2011 Special Interest Groups Research Priorities

Plus

Original Critical Issues & Research Needs

Extracted from

2009 Regional Council RS&T Strategy

(to be read in conjunction with the draft 2011 Regional Council Research, Science & Technology Strategy)

Executive Summary

This document is in two parts. Part 1 is the "Regional Council Special Interest Group Research Priorities" report. The report summarises the key critical issues and research needs identified by thirteen of the Regional Council Special Interests Groups. The issues and needs were initially identified at a Futures Workshop in November 2010 and then slightly revised into their current form. They provide detail that complements the high level Regional Council Research, Science & Technology Strategy, which is currently in final draft form (as of June 2011). The Regional Council Special Interest Group Research Priorities report will be updated as priorities change and the most recent versions will be available on the Envirolink website (www.envirolink.govt.nz).

Part 2 is the original "Critical Issues and Research Needs" document that formed an appendix in the 2009 Regional Council RS&T Strategy. It is included here so that readers can compare the list of issues and research needs considered critical in 2009 with those identified by the Special Interest Groups today. Many of the issues have of course persisted, but others are new.

Document Links:

Part 1 Regional Council Special Interest Group Research Priorities (to accompany Regional Council Research, Science & Technology Strategy – September 2011)

Part 2 - March 2009 - Regional Council Critical Issues & Research Needs

Part 1 - Regional Council Special Interest Group Research Priorities (to accompany Regional Council Research, Science & Technology Strategy – September 2011)

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Regional Council Special Interest Group Research Priorities

Background

Regional Council Special Interest Groups (SIGs) presented, and later modified, their critical issues and research priorities at a Futures Workshop in November 2010. This document summarises the key critical issues and research needs for the SIGs and will be revised as priorities change.

This document shows a good clustering of like themes from across SIG boundaries and there are several inter-related critical issues between SIGS. For example Natural Hazards Critical Issue 5 is consistent with Local Authority Environmental Monitoring Critical Issue 1, and Natural Hazards Critical Issue 2 is consistent with Policy and Planning Critical Issue 1. Any duplication has purposefully been left in this document to reflect the integrity of the process, i.e., that SIGs have brought their thoughts to a common forum, and the Science Advisory group has taken the work on for the sake of integration, efficiency, leverage, etc. It is important to look out of conventional subject silos and to understand what others are doing and what is important to them.

Note: Each SIG has a longer list of Issues and Research Needs than is listed here, but these are the top priorities.

Special Interest Group Critical Issues and Research Needs

National Air Quality Working Group

1. **Critical Issue:** Achieving accountability and effective air quality management appropriate to New Zealand emissions and solutions.

Research Need:

- Studies that evaluate whether or not emission reduction measures adopted throughout NZ are achieving desired health outcomes
- Emission studies that investigate whether new technologies (e.g. low emission wood burners) produce less emissions than old technology in practice.

Important to NZ because:

- Health effects are the primary driver for emission reduction programmes in NZ. Most health effects analyses undertaken in NZ are based on overseas data, generally derived from large urban populations exposed to a different atmospheric chemical cocktail and perhaps via different exposure pathways. NZ needs to be certain that the emissions reductions being sought will have the predicted health benefits in the NZ context.
- The limited testing of real-life emissions of wood burners undertaken to date has produced some disturbing results. When tested some laboratory certified ultra low emission burners produced much higher emissions when installed and operated in a home situation. In some cases the real-life emissions exceeded those of the older burners they were intended to replace. These results call into question the efficiency and equity of some burner replacement programmes and needs further work.

2. **Critical Issue:** Identification of key emission sources and quantifying their contribution.

Research Need:

- Substantial emission inventory review work is needed that compares inventories and methods used across the country, investigates how emissions by source type vary by area (as a result of methodology, differences in assumptions etc), identifies methodological issues, estimates uncertainties and proposes robust validation methodologies. Emission studies should be conducted to provide emissions, hours of use, burn rates, emission rates and daily fuel use.

Important to NZ because:

- Currently there is a poor fit between emissions calculated using emissions inventories, emissions monitored at air quality monitoring sites, and emissions modelled using computer based simulation models. Problems with fit occur with both the magnitude and timing of peak concentrations. Cross analysis of data sets suggest that part of the problem relates to the accuracy and resolution of emission inventories and points towards the need for more sophisticated inventories, more national consistency and better guidance for practitioners.

3. **Critical Issue:** Achieving a better understanding of the human health impacts of air toxics and other contaminants (e.g. BaP and formaldehyde).

