Simon Upton, Keynote address, 24 November

GSNZ Annual Conference 2025: Learning from the past – shaping the future

The importance of earth sciences to managing our environment

I'm one of those casualties of the school system for whom the abstraction of the mathematical sciences proved a bar too high to clear even with sympathetic teachers. I bailed out for the nebulous and unaccountable world of humanities, law and philosophy. But if I could have my time again, I would be an earth scientist. Particularly in a country like New Zealand, it is hard not to be enthralled by landforms, and my brain certainly works spatially. As long as I can remember, New Zealand has been a source of geological encounter.

When I was a kid, geology was about rocks, landforms and the way they have come to be the way they are. Over my lifetime, geology has become 'earth sciences' – a vast field with few boundaries. Basically, you can add the prefix 'geo' to almost any science discipline – physics, dynamics, chemistry, chronology and morphology – and you have a "**geo**science". Geologists have been good colonisers!

The earth sciences are just about impossible to disentangle from almost any of the environmental challenges we are dealing with – managing water, soil, mineral extraction, biodiversity and climate. And living along an active plate boundary, makes earth sciences central to managing natural hazards.

In short, earth sciences cut across huge areas of national life. Policy decisions, you would hope, draw on scientific knowledge and the information and data that flow from that knowledge. Some of you will be familiar with my relentless plea for comprehensive, freely available environmental data. This is because data and policy development are intrinsically connected.

Let me run through a non-exhaustive list of how earth sciences manifest in New Zealand's daily life. I'm sorry if this is telling you things you already know but I thought it would be valuable to pull this list together so that a wider audience is aware of the investments we have made as a nation and what is at stake if they are put at risk.

I've already mentioned **natural hazards**. This includes everything from the fundamental study of natural and physical active geological processes that underpin natural hazards, to applied event prediction, including modelling, monitoring, early warning and recovery. We have thought long and hard in New Zealand about how to respond to these threats. But the same research base is needed to drive the economy – **infrastructure development** from simple residential building sites to complex developments, such as the Auckland City Rail Link, new motorways or hydro developments – all need robust geological and geotechnical information.

As a result, we are rich in models and databases rooted in the earth sciences. Nine out of the 26 Nationally Significant Collections and Databases are directly associated with earth sciences**.** That on its own, says something about the importance of earth sciences.

Let me run through some of these Nationally Significant Collections and Databases and some others that New Zealand uses on almost a daily basis (the list is not exhaustive!):

- The **Geological Map of New Zealand collection** and the **digital Q-map** provide the foundational geological information needed on the entire spectrum from blue-sky research to engineering development. The Q-map 1:250,000 scale may however be too coarse to go as far down as property-based management.

- The **National Earthquake Information Database** enables us to analyse seismic recording over the region and feeds directly into risk assessments and supports emergency readiness. This information strengthens decisions on infrastructure investment and community resilience planning.

- The **New Zealand Active Faults Database** and the **National Seismic Hazard Model** provide authoritative information on fault locations, slip rates and likely shaking intensities. They form the backbone of land-use planning, engineering standards and building-code requirements over the motu. Together, they ensure development is aligned with the level of seismic risk.

- The **New Zealand Landslide Database** consolidates national information on more than 110,000 mapped landslides. It provides the evidence needed for landslide-susceptibility assessments and supports regional hazard mapping. This helps councils and developers make safe, defensible decisions about zoning, infrastructure and climate-related adaptation. I understand that it is currently undergoing a major upgrade.

- **S-map**, the digital soil map for Aotearoa, delivers the high-resolution soil information needed for smarter land-use, from water-holding capacity to nutrient-leaching risk. Regions not covered by S-map – still almost half of the country – rely on outdated information. Expanding S-map would dramatically lift the quality of environmental and farm-system decisions across New Zealand.

- The **National Groundwater Monitoring Programme** combines hydrogeological, geochemical and geophysical data to help the monitoring of New Zealand's aquifers. Together with the **Geothermal and Groundwater Database** and the **Hydrogeological Unit Map**, it provides the backbone for managing groundwater quantity, quality and long-term security. This is essential for freshwater modelling, allocation decisions and climate-change resilience.

- Likewise, the **National Digital River Network** provides essential spatially consistent maps of river pathways and catchment connections, to support everything from flood modelling to freshwater accounting. This is a critical link between earth sciences and freshwater management.

