

# Highlights from the National Science Challenges





*The Highlights from the National Science Challenges was produced by the Ministry of Business, Innovation and Employment, in consultation with A Better Start, Ageing Well, Building Better Homes Towns and Cities, Healthier Lives, High-Value Nutrition, New Zealand's Biological Heritage, Our Land and Water, Resilience to Nature's Challenges, Science for Technological Innovation, Sustainable Seas and The Deep South.*

#### **Crown Copyright © 2018**

This publication is protected by copyright owned by the Ministry of Business, Innovation and Employment on behalf of the Crown. Unless indicated otherwise, copyright material in this publication is licensed for re-use under a Creative Commons Attribution 4.0 International Licence. In essence, you are free to copy, distribute and adapt the material, as long as you attribute it to the Ministry of Business, Innovation and Employment and abide by the other licence terms. Please note that this licence does not apply to any logos, emblems and trade marks, or to any photography, or to any material that is identified as being protected by copyright owned by a third party. These items may not be re-used without express permission from the Ministry of Business, Innovation and Employment or the relevant copyright holder (as applicable). CC-BY 4.0 International license terms apply.












#### **Disclaimer**

Views expressed in this document, unless indicated otherwise, are those of the Ministry and do not reflect government policy. This document summarises information gathered during a preliminary study of the role of copyright and registered designs in the creative sector in New Zealand. Readers should seek advice from an appropriately qualified professional before undertaking any action in reliance on the contents of this document. The Crown does not accept any responsibility whether in contract, tort, equity or otherwise for any action taken, or reliance placed on, any part, or all, of the information in this document, or for any error or omission in this document.



ISBN 978-1-98-853560-9 (online)  
ISBN 978-1-98-853559-3 (print)  
MB14381

# Content

	<b>A Better Start   E Tipu e Rea</b>	<b>7</b>
	Highlights	8
	Case Study: What 'Big Data' Tells Us About Obesity in 4-year-olds	9
	<b>Ageing Well   Kia eke kairangi ki te taikaumātuatanga</b>	<b>10</b>
	Highlights	11
	Case Study: Drug Burden Index	12
	<b>Building Better Homes, Towns and Cities   Ko ngā wā kāinga hei whakamāhorahora</b>	<b>13</b>
	Highlights	14
	Case Study: Valuing Sunshine	15
	<b>The Deep South   Te Kōmata o Te Tonga</b>	<b>16</b>
	Highlights	17
	Case Study: First Antarctic Study of Sea Ice Thickness	18
	<b>Healthier Lives   He Oranga Hauora</b>	<b>19</b>
	Highlights	20
	Case Study: Biomarkers for Cancer Detection	21
	<b>High-Value Nutrition   Ko Ngā Kai Whai Painga</b>	<b>22</b>
	Highlights	23
	Case Study: a2 Milk™ for Gut Comfort	24
	<b>New Zealand's Biological Heritage   Ngā Koiora Tuku Iho</b>	<b>25</b>
	Highlights	26
	Case Study: I Smell You: A Super-lure for Stoats	26
	<b>Our Land and Water   Toitū te Whenua, Toiora te Wai</b>	<b>28</b>
	Highlights	29
	Case Study: Stock Exclusion and Water Quality	30
	<b>Resilience to Nature's Challenges   Ngā Ākina o Te Ao Tūroa</b>	<b>31</b>
	Highlights	32
	Case Study: Infrastructure Network Resilience Framework	33
	<b>Science for Technological Innovation   Te Ao Pūtaiao me Te Ao Hangarau</b>	<b>34</b>
	Highlights	35
	Case Study: Next Generation Health Care Systems	36
	<b>Sustainable Seas   Ko ngā moana whakauka</b>	<b>37</b>
	Highlights	38
	Case Study: Hui-te-ana-nui: Understanding Kaitiakitanga in our Marine Environment	39

# Minister's foreword

As Minister of Research, Science and Innovation, it is my pleasure to present this publication highlighting the progress New Zealand's science community has made towards addressing the 11 National Science Challenges.

The Challenges, established in 2014, aim to tackle the biggest science-based issues and opportunities facing New Zealand, bringing together the country's top scientists to work collaboratively across disciplines, institutions and borders to achieve their objectives. The Challenges cover an array of issues facing New Zealand, from diabetes and natural disasters to sustainable management of our seas.

Across the Challenges, over 150 projects are underway. An impressive number of achievements have been reached in 2016/17, for instance:

- › **New Zealand's Biological Heritage** has worked closely with researchers and Challenge partners to connect research that will enhance and protect New Zealand's biodiversity. The Challenge has shown leadership in its ability to strengthen links between Challenge research and biodiversity, biosecurity and ecosystems research occurring outside the Challenge (e.g. Predator Free 2050). Their success is illustrated by aligned research now totalling four times the value of Challenge funding.
- › Substantial progress has been made by **Science for Technological Innovation** researchers who are bridging the gap between their research ideas and the industries that can commercialise these ideas. The Challenge is working with researchers to lift communication standards and improve scientists' ability to describe research using terminology that industry and other end users can understand.

For New Zealand to be successful in the 21st century we must continually innovate. We must respond and adapt to the challenges we are facing, and we must look for new solutions to old problems.

This Government has a vision for a high wage, high productivity economy that is driven by innovation. One that is leading the world on renewable energy and is net-zero carbon by 2050. To achieve a major shift like this will require us to marshal all of our expertise, our creativity and our resources.

In a world that is becoming more interconnected than ever, we must be willing to pull together. This is precisely what our Challenges are successfully doing, and why they are so crucial to making our science system cutting-edge and integrative.

The scientists who are the lifeblood of that system need strong support and stability to focus on performing the excellent and high impact research we need to address the challenges New Zealand faces. To that end the Government will continue to invest in the National Science Challenges, with the option to consider further Challenges as the need and opportunities arise. This stability will enable our Challenges to continue their excellent research and deliver on their objectives.

I congratulate all the Challenges on their achievements so far, and look forward to continuing to work together to ensure a better New Zealand for all through science and innovation.



Hon Dr Megan Woods  
Minister of Research, Science and Innovation

# Tēnā koutou

The 11 National Science Challenges focus science investment on issues that matter to all New Zealanders. The National Science Challenges are cross-disciplinary, mission-led programmes designed to tackle New Zealand’s biggest science-based challenges. They require collaboration between researchers from universities and other academic institutions, Crown Research Institutes, businesses and non-government organisations to achieve their objectives.

A core part of our Government’s investment in science, just over \$680 million of funding over ten years, will be invested in the Challenges. Individually launched between 2014 and 2016, the Challenges are gaining momentum and delivering strong science. The Challenges focus heavily on mahi tahi, fostering strong partnerships with end users from New Zealand and abroad.

The Challenge research also gives effect to the Government’s Vision Mātauranga policy, a framework that aims to unlock the innovation potential of Māori knowledge, resources and people to assist New Zealanders to create a better future.



# Challenge Principles

The Challenges represent a new way of funding research and the five key areas below detail the principles that make them unique:



---

## Mission-led

---

Each Challenge is **mission-led** and will focus research on achieving the Challenge objective and outcomes.

Each research plan will provide a credible **impact** pathway of research and related activities to achieving the outcome of the Challenge.

The Challenge approach is used where **additionality** (additional research, progress, and impact) can be generated by collaborative research.

---

## Science quality

---

Each Challenge will be **dynamic** and will include mechanisms to bring in new ideas, researchers, and research providers to refresh the Challenge.

Each research plan will involve identifying and selecting the **best science** to address the Challenge.

Critical research capabilities including Mātauranga knowledge need to remain dynamic and must continue to be built and evolve to maximise outcomes for New Zealand.





---

### Best research team collaboration

---

Each Challenge will involve purposeful **collaboration** between researchers across a number of research providers to address the Challenge.

Each Challenge will be clearly linked with **international research** activity that will support the achievement of the Challenge.

Each Challenge collaboration will bring together New Zealand's **best team** to address the Challenge.



