Te Uru Kahika Regional and Unitary Councils Aotearoa

REGIONAL SECTOR EMERGING RESEARCH NEEDS

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SUMMARY

1. Te Uru Kahika is the partnership of the 16 regional and unitary councils comprising Aotearoa New Zealand's regional sector. The name Te Uru Kahika reflects our collaborative work to deliver improved real-world outcomes for people, the economy, and the environment.

2. Collectively, we have statutory responsibilities for integrated management of land, air and water resources, supporting biodiversity and biosecurity, providing for regional transport services, and building more resilient communities in the face of climate change and natural hazards.

3. Delivery of our statutory functions relies on sound evidence for decision-making. Accordingly, regional and unitary councils are major producers, users, and integrators of science and data. We regularly update our science and data priorities, with the aim of guiding research activities internally and externally to our sector.

4. **This paper lists new and emerging science and data needs for our sector**. This list is based on recent discussions across our network of Special Interest Groups[1] and key external stakeholders. It complements our existing research strategies and responds to increasing complexity in our sector's operating context.

Emerging science needs	***Example research opportunities***
Managing extremes	Science to understand and manage rare, highly impactful events and scenarios
Navigating overlapping goals	Systems science to support integrated decision-making across multiple objectives
Intervention design ***and*** early proof of progress	Science that enables early detection of the effectiveness of interventions
Supporting communities and partners	Applied social science to support effective community and partner enablement
Interfaces with economic and financial systems	Science to integrate resource and emergency management within socio-economic systems
Faster, cheaper insights while retaining robustness	Testing and integrating advanced technologies for resource management

5. This document is intended to focus science activities by identifying priorities and highlighting opportunities for collaboration. We welcome discussions within the regional sector and with our key external stakeholders to advance these opportunities for research and its application.

[1] See About Te Uru Kahika - Regional and Unitary Councils Aotearoa.

REGIONAL SECTOR SCIENCE

OUTCOMES FOR PEOPLE, THE ECONOMY, AND THE ENVIRONMENT

6. The 16 regional and unitary councils comprising the regional sector have statutory responsibilities as primary managers of the nation's natural resources. Our roles include:

    - Integrated management of land, air and water resources
    - Supporting biodiversity and biosecurity
    - Providing for regional transport services
    - Building more resilient communities in the face of climate change and natural hazards

7. Our statutory functions are grounded in place and people[2]. Our work is informed by relationships with communities, iwi/Māori, and stakeholders, and by long-term observation of local environments. We are also an integral partner for the delivery of central government policies.

AN INCREASINGLY COMPLEX OPERATING CONTEXT

8. The operating context for regional and unitary councils has always been challenging – enabling economic growth and development, while at the same time maintaining environmental protection and obligations under the Treaty of Waitangi.

9. Navigating these concurrent goals is becoming ever more complex as they grow more interconnected and acute[3]. Time to respond is increasingly limited, yet resources are constrained. Communities are divided about what responses should be taken, where, when and at what cost. Yet failure to act may have severe, long-lasting environmental, economic and socio-cultural consequences.

OUR SCIENCE: AN ESSENTIAL ROLE IN NEW ZEALAND

10. Given our ambitious vision and complex operating context, our sector has always relied on sound evidence for decision-making. Accordingly, we are major producers of science and data, as well as being key collaborators, integrators and users of science produced by other organisations.

~690	Our collective science and technical workforce, many with advanced degrees.
~$123M	Our annual expenditure on science, monitoring and related activities[4].
~5200	Number of sites for which we provide state-of-the-environment measurements annually, covering biodiversity, land, air, freshwater, estuaries, and coasts[5].
28	Number of sector Special Interest Groups, which coordinate, influence and leverage research activities, both internally and externally to our sector.

11. Our regional sector science expertise has several distinctive points of difference that deliver special value within the national RS&T system.

    - We deliver detailed, local-scale, long-term knowledge of our regions
    - We provide unique expertise in working at the science-policy-planning interface
    - We are experts at implementing research to deliver real-world outcomes at place
    - We provide much of the nation's vital state-of-the-environment monitoring data

[2] For more detail see Te Uru Kahika — Regional and Unitary Councils Aotearoa.
[3] Ipsos, 2023. A new world disorder? Navigating a polycrisis. Global Trends 2023.
[4] Updated for 2022. For 2018 figures see PCE's environmental research funding review (p.33).
[5] See Land Air Water Aotearoa and regional and unitary councils' environmental reports. LAWA has national and international reach with over 325,000 users and over 1 million page views per year.