- The **New Zealand Bathymetry Database** provides the essential map of our vast seafloor, underpinning coastal management, marine hazard assessment, benthic habitat mapping and marine spatial planning. High-quality bathymetry is fundamental for everything from marine conservation to infrastructure, resource assessment and safe navigation. It underpins the EEZ Act, the RMA and Marine and

Coastal Area (Takutai Moana) Act. It is worth noting that a large part of our enormous Exclusive Economic Zone is only available at a 250 metre resolution or coarser. We still do not know in detail the territory for which we are responsible.

- **Petlab**, New Zealand's national rock, mineral and geoanalytical database, provides information needed to make critical decisions on the future of our energy resources, whether it be fossil fuels, minerals, geothermal energy, natural hydrogen or hydroelectricity.

- Paleoclimate records derived from the **National Paleontological Collection**, **the Fossil Record Electronic Database (FRED)**, core archives of marine, and lake sediments and the ice core collection offer irreplaceable windows into past climate shifts. These databases provide information that is essential to forward-looking climate modelling.

- High-resolution, probabilistic sea-level rise projections from tools like the **NZ SeaRise database** give councils, infrastructure providers and communities the site-specific information they need for effective coastal adaptation planning.

All of these data bases – and many more – are on my mind as I consider what changes to New Zealand's publicly funded science system will mean for environmental research. One of my key roles, as set out in the Environment Act of 1986, is to maintain a watching brief over the system of agencies and processes the Government uses to manage our environment. I consider environmental research to be an absolutely foundational element of our environmental management system – possibly **the** most important building block.

The Government has established a Prime Minister's Science, Innovation and Technology Council (the **PMSITAC**) and is in the process of establishing something called **Research Funding New Zealand** which will be the entity that actually allocates research grants.

The PMSITAC was formally established in January this year. It is charged with ensuring that the science system is driving economic growth and in particular:

- identifying focused priorities
- identifying areas that could be deprioritised
- identifying opportunities for commercialisation
- ensuring that the science, innovation and technology system is aligned with New Zealand's economic strategy.

The emphasis seems to be about emerging technologies, commercialisation barriers, and aligning with investments to economic and societal outcomes. There is no reference to the environment in there. The PMSITAC will shortly propose priorities for public research funding, which will then be actioned by Research Funding New Zealand. MBIE describes the new arrangements as an outcomes-focused funding framework "built around four pillars aimed at driving economic growth and delivering tangible results for New Zealand." The four pillars are economy, health and society, technology, and environment.

I welcome a more transparent statement about what the Government's research priorities are. They have been lost sight of in our current, absurdly competitive system. My attention will obviously be focused on the priority accorded to the environment pillar. This pillar is less likely to attract private sector funding than some of the others. For that reason, environmental research of a public good nature should be clearly designated as a core governmental responsibility with a very long-term focus. The fact is that most of the environmental challenges we face today are not going to go away. We are going to have to learn how to live with them. That means having enduring research priorities that can support the human capital, i.e. the research workforce needed to meet the challenge.

I will be monitoring very closely how money is shifted around. The adequacy of the investment made in environmental science broadly defined is of critical national importance. Environmental research is not 'nice-to-have' research. It is almost entirely of a defensive nature – we are constantly reacting to economically and socially costly environmental outcomes that we need to be able to understand.

After I leave you today, I'm going to meet the MPI team who are responding to the arrival of the Asian yellow-legged hornet. These are very nasty hornets that can destroy beehives and kill people. What's the priority – an economic one, a social one or an environmental one? I'm less interested in the label than the fact that we have topflight researchers who can react to these sorts of events.

It will be interesting to see what areas for deprioritisation are identified by the PMSITAC. When it comes to environmental research, I think it would be naïve to believe that large sums of money are being wasted and are ripe for reallocation. It would be even more naïve to believe that cutting environmental research funding comes at no cost. As a remote economy heavily dependent on natural resources, we ignore the importance of environmental research at our peril. Indeed, the Government faces huge fiscal risks if we get this wrong. Let me provide a few examples.

Following Cyclone Gabrielle, the government spent $110 million cleaning up the debris in Tairawhiti alone. The local council has so far spent another $138 million fixing its infrastructure. Soil erosion and landslides are estimated to cost the country between $250–300 million per year. This number will continue to grow with climate change if we can't secure our highly erodible land. The Gisborne District Council is asking for government help to retire 10–15% of its total land area to permanent native forest at a cost of $359 million. To do something similar in other areas requires finely grained mapping of highly erodible land that is connected to waterways.