---

### Stakeholder engagement & public participation

---

Each Challenge will involve **public outreach** and will exhibit strong **engagement** between researchers and intended end users of the research activity, including, where appropriate, obtaining investment from end users in the Challenge's research.



---

### Māori involvement and mātauranga

---

All Challenge research will give effect to the **Vision Mātauranga** policy.

# Showcase

This publication highlights the progress of the Challenges and showcases examples of their research in 2016/17 as they strive to achieve their objectives.

**11** | National Science Challenges



\$681m

ALLOCATED FUNDING OVER  
10 YEARS FOR THE CHALLENGES



157

CHALLENGE PROJECTS OR  
PROGRAMMES OF WORK UNDERWAY



430

CHALLENGE PUBLICATIONS  
REPORTED



\$150m

OF ALIGNED PROJECTS  
CALCULATED BY THE CHALLENGES



323

FTES ACROSS  
25 COLLABORATION PARTNERS



## A BETTER START

E Tipu e Rea

### Objective

To improve the potential of young New Zealanders to have a healthy and successful life.



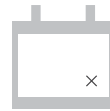
\$34.7m

UP TO \$34.7 MILLION  
FUNDING OVER 10 YEARS

### The Challenge is...

working to ensure young New Zealanders have a healthy weight, are confident at reading and learning; and that teenagers have greater access to evidence-based interventions for mental health issues.

To achieve this objective, the Challenge is researching improved methods and tools to predict, prevent and treat obesity, and is identifying and addressing learning and mental health problems in children and teenagers. The Challenge's research strategy is new for New Zealand as it will target children early, engage their communities, draw together different disciplines, and take a holistic approach to obesity, learning, and mental health difficulties, which are frequently studied in isolation. The Challenge is using 'Big Data' as captured by a range of government agencies to inform progress in reaching key developmental milestones in each of these areas.



19/2/2016

CHALLENGE  
LAUNCHED

### Host

University of Auckland

### Collaboration Partners

- › Auckland University of Technology
- › University of Waikato
- › Massey University
- › Victoria University of Wellington
- › University of Canterbury
- › University of Otago
- › AgResearch

[www.abetterstart.nz/en.html](http://www.abetterstart.nz/en.html)

### Key Research Themes

Healthy weight; Successful learning and literacy; Resilient teens; Big Data

Challenge researchers have conducted a large-scale trial of their phonological intervention tool. The tool helps children recognise the sounds that make up words. When children have difficulty understanding sounds, they are likely to have future problems with literacy. The intervention is based on evidence that the approach reduces the percentage of Year 1 students who fail to meet expectations of literacy from 26% to 6%.



The Challenge is looking to understand community views and attitudes on what is regarded as healthy and unhealthy weight. The A Better Start team gathered data from focus groups comprising parents and grandparents with strong representation from Māori and Pasifika families across Auckland. Data indicates that more than 80% of parents of overweight or obese children do not recognise that their child might have an issue.

**\$2.8  
million**

A Better Start partnered with national child health research charity Cure Kids to create a \$2.8 million contestable round to fund 10 successful proposals with a strong focus on Māori community needs and aspirations. The round successfully embedded a Vision Mātauranga approach into the science assessment process. Five of the projects include key roles with Māori researchers or advisers.



In partnership with Māori and Pasifika young people and their communities, the Health Advances through Behavioural Intervention Technologies (HABITS) research group is working to design, develop and test a digital platform to assist young people and their families maintain good mental health. This integrated web and mobile-based platform will provide tools to screen for common health concerns, online support for adolescents experiencing depression, anxiety, stress, and problems with substance abuse.



A Better Start, with partners Healthier Lives and the Edgar Diabetes and Obesity Research Centre, hosted a major international conference, The Diabesity Crisis. Held in Auckland, this event focused on how preventive actions and treatments can make a difference to the rise of diabetes and obesity.

CASE STUDY

# What 'Big Data' Tells Us About Obesity in 4-year-olds



A Better Start recently found evidence of a 2.2% decline in the obesity rates of 4-year olds between 2010 and 2016. This project is the first of a series of investigations into data from the national *B4 School Check (B4SC)*, the health and developmental check carried out on about 200,000 New Zealand 4-year-olds. Analysing these large data sets ('Big Data') allows researchers to identify patterns and trends in the information. Few countries have access to such rich datasets.

The declining rates of childhood obesity are a positive result, although rates in New Zealand still remain high compared to other OECD countries. Obesity is the greatest child health issue facing New Zealand and a major contributor to the country's most common non-communicable diseases, e.g. type 2 diabetes,

---

**The declining rates of childhood obesity are a positive result, although rates in New Zealand still remain high compared to other OECD countries.**

---

heart disease, stroke, arthritis and cancer. One in three New Zealand tamariki (children) are overweight or obese, exceeding rates seen in the USA. This research tells us that although we have made a step in the right direction with childhood obesity, we have a long way to go.

Untangling the factors associated with the decline in obesity will be critical to develop effective ways to continue to reduce early childhood obesity and improved health equity between disadvantaged and advantaged communities. The findings from this study suggest that countrywide social rather than local community changes are having some effect on obesity rates.

This 'Big Data' study is the first of 11 planned for the next two years that will examine the associations between early life events and childhood obesity. The A Better Start Healthy Weight and Big Data teams will examine important associations between childhood obesity and being born early (preterm), late (post-term), too small (small for gestational age), too large (large for gestational age), increased maternal age, maternal antibiotics in pregnancy and frequent antibiotic exposure in early childhood. This research is integral to the Challenge mission to predict, prevent and treat issues compromising a healthy weight, successful learning and mental health through research excellence that will enable tamariki to live healthy and successful lives.

*Research Team Leader: Dr Rick Audas, Senior Research Fellow at the Dunedin School of Medicine at Otago University.*



## AGEING WELL

Kia eke kairangi ki te  
taikaumātuatanga

### Objective

To harness science to sustain health and wellbeing into the later years of life.

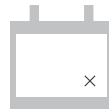


\$34.9m

UP TO \$34.9 MILLION  
FUNDING OVER 10 YEARS

### The Challenge is...

aiming to add life to years for all older New Zealanders. The mission of this Challenge is to push back disability thresholds to enable all New Zealanders to reach their full potential through the life course with particular reference to the latter years of life.



4/3/2015

CHALLENGE  
LAUNCHED

The Challenge is harnessing science to sustain health and wellbeing into the later years of life in ways that allow personal dignity to be preserved, support health, wellbeing and independence for New Zealanders as they age, to recognise the resourcefulness of older people and their on-going contributions to society and to encourage mutual respect and support amongst people of different ages.

### Key Research Themes

Promote social integration and engagement;  
Reduce disability and the impact of disability;  
Value older people in all settings; Maintain wellness and autonomy; Enhance age-friendly environment

### Host

University of Otago

### Collaboration Partners

- › University of Auckland
- › Auckland University of Technology
- › University of Waikato
- › Massey University
- › Victoria University of Wellington
- › University of Canterbury
- › AgResearch
- › Centre for Research Evaluation and Social Assessment (CRESA)

[www.ageingwellchallenge.co.nz](http://www.ageingwellchallenge.co.nz)

## AGEING WELL

Kia eke kairangi ki te  
taikaumātutanga

The Challenge is researching approaches to preventing stroke and other cardiovascular diseases (CVD). There are two current primary prevention strategies: population-wide and high-risk prevention. New research suggests that for stroke prevention to be effective, focus should shift from high-risk prevention to prevention at any level. A motivational population-wide strategy using smartphone technologies could motivate and empower people to reduce their risk of having a stroke/CVD.



Together with the Otago Museum and students at the University of Otago's Centre for Science Communication, the Challenge developed 'Well Balanced', an interactive travelling exhibition. Well Balanced encourages people to improve balance and strength regardless of age, reducing the likelihood of falls in old age. At its first stop at the Otago Museum, the exhibition attracted over 7,000 people.