Research Need:

- An evaluation conducted of key air toxics, their measurement and potential health effects in NZ. Investigations into affordable screening measurement/analytical methods are vital.

Important to NZ because:

- Atmospheric contamination and its impact on human health is a very complex area. Many toxic substances with potentially significant human health impacts are routinely used in transport (e.g. BaP) and industry (e.g. formaldehyde) and common in the atmosphere. Little is known of their individual or combined health impacts.
- These pollutants are not routinely monitored in NZ due to lack of suitable methodology and/or high sampling cost. Further research is needed to establish the magnitude of health impacts and develop cost-effective approaches to monitoring.

Biosecurity Managers Group

1. **Critical Issue:** Integrated and coordinated possum/predator control programmes on private land for both landscape and site-based control.

Research Need:

- Systems (tools and methodologies) to manage multiple pests at sites and across landscapes.

Important to NZ because:

- Significant contributions will be made toward achieving strategic biodiversity and economic objectives.
- The sustainability and cost effectiveness of multi-pest management will be increased over the long term. New tools will help optimise and retain benefits of Tb Vector management (25% of NZ land area).
- This has become especially critical in the post-Tb/transition period.

2. **Critical Issue:** Alternative toxins to 1080 and brodifacoum for mammalian pest control.

Research Need:

- Humane, cost-effective toxin, specific to target species, that are environmentally friendly, safe and acceptable to the public.

Important to NZ because:

- 1080 and brodifacoum are under threat as pest control tools and focused research into alternative toxins is urgently required.

3. **Critical Issue:** Performance measurement tools for cost-effective pest management.

Research Need:

- Cost-effective performance measurement/outcome monitoring tools for protecting and enhancing biodiversity values through the application of pest management.

Important to NZ because:

- This is essential for Regional Councils to meet their RMA and BSA requirements and to evaluate whether the money spent on pest control is producing the desired outcomes.

Biodiversity Forum

In addition to the key issues and research needs identified by BMG above:

1. **Critical Issue:** Determining indicative pest levels for optimising biodiversity gains (How much is enough?).

Research Need

- The cost/benefit ratio for the control of various species is not well understood in terms of biodiversity gains. There is a need for research into the relative biodiversity gains from various levels of pest control affecting multiple pests (e.g., what is lost (in biodiversity) if possums are controlled to 10% residual trap catch (RTC) vs 2% and what costs (in dollars) are saved?)

Important to NZ because:

- We know that more pest control nationwide is absolutely crucial to reversing the decline in biodiversity. We need to do more, but have no more money to do it with. We need to understand areas of potential savings and the associated trade-offs.

2. **Critical Issue:** Maximising gains and habitat connectivity in fragmented, productive landscapes?

Research Need

- Most of NZ is characterised by fragmented, highly modified ecosystems dominated by productive use. In that context, we must understand how to get the most value from biodiversity spending. Is it better to fence stock from forest fragments in pasture? Or to let stock in but spend money on rat control?

Important to NZ because:

- Those fragmented ecosystems dominated by productive use are all we have left in most parts of NZ. We have little to work with and so must make the most of our efforts.

3. **Critical Issue:** Can biodiversity management be more 'holistic' to benefit both terrestrial and aquatic systems?

Research Need

- We need a better understanding of the relative costs and benefits of various management options that could benefit both terrestrial and aquatic biodiversity.

Important to NZ because:

- Terrestrial and aquatic biodiversity needs are in practise often addressed separately. However, we suspect more value could be gotten from a holistic approach. For example, stream/riparian planting is a common high priority for many councils. However, those programmes generally are unlikely to have analysed what approach maximises the combined values of nutrient reduction, bird food sources, aquatic biodiversity needs, etc.

Land Monitoring Forum and Land Managers Group

1. **Critical Issue:** Soils underpin much of the New Zealand economy and they are mainly valued for their contribution to primary production. The value of soil environmental services for contributing to water quality, biodiversity, and carbon storage etc., are poorly understood and appreciated.

Research Need:

- Methods to enable RCs to place financial and non-financial values on soil environmental services for determining tradeoffs for policy.
- Valuing 'natural capital' in a robust, defensible and transparent way that is capable of wide application across all natural resources.

Important to NZ because:

- NZ is heavily dependent on primary production, which is underpinned by the soil resource. Assessing soil environmental services, beyond primary production, broadens the way in which soils can be valued. It also provides a means to link soil to water and biodiversity and placing a value of the management impacts on soil resources on off-site effects.

2. **Critical Issue:** There is a need for improved soil and land use information in order to increase primary production, better value environmental services, and improve the performance of catchment models to assist with land use planning and policy.