OUR EMERGING RESEARCH NEEDS

12. Our regional sector RS&T strategy[6], last updated in 2020, identifies ten research priorities to focus science activities and investments nationwide:

    - Retaining and building science capability and capacity
    - Influencing government science direction
    - Incorporation of mātauranga Māori
    - Better science utilisation
    - Enhancing policy effectiveness
    - Integrated land and freshwater science for enhanced resource management
    - Improving biosecurity and biodiversity
    - Better hazard risk management
    - Improving coastal management
    - Cross-cutting themes: Adaptation and mitigation of climate change; improving data management

13. While the science and data priorities identified above are still highly relevant, our challenging operating context is creating several 'pain points' that create new and emerging science and data needs as outlined in the following paragraphs.

MANAGING EXTREMES

14. **Pain point.** A large and growing proportion of the impacts and costs to communities arises from extreme situations. These may be highly impactful weather or climate events, such as severe storms or droughts. Extremes also manifest in social and political viewpoints, for example in highly polarised public debate. Extremes can also appear in the intensity of work on particular topics, e.g. where much focus and energy are put into a particular area of legislative reform, only to have the progress unwound by a change in government.

15. **Opportunity.** The opportunity is to support decision-making under the most impactful extremes. The aim is to move beyond average-based thinking and instead focus on tail risks, rare events, worst-case scenarios, and the most highly polarised viewpoints.

16. **Science examples.** New research can improve how data are collected and interpreted to better characterise the edges of distributions, and to develop models that are reliable for rare or extreme situations. For example, research could design monitoring networks that oversample rare events, develop statistical methods for extreme value analysis, and improve predictive models for high-impact weather[7]. Other examples include scenario modelling for compound hazards, analysis of tipping points in environmental systems, and social science research into how communities respond under insecurity, uncertainty, stress or polarisation, including in emergencies[8]. This can involve integrating physical and social dimensions of extremes, recognising that environmental shocks and social responses are connected.

NAVIGATING OVERLAPPING GOALS

17. **Pain point.** Regional councils need to manage multiple statutory responsibilities that overlap and sometimes conflict. Responsibilities such as hazard management, biodiversity protection, and climate adaptation can interact in complex ways that are not always well understood. It can be a challenge to understand how actions to address one statutory responsibility might affect other

[6] See Research for Resource Management: Regional Council Research, Science and Technology Strategy 2020. See also Critical Datasets for Adaptation to Climate-related Natural Hazards, published May 2026, and individual Special Interest Group Science Strategies

[7] Nerantzaki SD, Papalexiou SM, 2019. Tails of extremes: Advancing a graphical method and harnessing big data to assess precipitation extremes. Adv Water Resour 134: 103448.

[8] Drakes O, Tate E, 2022. Social vulnerability in a multi-hazard context: A systematic review. Env Res Lett 17: 033001.

outcomes that are also important to achieve. As environmental issues become more interconnected, this challenge has become more pronounced and can lead to delayed decision-making, or to decisions that result in unintended outcomes.

18. **Opportunity.** This points to the need for interdisciplinary systems-based science (recognising that discipline-specific insights remain important). The requirement is for approaches that connect knowledge across domains and present it in ways that support integrated decision-making across multiple goals. This includes identifying trade-offs, co-benefits, and unintended consequences of interventions. Ensuring alignment of activities across timescales is also important, for example enabling emergency event recovery to support longer-term risk reduction. Framed as a national objective, this could look like improving the effectiveness of environmental regulation through better monitoring, compliance systems, and policies across multiple scales and outcome areas.

19. **Science examples.** Science can help by framing problems as interconnected systems rather than isolated issues, and by producing outputs that explicitly support multi-objective decision-making[9]. Specific research activities could include developing integrated models and data systems that link hydrology, biodiversity, land use and climate processes[10]. Especially useful would be models and tools that allow regional councils to test different policy options across multiple objectives[11]. Other valuable work could include mapping cross-sector impacts of interventions[12], creating frameworks for evaluating trade-offs[13], and conducting interdisciplinary studies to assess the combined outcomes of real-world interventions.

INTERVENTION DESIGN AND EARLY PROOF OF PROGRESS

20. **Pain point.** For many years science has been a vital input to the design of interventions to address environmental issues, for example what policy approach to take in which situations. This is an important role that needs to continue. However, regional councils are increasingly expected to demonstrate the effectiveness of their interventions, often very soon after the intervention has been made. But many environmental and social outcomes take years or decades to be fully realised after an intervention, during which time regional councils can face scrutiny from communities, politicians and funders. Without early evidence of progress towards the desired outcome, regional councils can risk losing support, funding or momentum, even when interventions are sound. The growing urgency of environmental challenges has made this lag between action and evidence of progress towards an outcome even more problematic.