# \$3.25 million

In recognition of the specific challenges and opportunities faced by Māori and Pasifika Peoples to age well, the Challenge approved \$3.25 million of contestable funding for research that investigates aspects of ageing well for these groups. Led by researchers from universities and community agencies, the projects look at all stages of life, including intergenerational relationships and experiences of older generations. This outcome represents a significant funding boost to this area of research.



Ageing Well's research on risk factors in reduced social engagement has highlighted that loneliness is a significant predictor of poor health outcomes for older adults in New Zealand and has identified how ethnicity and living arrangements influence loneliness. Research findings are shared with policy makers, health professionals and community organisations to help improve services to minimise social isolation for older people.



A Post-Doctoral Fellowship has been awarded to look at Te Whakahaumitanga: unlocking the potential of mātauranga to support Māori women ageing well within whānau. The research aims to consider the cultural context of ageing well for kuia, with specific reference to the value and esteem that kuia are held in and the essential roles that they have in facilitating whānau and hapū wellbeing.

CASE STUDY

# Drug Burden Index



---

**Reducing the likelihood of falls will increase the quality of older people's lives and reduce healthcare costs.**

---

Ageing Well completed a research project on the Drug Burden Index and its association with falls among older adults.

While medications have benefits for people, all medications however have side effects. It is common for older patients to be on multiple medications, which can sometimes have adverse consequences. Side effects can lead to falls, fractures and potentially early admissions into aged residential care. It is a challenge for health professionals to take into account all potential side effects of medications, and identify which older adults are at risk of drug harm.

To address this, a research team led by Dr Hamish Jamieson from the University of Otago, developed a new scale, the Drug Burden Index (DBI) for health professionals to help predict the impact of side effects of medications in a way that is easy to interpret.

The project used the Ministry of Health's interRAI database, a unique New Zealand asset which gives researchers and medical staff access to detailed statistical information about the needs of older people in the community and in care. Using interRAI to evaluate the DBI, the researchers were able to measure whether an older person is being prescribed too many medications, after taking into account other related concerns that older people may have, for instance poor mobility and reduced memory.

Reducing the likelihood of falls will increase the quality of older people's lives and reduce healthcare costs. Results align with previous papers utilising the DBI and highlight the strength of this as a tool for medication risk assessment. Further research has been funded in this area with a \$1.17 million three-year Health Research Council project grant.

*Research Team Leader: Dr Hamish Jamieson, University of Otago.*



**BUILDING BETTER  
HOMES, TOWNS  
AND CITIES**

Ko ngā wā kāinga hei  
whakamāhorahora

**Objective**

To improve the quality and supply of housing and create smart and attractive urban environments.

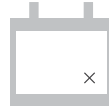


\$47.9m

**UP TO \$47.9 MILLION  
FUNDING OVER 10 YEARS**

**The Challenge is...**

seeking to improve the quality and supply of housing and create smart and attractive urban environments through an improved housing stock, meeting future demand for affordable housing, taking up innovation and productivity improvement opportunities, improving current and future urban environments and resident's well-being and better systems for improved land use decisions. Research outcomes will support New Zealanders to embrace change and to understand what sustainable and effective land-use means for our 21st century lives.



5/5/2016

**CHALLENGE  
LAUNCHED**

**Host**

BRANZ

**Collaboration Partners**

- › Auckland University of Technology
- › Lincoln University
- › Massey University
- › University of Auckland
- › University of Canterbury
- › University of Otago
- › University of Waikato
- › Victoria University of Wellington
- › Opus International Consultants
- › PrefabNZ
- › Scion
- › Auckland Council Research Investigation and Monitoring Unit (RIMU)
- › Centre for Research, Evaluation and Social Assessment (CRESA)
- › Institute of Geological and Nuclear Science (GNS Science)

**[www.buildingbetter.nz](http://www.buildingbetter.nz)**

**Key Research Themes**

Housing supply; Housing quality;  
Urban development

## BUILDING BETTER HOMES, TOWNS AND CITIES

Ko ngā wā kāinga hei whakamāhorahora

A bi-cultural ethos is at the heart of the Challenge with a focus on building a cohort of researchers that can effectively collaborate across disciplines and work within both mātauranga Māori and Western science discourses. Twenty-two Māori researchers have been recruited, adding up to one fifth of all Challenge researchers.



To answer the question how do you reboot regions and prevent the development of 'zombie towns', research has commenced with communities in three east coast settlements, Ashburton, Timaru and Oamaru, to examine how residents define their situation and engage in initiatives to work towards building settlements that are attractive, prosperous, liveable and sustainable.

Challenge research is developing a clearer picture of the 'architecture' of the building industry, the relationships between housing providers and housing consumers, the pathway dependencies between actors in the complex web of transactions that deliver housing, and the calculative logics that generate current outcomes so that we can have better housing solutions for everyone.



In year one of operation, the Challenge has fostered collaboration across 20 research and industry organisations to form a multi-disciplinary team that includes expertise in kaupapa Māori, design, architecture, construction, planning, geography, behavioural sciences, economics and technology.



Early research on people's experience and satisfaction living in higher density housing has highlighted the importance of high quality neighbourhood services, amenities and public spaces, access to public transport and walkability. As residential density increases, the quality of the public realm increasingly influences housing satisfaction, where public spaces and amenities replace suburban backyards. These findings have implications for how we plan and build future urban environments.

CASE STUDY

# Valuing Sunshine



## Beams of light and warmth make a house desirable.

Warm, light spaces are generally preferred as places to live and work compared to those with lesser levels of light. Until recently, however, the value of the sun shining on properties has not been calculated. This creates a difficulty when a building is designed in a way that will shade its neighbour, decreasing the value of the existing building. At present this is controlled by often inflexible regulations that specify building parameters. The financial impact of sunlight loss is likely to become an increasing issue with dwelling intensification in cities potentially creating urban canyons or other forms of overshadowing by neighbouring buildings.

The research was designed to understand the value of sunlight for property owners, so that changes can be priced, potentially enabling compensation for affected owners and better valuation of development sites.

To tackle the problem of assigning sunlight a quantifiable value, researchers from Motu Economic and Public Policy Research, The Modelling House and MRCagney analysed the 2008 to 2014 sales data of over 5,500 houses in Wellington. They combined these data with the geographical coordinates of the properties and calculated zenith angles, view span and elevation using fine-resolution topographical

---

## Building Better Homes, Towns and Cities National Science Challenge research has put a value on sunlight.

---

models from Wellington City Council. This enabled the researchers to determine how much sun a given property receives throughout each day of the year, assuming a clear sky. Subsequently, they computed the average daily hours of direct sunlight received during the year by each house in the database. The average house in the sample received 8.7 hours of sunlight per day, on average, across the year. However, as expected, sunlight data vary considerably across the sample with some houses receiving as low as 3.7 hours of sunlight on average across the year, while some houses received more than 11 hours.

The team found that each additional hour of direct sunlight exposure for a house per day (on average across the year) adds 2.6% to a dwelling's market value. This estimate is robust to a variety of specifications that investigate whether the value is conditional on other factors relating to the characteristics of the house or its suburb. The 2.6% estimate of value is specific to Wellington, but the research approach can be replicated in studies for other cities to help price the value of sunlight in those settings.

In an interview with Radio New Zealand, research team leader Professor Arthur Grimes said that most developers understand the value of sunshine, but putting a value on it opens up a new way of thinking for city planners. "Instead of having inflexible height regulations and setbacks and building envelopes and things like that, they can be more flexible and say; 'If you're going to build a property next to another and it's going to block their sunlight, you need to pay them off.'"

*Research Team Leader: Professor Arthur Grimes, Motu Economic and Public Policy Research.*



## THE DEEP SOUTH

Te Kōmata o  
Te Tonga

### Objective

To understand the role of the Antarctic and the Southern Ocean in determining our climate and our future environment.

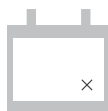


\$51.1m

UP TO \$51.1 MILLION  
FUNDING OVER 10 YEARS

### The Challenge is...

working to understand the role of the Antarctic and Southern Ocean in determining New Zealand's future climate and the impact this has on key economic sectors, infrastructure and natural resources. This will enable New Zealanders to adapt, manage risk and thrive in a changing climate. Through collaboration with communities and industry, the Challenge will assist planning and policy to enhance resilience and exploit opportunities. The Challenge framework of five linked programmes will connect society with scientists, and combine community engagement with a world-class earth systems model to better predict New Zealand's climate.



