PSGR

Physicians & Scientists for Global Responsibility

March 16, 2022.

Submission

Te Ara Paerangi - Future Pathways Green Paper

Submitted to the:

Future Pathways Policy Team Ministry of Business, Innovation & Employment

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PSGR would welcome an opportunity to speak to this submission.

Physicians and Scientists for Global Responsibility Charitable Trust (PSGR) work to educate the public on issues of science, medicine, technology (SMT). PSGR work to encourage scientists and physicians to engage in debate on issues of SMT, particularly involving genetics and public and environmental health.

The Physicians and Scientists for Global Responsibility welcome the opportunity to submit to the Te Ara Paerangi - Future Pathways Consultation.[1] Our responses are numbered to reflect the numbering of questions in the Te Ara Paerangi - Future Pathways submission form.

10. What best describes the use of Mātauranga Māori (Māori knowledge) in your organisation?

There is some Mātauranga Māori, but it is not the main science knowledge

11. Priorities design: What principles could be used to determine the scope and focus of research Priorities?

11.A. CURRENT SCIENCE POLICY (BACKGROUND)

Reforms by government to the structure and funding of public good science funding in the 1980s resulted in a substantial abandonment of basic science and interdisciplinary expertise that could inform government regulatory decision-making required for that decision-making to give adequate attention to the best interests of society and the environment.

Rather those reforms placed an undue emphasis on partnerships between applied research, science and innovation– primarily so as to deliver novel products to market quickly. That bias gave rise to a structure that ill-informed regulatory decision-making about risks to society and the environment from novel product developments.

Thus, we now have a legacy of approximately three decades of accumulated risks being born by society and the environment in which society is supposed to flourish.

Funding of independent basic science funding largely evaporated – with a consequential loss of in-depth science expertise in clusters of disciplines that could inform regulatory decision-making about likely risks and risk-weightings that would address the precautionary principle required of government regulatory behaviour. The loss of basic science similarly narrowed the knowledge base for future discovery at scale.

Now, more than three decades of policy formulation and legislation have prioritised research, science and innovation (RSI) for private interest and economic gain, shepherding science production towards narrow forms of applied science that cannot address societal and environmental problems. Yet, 'there is no guarantee that market-led opportunities correspond to societal needs and priorities'. It is not only the public space where publics, scientists and policy-makers meet that has been impaired, the privatisation of knowledge has created barriers to the diffusion of knowledge, and the difficulty in securing funding for public good, basic research ultimately reduces the potential for further discovery.[2]

Science is perpetually vulnerable to the claims of elite scientists that might direct research trajectories to satisfy either personal interests or more dangerously the interests of industry backers.

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[1]Te Ara Paerangi - Future Pathways Consultation https://www.mbie.govt.nz/have-your-say/future-pathways/

[2] Archibugi, D., & Filipetti, A. (2018). The retreat of public research and its adverse consequences on innovation. Technological Forecasting & Social Change, 97-111. https://doi.org/10.1016/j.techfore.2017.05.022

The 1980s reforms demolished the DSIR: yet its science contribution to public policy formulation was at least substantially independent of industry influence – and was required by public law principles to deliver on assessments of science risks to people and the environment.

Cultural shifts in the late 1990s to New Public Management cultures, science as national systems of innovation[3] [4] and competitive funding models, redirected science funding in the DSIR and universities towards innovation-output goals.

These political and cultural shifts similarly undermined the role of universities as critic and conscience of society. Profit-based new public management cultures, private-public partnership imperatives, and competitive funding environments, propelled university activities towards the pursuit of economic growth.[5] [6] But they also became owned, confined and directed by industry interests.

Innovation and excellence cultures were then cemented in with the establishment of business-model Crown Research Institutes (CRIs)[7]; and by directing the majority of science funding through the Ministry for Business, Innovation and Employment (MBIE) and giving the Ministry responsibility for RSI policy. With the transfer of the bulk of science funding inside the MBIE the majority of science became aligned with the principles and purposes of the MBIE, which prioritise economic growth. The legacy of these changes continues to shape science policy in 2022.

While many European cultures followed similar trajectories, more frequently, funding channels remained clustered in science and education, rather than stewarded under business-focussed Ministries. In many countries which lead in RSI, education and science are co-stewarded. For example in Germany, central control over the funding instruments and programs was given to the Ministry of Education and Research. Sweden, with expenditures for R&D more than 3% of GDP directs investment through the Minister for Higher Education and Research who coordinates research policy, and the greatest share is directed to higher education institutions. Denmark's RSI is directed through the Ministry of Higher Education and Science.

Innovation differs from knowledge for public good or novelty in scientific research. Innovation has been a key driver in funding decisions[8] – as innovation promises a tangible endpoint.

> "the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations" (OECD 2005).

This alignment has created a brittle science system, and it has produced a knowledge system that cannot properly inform the public, the machinery of government and the media.

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[3] Freeman, C. (1995). The 'National System of Innovation' in historical Perspective. Cambridge Journal of Economics, 5-24. https://doi.org/10.1093/oxfordjournals.cje.a035309

[4] Leitch, S., & Davenport, S. (2005). The politics of discourse: Marketization of the New Zealand science and innovation system. Human Relations, 891-912. https://doi.org/10.1177/0018726705057810

[5] Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and ''Mode 2'' to a Triple Helix of university–industry–government relations. Research Policy, 109-123.

[6] Gläser, J., & Laudel, G. (2016). Governing Science how science policy shapes research content. European Journal of Sociology, 57(1), 117-168.

[7] Crown Research Institutes Act 1992, 5 (a).