21. **Opportunity.** This creates an opportunity for science that focuses on early signals of progress. The goal is to provide evidence of whether an intervention is moving a system in the right direction, well before its final outcomes are achieved. This requires rethinking what is measured, where it is measured, and how frequently. It also involves distinguishing between indicators of direction of travel and indicators of final success.

22. **Science examples.** Research could identify and test leading indicators for different environmental and social outcomes. Adaptive monitoring frameworks for early detection of change would be beneficial, e.g., through short-term ecological indicators that precede

[9] Moallemi EA, Kwakkel J, de Haan, FJ, Bryan BA, 2020. Exploratory modeling for analyzing coupled human-natural systems under uncertainty. Global Env. Change 65: 102186.
[10] Pörtner HO, Sholes RJ, Arneth A et al., 2023. Overcoming the coupled climate and biodiversity crises and their societal impacts. Science, 380 (6642), DOI: 10.1126/science.abl4881
[11] Howlett M, Mukherjee I, Woo JJ, 2015. From tools to toolkits in policy design studies: The new design orientation towards policy formulation research. Policy and Politics 43: 291-311.
[12] Howe SR, Sokolow SH, Buck JC, De Leo GA, Jones IJ, Kwong LH, LeBoa C, Lund AJ, MacDonald AJ, Nova N, Olson SH, Peel AJ, Wood CL, Lafferty KD, 2021. How to identify win-win interventions that benefit human health and conservation. Nature Sustainability 4: 298-304.
[13] Howe C, Suich H, Vira B, Mace GM, 2014. Creating win-wins from trade-offs? Ecosystem services for human well-being: A meta-analysis of ecosystem service trade-offs and synergies in the real world. Global Env. Change – Human and Policy Dimensions 28: 263-275

biodiversity recovery[14], or behavioural indicators that signal successful community engagement. Experimental designs to rapidly test intervention effectiveness would also be highly valuable[15].

SUPPORTING COMMUNITY AND PARTNER ENGAGEMENT

23. **Pain point.** Regional councils rely on local partnerships to deliver target outcomes. Experience shows that regional council interventions are more effective and more durable when communities and partners are actively involved in design and delivery. Accordingly, there is increasing call for guidance for regional councils on how best to partner with communities, including iwi and hapū, and to co-deliver research on mutually important topics such as water quality improvement, biodiversity enhancement and climate adaptation.

24. **Opportunity.** This creates an opportunity for applied social science to support effective community enablement, engagement and co-delivery[16]. This includes embedding Treaty-based approaches in environmental management and decision-making. The focus is on understanding what motivates participation, how trust is built, and what forms of communication and engagement lead to sustained partnerships and action[17]. Critical is to understand how local actions can be supported and guided so they optimally scale upwards for system-wide impact.

25. **Science examples.** Examples of relevant research could include behavioural studies on environmental decision-making, evaluation of co-design and co-governance approaches, and analysis of factors that build or erode trust[18]. Useful research could be focused on tools for measuring social licence (accounting for social polarisation), trials of different methods for behaviour change, studies on integrating scientific and indigenous knowledge[19], and frameworks for building equitable, enduring and effective partnerships[20].

INTERFACES WITH ECONOMIC AND FINANCIAL SYSTEMS

26. **Pain point.** Regional councils may face a mismatch between their statutory 'levers' and the economic and financial systems in which they operate. Existing economic mechanisms can work against the regulatory and non-regulatory approaches that councils typically rely on. For example, land use incentives, insurance arrangements, or urban development patterns may increase exposure to hazards or degrade natural capital, counter to the objectives of regional councils.

27. **Opportunity.** Environmental and natural hazards management could be better integrated with economics and financial systems. A key requirement is to ensure that monetary and non-monetary benefits can be meaningfully quantified and compared. The aim is to better align regulatory and non-regulatory approaches with economic incentives and instruments, e.g. market-based approaches. This includes understanding how pricing, (re-)insurance, and investment decisions influence environmental outcomes, and designing regional council regulatory and non-regulatory mechanisms that work with rather than against them. The opportunity can extend to include finance/insurance innovation and new approaches for risk-based asset management.