5/8/2015

CHALLENGE  
LAUNCHED

### Host

National Institute of Water and Atmospheric Research (NIWA)

### Collaboration Partners

- > Victoria University of Wellington
- > University of Otago
- > Institute of Geological and Nuclear Science (GNS Science)
- > Manaaki Whenua - Landcare Research
- > New Zealand Antarctic Research Institute
- > Antarctica New Zealand

### Key Research Themes

Earth systems modelling and prediction;  
Processes and observations; Climate change impacts and implications; Vision Mātauranga; Engagement

[www.deepsouthchallenge.co.nz](http://www.deepsouthchallenge.co.nz)

## THE DEEP SOUTH

Te Kōmata o  
Te Tonga

The Challenge made extensive observations in Antarctica and the Southern Ocean to improve the New Zealand Earth Systems Model. Campaigns included a successful international collaboration that provided New Zealand researchers unprecedented access to the Ross Sea in late autumn and early winter on the US research icebreaker, the Nathaniel B Palmer.

**\$1.5**  
million

The Deep South's Vision Mātauranga investment (\$1.5 million) supports seven projects and is the largest research programme in New Zealand exploring the impacts and implications of climate change for Māori communities.

A project centred on two coastal Māori farms and a whānau trust in the Horowhenua-Kāpiti region created opportunities for hapū and iwi to consider how they might adapt their land management and community planning in line with future sea level rise, coastal erosion, salinification and extreme weather. Participants, including Māori land and farm-owners, scientists and senior architecture students, co-designed solutions for land and water use that brought together understanding of kaitiakitanga (guardianship) and climate change risks.



In the first civilian science deployment on a NZ Defence Force ship, researchers made measurements of clouds from the HMNZS Wellington to improve modelling capability. Researchers also provided the Defence Force with wave data, which will be used in the design of the Defence Force's new offshore patrol vessel.

'Deep South Dialogues' engaged a wide range of stakeholders in discussions to co-develop future research priorities. Dialogues included: insurance, housing and climate change adaptation; flood-prone communities and sea level rise; and climate impacts and storm water and wastewater systems.



CASE STUDY

# First Antarctic Study of Sea Ice Thickness



The Deep South Challenge conducted the first Antarctic study of sea ice thickness using electromagnetic measurement techniques from fixed wing aircraft. Antarctic sea ice is a key element in the global climate system.

It maintains the cold ocean conditions that help sustain Antarctica's ice sheets, it modifies storm tracks in the Southern Hemisphere, and it affects the rate of global warming by influencing ocean heat and CO<sub>2</sub> uptake in

---

**Measurements of sea ice thickness are increasing our understanding of how sea ice influences New Zealand's climate.**

---

the Southern Ocean. The annual mean sea ice area in Antarctica has been increasing slightly over the past four decades, before a dramatic summer decline in the last two years, a behaviour that is not captured in current earth systems models.

Researchers are providing details on processes understood through observation to improve the New Zealand Earth System Model (a mathematical model of the Earth's natural systems that can predict the behaviour of our atmosphere, land and seas, human industry and biological production, far into the future).

The study has greatly extended datasets that will help understand the influence of melting ice shelves on sea ice, and the model will increase our understanding of how sea ice influences New Zealand's climate. The study included measurements of a layer beneath the sea ice that provides evidence of refreezing of ice sheet meltwater.

New Zealand's future climate will be influenced by the persistence of sea ice around Antarctica and improvements to the New Zealand Earth System Model will help improve predictions of how climate change might impact on New Zealand.

*Research Team Leader: Pat Langhorne, University of Otago.*

## HEALTHIER LIVES

He Oranga  
Hauora

### Objective

To reduce the burden of major New Zealand health problems.

### The Challenge is...

aiming to substantially reduce the burden of the major non-communicable diseases, and achieve equity in health for all New Zealanders. Working with its research partners and stakeholders, the Challenge is undertaking innovative research on cardiovascular disease, cancer, diabetes and obesity. Co-design of research with communities is an important feature of several research programmes. Māori and Pacific researchers are leading many initiatives. The Challenge will also focus on translating its innovations into practical solutions and research for effective health policy and practice.

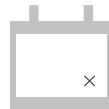
### Key Research Themes

Personalised prevention through new technologies; Minimally invasive markers for effective cancer diagnosis and treatment; Enhanced cardiovascular disease and diabetes risk prediction; Culturally centered health initiatives; Slowing progression of prediabetes to diabetes.



\$31.3m

UP TO \$31.3 MILLION  
FUNDING OVER 10 YEARS



4/12/2015

CHALLENGE  
LAUNCHED

### Host

University of Otago

### Collaboration Partners

- › University of Auckland
- › Auckland University of Technology
- › University of Waikato
- › Massey University
- › Victoria University of Wellington
- › University of Canterbury
- › Malaghan Institute
- › Institute of Environmental Science and Research (ESR)
- › AgResearch

[www.healthierlives.co.nz](http://www.healthierlives.co.nz)



The research portfolio includes projects co-designed with Māori and Pasifika communities. University researchers and communities are jointly developing a culturally tailored, personalised healthy lifestyle support programme for Māori and Pasifika using smartphones. Another research team has created *He Pikinga Waiora Implementation Framework* using a Kaupapa Māori approach to guide successful research and health interventions with communities. These innovative co-design methods will increase the likelihood that the research results will be used.



## \$7.9 million

Healthier Lives entered a partnership with the Ministry of Health and the Health Research Council of New Zealand to establish a \$7.9 million contestable fund for research on Long-Term Conditions. Five research projects were funded in 2017, with four of these aimed at reducing the impact of type 2 diabetes on New Zealanders.

Healthier Lives is collaborating with the Pacific Rugby Players Association, the Edgar Diabetes and Obesity Research Centre and private philanthropists on a series of short films starring high profile Pacific rugby players, which incorporate subtle messaging about healthy lifestyles alongside entertainment. It is hoped the videos will have widespread reach within the Pacific communities in New Zealand and the Pacific Islands.

*The Equitable cardiovascular and diabetes risk prediction* research team developed new equations for assessing cardiovascular risk that are unique to the New Zealand population. These equations will improve screening for Māori, Pacific and Indian subcontinent populations. The equations will be incorporated into the Ministry of Health Guidelines for Cardiovascular Risk Assessment.

New Zealand has a unique resource of linked social and health datasets, the Integrated Data Infrastructure (IDI), which can be explored using Big Data techniques. Using the IDI, Healthier Lives discovered in the first year after the 2010/11 Christchurch earthquakes that rates of heart disease and heart attacks increased for people living in areas with more severely damaged homes.



## CASE STUDY

# Biomarkers for Cancer Detection



The Healthier Lives National Science Challenge project Biomarkers for Cancer Detection is developing better methods to tell if a cancer patient is receiving the best treatment.

Current methods for accurate cancer surveillance are expensive and only available in large hospitals. If successful, this research could lead to more personalised lower-cost cancer treatments, and contribute to better health for New Zealanders regardless of where they live.

At present, New Zealand's healthcare system relies on expensive hospital-based imaging techniques to detect most tumours, to make decisions about treatment and to monitor how well the treatment is going. In place of current imaging techniques, the Biomarkers for Cancer Detection research aims to identify and develop biomarkers, naturally occurring molecules by which a disease can be identified. If successful, the research will result in more accurate, less invasive and cheaper cancer surveillance blood tests. Patients could be spared unnecessary, ineffective treatments and offered more

---

**Current methods for accurate cancer surveillance are expensive and only available in large hospitals.**

---

promising treatment options with less delay. It will also be easier to carry out tests in a wider range of community settings, and allow patients in rural areas to get treatment close to home.