[8] MBIE (2015 Oct). National Statement of Science Investment. https://www.mbie.govt.nz/assets/2eaba48268/national-statement-science-investment-2015-2025.pdf

Despite claims that the science policy system balances economic growth, environment, mātauranga Māori, health and society, the crafting of scope to prioritise 'which' science will be prioritised for funding, has directed funding towards narrow forms of science which prioritise *innovation* which has displaced *knowledge* as a key rationale for scientific enterprise. The MBIE science policy has oriented around the pillars of science, *impact* and *excellence* – this directly undermines complex long-term monitoring, public good research and interdisciplinary, or post-normal science.[9] Impactful science is not easily predicted, and excellence tends to reflect expertise within a scientific discipline, favouring applied research. Excellence narratives fail to make a safe space for cutting edge interdisciplinary science which rarely conforms to excellence mindsets, as excellence differs by expertise and culture.[10]

> 'The retreat of the public from the realm of knowledge is not the solution; on the contrary it is aggravating the problem because it forces universities and research centres to please the market, something they are not very good at, while making more difficult what they should be able to do at best, namely to generate good and useful knowledge accessible to all society.'[11]

The resulting political and scientific culture has produced barriers to public-good knowledge production which have a chilling effect on policy. These processes result in an absence of an authoritative field of researchers or scientists with security of tenure that might seek to draw attention to these issues. It is very difficult for researchers or scientists to develop a quorum of expertise that contests powerful institutional interests.

Some elites may occasionally tackle economically controversial issues such as environmental drivers of health and disease, or digital security and government contracts. These researchers and scientists draw attention to uncomfortable or politically controversial science that may interfere with the activities of powerful institutions. Such attempts are sporadic, and unlikely to be considered by mid-career scientists with precarious funding.

The effect across the policy-public-scientist interface, is research and science that is largely impotent contributing to public debate that might protect non-economic resources in a timely manner. Instead, what is often observed are one or two scientists who might struggle to address gaps or inappropriate polices, but at the risk of political and cultural exclusion, and/or undermining of their career.

11.B. STRUCTURING RESEARCH AND SCIENCE AWAY FROM POLICY

New Zealand 'does not pay sufficient attention to the future or guard against risks that can be readily foreseen.' (Palmer & Butler 2018). Risk governance should be the highest priority of the science system, which would then inform technological development that is in demand internationally, and that would serve a public purpose – to promote health, prevent pollution and degradation, protect democracy. Without higher principles of protection, transparency and accountability embedded into resilient systems, future generations cannot be protected.

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[9] Friedrichs, J. (2011). Peak energy and climate change: The double bind of post-normal science. Futures, 469-477. https://doi.org/10.1016/j.futures.2010.12.004

[10] Moore, S.et al. (2016). "Excellence R Us": university research and the fetishisation of excellence. Palgrave Communications. https://doi.org/10.1057/palcomms.2016.105

[11] Archibugi, D., & Filipetti, A. (2018). The retreat of public research. P.109

Existential risks will never be 'innovative' as per the OECD definition. These risks require long term uncertain, complex and institutional monitoring and research, in order to develop appropriate expertise. Universities role as critic and conscience of society have been disestablished and CRIs were never granted latitude, through legislation, managerial intent or funding to step into a public-interest policy-informative role. The effect is that science is applied as a tool to support government initiatives, rather than to promote scientific and policy debate and deliberation.

This is not an *apolitical* science system, it is strategically targeted to favour economic growth. The absence of secure scientists producing science that might challenge often predetermined state policy, means that our policy environment is weaker, and our policies that might produce a resilient Aotearoa, lag some one or two decades behind best practice.

Directive policy and legislation have produced intergenerational, institutional double-binds directing universities and CRIs to prioritise innovation, excellence and economic growth. As long-term monitoring and research for public good is expensive and uncertain, naturally swings to supporting commercial industry. Institutions must cover the cost of capital invested or be drip fed project funding by Ministries and agencies. University administrations capture administration costs, restricting the agency of scientists.

The legislation that the CRIs operate under includes 'social responsibility' as a metric, however, socially responsible science requires long term funding and can be politically unpalatable, as it draws attention to the off-target effects of social and economic life. Such activities can be inconsistent with the MBIEs operational intent. In addition, CRIs are closely monitored through the MBIE via expectation, intent and performance mechanisms. Furthermore, the 'no surprises' clauses that boards must abide by, further entrenches patterns of research that accord with government priorities.[12] Even while the ESR has a larger funding pool from public, rather than private institutions, it is dependent on trickle in funding, and rarely strays into research areas which call attention to pollution or existential risk from emerging technologies.

Case 1.

For example, in a recent review of drinking water standards, there was no review of the health risks relating the potential for mixtures to accumulate, and to produce harm at endocrinologically relevant levels in drinking water. It was beyond the scope of the review. Agentic research might then have provided an RSI pathway for research and development to tackle this urgent and encroaching public health problem[13] [14] [15] [16] and garner funding to develop filtration technologies. But our current system does not contain policy directing to these ethical public-health issues, nor provide sufficient 'slack' to provide the agency to extend beyond narrow scopes.

Case 2.