Research Need:

S-map completion:
- S-map is an essential tool for policy developers and land managers; it provides national consistency, access and interpretation.
- S-map fills in the gaps of very patchy soil information used in NZLRI (large areas of 1:250,000 scale) and is critical for catchment models.

Land use information:
- Land use information needs to be updated as current availability, quality and cost limits RC work.
- Agribase and the Land Cover Database (LCDB) are two key examples. These should be integrated for consistency.
- The need for improved land use information is well known in central government and has previously been identified as a priority need for Regional Councils.

Important to NZ because:

- NZ is heavily dependent on primary production and soil resource information underpins efficient land use to maximise resource potential and to ensure appropriate soil management to minimise long term degradation of the soil resource.
- Soil and land use informatin underpins models that in turn are used for land use planning and decisions, all of which are becoming increasingly important as demand for soil/land resource increases.

3. **Critical Issue**: There is widespread soil contamination throughout New Zealand, in many cases as a consequence of fertiliser applications. This is a critical issue for agricultural production and exports and also for residential subdivision. In extreme cases there are also issues for human health.

Research Need:

- Contaminants are predominantly fertiliser related but not exclusively and include:
    - Copper chrome arsenic – from treated timber, and for which a lot of research questions are unanswered.
    - Zn – from facial eczema chemical treatment and from powerlines.
- Cd, F – from fertilisers
    - Cd working group is finishing and a new strategy is required, including priorities and tiered guidelines.
- Biological effects of contaminants require further research to improve understanding.
- Key research gaps are in spatial distribution of contaminants, modelling, and accumulation rates.
- The issue has been previously identified and is well known in central government.

Important to NZ because:

- Accumulation of soil contaminants can severely limit the availability of soils/land for production and subdivision (reduces land versatility), and can impose large costs for remediation.
- High levels of some soil contaminants pose a risk to human health, with thresholds breached within the next generation if no intervention.

4. **Critical Issue:** There is an increasingly serious issue concerning the impacts of nutrients and sediments on estuaries and coastal environments, which are used for production, recreation, tourism, and other environmental services.

Research Need:

- Understanding land use effects on nutrients and sediment generation and transport and the effects on estuaries, lakes and the coastal environment.
- Empirical, evidence-based approach to policy development integrating management of contaminants aligned to contaminant fate and environmental consequences.
- The issue has been previously identified and also appears in the Coastal SIG list of priorities.

Important to NZ because:

- NZ's coastal environments are used for recreation, tourism and aquaculture – degradation from contaminants will have negative impacts.
- Coastal environments have sensitive ecology which is important as part of the broader marine ecosystem, including fish breeding and population maintenance.

5. **Critical Issue:** Land use impacts on water quality are a major issue for New Zealand and despite considerable research effort there are still major gaps in our knowledge. Better understanding is critical to minimise negative impacts of productive land use on the downstream environment.

Research Need:

- There is an ongoing need for better links between farm scale and catchment scale models; better understanding of the cumulative effects of land use on water quality; and transfer pathways and attenuation of nutrients and contaminants through soil and the vadose zone.
- Research is needed to improve links to accuracy of models; quality of soil and land input data; groundwater data.
- The issue has been previously identified and is also important to other SIGs, e.g., SWIM and GWF.

Important to NZ because:

- Water is a resource under pressure, both quantity and quality. Maintaining good water quality ensures availability into the future.
- There are high remediation costs of degraded water quality that can be avoided.

6. **Critical Issue:** New Zealand's ecosystems are at risk to the cumulative effects of activities on ecosystem structure, function and resilience.

Research Need:

- There is a need for improved understanding of natural ecosystem complexity, diversity and resilience, and the cumulative effects of on-site and off-site activities on natural systems.
- The issue has been previously identified.

Important to NZ because:

- Long-term ecosystem diversity helps resilience against biosecurity risks, climate change impacts and maintains land use versatility.

Regional Waste Managers and Contaminated Land Forum

1. **Critical Issue:** There is widespread land (soil) contamination as a consequence of sheep dips, treated fence posts, leaky petrol tanks etc in soils. The issue is to develop practical means to deal with this issue including guidelines and remediation technologies.

Research Need:

- There is a need for improved understanding of ecological effects of contaminants (esp. on native species)
- Development of efficient ways to identify, prioritise and remediate hot spots
- Understanding human factors (public, land owners, developers etc.)
- Development of methods for remediation / management (including sampling)
- Development of NZ risk-based guidelines and
- Development of tools for behaviour changes and risk communication.