This research uses circulating tumour DNA. These are fragments of DNA, derived from a cancer, that circulate in the bloodstream of cancer patients. To date, the research team has made progress on techniques to isolate, store and sequence the circulating tumour DNA. They have also examined ways to make accurate, low-cost blood tests. For example, the research team has been able to use digital polymerase chain reaction to detect as little as one mutated DNA sequence in a background of 10,000 normal copies. This level of sensitivity is comparable to the best results being obtained internationally.

While there is still a lot of work to do to implement the technology in clinical practice, interest is growing among cancer clinicians and patient groups. A number of oncologists and cancer surgeons are now active partners in the research. The Health Research Council of NZ, Breast Cancer Research Foundation, Karen Louisa Foundation and paediatric cancer charity REACH are all now supporting the research team to work on biomarkers for melanoma, and bowel, stomach, breast, and some childhood cancers.

*Research Team Leaders: Professor Parry Guilford, University of Otago; Professor Cristin Print, University of Auckland.*

## HIGH-VALUE NUTRITION

Ko Ngā Kai  
Whai Painga

### Objective

To develop high-value foods with validated health benefits to drive economic growth.

### The Challenge is...

enabling the transformation of New Zealand's food and beverage industry to become an exporter of high-value foods with scientifically proven health benefits. Informed by insights into the needs of consumers in Asia and other key markets, and identified opportunities where investment in science can have significant economic impact, the Challenge will conduct research into metabolic, digestive, immune and infant health, the Science of Food and Consumer Insights.

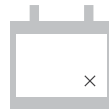
### Key Research Themes

Metabolic Health; Digestive Health; Immune Health; Infant Health; Science of Food; Consumer Insights



\$83.8m

UP TO \$83.8 MILLION  
FUNDING OVER 10 YEARS



1/4/2014

CHALLENGE  
LAUNCHED

### Host

University of Auckland

### Collaboration Partners

- > Massey University
- > University of Otago
- > AgResearch
- > Plant and Food Research

[www.highvaluenutrition.co.nz](http://www.highvaluenutrition.co.nz)

## HIGH-VALUE NUTRITION

Ko Ngā Kai  
Whai Painga

Representatives from 63 organisations, ranging from small to medium sized businesses to multinational companies attended the High-Value Nutrition Industry Forum in October 2016. At this Forum the Challenge aimed to demonstrate how their science can benefit businesses, and to also hear from participants on what support they would like from the Challenge.



The Challenge applied an innovative, combined reverse genomics approach to identify a strong local food candidate for a pilot clinical trial on weaning foods to boost infant immune systems. This approach differs from conventional 'feed and look' research design. It starts with the desired health outcome, and works backwards to identify what bacteria in the microbiome are likely to provide that benefit, and then what foods will nourish those bacteria.

# \$1 million

In partnership with the Nuku ki te Puku Māori food business cluster, the Challenge has launched Tū Ora (Stand for Wellness). The \$1 million partnership will look at how Māori businesses and some of the country's top researchers can share science and cultural expertise to collaborate on the development of new food for health products for export.



Two research projects are preparing to apply to Food Standards Australia and New Zealand (FSANZ) for a food health claim based on identified biomarkers. The high quality research results are able to support a food health claim, which could be used by the industry partners to market their product as a high-value food.



The Challenge is on target to exceed \$1 million of industry co-investment by 2019, indicating New Zealand businesses are prepared to invest in the research being conducted within the Challenge.



CASE STUDY

# a2 Milk™ for Gut Comfort



There is emerging evidence that milk containing only the A2 form of beta-casein aids digestive wellbeing. Research supported by the High-Value Nutrition National Science Challenge has found that a2 Milk™ prevents some symptoms of dairy intolerance and eases others, even though it contains the same amount of lactose as conventional cow's milk.

Conventional milk contains A1 and A2 beta-casein, proteins comprising 25-30% of total milk protein. It is thought that originally all cows produced only the A2 protein type, and the A1 'mutation' appeared around 5,000-10,000 years ago.

In 2017, the first of two human clinical trials which investigated and compared the acute digestive responses to consumption of a2 Milk™ with conventional milk and lactose-free conventional milk was completed. The initial results indicate that in lactose intolerant individuals the gastrointestinal discomfort was lower in response to a2 Milk™ than conventional milk, and results were comparable

---

**Dairy products comprise New Zealand's largest export sector, earning \$12.4 billion in the year ending June 2016.**

---

to lactose-free conventional milk. The amount of hydrogen in the breath was also measured. The lower and later rise in breath hydrogen of lactose intolerant individuals reinforced the findings of reduced gastrointestinal discomfort when consuming a2 Milk™ compared to conventional milk.

The research has demonstrated evidence of a novel dairy intolerance named, "non-lactose dairy intolerance". Sufferers experience belching and abdominal distension that resolves rapidly. This differs from the symptoms experienced with lactose intolerance, which relate to later onset of non-resolving gastrointestinal symptoms such as stomach bloating and rumbling.

Dairy products comprise New Zealand's largest export sector, earning \$12.4 billion in the year ending June 2016. China is New Zealand's top market for dairy exports. Globally, about 70% of adults consider themselves lactose intolerant, with an even higher prevalence in East Asia. The outcomes of this research will contribute to the a2 Milk™ Company's ability to target their product to consumers who had previously avoided dairy. Results of the ground breaking research were announced at the Food and Nutrition Conference and Expo hosted by the American Academy of Nutrition and Dietetics in October 2017 in Chicago.

*Research Team Leader: Dr Matthew Barnett, Food Nutrition and Health Team, AgResearch.*

## NEW ZEALAND'S BIOLOGICAL HERITAGE

Ngā Kōiora  
Tuku Iho

### Objective

To protect and manage New Zealand's biodiversity, improve our biosecurity, and enhance our resilience to harmful organisms.

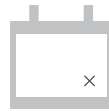


\$63.7m

**UP TO \$63.7 MILLION  
FUNDING OVER 10 YEARS**

### The Challenge is...

aiming to reverse the decline of this country's biological heritage by protecting and managing native biodiversity, improving biosecurity, and enhancing resilience to harmful organisms. The Challenge includes research on ways to reduce rates of incursion or establishment by foreign invader species, and to enhance and restore the resilience of vulnerable ecosystems to prevent biodiversity loss and mitigate the effects of global change. The Challenge's national partnership between researchers, Māori and other stakeholders will deliver a step-change in research innovation, technologies and sector action to help reduce increasing pressures on our environment.



29/8/2014

**CHALLENGE  
LAUNCHED**

### Key Research Themes

Biodiversity assessment; Reducing risks and threats from pests and diseases; Ecosystem resilience

### Host

Manaaki Whenua – Landcare Research

### Collaboration Partners

- › Auckland University of Technology
- › Lincoln University
- › Massey University
- › University of Auckland
- › University of Canterbury
- › University of Otago
- › University of Waikato
- › Victoria University of Wellington
- › AgResearch
- › Institute of Environmental Science and Research (ESR)
- › Institute of Geological and Nuclear Science (GNS Science)
- › National Institute of Water and Atmospheric Research (NIWA)
- › Plant and Food Research
- › Scion
- › Ministry for Primary Industries
- › Department of Conservation

[www.biologicalheritage.co.nz](http://www.biologicalheritage.co.nz)

## NEW ZEALAND'S BIOLOGICAL HERITAGE

Ngā Koiora  
Tuku Iho

The Challenge developed novel biochemical assays to identify compounds that inhibit *Phytophthora*, the pathogen causing kauri dieback. This is a significant first step in development of new tools to protect kauri from dieback.

New Zealand's Biological Heritage coordinated the development of Predator Free 2050 science strategy to eradicate at least one small mammalian predator from the mainland by 2025; an important milestone in New Zealand becoming predator-free by 2050.



Social-ecological research on landowner perspectives on managing predators was a deciding factor in the Hawke's Bay Regional Council's decision to include predator control in their updated draft Regional Pest Management Plan for public consultation.

A PhD study is determining the impact of the honey industry on indigenous biodiversity, to improve management of hives on public land. This research is one of 18 PhDs currently supported by the Challenge.