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[12] New Zealand Government (2020, Oct). Monitoring arrangements for MBIE-monitored Crown entities https://www.mbie.govt.nz/assets/monitoring-arrangements-for-mbie-monitored-crown-entities.pdf

[13] The Soil & Health Association and the Physicians and Scientists for Global Responsibility. Aotearoa New Zealand Policy Proposals on healthy waterways: Are they fit for purpose? 978-0-473-50130-3 https://psgr.org.nz/component/jdownloads/send/1-root/64-2019-freshwater

[14] Ferraro, P.J. and Prasse C. (2021). Perspective: Reimagining safe drinking water on the basis of twenty-first-century science. *Nature Sustainability* 4, 1032-1037. https://doi.org/10.1038/s41893-021-00760-0

[15] Stalter D. et al. (2020). Mixture effects of drinking water disinfection by-products: implications for risk assessment. *Env. Sci. Water Res.*, 6, 2341-2351. DOI https://doi.org/10.1039/C9EW00988D

[16] Valbonesi. P. et al. (2021). Contaminants of emerging concern in drinking water: Quality assessment by combining chemical and biological analysis. *Sci.Total Env.* 758, 1, 143624. https://doi.org/10.1016/j.scitotenv.2020.143624

A recent policy consultation drew attention to startling gaps in institutional knowledge that might draw attention to New Zealand's parlous vulnerability across the digital environment. The policy informing the proposed Digital Identity Services Trust Framework Bill could not iterate the risk to democratic stability, and human autonomy and rights from large digital platforms and issues relating to market failure. It ignored the digital and political power of supranational institutions and their capacity to exploit the public interest, and the potential for institutional interests in New Zealand's public sector to exploit digital identity systems, either for political or financial gain. The Bill and guiding policy did not provide an adequate legislative architecture that would ensure that oversight was sufficiently resourced; future proof, transparent and accountable; and proactive (or agentic). The governance body was not provided with adequate agency to protect the public interest – regulatory teeth. [17]

Case 3.

An August 2021 exposure draft for the Natural and Built Environments Bill did not address the threat to New Zealand from manmade, or anthropogenic pollution. While the draft discussed climate change emissions, it replicated the failings of the RMA and inadequately articulated the links between pollution, climate change, biodiversity loss and ecosystem degradation. It was unable to entrench an obligation of the public sector to work across these spheres to and preserve ecosystem systems and protect intergenerational human and environmental health, yet emphasised 'efficiencies'. It could not understand the potential of accumulative pollutant emissions to drive pollution and reduce health and the potential for newer technologies to inform and steward protective regulation. [18]

Case 4.

New Zealand's health research system directs the majority of funding to biomedical research which reflects innovation and excellence expectations.[19] This has powerfully incentivised directed health research away from physical science that can explore the social and environmental drivers of disease. Medicine is the most highly cited research field. [20] This underpins a health system which emphasises medical equity, rather than health equity, [21] and struggles to protect health and disease.[22] Medical goals do not make allowance for the pervasive presence of multimorbidity, including mental illness, which is more closely associated with the environmental and social drivers of health and disease than genetics.[23] PSGR highlighted the failure of pandemic priorities to understand and make allowance for individual risk. This included decades long failures to entrench policies that actively protected Māori and Pasifika who are more at risk of infectious disease because of their socio-economic status. We also drew attention to the failure to recognise age stratified risk, where young people and children, who were not at risk from Sars-Cov-2, were required to accept a

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[17] PSGR (2021 Dec, 2). Digital Identity Services Trust Framework Bill. Submission to Economic Development, Science and Innovation Committee https://psgr.org.nz/component/jdownloads/send/1-root/86-digidentity

[18] PSGR (2021 Aug), Inquiry on the Natural and Built Environments Bill: Parliamentary Paper Environment Committee. https://psgr.org.nz/component/jdownloads/send/1-root/72-21nba

[19] MBIE & MoH. (2017). New Zealand Health Research Strategy. The Ministry of Business, Innovation and Employment and the Ministry of Health.

[20] MBIE. (2018). Research, Science and Innovation System Performance Report. Ministry of Business Innovation and Employment.

[21] Marmot, M. (2018). Medical Care, Social Determinants of Health, and Health Equity. World Medical and Health Policy, 10(2), 195-197. https://doi.org/10.1002/wmh3.261

[22] MoH. (2018). Health and Independence Report 2017. The Director-General of Health's Annual Report on the State of Public Health. Ministry of Health

[23] Bruning, J. (2021). Master's thesis (research). Innovation and Ignorance: How Innovation Funding Cultures Disincentivise Endocrine Disruption Research. Department of Sociology. University of Auckland.

medical intervention to engage in work, and social life including sports.[24] These issues remain markedly controversial, but inadequately parsed. For example, the experts in New Zealand who might have discussed the impact of vitamin D for the health of Māori and Pasifika and the potential for vitamin D to protect these low-vitamin D groups from the respiratory virus, have remained silent.[25]

Case 5.

Agriculture's prioritisation on genetics have kept it diverted from open-ended research that supports the resilience of agricultural systems and farm health. European policy recognises the interlinkages of soil health, biodiversity, and air and water pollution with agriculture, and has committed to supporting a transition from chemical-based farming to agroecological and organic principles.[26] [27] Often the polluting externalities of chemical agriculture, and the risk from biotechnology/gene editing techniques are ignored and externalised.[28] [29] Resilient agriculture that doesn't produce unfortunate externalities and risks, require radically different science-system (or cultural) approaches. The lack of an overarching extension system in New Zealand has produced substantial barriers to knowledge in New Zealand, and resulted in a paucity of data that is relevant on-farm. Extension systems are the glue that joins farmers & growers on farm with the science system ensuring effective two-way flow of information.