The central government response to the North Island Weather Events cost us just shy of $2.5 billion. Looking forward, climate change could hand us a bill of around $200 billion for residential properties alone. The impacts on infrastructure, businesses or productive land are on top of that. To contain those costs, we need to double down on our research efforts and provide local communities with an understanding of the risks they face and the options they have to mitigate them.

Pasture based industries are worth around $38 billion to New Zealand's economy. For all the value that our soil generates, we know shockingly little about the state and trend of its condition. The impact of different land uses on soil health, biodiversity, pesticide residues and microplastics are all large gaps in our knowledge. This is particularly concerning given that growth in pasture productivity has stalled and, in some areas, is going backwards. We don't know why, but as a biological economy we need to find out fast.

The Havelock North drinking water affair resulted in over 5,500 people falling ill and three deaths. It is a tragic example of what poor understanding of groundwater systems can lead to. The Government's inquiry into the event found that the Regional Council's understanding of the aquifer and catchment contamination risks fell below required standards. Deficient knowledge in that case cost lives. With over $2 billion being spent every year on water infrastructure, we need to make sure decisions are based on good information.

Last but not least, the Clyde High Dam, which goes back to my earliest days as a (very) young MP. It was committed and half built before the risks posed by potential landslides were properly understood. The bill to derisk the project was over $400 million – a colossal sum in the late 1980s. No one wants to spend more time approving projects than is necessary, but without good information some decisions will be ones we will live to regret.

I have been trying to ascertain how much we spend on environmental research at present. In December 2020, I released a report entitled, "*A review of the funding and prioritisation of environmental research in New Zealand*".[1] While this is now five years old – almost to the day – I believe some of its recommendations remain pertinent today.

At the time, I developed two definitions of environment science – a broad one and a narrow one – based on the Australian New Zealand Standard Research Classification (ANZSRC). Using a narrow definition, we obtained a level of public investment back then of about $427 million per year in 2019, while a broader definition suggested spending of anything up to $516 million.

This Sankey diagram disaggregates what we know about public research expenditure by key government agencies and what environmental domain it supports based on the 11 Socio-Economic Outcomes (SEO) classes that underlie the broad definition of the environment. In the intermediate bands you will recognise MBIE funding mechanisms. This is for the 2018/19 financial year. The graphic represents only one year of data and needs to be interpreted with some caution because of a lack of consistency in reporting and classification of environmental research by different institutions. As you can see, we have no idea how what tertiary sector environmental research expenditure contributes to in terms of outcomes. It is the best we could do.

More recently MBIE has provided me with total research expenditure by funding mechanism for environmental science from 2018/19 right to the present with some projections out to 2029/30.

Between 2020/21 and 2023/24, the average total spending on environmental research was **$262.5 million.** The interesting question is what is going to happen between now and 2027/28. As you can see, a funding cliff opens up then. That's because the main CRI SSIF platforms will be renegotiated. The majority of GNS, NIWA and Manaaki Whenua Lancare Research SSIF platforms along with other CRIs, have significant environmental components. To what extent will those platforms continue to support environmental research between now and 2027/28 and then beyond is unknown. It all depends on the current prioritisation exercise.

Our work enables us to look at that spending in terms of environmental outcomes. All CRIs have SSIF programmes focusing on aspects of climate change. For example, GNS is working on **Global Change Through Time**. In the land and freshwater domain, Manaaki Whenua is working on soil carbon, erosion and sedimentation processes, while GNS and ESR are

[1] https://pce.parliament.nz/publications/environmental-research-funding-review/

working on groundwater. Work in the coastal and marine domain is led by NIWA and GNS, for example, their **Marine Geological Processes** and **Understanding Zealandia** programmes. All of which may terminate in 2028. How and where this funding will be reallocated is of critical importance. Will the Research Funding New Zealand environment pillar continue to support the investments we have sustained over decades? Will money be redirected to the pot of gold that is believed to lie at the end of the rainbow beneath the economic pillar? Or might environmental research be relabelled?

It is hard to say how much of our current spending is devoted to earth sciences. If we knew, we would – I am sure – identify research that contributes both to economic development and to environmental management. A first 'back-of-the-envelope' estimate undertaken by my staff last week using ANZSRC codes for earth science gives a number of around **$100 m** in 2022/23. This will not all, by any means, be regarded as environmental science. I can't tell you how much will feed into the environment and economic pillars. I don't care much about the labels. What matters is that we protect the investments we have made in understanding how our slice of the earth's surface fits into the earth systems that drive life on this planet.