New Zealand's Biological Heritage is playing a pivotal role in coordinating biodiversity and biosecurity research across multiple research disciplines and science providers. In 2016/17, Challenge parties aligned \$111 million of research to the Challenge objective. The inaugural conference, 'Crazy and Ambitious', provided a forum for over 340 scientists, Māori and stakeholders to exchange ideas on science solutions to reverse the decline of New Zealand's biological heritage.



The Challenge held a series of marae-based workshops to revitalise and strengthen tikanga and local mātauranga Māori, as part of research on customary approaches and practices to optimise cultural and ecological resistance.

CASE STUDY

# I Smell You: A Super-lure for Stoats



Photo credit: Patrick Garvey

Stoats inflict a devastating toll on native wildlife. Like most mammals, stoats have a highly developed sense of smell which can be exploited to catch them.

The New Zealand's Biological Heritage Challenge has been working to discover 'super-lures' to improve the success of pest control operations. Food lures are typically used as attractants, yet these lures may be ineffective when prey is abundant or where pests are wary of food lures to which they have been previously exposed. Food lures also degrade quickly and must be replenished frequently.

The project builds on the discovery that stoats are attracted to predator pheromones, particularly to the scent of another predator: ferrets. Stoat detection increased three-fold when ferret odour was added to monitoring sites.

---

## Stoat detection increased three-fold when ferret odour was added to monitoring sites.

---

As a bonus, the research found that two other damaging invasive predators, hedgehogs and ship rats, were also attracted to ferret odour.

The next step in the research is to identify compounds in the ferret odour that stimulate attraction, so that artificial scent can be created. Using artificial scent rather than the primary biological material will extend the longevity and effectiveness of the lure, and enable sufficient quantities produced to benefit invasive mammal predator control projects across New Zealand.

Development of new super lures could provide noticeable improvements for invasive species management in New Zealand. Ferret odour is a non-toxic natural lure that is suitable for use in all environments. It is already being used for predator monitoring and control in the Hawke's Bay Regional Council's 'Cape to City' programme, one of the largest control operations in the country. It has also been trailed by Predator Free Waiheke, Hauraki Gulf Conservation Trust, and will be trailed in 2018 by Ark in the Park in Auckland and additional island eradication programmes in Hauraki Gulf.

*Research Team Leaders: Dr Patrick Garvey (Manaaki Whenua – Landcare Research) and Dr James Russell (University of Auckland).*



## OUR LAND AND WATER

Toitū te Whenua,  
Toiora te Wai

### Objective

To enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations.

### The Challenge is...

aiming to enhance the production and productivity of New Zealand's primary sector, while maintaining and improving the quality of the country's land and water for future generations. The way New Zealand uses and manages its land and water will be transformed by Challenge research on gaining greater value from global markets, innovative resilient land and water use, and building collaborative capacity. These drivers, along with research to connect them, form the themes that focus the Challenge's multi-disciplinary approach that includes research expertise from a wide range of organisations.

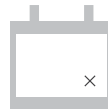
### Key Research Themes

Greater value from global markets; Innovative and resilient land and water use; Collaborative capacity



\$96.9m

UP TO \$96.9 MILLION  
FUNDING OVER 10 YEARS



26/1/2016

CHALLENGE  
LAUNCHED

### Host

AgResearch

### Collaboration Partners

- › Institute of Environmental Science and Research (ESR)
- › Institute of Geological and Nuclear Science (GNS Science)
- › Manaaki Whenua – Landcare Research
- › National Institute of Water and Atmospheric Research (NIWA)
- › Plant and Food Research
- › Scion
- › University of Auckland
- › Massey University
- › Lincoln University
- › Waikato University
- › University of Otago
- › Lincoln Agritech
- › Cawthron Institute

[www.ourlandandwater.nz](http://www.ourlandandwater.nz)

## OUR LAND AND WATER

Toitū te Whenua,  
Toiora te Wai

Challenge research has shown how temperature and nitrogen affect the uptake of phosphorus into stream-bed sediments. Results suggest that as temperatures increase with climate change, limiting movement of phosphate from land to water would help improve water quality.



Working with stakeholders, industry bodies, and central and local government, the Challenge developed a land use suitability classification. The classification categorises land according to its potential for production and profitability, generation of contaminants and the environmental impact of these contaminants. It could be used to inform land-use decisions, assess environmental constraints and to identify areas for future development, or where more stringent controls are required.

The Challenge is investigating ways of making indicators of agricultural productivity and environmental impact more useful for a greater number of stakeholders in the agricultural sector. A workshop convened interested parties from central government, the science sector and agricultural industries. A subsequent report is available on the Challenge website on the qualities of fit-for-purpose indicators.



Using a collaborative think-piece process, Challenge genomics research has illustrated the potential for manipulation of soil-plant-animal microbiome interactions to improve pasture and animal productivity, as well as water quality.



The Challenge is working with iwi and hapū in Te Tai Tokerau to design innovative decision-making tools and processes for Māori landowners to help identify land use and agribusiness opportunities for Northland Māori.

CASE STUDY

# Stock Exclusion and Water Quality



The way we use our land affects the quality of New Zealand's freshwater. Our Land and Water conducted research to determine the load (kg/yr) of catchment contaminants that come from large or small streams, and if excluding livestock from large streams (> 1-m wide, >30-cm deep) in flat catchments used for pastoral grazing would substantially decrease the load of catchment contaminants. Results showed that contaminants from small streams in catchments dominated by agriculture contribute significantly to the load of freshwater contaminants.

A decade of concentration and flow data (1998-2009) were used to calculate catchment load and yields (load per catchment area) of nitrogen and phosphorus,

---

## Contaminants from small streams in catchments dominated by agriculture impact significantly on freshwater quality.

---

suspended sediment and *Escherichia coli* at 728 water quality monitoring sites. These data were combined with catchment characteristics (e.g., climate, topography, geology, land cover) and stream order (relative stream size) in statistical models to aid in the prediction of mean annual loads and yields across New Zealand.

On average, the yields of all contaminants increased with increasing stream order in catchments dominated by agriculture. Loads from low-order small streams (< 1-m wide, <30-cm deep), in flat catchments dominated by pasture accounted for an average of 77% of the national load across all contaminants.

These data suggest that fencing of larger streams will likely affect, on average, 23% of the national contaminant load, and for further reduction, additional mitigations should be implemented to reduce the amount of contaminants entering small streams.

This work is being used by local government to determine policy to improve the quality of freshwater. For example, Taranaki Regional Council has committed to fencing more streams than those covered by central government's recently promulgated stock exclusion regulations.

*Research Team Leader: Professor Richard McDowell, AgResearch/Lincoln University.*

## RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa –  
Ngā Ākina o  
Te Ao Tūroa

### Objective

To enhance New Zealand's resilience to natural disasters.

### The Challenge is...

enhancing New Zealand's ability to anticipate, adapt and thrive in the face of ever-changing natural hazards. Working closely with research users, the Challenge is developing technical resilience solutions and applying them in high-priority geographic and economic settings. This includes developing Māori-specific tools and business strategies to make communal assets more resilient and enhance kaitiakitanga. In rural economies, work is aimed at strengthening value chains, and using future scenarios to identify effective interventions. In cities, the Challenge looks to build-in resilience in growing populations, housing, and transport systems. For our vulnerable coastlines, the Challenge will integrate community and governance views to design innovative pathways that balance our desire to live near the sea with resilience to the hazards brought about by sea level rise and climate change.