Institutional priorities have also stymied open ended agricultural science. It is challenging for scientists outside the primary industry CRIs (Plant & Food, AgResearch) and the levy payer bodies to get funding for sustainable agricultural research, as the main source of funds, the Ministry for Primary Industries' Sustainable Food and Fibre Futures requires industry collaboration, but the industry is locked into their respective CRI who vigorously protect their industry linkages. The result is scientists strongly focus on the research they can do without industry collaboration and that has the highest likelihood of being funded, which, is often high-tech, cutting-edge research, with limited value to real-world farming, rather than what is required to fix farming, which is often low-tech research addressing very practical problems, that will make a difference on-farm.

Case 6.

Consumer products, including food packaging containing polyfluoroalkyl and perfluoroalkyl substances, or PFAS, are persistent, bioaccumulative and toxic (PBT). Although the legacy long carbon-fluorine chain PFAS are increasingly regulated, the shorter chain PFAS also carry PBT qualities. Contamination of humans, and soil and water contamination via leachate from landfills and rubbish dumps and contamination of wastewater, biosolids and groundwater is very large problem – these are the 'forever chemicals.' Science can work in multiple ways here. Firstly, important monitoring work is required to identify the level of contamination in New Zealand's environment. Secondly, public sector science will play a potential role in transitioning to non-toxic

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[24] PSGR (2021, Oct). Submission to the Health Select Committee. COVID-19 Public Health Response Amendment Bill (No 2) https://psgr.org.nz/sars-cov-2-covid-19/246-submission-to-the-covid-19-public-health-response-amendment-bill-no-2

[25] Dror, A.A. et al. (2022). Pre-infection 25-hydroxyvitamin D3 levels and association with severity of COVID-19 illness. *PLoS One,* 17(2), e0263069. https://doi.org/10.1371/journal.pone.0263069

[26] European Commission (2022). Farm to Fork strategy https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en

[27] The EU's Assembly of Regional and Local Representatives (2021, Feb 4). Agroecology: the answer to Europe's agricultural, social and environmental challenges https://cor.europa.eu/en/news/Pages/answer-to-agricultural-social-environmental-challenges.aspx

[28] Heinemann, J.A. et al. (2021) Differentiated impacts of human interventions on nature: Scaling the conversation on regulation of gene technologies. Elem Sci Anth , 9: 1. https://doi.org/10.1525/elementa.2021.00086

[29] Sánchez-Bayo, F., & Wyckhuys, K. (2019). Worldwide decline of the entomofauna: A review of its drivers. Biological Conservation, 8-27

PFAS replacements. Thirdly, in order to support industry transition as quickly as possible, public support is required as failure to transition creates potential irreversible harm, the work is uncertain and long term which may produce barriers to both regulation and change. Finally, and importantly, public sector scientists can be tasked with a duty to ensure that replacement products do not end up as regrettable substitutes, for example, by building into funding an obligation to ensure that substitute biopolymers break down nontoxic macromolecules.[30] [31] [32]

11.C. EXPLOITATION OF AOTEAROA

The consequence is that Aotearoa is effectively a sitting duck for exploitation from local and large institutional interests, which include foreign governments and supranational global institutions, or hidden oligarchies. These institutions might be polluting and/or extractive. They're insight and infiltration into policy processes also ensures that they constitute a threat to democracies, and this was observed in the Brexit crisis.[33] Our science system should be interconnected with our education system, but in New Zealand is de-coupled into separate government Ministries. Globalism and vested interests shape what our education systems value and prioritise, impacting the capacity for deliberation and debate in the democratic interest.[34] Knowledge for public purpose is required to navigate the dominant existential crises, but also threats to national sovereignty. Threats to democracy which will always be dynamic, grey and long term.

Yet knowledges, which might properly inform policy has been deposed, or systematically undermined by the existing political frameworks. Other factors contribute to institutional ignorance. Our policy environment has similarly been captured by institutional preferences directing agencies and Ministry consultation to defer to the insight of offshore-owned consultancy firms, rather than to contract research and science expertise inside our public sector. Economist Mariana Mazzucato has drawn attention to this practice, which systematically places more knowledge in offshore institutions, and which undermine both the knowledge and the agency of the New Zealand public sector.[35] Persistent challenges that can undermine health, sovereignty, digital security and infrastructure services at all levels of governance should be addressed by our science system, not offshore-owned consultancy firms.

Competition based mindsets sit uncomfortably with long term post-normal, interdisciplinary research addressing existential questions. Funding is precarious and piece meal, and often short term, e.g., a few years, seven years is frequently the maximum, and often single issue focused. This prevents meaningful research in environments including agricultural, freshwater, obesity and mental illness and digital security – where research is strategic, often whole system, multidisciplinary, open ended, long-term, research that can evolve to find solutions to the problems it is trying to address.

The large missions, such as the large hadron collider and the mission to the moon, produced extensive innovations that the world – and especially the private sector - continues to benefit from,

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[30] Kwiatkowski, C., Andrews, D., Birnbaum, L., Bruton, T., DeWitt, J., Knappe, D., . . . Blum, A. (2020). Scientific Basis for Managing PFAS as a Chemical Class. Environ. Sci. Technol. Lett., 7, 532-543.

[31] Ng, C., Cousins, I., DeWitt, J., Glüge, J., Goldenman, G., Herzke, D., . . . Wang, Z. (2021). Addressing Urgent Questions for PFAS in the 21st Century. Environ. Sci. Technol., 55(19), 12755-12765. doi:10.1021/acs.est.1c03386

[32] Webinar: Restriction of per- and polyfluoroalkyl substances (PFAS) under REACH. https://echa.europa.eu/documents/10162/8550003/qa_pfas_en.pdf/64a60df2-9805-98e1-4ea9-bd1a6e3f58c5?t=1606492861456

[33] Grayling, A.C. (2021). Democracy and its Crisis. Oneworld Publications.