Important to NZ because:

- Soil contamination can limit productivity, can lead to restrictions on the export of primary products, and can have implications to human health and thereby limit land use options.
- This issue has also been identified by the Land Monitoring Group.

2. **Critical Issue:** Dealing with diffuse chemical contamination from agricultural and industrial practices like cadmium and fertilisers in soils, arsenic and dam in rivers and lakes.

Research Need:

- There is a need for issue specific risk assessment
- Effective ways to monitor accumulation in environment including groundwater
- Human factors research (public, industries, regulators etc.)
- The development of NZ risk-based guidelines
- Modelling contaminant fate and transport, and
- Tools for behaviour changes and risk communication

Important to NZ because:

- There are biodiversity, human health as well as land use issues associated with diffuse chemical contamination.

3. **Critical Issue:** There is a need to better deal with problem waste streams such as tyres, e-waste, construction and demolition, putrescibles etc including a need for better landfills.

Research Need:

- The development of effective technologies to deal with the waste streams that are economically viable (opportunities from new businesses, carbon sequestration, bioenergy etc.)
- Understanding the real cost of landfills
- The development of waste minimisation technologies - new (but proven) technologies / designs with economic data, and
- Methodologies for behaviour changes and risk communication

Important to NZ because:

- Some waste streams are creating problems for some communities and require solutions.

4. **Critical Issue:** There is a lack of an integrated, shared, and widely accepted system to collect, monitor and report on waste-related (quality) data in New Zealand.

Research Need:

- A method to legally connect data collected from various agencies.
- Consistent data management and quality of data collected.
- Research to address the attitude towards data collection.
- Coordinated emergency response for all types of wastes.
- New tools to quantify waste minimisation activities (re-use etc.) and a
- System approach.

Important to NZ because:

- Having a nation-wide data sharing system would provide opportunities to improve waste management in many parts of New Zealand.

Surface Water Integrated Management

1. **Critical Issue:** Community change

Research Need:

- Social science research - how to effectively promote highly targeted behaviour changes towards desired ends amongst particular populations, for particular issues. Including a mix of policy options. Investigate impacts on, and ability for communities to adapt /respond to changes in their environment and the distribution of impacts including identification of equity issues and mechanisms to minimise negative consequences on well-beings.
- Identify examples of co-management models between Maori and Council and evaluate.

Important to NZ because:

- Identification of the issue has not necessarily brought about the required behavioural change to make effect, by understanding how these changes can be made will increase NZ's environmental performance.

2. Critical Issue: Uptake of existing science

Research Need:

- An age-old problem of transferability of science into the community and the consequent application; often this is more a time constraint issue of the recipients than science providers. A critical issue and probably a social science research need.
- Demystifying science to enable informed water resource debates

Important to NZ because:

- A lot of science within NZ that has a significant applied component does not get into the community (whether local government, industry or domestic), this has lead to duplication of effort and slow uptake, resulting in unnecessary delays in addressing social, economic, cultural and environmental issues. Improving the uptake and articulating the message to multi-sector audiences will improve NZ's environmental performance.

3. Critical Issue: Valuing environmental services

Research Need:

- Research to develop and trial new methodologies and tools to enable RC's to place financial and non-financial values on environmental resource services. Valuing 'natural capital' in a robust, defensible and transparent way that is capable of wide application across all natural resources.
- Multivalue criteria analysis to enable robust water management decisions which enable communities expectations and deliverables to be met (i.e., balance values of communities for multiple protection while having regard to national and international requirements).

Important to NZ because:

- There is a need to ensure decisions are made from robust frameworks that balance the four well-beings. This will ensure an easier path for planning both for statutory and participatory processes and ensure the "right" decisions are made.

4. **Critical Issue**: Cumulative effects of activities on ecosystem structure, function and resilience

Research Need:

- Improved understanding of natural ecosystem complexity, diversity and resilience, and the cumulative effects of on-site and off-site activities on NZ natural ecosystems (i.e., how to avoid 'death by a thousand cuts' in our ecosystems; are there 'tipping' points and if so, when do they occur?)
- Ecotoxic compounds relative to NZ species – provide robust chronic and acute toxicity data relevant to NZ conditions. Includes threshold setting and scenario modeling. ANZECC guidelines are deficient in "real" NZ data on species toxicity

Important to NZ because:

- Action equals reaction - over simplifying complex ecosystem processes can lead to unanticipated effects that can have critical outcomes for NZ's environment and communities. The cost of mitigation and remediation could be greatly reduced if our decision making processes are robust and adaptive.
- The lack of NZ specific data on NZ species causes the setting of limits to be contentious. Validating to NZ species would reduce contentiousness and enable the setting of limits to be more robust and dependable.