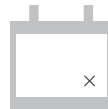
### Key Research Themes

Mātauranga Māori; Coastal, Urban, Rural, Hazards; Infrastructure; Economics; Culture; Governance; Trajectories



\$59.4m

UP TO \$59.4 MILLION  
FUNDING OVER 10 YEARS



30/6/2015

CHALLENGE  
LAUNCHED

### Host

Institute of Geological and Nuclear Science  
(GNS Science)

### Collaboration Partners

- › National Institute of Water and Atmospheric Research (NIWA)
- › Scion
- › University of Auckland
- › Massey University
- › Victoria University of Wellington
- › University of Canterbury
- › Lincoln University
- › University of Otago
- › BRANZ
- › Opus International Consultants

[www.resiliencechallenge.nz](http://www.resiliencechallenge.nz)



## RESILIENCE TO NATURE'S CHALLENGES

Kia manawaroa –  
Ngā Ākina o  
Te Ao Tūroa

The Challenge's rural resilience, engineering systems impact and recovery and infrastructure network disruption research featured in four articles in a special publication of the Bulletin of the New Zealand Society for Earthquake Engineering following the 14 November 2016 magnitude 7.8 Kaikoura earthquake. This collation of physical and functional impacts, network management and decision-making data is being used to inform the development of improved models of New Zealand infrastructure.

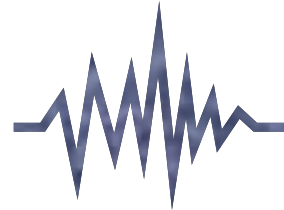


*The Living at the Edge – Transforming the Margins* co-creation Laboratory researchers have teamed up with the Hawke's Bay Regional Council, Hastings and Napier District councils to develop New Zealand's first 100-year Coastal Hazard Management Plan.

*The Mātauranga Māori: Better understanding and implementation of Mātauranga Māori and tikanga to build resilience* programme is integrating local/traditional/Iwi knowledge including new Te Reo and Māori values into improved natural hazard resilience strategies and solutions for all New Zealand communities.



The Modelling the Economic Resilience of Infrastructure Tool (MERIT) has formed the basis of a series of new approaches to model the economic consequences of hazard shocks and resilience/adaptations on New Zealand infrastructure and communities. Modules have been added to enable different infrastructure sectors and locations to be studied so that spatial and temporal information can be forecast. Challenge researchers provided an initial assessment of the economic impacts resulting from the 2016 Kaikoura earthquake.



CASE STUDY

# Infrastructure Network Resilience Framework



Photo credit: Dizhur and Giaretton

**Resilience to Nature's Challenges**  
Infrastructure Toolbox has developed a framework to quantify the resilience of network connectivity for electricity distribution infrastructure known as the Power Systems Resilience Toolbox.

This toolbox will be combined with other network frameworks, such as transportation and water, to develop interdependency models to gain a better understanding of the interaction across networks and how this influences overall infrastructure resilience (the 'Infrastructure Network Resilience Framework'). This information will be used to model the effect of pre-disaster mitigation actions and network management and recovery strategies post disaster. These frameworks are constantly evolving,

---

**The Infrastructure Toolbox has now become the focal point of infrastructure resilience research in New Zealand.**

---

with the most recent Power Systems Resilience Toolbox focussed on assessing resilience by modelling the network functionality, or network power flow, over time. This is an improvement on models that only capture the general component functionality and ignore the dynamic nature of these networks.

Following the 2016 Kaikoura earthquake, the New Zealand-wide research and stakeholder community that was brought together through the Infrastructure Toolbox worked together to collate data on infrastructure physical and functional impacts, network management and decision-making strategies. This information fed into four journal papers co-authored with stakeholders in a special volume of Kaikoura earthquake research in the Bulletin of the New Zealand Society for Earthquake Engineering, which was made publically available to enable rapid dissemination of learnings from this event. This accelerated the development and scope of the Infrastructure Network Resilience Framework, with these learnings being used to validate and refine infrastructure models. The Infrastructure Toolbox has now become the focal point of infrastructure resilience research in New Zealand, growing the co-funding, stakeholder partnerships, number of aligned researchers and post graduate students.

*Research Team Leader: Dr Liam Wotherspoon,  
University of Auckland.*

**SCIENCE FOR  
TECHNOLOGICAL  
INNOVATION**

Kia kotahi mai –  
Te Ao Pūtaiao me  
Te Ao Hangarau

**Objective**

To enhance the capacity of New Zealand to use physical and engineering sciences for economic growth.

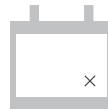


\$106m

**UP TO \$106 MILLION  
FUNDING OVER 10 YEARS**

**The Challenge is...**

aiming to tackle New Zealand's big, high-tech challenges to grow the economy through engineering and the physical sciences. Research areas cover Vision Mātauranga; Materials, Manufacturing and Design; Sensors, Robotics and Automation; and IT, Data Analytics and Modelling. The mission to unlock the science and innovation potential of Māori knowledge, resources, and people is integrated across the Challenge. The Challenge has three related 'capacity' components: technical (science and engineering); human (people and their skills); and relational (networks between researchers and industry).



16/9/2015

**CHALLENGE  
LAUNCHED**

**Host**

Callaghan Innovation

**Collaboration Partners**

- › Auckland University of Technology
- › Lincoln University
- › Massey University
- › University of Auckland
- › University of Canterbury
- › University of Otago
- › University of Waikato
- › Victoria University of Wellington
- › Institute of Geological and Nuclear Science (GNS Science)
- › Scion
- › AgResearch
- › Lincoln Agritech

**[www.sftichallenge.govt.nz](http://www.sftichallenge.govt.nz)**

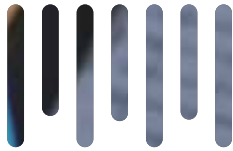
**Key Research Themes**

Materials, Manufacturing and Design; Sensors, Robotics and Automation; IT, Data Analytics and Modelling

## SCIENCE FOR TECHNOLOGICAL INNOVATION

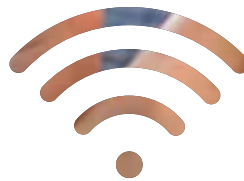
Kia kotahi mai –  
Te Ao Pūtaiao me  
Te Ao Hangarau

Challenge researchers are producing a Dynamic Electrostatic Spraying system for application within the horticultural industry. This system will sense the crop canopy location and apply agrichemicals to achieve optimal leaf coverage, while minimising chemical wastage and loss to the environment. The initial focus is high-value row crops such as potatoes, grapes, apples and kiwifruit.



Researchers within the *Inverting Electromagnetics – a new way to measure groundwater flow* project have built a lab-scale aquifer which includes a customised magnetic field coil for testing and concept validation. If successful, the research will determine the spatially-averaged velocity of shallow groundwater, resulting in a sensor system marketable to global regulators, farmers, and consultants.

The *Mechanically induced drug release* project has developed a new technology for controlled drug release based on mechanically-sensitive gels. These could contain tiny reservoirs of drugs supporting treatment or repair, triggered when needed to release their contents through stretching, compression, or ultrasound. If long-term repeated release can be achieved, this could be used in clinical situations where pulsed delivery is desirable including epilepsy, cancer, and pain relief.



The *Next Generation Additive Manufacturing* project represents an opportunity for New Zealand in the application of biopolymers - natural products - to create new plastic-like materials suitable for 3 and 4D printing into engineering components and furniture. The research team has iteratively developed a swimming prosthesis (swim fin) to reframe a current prosthesis made from standard non-biodegradable polymeric materials. Unlike conventional multi-party and multi-disciplinary project teams that follow a technology push approach ("achieve great science and worry about applications and impact later"), the research team employs a design-led approach, starting with aspirational product concepts that channel and inspire science effort.





CASE STUDY

# Next Generation Health Care Systems



A team from Science for Technological Innovation's *Medical technology home and community* project is researching next-generation care systems that integrate point-of-care medical sensors and non-invasive delivery systems with mobile communications, personalised physiological modelling, and novel medical informatics.

While New Zealand's MedTech sector is strong, many companies are often small. There is considerable need for capacity development to link researchers, clinicians, health organisations and businesses to maximise effort and synergy across these groups so great ideas can be translated into great products and improved health care solutions.

Eleven participating organisations, led by Distinguished Professor Geoff Chase (University of Canterbury), are aiming to improve three key technology areas:

- › Measurement: to advance point-of-care sensing and drug/therapy delivery.