[34] Olssen, M. (2004) Neoliberalism, globalisation, democracy: challenges for education. *Globalisation, Societies and Education,* 2, 231-275 https://doi.org/10.1080/14767720410001733665

[35] Mazzucato, M. (2021)Mission Economy: A Moonshot Guide to Changing Capitalism. Penguin.

but the overarching principles – the scope - directed the creativity of scientists. Therefore, reprioritising the science community to tackle critical issues does not mean private industry will not be supported. It simply ensures that innovation and technological development are more likely to be stewarded towards the public interest. Tax incentives can provide leverage to support industry-led RSI; faster regulation may mean that industry develops technologies that precede and anticipate regulatory shifts in more weakly regulated countries; and publicly owned discoveries can be taken up and exploited by the private sector for commercial gain.

11.D. OVERLAPPING, EXISTENTIAL CRISES

Current crises involve issues of pervasive complexity, uncertainty and ambiguity[36] [37]. They are directly political and involve long term and dedicated deliberation across civic (if democracy is valued), public sector and scientific institutions. Navigation of crises dependent upon the independence and integrity of the science enterprise and its capacity to act in the public interest. The only way these crises will be addressed – in the public interest – is via knowledge production arising out of a robust and secure science system that has autonomy and agency. This is not currently the case.

Scientific ignorance and failure to regulate and restrict pollution and current and emerging technologies are the greatest drivers of existential risk. [38] [39] [40]

Countries including Germany, Sweden and Denmark have incorporated green policies and circular economy polices, where growth is decoupled from the consumption of non-renewable resources at a high level in policy. This then informs the science enterprise.

New Zealand does not have an overarching public sector culture, policy and legislative environment that entrenches value-based strategic priorities that then require science policy to address the global challenges. We have no Green New Deal, that directs science and technology to protect human and environmental health at a high level, nor a circular economy directive, nor do we have the precautionary principle established at a high level, to guide policy and prevent irreversible harm. Such policies directly challenge business as usual mindsets that promotes mātauranga Māori friendly terminology, but which cannot challenge politically embedded practices, such as

[36] Ren, O. (2021) New challenges for risk analysis: systemic risks. Journal of Risk Research, 24,1, 127-133. https://doi.org/10.1080/13669877.2020.1779787

[37] Renn, O. et al (2011). Coping with Complexity, Uncertainty and Ambiguity in Risk Governance: A Synthesis. *Ambio,* 40, 231-246. https://doi.org/10.1007/s13280-010-0134-0

[38] Karieva P. & Carranze V. Existential risk due to ecosystem collapse: Nature strikes back. *Futures, 102, 39-50.* https://doi.org/10.1016/j.futures.2018.01.001

[39] Bostrom , N. (2013). Existential Risk Prevention as Global Priority Global Policy 4, 1. doi: 10.1111/1758-5899.12002

[40] Ord T. The Precipice. Bloomsbury Publishing. 2020.

obesogenic cultures[41] [42] [43] or chemical pollution[44] and the threat of emerging and under-regulated technologies.[45] [46]

Regulatory impotence, and the absence of agency-led feedback loops lead to downwards pressure and erode New Zealand's safe space. Independent science that can challenge vested interests and institutional interests to safely steward Aotearoa will be political. Law and ethics are interwoven, and the values and principles that guide the science system will either support autonomy for the science field to steward New Zealand or will reduce the agency of scientists if institutional oversight is deployed away from politically controversial environs.

Q11: Priorities design: What principles could be used to determine the scope and focus of research Priorities?

These are as Boston et al. (2019)[47] have discussed, often creeping policy problems and have significant long-term implications. Our science trajectory has handicapped New Zealand in the very decades that the globe has observed major transitions that directly affect the resilience and security of Aotearoa:

1. Planetary boundaries overshoot, reducing the safe space for humanity.
2. Current and emerging technologies as central to existential risk threatening both: (a) biodiversity and human health; and (b) Democracy and national sovereignty.

These major transitions involve navigation of ethical issues that intersect with Renn's challenges of risk governance complexity, uncertainty and ambiguity. They require that modern democratic policy arenas entrench accountability metrics that protect sovereignty and entrench rights that override political shifts. They require that precautionary approaches are integrated across the legal and science-policy interface.

Focus on climate change has overshadowed the urgency of these similarly pressing issues. In many ways, pollution driving biodiversity loss may be accelerating risk scenarios more rapidly than climate change. Democratic crises driven by digital capture, which reduces accountability and transparency mechanisms, may be even more pressing in the shorter term.

Therefore, the principles that determine the scope and focus of New Zealand's research priorities should be informed by principles of stewardship and resilience.

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[41] Swinburn, B. et al. (2019). The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. The Lancet, 791-846.