Whatever decisions the new funding entities make, they will have consequences for the science workforce. Some sectors of science are by nature international, forcing us to rely on overseas collaboration. But the landmass and oceanic environment in which New Zealand is situated is remote. Human arrival on these islands over the last 800 years has set in train a profound ecological upheaval. The truly distinctive geo-biodiversity that surrounds us means that much of our science must be home-grown. Some fields of environmental research are specific, if not unique, to New Zealand and take time to build. Sir Peter Gluckman wrote in his April 2025 SSAG report that "Due to decades of underinvestment, the New Zealand science system is extremely fragile and vulnerable." Environmental science has lots of corners where resident expertise lacks critical mass and, in some cases, may be **one-scientist deep**. This expertise is at risk of being lost. If it is, it will not be easily recreated.

Collection curators along with taxonomists are very thin across flora and fauna. So too for palaeontological collections. This is foundational for conservation science, biosecurity and ecosystem restoration. Many national collections (museums and herbaria) depend on single curators or taxonomic experts — a retirement or redundancy can effectively erase capability. Expertise in cetaceans or passive acoustics is only available in the university or the private sector.

A transparent funding system must track and value the researchers themselves and track how reforms affect staffing, career stability and inter-generational capability in environmental domains.

From the information provided by MBIE, I estimate that in 2023/24 there were **291 FTEs** in environmental science. This number only includes MBIE funding for environmental research, so to this you would need to add academic researchers. To put this number in perspective, it represents about 25% of the 1,200 or so staff employed by Earth Science New Zealand. I don't know whether it is low or high or whether it represents critical mass. We need to do more work. But the numbers suggests that our entire environmental management capability rests on a pretty small human research capability.

We will hear very soon from the PMSITAC about their recommendations, and how science prioritisation – and indeed deprioritisation – could affect these numbers and environmental research in general. I will be applying a critical eye to the criteria that will be used to determine the relative allocation of resources to the four pillars by Research Funding New Zealand. I plan to publish a report, probably in 2027, on where public research funds have been moved and what any change to the prioritisation of environmental research will mean for our ability to manage environmental challenges.

A forthcoming reform that will rely heavily on the quality of environmental information and upstream research is the replacement of the RMA with a Spatial Planning Act and an Environmental Protection Act. The reform will rely heavily on high quality information. I'm particularly interested in what new research priorities will mean for generating that information and the research that lies upstream of it. Changes to resource management law are designed to place more emphasis on spatial planning and more reliance on permitted uses (with pre-ordained conditions) than individual resource consents. That requires much better information than we currently have.

One of the things that has held up developments large and small has been the absence of reliable, accessible, freely available information. There is no shortage of raw data, but methodologies, time series and standards are not always coherent or up to date. Early this year, I put forward an argument for pursuing a federated data system for environmental information as a means of helping coordinate the many disparate datasets and collection programmes that currently exist.

By using shared standards, policies and protocols, coupled with clear governance arrangements, we could unlock the treasure trove of information that we have collected as a nation. The main advantage of pursing a federated data system is that it balances authority between central oversight and local ownership and control of data. It allows organisations to collaborate and share resources without giving up control of the data they hold.

We also need – in parallel – the more systematic adoption of new technologies to improve, speed up and minimise the costs of acquiring, processing and interpreting environmental data. Early next year, I will release the result of an investigation on the options available for improving New Zealand's environmental monitoring system. Recent technological advances in remote sensing, artificial intelligence and e-DNA – that most of you are probably using on a daily basis – can assist in improving our existing environmental monitoring, whether it be by filling spatial data gaps, increasing the resolution of coverage or developing high-frequency sampling. However, many challenges remain to develop and deploy such technology at scale and within the limits of ever tightening budgetary constraints.

I hope I've given you an idea of some of the work I have done, and am doing, to ensure that the importance of environmental research is well understood. I've used examples from the earth sciences. Had this been an audience of ecologists or biosystematists, I would have used different examples. But the message would be the same: public good, environmental research is absolutely foundational to our ability to manage the environment on which we depend, economically and socially; and failing to maintain that investment and the workforce it represents will carry heavy costs.

I wish you all a successful conference.