- › Management: to create patient-specific modelling to provide better drug or treatment dosing to enable expert, patient-centric, care.
- › Monitoring: to use Information and Communications Technology (ICT) to link measurement and management to automated algorithms, improving productivity and directing clinical resources to those most in need, as they need it.

The team has commenced experimental work in these areas. Clinical trials are ongoing to provide safe, effective solutions to managing type 2 diabetes, where the goal is to provide easy-to-use systems that maximise patient compliance to care they deliver themselves, and provide better outcomes. The team have also created first thin film sensor concepts for Advanced Point of Care Insulin Sensors, which could someday significantly change diabetes care.

Worldwide, healthcare costs are driven by ageing populations, multiplied by the exponential growth of chronic diseases such as type 2 diabetes, Chronic Obstructive Pulmonary Disease (COPD), asthma, and cardiovascular disease, each of which costs ~1% of GDP annually. This research programme pushes current boundaries with the aim of creating a high tech solution to improve New Zealand's access to the multi-billion-dollar global medical device market through novel devices and systems that provide better care, while reducing costs.

The research is receiving strong interest from science and industry. Technologically, it involves Intellectual Property (IP) and researchers from diverse groups across New Zealand. Clinically it requires, and has, buy-in from multiple hospitals and District Health Boards via their participation. It seeks to create solutions where any one piece makes an impact in the MedTech sector, with the overall goal of transforming care across a system of such advances.

*Research Team Leader: Distinguished Professor Geoff Chase, University of Canterbury.*

## SUSTAINABLE SEAS

Ko ngā moana  
whakauka

### Objective

To enhance utilisation of our marine resources within environmental and biological constraints.

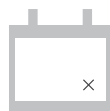


\$71.1m

UP TO \$71.1 MILLION  
FUNDING OVER 10 YEARS

### The Challenge is...

Involving leading experts, including Māori, to develop knowledge and tools to underpin ecosystem-based management (EBM). This will enable researchers to provide decision-makers with up-to-date information about marine ecosystems; best practices for participatory decision-making; and information about cultural, economic, social and environmental values. The aim is that the New Zealand marine environment is understood, cared for, and used wisely for the benefit of all, now and in the future.



4/9/2014

CHALLENGE  
LAUNCHED

### Host

National Institute of Water and Atmospheric Research (NIWA)

### Collaboration Partners

- › University of Auckland
- › University of Waikato
- › Victoria University of Wellington
- › University of Canterbury
- › University of Otago
- › Institute of Geological and Nuclear Science (GNS Science)
- › Cawthron Institute

### Key Research Themes

Marine ecosystem structure, function and connectivity; Tools and knowledge for EBM; Marine economy; Collective decision-making; Economic, social, spiritual, cultural and environmental marine values; Enabling Māori as partners in marine management

[www.sustainableseaschallenge.co.nz](http://www.sustainableseaschallenge.co.nz)

## SUSTAINABLE SEAS

Ko ngā moana  
whakauka

Sustainable Seas is developing tools and knowledge to underpin ecosystem-based management (EBM): a holistic and inclusive way to manage marine environments, and the competing uses for, demands on, and ways New Zealanders value them.



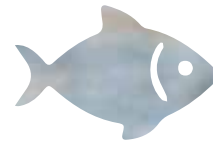
Sustainable Seas is working with iwi, Tasman District Council and Nelson City Council to co-design a trial of EBM focused on managing the health of Tasman and Golden Bays' seafloor.

206 researchers from 36 organisations are involved in 38 projects. 49 researchers identify as Māori, and 24 projects (two-thirds) have Māori researcher(s) on the team. Excellent engagement with Māori and stakeholders is critical for developing successful EBM. 49 are early career researchers.

Sanford Ltd has offered the use of its new eco-mussel farm and Marlborough District Council is funding the field experiments to test proof-of-concept for the Coastal acidification mitigation project. With coastal waters becoming more acidic, this project is testing two techniques to alleviate local acidification.



Sustainable Seas has been working with the Ministry for Primary Industries to provide input into policy changes for the Future of our Fisheries review, particularly the potential for Ecosystem-Based Fisheries Management.



The Tipping points in ecosystem structure, function and services project is Aotearoa's first national marine experiment, and received the NZ Coastal Society's inaugural Sustainability Award.

CASE STUDY

# Hui-te-ana-nui: Understanding Kaitiakitanga in our Marine Environment



Photo credit: Kelly May

Mātauranga Māori is a complex system of experiential knowledge, comprising intergenerational beliefs, values and practices that contribute to sustainable marine management. Kaitiakitanga (spiritual and physical guardianship) is one expression of mātauranga Māori. However, there is no single repository or index of mātauranga and kaitiakitanga relating to the marine environment, and much knowledge has been diminished or lost. This makes it difficult for Māori, resource managers, and other interest groups, to be fully informed when making decisions about the marine environment – depriving Aotearoa of relevant knowledge established over thousands of years.

**The findings improve our understanding of the mātauranga of the marine environment as expressed through features of Māori oral tradition.**

Understanding, developing and retaining this mātauranga and kaitiakitanga is a vital component of ecosystem-based management (EBM). For example, it is crucial for developing spiritual, cultural, social, environmental and economic practices, indicators and metrics that are relevant to Aotearoa.

To address this gap, the *Hui-te-ana-nui: Understanding kaitiakitanga in our marine environment* Māori-led project, with a Māori research team and advisory group, used Kaupapa Māori and critical discourse analysis to examine mātauranga by researching archives and reviewing key texts – including literature (personal diaries to Waitangi Tribunal papers), reports, frameworks and legislation – that relate to Māori perspectives of the marine environment.

The project also investigated historical examples of marine kaitiakitanga that highlight the depth of mātauranga which express Māori connection to the marine environment, identifying and analysing the context and practice of kaitiakitanga through:

- › Whakapapa (the contextual relationships and basis of obligation)
- › Tikanga (principles underlying correct practice)
- › Karakia, mōteatea, pūrākau, whakataukī (the various forms of its use and transmission)
- › Maramataka (lunar calendar and heavenly bodies)
- › Waka voyaging traditions and identity

...continued over page



...continued from previous page

Using this information the project analysed elements of creation narratives, human and non-human forms of kaitiakitanga, spiritual beliefs and values, and taonga.

This research provides important context to the unbroken ancient connection between Māori and the marine environment. Results acknowledge that the marine environment is a taonga, and must be viewed in relationship to the organising principles of whakapapa, whanaungatanga and kinship, mediated through understandings of mātauranga and kaitiakitanga. The texts reinforce that kaitiakitanga is not spatially limited.

The findings improve our understanding of the mātauranga of the marine environment as expressed through features of Māori oral tradition, providing insights into the past whilst offering understandings of mātauranga that are useful for kaitiakitanga and better marine management. For instance, the Waitangi Tribunal has noted that mātauranga encompasses not only what is known, but also how it is known. In other words, the way of perceiving and understanding the world, and the values or systems of thought that underpin those perceptions.

The findings recognise kaitiakitanga has two vital and critically linked elements – the metaphysical and the practical – that provide insight to how the connection between Māori and the environment is fundamental to the hauora (wellbeing) of people and the environment.

Ultimately the research was guided by the kaupapa Māori principles of tino rangatiratanga (self-determination) and taonga tuku iho (cultural aspiration). A critical finding is that for marine management to benefit from the contribution of mātauranga Māori, Māori need to be at the core of deciding their future and to decision making at all levels.

This research also highlights the need for the development of a system and framework that protects and safeguards mātauranga and kaitiakitanga of the marine environment, and enables advancement and contribution consistent with Māori aspirations. It clarifies that Māori are a critical component to an EBM approach that is meaningful and effective in an Aotearoa context.

These findings are based on specific sources of information; each rohe (area), iwi (tribe), hapū (subtribe), hapori (community) and whānau (family) will have their own mātauranga connected to the marine environment.

The report indexes the reference sources so is a practical resource for those interested in marine management. Many iwi and organisations have already requested the report.

*Research Team Leader: Anne-Marie Jackson, University of Otago.*





[www.mbie.govt.nz](http://www.mbie.govt.nz)