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[14] Clements C, McCarthy M, Blanchard J, 2019. Early warning signals of recovery in complex systems. Nature Communications, *10*. https://doi.org/10.1038/s41467-019-09684-y

[15] Leatherdale S, 2018. Natural experiment methodology for research: A review of how different methods can support real-world research. Int J Social Res Methodol, 22: 19-35.

[16] The UN Sustainable Development Goals provide an analogy, in which Goal 17 is about enabling effective partnerships across and between the other 16 SDGs (See https://sdgs.un.org/goals/goal17).

[17] Pande S, Sivapalan M, 2017. Progress in socio-hydrology: a meta-analysis of challenges and opportunities. WIREs Water, 4: e1193

[18] Yoon J, Klassert C, Selby P, Lachaut T, Knox S, Avisse N, Harou, J, Tilmant A, Klauer B, Mustafa D, Sigel K, Talozi S, Gawel E, Medellin-Azuara J, Bataineh B, Zhang H, Gorelic, SM, 2021. A coupled human-natural system analysis of freshwater security under climate and population change. Proc. Symp. Nat. Acad. Sci., 118, e2020431118.

[19] Hikuroa D, 2017. Mātauranga Māori-the ukaipo of knowledge in New Zealand. J. Royal Soc. NZ 47: 5-10.

[20] Castro-Diaz L, Wutich A, Peek L, et al., 2026. Participatory convergence: Four cases for conducting convergent research using community-based approaches. Env. Sci. Policy 180: 104396.

28. **Science examples.** Research could contribute by developing risk or natural capital accounting frameworks that quantify environmental assets and benefits, and by modelling how different economic or regulatory settings influence land use and natural hazard and environmental risk exposure[21]. A key opportunity is to link environmental and natural hazard risk information together, and then further link with financial systems models so that risks (and residual risks) are properly recognised and managed across the economy. Other opportunities include analysing the role of insurance and reinsurance in shaping behaviour in hazard-prone areas, designing and testing trustworthy market-based instruments, e.g., for biodiversity credits, water trading or climate adaptation finance mechanisms for the NZ context. Research could also focus on integrating environmental data with social vulnerability and financial risk models, enabling better alignment between council planning, private investment, and national economic policy.

FASTER, CHEAPER INSIGHTS WHILE RETAINING ROBUSTNESS

29. **Pain point.** Councils are under increasing pressure to act quickly and within constrained budgets, while maintaining defensibility of decisions. So, despite the expertise of regional council scientists and technicians, there is growing need for faster generation of knowledge and insights.

30. **Opportunity.** This creates an opportunity for new methods that reduce cost and time of generating insights while maintaining their robustness. The aim is to accelerate the full cycle from data collection, to interpretation, to communication, to decision-making. This includes determining which new knowledge would be most valuable and then designing programmes for the rapid and efficient collection of that knowledge, e.g. through pinpointing information blockages, adopting new measurement technologies, automating analysis, and streamlining workflows. The challenge is not only technical but also institutional, because new methods must be integrated into standard practices, with choices about when and how to move away from legacy methods.

31. **Science examples.** Research could develop generalised, transferable methods for identifying the information of highest value for designing interventions to achieve a given set of target outcomes or objectives. Research could also test and validate new measurement techniques, such as remote sensing approaches for monitoring land, water and ecosystems, or environmental DNA for faster biodiversity and biosecurity assessments. Efficient, safe and appropriate use of artificial intelligence and machine learning could streamline environmental monitoring[22], improve predictive modelling, and reveal outside-the-box policy approaches that might not have been identified by human experts[23]. Other useful activities could compare new and traditional methods, develop protocols for integrating new technologies into regulatory frameworks across sectors and regions.

CONCLUDING STATEMENT

32. Regional and unitary councils are deeply committed to the effective use of science and data in delivery of our statutory functions. We welcome the opportunity to collaborate within the wider New Zealand science system to advance research on our priority topics. We also welcome partnerships with key stakeholders to co-design the research and apply the findings.

[21] Sanderson DR, Cox DT, Amini M, Barbosa AR, 2022. Coupled Urban Change and Natural Hazard Consequence Model for Community Resilience Planning. Earths Future 10(12): e2022EF003059

[22] Alotaibi E, Nassif N, 2024. Artificial intelligence in environmental monitoring: in-depth analysis. Discov Artif Intell 4:84. https://doi.org/10.1007/s44163-024-00198-1

[23] Strnad FM, Barfuss W, Donges JF, Heitzig J, 2020. Deep reinforcement learning in World-Earth system models to discover sustainable management strategies. https://arxiv.org/abs/1908.05567