Groundwater Forum

1. **Critical Issue**: Groundwater is in limited supply in some regions and there is a need to ensure that groundwater allocation is optimised.

Research Need:

- Understanding surface water groundwater interaction and potential to offset seasonal peak demand and evaluate conjunctive management in riparian zones;
- Opportunities to augment supply through a range of storage options and artificial aquifer recharge;
- Methods to determine sustainable yield to avoid saltwater intrusion;
- Potential effects on surface and groundwater quality from abstraction;
- Developing allocation models and mechanisms which include economic, cultural and social considerations;
- Characterising aquifer boundaries and flow paths within and between aquifer systems.

Important to NZ because:

- There is an urgent requirement to determine how water resources can be effectively and sustainably allocated between competing uses; and
- To determine how defensible groundwater quality targets can be set to provide acceptable long- term environmental outcomes while enabling appropriate community desired land- use.
- Additionally, although the allocation question is important and topical, the principal constraint often is socio-political direction rather than new science. For example, is it possible to provide any further allocation for competing needs in a catchment (closed hydraulically) where national prioritisation has been given to power generation?

2. **Critical Issue:** Groundwater quality is under threat in many regions particularly from nitrogen contamination. There is an urgent need to develop groundwater

quality targets to set goals for improved management, however, there are many complicating factors such as time lags in contaminant migration through the groundwater system and chemical transformation processes that are not completely understood that are restricting the development of groundwater quality targets.

Research Need:

In order to set scientifically defensible "groundwater quality targets" further research is required into the following:

- Occurrence and likely extent of contaminant attenuation (particularly nitrogen) within New Zealand groundwater and the vadose zone conditions;
- Time lags involved in contaminant migration through the groundwater system and the vadose zone;
- Development of predictive models of diffuse contaminant transport accounting for the above (lag and transformation) and considering uncertainty;
- Development of decision support mechanisms (linking with socio-economic considerations) for groundwater quality target setting looking back up the catchment from an endpoint perspective. (this would in turn enable realistic land use constraints to be imposed);
- Migration and attenuation of microbial pathogens to protect water supplies.

Important to NZ because:

- Degradation of groundwater quality is the greater long-term threat than groundwater availability. Only in recent times have the large time lags in the groundwater system (decades to hundreds of years) been fully appreciated. This has huge implications for future freshwater quality, given much of the land-use impacts have yet to be realised (i.e. equilibrium with water quality has not been reached). Lags and contaminant transformations complicate interpretation of monitoring and future effects prediction.

River Managers Group

1. **Critical Issue**: The nation's economic performance and community functioning remains at risk from flooding of our major river systems. Events with a return period on par with the March 2010 earthquake may cause damage and disruption on the scale of that event.

Research Need:

- The development and implementation of updated (state of the art) techniques for modelling and mapping to determine the economic risk of river flood hazards that are applied consistently regionally and nationally.
- The application of flood modelling to identify areas of greatest economic risk from flooding combining economic value with flood-risk areas and recommended approaches to mitigate that risk.

Important to NZ because:

- This is critical to be able understand and categorise consistently around the country as to which areas are at greatest risk from flooding for strategic local and national planning and decision making.

(Note that current best practice for Flood Risk Assessment such as NSZ 9401:2008 Managing Flood Risk – A process Standard; and MFE Preparing for Future Flooding – A Guide for Local Government in New Zealand, May 2010, could form the basis for flood risk assessment from the flood hazard mapping. Riskscape has the potential to assist with this process, however it does not at this stage have the flexibility or capability to analyise alternative mitigation options.)

2. **Critical Issue:** Climate change and future development effects on the economic sustainability of river schemes.

Research Need:

- Understanding how the effects of climate change and future development will impact on river systems is critical to their economic sustainability. This includes:
    - Understanding impacts of changes in extreme, annual and seasonal rainfall, sea level rise and storm intensity, on the costs to schemes such as the need for higher standards of protection, more pumping, reduced levels of service or managed realignment of flood defences.
    - Changes to the natural geomorphological (sediment transport and erosion) behaviour of our major river systems.
    - Managing gravel resources and planning for use of this resource in an environment altered by climate change through differences in accretion and degradation.
    - Changes to landform, vegetation and soil characteristics of the catchment and how interventions in these areas can assist in the mitigation of flood risk.
    - Gaining a better understanding socio-economic profiles, energy use and transport choices into the future – including how many people and what assets are at flood risk currently and into the future.