[42] Baker et al. (2018). What Enables and Constrains the Inclusion of the Social Determinants of Health Inequities in Government Policy Agendas? A Narrative Review. Int J Health Policy Manag, 7(2), 101-111. https://doi.org/10.15171/IJHPM.2017.130

[43] Wild et al. (2020) Challenges of making healthy lifestyle changes for families in Aotearoa/New Zealand. Public Health Nutrition: 24(7), 1906–1915

[44] UNEP. (2019). Global Chemicals Outlook II: From Legacies to Innovative Solutions. Implementing the 2030 agenda for sustainable development. Nairobi: United Nations Environment Program

[45] Annual Report of the Government Chief Scientific Adviser 2014. (2014) Innovation: Managing Risk, not Avoiding it. https://www.fhi.ox.ac.uk/wp-content/uploads/Managing-existential-risks-from-Emerging-Technologies.pdf

[46] Persson, L. et al. (2022) Outside the Safe Operating Space of the Planetary Boundary for Novel Entities. Env Sci. Tech. https://doi.org/10.1021/acs.est.1c04158

[47] Boston et al. (2019) Foresight, insight and oversight: Enhancing long-term governance through better parliamentary scrutiny. Institute for Governance and Policy Studies, Victoria University of Wellington. ISBN 978-0-473-48292-3

I. Appreciation that science, research and innovation is:
   a. Engaged to protect and promote the health of the citizens of New Zealand;
   b. Engaged to protect and promote the flora and fauna and the ecologies of New Zealand.
   c. Embedded in our social, indigenous, political, and economic cultures.
   d. A function of influences across these cultures.
   e. Often complex and uncertain, particularly concerning the impact of emerging technologies and human and environmental health.

II. Establishes the principle of kaitiakitanga to ensure the guardianship and protection of the people and ecologies of Aotearoa New Zealand.
   a. Kaitiakitanga extends across resource management; defence; ecosystem protections; infrastructure; the protection of human health and stewardship of digital and emerging technologies.
   b. The principle of kaitiakitanga obligates New Zealand's science system to prioritise science which can inform policy to:
      i. Protect environmental systems to ensure planetary boundaries (thresholds) are not irreversibly transgressed.
      ii. Promote agriculture that protects ecosystem services and ensures that soil quality is protected.
      iii. Resource science and technology to support critical local, regional and national publicly owned infrastructure and ensure that the national interest is protected.
      iv. Resource robust public sector digital and technological infrastructure to ensure the strategic protection of the citizens of New Zealand from predatory or abusive interests.
      v. Research and report on the social and environmental determinants of health that drive multimorbidity and infectious and non-infectious disease risk.
      vi. Strategically target and protect democratic systems from predatory and abusive institutional interests.
      vii. Prioritise the protection of future generations.

III. Prioritise critical research which can proactively inform and provide feedback loops into the regulatory sphere.

IV. Promote cutting-edge basic science that engages research, science and innovation across disciplinary boundaries.

V. Resource global alliances which specifically support scientific endeavour:
   a. To prevent overstepping of planetary boundary thresholds.
   b. To address the social and environmental drivers of disease.
   c. To protect from existential threats from current and emerging technologies.
   d. To promote open science and open source democratic safeguards.

VI. Communicate that leading edge innovation will arise from active regulation:
   a. Active regulation requires that science is resourced to support public interest

b. Technologies in global demand are those that address concurrent crises:
    i. Pollution from industrial and urban activities.
    ii. Potential for digital technologies to erode sovereignty & rights.
    iii. Stewardship and best practice science to ensure a robust national infrastructure.
    iv. Chronic disease epidemics driven by food insufficiency and nutrient depletion.

c. Innovation is not decoupled from public life; but is embedded in the social, political and economic life of New Zealand and deployed to contribute to the wellbeing of the citizens of New Zealand.

12. Priority-setting process: What principles should guide a national research Priority-setting process, and how can the process best give effect to Te Tiriti?

i. The protection of future generations and kaitiakitanga should guide decision-making, and science and research institutions should be provided with a legislative mandate to speak on behalf of clearly specified future-oriented interests.
ii. Research, science and technology should be driven by a principle of protection of the public interest, where the public interest is the health and security of the citizens of Aotearoa New Zealand, the stability and resilience of democracy in New Zealand.
iii. Foresight processes should be in place to ensure that major risks and vulnerabilities are identified and prioritised, and the scale and harm of potential risks are transparently drawn attention to.
iv. Policy-makers, management and staff should be obliged to adhere to the precautionary principle.
v. Public sector managers should be required to exercise prudent stewardship of their organisations.
vi. Priority should be informed and assisted by international best practice in scientific research
vii. Ensure that the safe space for uncomfortable knowledges that challenge institutional interests, and/or represent a challenge to existing scientific paradigms is protected and stewarded.[48]

13. Operationalising Priorities: How should the strategy for each national research Priority be set and how do we operationalise them?

The Parliamentary Commissioner for the Environment's March 2021 report, Knowing what's out there,[49] provides an overview of the current deficiency in environmental monitoring and analysis of risk relating to chemical pollutants in Aotearoa New Zealand. The Report provides pathways for desperately needed research. It draws attention to the important role of monitoring, data management, and recognising risk that accords with the 21st century scientific knowledge.

[48] Some of these principles are drawn from Boston et al. 2019.

[49] Parliamentary Commissioner for the Environment (222, March) Knowing what's out there: Regulating the environmental fate of chemicals

One area that is particularly insightful is a Venn diagram that considers three overlapping problems that contribute to systemic risk. This is the presence of the risk, in this case environmental chemicals, the scale of the risk, and the potential for harm. [50]

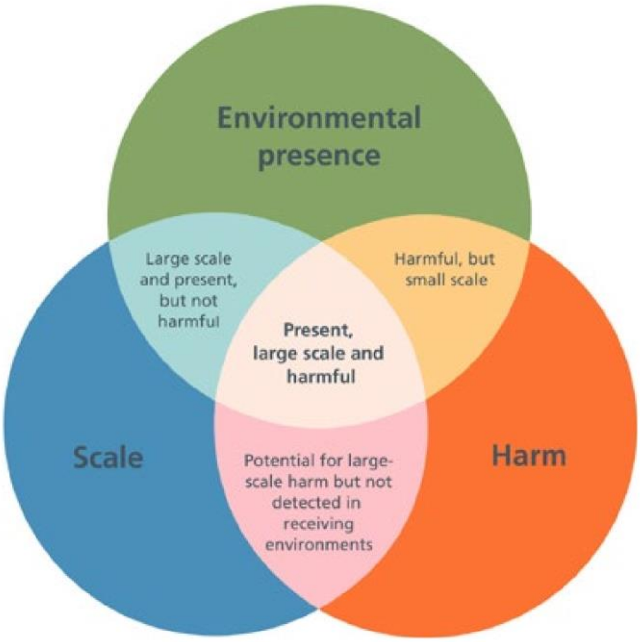

Figure 6.1: A framework to help focus regulation and monitoring on the most important environmental contamination risks.

