneath the east coast of the North Island. A rupture can produce large earthquakes and tsunamis, and a significant event could strongly impact our largest population centres including Auckland, Wellington and Christchurch.

Since 2016, through our MBIE SSIF programmes, a five-year MBIE-funded Endeavour programme and other research funding, GNS Science has been leading several onshore and offshore projects investigating the behaviour of the Hikurangi subduction zone. This work is advancing our knowledge about the earthquake potential of the plate boundary and the physical processes behind it.

Our collaborations with national and international partners, community engagement, papers published, and significant contributions from early career scientists have all contributed to the impact of our research in this area.

Over time, the knowledge from these GNS-led research programmes will enable more reliable forecasts of the hazard and risk which the subduction zone poses to Aotearoa New Zealand.

Building public awareness and resilience

As our research on the Hikurangi subduction zone progresses, we share our findings to build awareness of the active fault and resilience to the potential earthquake and tsunami impacts. To do this, we have partnered with East Coast Life at the Boundary (LAB), a programme that brings together scientists, emergency managers and other experts, with communities along the North Island's East Coast.

This year we invested considerable effort in public engagement and education, with our scientists joining forces with NIWA and East Coast LAB to present talks in 11 communities in the North Island, reaching more than 1100 people. Whilst undertaking fieldwork in the region, our scientists have also been involved with school fieldtrips and educational visits to East Coast schools, which we hope will help to inspire the next generation of scientists.

We contributed to the development of the Hikurangi Response Planning Toolbox, working alongside Civil Defence and Emergency Management groups who are planning for a magnitude 8.9 Hikurangi subduction zone earthquake and tsunami. News media interest in the work has been very high, with more than 150 articles focused on the research since the programme began.

Strong international collaborations

Our deep partnerships with international research institutions have helped cement this country's reputation as a focal point for the investigation of subduction plate boundary processes. For example, the high-quality research and datasets created by GNS Science have led to Aotearoa New Zealand being one of three global focus sites for subduction zone research under the US National Science Foundation GeoPRISMS programme.

This year, GNS Science embarked on two projects with Japanese collaborators, the first investigating the parallels between subduction zones in north-east Japan and Aotearoa New Zealand. A key aim of this project is to improve understanding of what causes earthquakes on both subduction zones. This new work will help to shed light on the types of earthquakes that might be expected from the Hikurangi fault in the future. In the second project, scientists from GNS Science and Tokyo Institute of Technology, in collaboration with Chorus Ltd, installed instruments to measure the Earth's natural magnetic and electrical fields at sites across the Gisborne region. These measurements will be used to create a three-dimensional image of the Hikurangi subduction zone and to improve understanding of the earthquake and tsunami risk to the East Coast.

This global interest in our subduction zone has helped attract around $70 million worth of international investment in science focused on trying to understand the Hikurangi subduction zone.

Growing body of research and capabilities

The activities in our SSIF programmes and Hikurangi Endeavour programme build on knowledge developed from decades of previous research by GNS Science. We are now expanding into frontier areas of research for Aotearoa New Zealand including scientific ocean drilling, seafloor geodesy, and using offshore sediment cores to reveal prehistoric subduction earthquakes. In addition, more than a dozen early career scientists and students are being trained in skills such as undersea earthquake monitoring techniques, imaging the subduction zone, and using sediment cores to investigate past earthquakes, which will enhance our country's scientific capability base.

In the past year, more than 20 papers have been published in international journals, bringing total publications on the Hikurangi subduction zone (stemming from GNS SSIF and Endeavour fund programmes) to more than 40 to date.

The NZ National Seismic Hazard Model is currently being updated and revised in partnership with MBIE and EQC, work on this started in May 2020 and will be delivered in mid-2022. Our researchers are incorporating geodetic data gathered under the GNS *Understanding Zealandia* SSIF programme and its predecessors into the NZ National Seismic Hazard Model (NSHM). This will be the first time that geodetic data has been incorporated fully into the New Zealand NSHM and new approaches are being developed to do this. The vast majority of information being used to characterize the Hikurangi subduction source for the NSHM and the geodetically based source model was funded by MBIE SSIF under our Understanding Zealandia and Hazards Risk Management programmes and their predecessors, and our MBIE Endeavour 'Hikurangi subduction earthquakes and slip behaviour' programme. Ultimately, the research from these programmes will feed into initiatives such as New Zealand's National Seismic Hazard Model and has developed new capability to enable monitoring of our offshore active faults. This is an excellent example of using underpinning scientific findings to inform hazards planning.

Our collaborators and funding

The Endeavour funded Hikurangi programme and our SSIF programmes involve multi-disciplinary collaboration between GNS Science, NIWA, Victoria University of Wellington, Canterbury University, Otago University, the University of Auckland, East Coast Life at the Boundary (LAB), and iwi/taiwhenua partners. In addition, there is an extensive network of international collaborators in the United States, Japan, the United Kingdom and Europe.

This research is funded by SSIF (approximately 33%), Endeavour (approximately 33%), and other funding (approximately 33%) which includes international investment for activities such as drilling and some of the offshore work.

End-user Commentary

Research on the 'sleeping giant' has galvanised action

This research programme, to better understand Hikurangi subduction earthquakes and slip behaviour, has put a spotlight for the Hawke's Bay Civil Defence Emergency Management Group on the sleeping giant just off our shore.

While recognised previously, it is fair to say the Hikurangi subduction zone has been poorly understood and underestimated. Yet this research has clearly established it is potentially the largest source of earthquake and tsunami hazard in New Zealand, which poses a significant threat, being capable of producing a catastrophic disaster for the country, similar to the 2011 Tōhoku Japan event.

Therefore, the work gathering geological and historical evidence of large Hikurangi earthquakes, detecting offshore earthquakes, and better understanding slow slip events to reveal New Zealand's offshore plate tectonic movements for the first time, is hugely significant. GNS Science is to be commended for this work.

The importance of this research is immense. It has galvanised action across Civil Defence Emergency Management Groups along the east coast, bringing emergency managers and scientists together to better understand the information needed and the key interdependencies to plan for something our communities have never experienced.

This is incredibly beneficial, as understanding this risk enables our communities to identify potential consequences ahead of time. This allows us to better anticipate what might happen in the future, to help minimise losses and, we hope, ultimately it will save lives.

Lisa Pearse
Team Leader, Hazard Reduction, Hawke's Bay Civil Defence Emergency Management Group; and Chair of East Coast Life at the Boundary