Important to NZ because:

- The effect of climate change on extreme rainfall duration and intensity, as well as annual and seasonal changes in rainfall has potentially significant implications for our river systems and flood management.

Local Authority Environmental Monitoring

1. **Critical Issue:** Regional flood estimation is based on the application of a tool that hasn't been revised nationally since 1989. This is a tool that is utilised throughout NZ for both engineering and flood management purposes.

Research Need:

- The Regional Flood Estimation (McKerchar AI, Pearson CP. 1989. Flood Frequency in New Zealand. Publication No 20 of the Hydrology Centre. Christchurch: Department of Scientific and Industrial Research') to be revised and updated.
- This tool needs to be updated based on the longer flow record and more comprehensive data that is now available throughout the country.

Important to NZ because:

- This tool provides a robust methodology that is widely used within New Zealand to enable flood magnitude and frequency to be determined, particularly within un-gauged catchments. This document is now 22 years old. Considerably more and better quality data is now available to enable this methodology to be updated. Much improved spatial coverage is now available as well as considerably longer flow records. It is important that the tool be updated to improve flood design information for river works, bridges and culverts.

2. **Critical Issue:** Councils and other engineering agencies need to be able to calculate river flow and flood frequency for the design of structures, however, New Zealand's primary tool for flood analyses is now significantly dated.

Important to NZ because:

- The design of structures that will withstand significant flood events is of critical importance to the New Zealand economy. All Regional Councils and many other engineering agencies reference this methodology when undertaking the design of structures in and adjacent to our nation's waterways. It is important that this design work is undertaken using the best methodology and information available to ensure that efficient use of financial resources occurs in construction.

Coastal Planners Group

1. **Critical Issue:** The quality of NZ coastal waters is under threat of contamination from catchment development and the cumulative impacts of multiple contaminants. Guidelines and standards are required to enable more effective management and reduced impacts.

Research Need:

- Analysis of existing data to identify whether meaningful marine (estuarine, harbour, open coast) WQ guidelines/ standards suitable for use in coastal plans can be developed, at what spatial scales they can be applied, and guidance on appropriate monitoring approaches to determine compliance.

Important to NZ because:

- Near-shore coastal and marine ecosystems are highly productive and biodiverse areas that provide a wide range of goods and services, many with iconic status, that are of particular social, cultural and economic value to NZ. However, the very characteristics that provide for their high productivity, such as shallow sheltered waters receiving enriching land-sourced discharges, also exposes them to potentially catastrophic risks of contamination and water quality degradation as their catchments are developed.
- Effective management of these precious resources requires regulatory interventions guided by robust and reliable ecosystem condition indicators (e.g. guidelines, standards). No such guidelines currently exist specific to NZ marine and estuarine waters.
- The research is directed at filling this critical information gap as well as providing advice on how the resultant guidelines can be applied and implemented.

2. **Critical Issue:** There is limited understanding of the cumulative effects of human activities on estuarine and coastal ecosystems and this lack of knowledge limits effective management of ecosystem values.

Research Need:

- Including point and diffuse sources, transport mechanisms, effects (sublethal, synergistic, antagonistic) of multiple stressors on marine flora and fauna, structure, function and resilience and indicators (potentially including biomarkers as indicators of sub-lethal stress), and determining carrying capacity .

Important to NZ because:

- Coastal ecosystems rank among the most productive ecosystems on earth, are of great social, cultural and economic importance to NZ, but are also highly threatened by exposure to a multitude of stresses levels of both ocean-and land-based human activities increase.
- Current management primarily considers activities in isolation; however, focussing on single stressors is inefficient and often ineffective because co-occurring human activities lead to multiple simultaneous impacts.
- Mechanisms available to address cumulative effects under the RMA are limited and we have only limited scientific knowledge of how stressors interact and how ecosystems respond to multiple stressor exposures.
- The research is directed at filling gaps in our scientific understanding of cumulative impacts upon our valued coastal ecosystems so that they can be more effectively managed.

3. **Critical Issue:** Agriculture intensification and urban development are greatly increasing the discharge of nutrients to estuarine and coastal areas and the effects on coastal ecosystems are poorly understood.

Research Need:

- There is a need for improved understanding of point and diffuse nutrient sources, transport mechanisms, effects of nutrients on marine flora and fauna, structure, function and resilience; and also indicators (potentially including biomarkers) of sub-lethal stress, and determinants of carrying capacity. Tools, based on this research, are required to enable effective management and reduced negative impacts.