This model could be enlarged upon and extrapolated to evaluate and prioritise many high-risk issues that have been neglected through current legislative and policy trajectories. These might include:

i. Pollution from industrial and urban activities.
ii. Potential for digital technologies to erode sovereignty & rights.
iii. Stewardship and best practice science to ensure a robust national infrastructure.
iv. Chronic disease epidemics driven by food insufficiency and nutrient depletion.

14. Engagement: How should we engage with Māori and Treaty Partners?

An overarching principle of kaitiakitanga, and a meaningful policy that provides scientists agency to monitor, research and analyse the drivers of ecosystem degradation and the epidemic of chronic disease are important primary steps. Establishing base knowledges that then provide a policy platform that direct knowledges to regulation, stewardship and care are a primary step in shifting away from the current extractive science, research and innovation cultures that serve the Crown rather than the citizens and flora and fauna of Aotearoa. The current extractive-science system

[50] Parliamentary Commissioner for the Environment (222, March) Knowing what's out there. P.6.

continues the colonisation culture that has prevented science and policy from actively honouring Te Tiriti.

15. Mātauranga Māori: What are your thoughts on how to enable and protect mātauranga Māori in the research system?

There is risk that mātauranga Māori terminology is entrenched at a superficial level across the science system, and simply 'ethics-washing' rather than meaningfully working to honour Te Tiriti. This is why our submission considers that the policy of kaitiakitanga should be engaged at high level. This provides a pathway for Māori knowledges to intersect with meaningful agency, across the science system.

16. Regionally based Māori knowledge hubs: What are your thoughts on regionally based Māori knowledge hubs?

Fusion of Māori into university and research systems is possibly the first aim. However, there are environments where local Māori knowledges may benefit from specific hubs, such as to promote local food systems resilience, as kaitiaki of water, to ensure Māori integration in scientific and policy decision-making concerning infrastructure and resources and to inform and ensure that cultural life is not eroded by digitisation and policy that is discriminatory to Māori life and culture.

17. Core Functions: How should we decide what constitutes a core function, and how do we fund them?

New Zealand's science budget is small, and it is tempting to divert scarce resources to funding channels that claim a direct economic benefit. Yet if we do not pivot core functions to uphold principles of protection and stewardship of human health, agriculture, ecosystem services, and infrastructure, and to ensure a robust digital architecture that protects the public interest and safeguards democracy – can public servants and the New Zealand government ever claim to accord by principles of stewardship required by Te Tiriti?

18. Establishing a base grant and base grant design: Do you think a base grant funding model will improve stability and resilience for research organisations?

Base or block funding is important. Precarious funding environments privilege higher status researchers, and steer less established researchers towards more conservative research.[51] [52] [53] Women and ethnic minorities are at greater risk of non-funding.[54] Researchers with precarious incomes ensure research conforms to norms in order to sustain their income.[55]

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[51] Anderson, M., Ronnin, E., De Vries, R., & Martinson, B. (2007). The Perverse Effects of Competition on Scientists' Work and Relationships. Sci Eng Ethics, 13, 437-461.

[52] Edwards, R. (2020). Why do academics do unfunded research? Resistance, compliance and identity in the UK neo-liberal university. Studies in Higher Education. https://doi.org/10.1080/03075079.2020.1817891

[53] Wang, J., Lee, Y., & Walsh, J. (2018). Funding model and creativity in science: Competitive versus block funding and status contingency effects. Research Policy, 1070-1083.

[54] Fang, F., & Casadevall, A. (2015). Competitive Science: Is Competition Ruining Science? Infection and Immunity, 1229-1233.

[55] Sigl, L. (2016). On the Tacit Governance of Research by Uncertainty: How Early Stage Researchers Contribute to the Governance of Life Science Research. Science, Technology, & Human Values, 347-374.

Incentivisation measures such as performance-based funding which rewards experienced researchers, can negatively impact younger researchers[56] and Māori.[57] Scientists abandon worthy projects when institutional elites declare a project 'done'.

Emphasis on innovative entrepreneurialism and financial precarity in research increase the potential for science to be commercially safe. In environments promoting innovation and technology transfer, faculty are more likely to be applied scientists or from professional schools who whose research had entrepreneurial potential.[58]

> 'We found that as professors sought more applied funds as money for basic research was curtailed, they began to define themselves as inventors and entrepreneurs and sought to negotiate contracts for themselves, to understand patent law and markets for scientific products and processes. They knew if they did not sit at the table with industry and government, they would not be players. They developed extensive entrepreneurial knowledge to protect their autonomy, prestige and expertise'.[59]

19. Establishing a base grant and base grant design: How should we go about designing and implementing such a funding model?

Ensure secure, long term core funding on the above principles, and promote institutional security by doing away with the globally uniquely large overheads of ~120% that universities and CRIs are forced to charge due to the lack of core funding.