Important to NZ because:

- The progressive development of the majority of NZ's land area from natural terrestrial ecosystems towards agricultural productivity, and urbanisation for our growing population, has resulted in greatly increased discharges of nutrients to fresh water and near-shore coastal ecosystems.
- These aquatic ecosystems are of great social, cultural and economic value to the country, but they are under threat if nutrient effects are not properly understood and effectively managed.

Regional Policy Managers

1. **Critical Issue:** There is a need for more and better tools to assist in the analysis of and responses to natural hazard risks.

Research Need:

- In this is quite a large portfolio of research need to be considered, including managed retreat, insurance as a tool for managing risk and the 4R's – emergency management. In the past most hazard responses are captured by engineers and this approach has not really given us the tool to manage the residual risk component. Specific criteria against which risk is assessed would be very helpful as would an idea of what's acceptable risk? It is noted that there are some international standards and work in this area, however the criteria aren't specific enough to measure against. What's the spectrum of intervention options?

Important to NZ because:

- Generally there is a lack of coverage of the natural hazards area in the original CI&RN document (March 2009). There is an overall need for better tools to assist with the analysis of, and responses to, hazard risks. There are some standards available, but more research is needed to provide a more robust and defensible position to address hazard risk more effectively, and to give decision makers confidence. The key issue is risk management - how to deal with risk. This includes residual risk, which is seen as a critical planning issue around questions of where development is appropriate in relation to our understanding of the various risks.

2. **Critical Issue**: There is a lack of research capability for investigating policy effectiveness and a lack of tools to model likely effectiveness of policy options.

Research Need:

- There is a need for new research capability in regard to policy effectiveness in environmental management, particularly in the context of the RMA. There is an opportunity to package up this idea and take it to central government to develop new capability in NZ. Termed consequences evaluation the idea is to actively undertake research into the difficult area of assessing the efficacy of different policy approaches. A first step would be to develop a business case justifying the benefits of developing greater capability in New Zealand.

Important to NZ because:

- Currently there are limited tools and limited research capability to determine the effectives of environmental policies in New Zealand. There is a need for this type of research to be integrated with State of the Environment and Long-term Plan monitoring. Regarded as being relatively easier in water management it is clearly a more difficult task in areas such as conservation management etc. Importantly, such a research stream would need to determine what produced the benefit and make connections with other disciplines, including economics, the biophysical sciences, social sciences and with existing programmes.

3. **Critical Issue:** Methods for determining priority access to water are currently limited. This is a critical issue for situations where water has been fully allocated and/or where there is intense and increasing competition for scarce water.

Research Need:

- There is a need for greater research effort into methods for determining priority access to water.

Important to NZ because:

- This type of research would be especially useful if it focused on what might be done in cases of full allocation and competition. There are a couple of options to consider, each with problems. The Land and Water Forum is dealing with this, as is MfE. Is there a research requirement? Views across regions are influenced by understanding of current law. No one is, however, really looking at how to design a system to deal with scarce water. The Land and Water Forum may provide something useful. There is a need for coordination with SWIM and GWF.

Natural Hazards Group

1. **Critical Issue:** Low lying coastal areas are potentially vulnerable to storm surge and sea level rise. There is a need for complete LiDAR coastal survey data to provide underpinning data to assess hazard risk for these coastal areas.

Research Need:

- A cost effective alternative to conventional ground surveying for medium to large-scale terrain modelling projects. The NZ Geospatial Office is looking to publish NZ description (metadata) coverage extent of LiDAR (a lot of the data has been provided by RC's) but there are still large gaps.

Important to NZ because:

- Nation-wide coastal LiDAR enables identification of vulnerable low lying coastal areas and provides digital terrain elevation data that can be used quantitatively in modelling storm surge inundation and sea level rise. When conducted at low tide it can obtain high resolution coverage of the intertidal zone that is not easily surveyed by any other method. This area is an important part of modelling any processes in the foreshore, and as also proved an excellent tool for surface fault-line mapping.

2. **Critical Issue:** Seismic hazard research including all the hazards associated with earthquakes e.g. (ground shaking and amplification; liquefaction and lateral spreading; slope failure (rock fall and landslides); fault rupture) throughout NZ.

Research Need:

- Fault trace mapping according to the MfE Guidelines "Planning for development of land on or close to active faults" (Kerr et al 2003). Priority for all Class I faults and should determine where possible fault locations, types, return periods and establishment of Fault Avoidance Zones (FAZ).
- Liquefaction research to include improving methodology for evaluating liquefaction susceptibility and hazard, and undertaking mapping in known risk areas.