20. Institution design: How do we design collaborative, adaptive and agile research institutions that will serve current and future needs?

Adopt high level principles that require science serves the public interest. Most institutions have foci that reflect to the existential problems iterated above and can transition to public good research, which many researchers and scientists would support. Remove the CRI legislation and re-establish universities as centres of knowledge for public good. Conduct a review of the national institutions and their corresponding commercialisation, or patent centres to understand how these centres might be re-established to support public good research and science. RSI institutions that can address the challenges addressed above need to decouple from financial conflicts of interest, such as public-private partnerships and financialised

21. Role of institutions in workforce development: How can institutions be designed to better support capability, skill and workforce development?

Block funding, tied to publicly accessible transparency and accountability mechanisms are essential to grow public-interest science. Block funding also contains a degree of 'slack' where novel and uncertain questions or ideas can be explored before formal applications for funding are made. There is little capacity for this now, other than in elite groups.

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[56] Buckle, R., & Creedy, J. (2017). The Evolution of Research Quality in New Zealand Universities as Measured by the Performance-Based Research Fund Process. Working paper 11/2017. Victoria University .

[57] Roa, T., Beggs, J., Williams, J., & Moller, H. (2009). New Zealand's Performance Based Research Funding (PBRF) model undermines Maori research. Journal of the Royal Society of NewZealand, 233-238.

[58] Slaughter, S., & Leslie, L. (1997). Academic Capitalism. Johns Hopkins University Press.

[59] Slaughter, S., & Leslie, L. (1997). Academic Capitalism. Johns Hopkins University Press. p.252

Short-term restrictive funding makes it more difficult for scientists to persevere where the work is important but difficult. The action of abandoning research becomes habitus, normatively accepted and invisible to the scientists.[60] In order to progress research that may not be prioritised by institutional actors, scientists undertake unfunded research, often self-funding and pursuing work outside of working hours.[61]

Over the past three decades, governments and institutions have implicitly and explicitly created mechanisms to steer research discoveries towards the patenting, licensing and commercialisation of public research.[62] [63] Biomedical science through the process of biological discovery and the potential to identify new technologies in diagnostics, treatment, and clinical care that can be potentially commercialised, has enhanced the potential for this sector to be resourced. Medicine is the most highly cited research field in New Zealand[64] and research funding contracts impose considerable obligations on researchers to secure intellectual property rights for research.[65]

22. Better coordinated property and capital investment: How should we make decisions on large property and capital investments under a more coordinated approach?

Invest in regional hubs where there are universities which prioritise the development of basic laboratory, instrumentation and digital technologies and expert staff which can be broadly engaged and ensure that these are funded as a commons and accessible across scientific communities.

23. Institution design and Te Tiriti: How do we design Tiriti-enabled institutions?

Stop commercialising everything and prioritise Aotearoa.

24. Knowledge exchange: How do we better support knowledge exchange and impact generation? What should be the role of research institutions in transferring knowledge into operational environments and technologies?

The entire science system should promote knowledge exchange, through the machinery of government, into infrastructure, secondary and tertiary education and into democratic environments. See Mariana Mazzucato Mission Economy.

25. Workforce and research Priorities: How should we include workforce considerations in the design of national research Priorities?

New Zealand's health research and policy has promoted a science trajectory that has privileged genetics and biomedicine research, resulting in considerable patent production. At the same time,

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[60] Jeon, J. (2019). Invisibilizing politics: Accepting and legitimating ignorance in environmental sciences. Social Studies of Science, 839-862.

[61] Edwards, R. (2020). Why do academics do unfunded research? Resistance, compliance and identity in the UK neo-liberal university. Studies in Higher Education. https://doi.org/10.1080/03075079.2020.1817891

[62] Gläser, J., & Laudel, G. (2016). Governing Science how science policy shapes research content. European Journal of Sociology, 57(1), 117-168.

[63] Whitley, R., Gläser, J., & Laudel, G. (2018). The Impact of Changing Funding and Authority Relationships on Scientific Innovations. Minerva, 109-134.

[64] MBIE. (2018). Research, Science and Innovation System Performance Report. Ministry of Business Innovation and Employment.

[65] HRC. (2018). Contract for Research Funding: MMH-030225-16-482-V3HRC. Health Research Council New Zealand.

New Zealand's chronic disease and obesity status has worsened, with these diseases increasing in children.

Many scientists would prefer to focus on basic science and discovery rather than be driven to produce translatable research that consistently prioritises biomedical and innovation centric research. Scientists across multiple agriculture sectors (horticulture, arable and forestry) have communicated their frustration to our trustees at a science institution which prioritises narrow technical science over systems-based knowledge that can support farmers, producers and trade outcomes.

New Zealand agriculture has privileged genetics research, at the same time there have been barriers to research which explore soil quality, nutrition and resilience.

New Zealand's innovation system has prioritised innovation, as our waste streams have expanded, yet there is no dedicated cohort of scientists with solid funding to understand consequence of sustained pollution – and therefore no capabilities have been developed to work at a high level to remove heavy metals and endocrine disrupting contaminants from biosolids, waste water, nor meaningfully address hard and e-waste.

26. Base grant and workforce: What impact would a base grant have on the research workforce?

See above 18 & 21

27. Better designed funding mechanisms: How do we design new funding mechanisms that strongly focus on workforce outcomes?

See above local outcome of18 & 21

28. Funding research infrastructure: How do we support sustainable, efficient and enabling investment in research infrastructure?

See above 18 & 21