Important to NZ because:

- Earthquakes are a feature of much of New Zealand and appropriate planning needs to be applied to avoid unnecessary land development risk.
- Once faults are identified through continued fault trace mapping we can implement "Planning for development of land on or close to active faults" guidelines (MfE Guidelines). Priority needs to be given for all Class I faults and

should determine where possible fault locations, types, return periods and establishment of Fault Avoidance Zones (FAZ).

- Liquefaction hazard information can be used by councils and the community to ensure appropriate advice is obtained from chartered professional engineers about using foundation details that provide enhanced building performance on land where liquefaction and/or lateral spreading could occur, while awaiting new national guidance from the Department of Building & Housing on lessons learnt from Canterbury on building performance requirements expected in the future.

3. **Critical Issue:** Much of coastal New Zealand is **exposed to significant risk from tsunamis and more** tsunami inundation mapping is required to fully identify this risk.

Research Need:

- Develop inundation hazards maps based on dynamic wave propagation models – focussed on areas of greatest risk. These inundation maps need to be adequate for evacuation planning using the methodology outlined in the MCDEM Directors Guidelines 'Tsunami Evacuation Zones' DGL 08/08, and ultimately land use planning.

Important to NZ because:

- GNS Tsunami Risk Report 2005 concluded NZ's ongoing risk from tsunami is significant. Central government (MCDEM) advocates for the development of tsunami evacuation zones throughout NZ, and tsunami inundation mapping is an essential first step.

4. **Critical Issue:** Councils need to have a better appreciation as to what level natural hazard risk becomes acceptable to be able to use this knowledge in land use planning.

Research Need:

- Further research is needed to provide guidance to Councils on how to include natural hazard risk into land use plans and how to determine what an acceptable level of risk is.

Important to NZ because:

- There is a need to know at what levels (social, economic, environmental, cultural, and health and safety criteria (LG, RM, CDEM Acts)) natural hazard risk becomes acceptable (CDEM Act, s 3(b)), tolerable (AS/NZS ISO 31000:2009, clause 5.3.5, 6th bullet) and intolerable (SAA/SNZ HB 436:2004, ch 7). There is also a need to provide guidance on how to include hazard risk into land use plans i.e., better tools to assist with the analysis of, and responses to, hazard risks.

5. **Critical Issue:** Councils need to be able to predict river flood and flow frequency, however, New Zealand's national flood risk maps are out of date and need to be revised to provide more accurate information.

Research need:

- There is a need for the report 'McKerchar AI, Pearson CP. 1989. Flood Frequency in New Zealand. Publication No 20 of the Hydrology Centre. Christchurch: Department of Scientific and Industrial Research' to be revised and updated.

Important to NZ because:

- All Regional Councils reference this report for flood flow & frequency but at 21 years old, a review is overdue. NIWA has been aiming for this revision with proposals to FRST & commenced work under other projects, such as Riskscape. But there have been constraints and there is limited progress to date.

Part 2 - March 2009 - Regional Council Critical Issues & Research Needs

Introduction

This document presents the critical issues and research needs considered to be of very high strategic importance by New Zealand's Regional Councils over the next 20 years. In developing the document he priority was to look beyond a pre-occupation with immediate needs, to anticipate what councils might have to deal with in the future and so bring timely research to bear; but this principle was not followed exclusively in developing the agreed list of critical issues. The document also indicates "Themes" or "cross-FRST portfolio" topics that the Regional Councils consider need to be addressed by FRST and other government departments.

Additional important critical issues and research needs are included on the Envirolink Website (www.Envirolink.govt.nz).

Critical Issue	Research Needs
Valuing environmental services	• Research to develop and trial new methodologies and tools to enable RC's to place financial and non-financial values on environmental resource services. Valuing 'natural capital' in a robust, defensible and transparent way that is capable of wide application across all natural resources.
Accumulation of contaminants in soils – resulting from the application of fertilisers and other chemicals etc. - the side effects of productivity-modifying actions	• In a future world of alternative fertilisers (e.g., slags, biochar, effluent, chicken litter) and pesticides, what will be the consequences of use on the soil-water system (e.g. potential effects upon soil structure and quality, groundwater and surface water receiving environments, carbon sequestration) and the risks for productive and consumptive uses of the system (including plant and animal production and human occupation of sites).
Application of planning mechanisms and social and economic research for land use changes	• Development of planning tools, including social and economic research, for investigating the implications and consequences of future land use changes. Tools may include models.
Understanding the impacts of nutrients and sediments on estuaries and coastal environments – both urban and rural context	• Land use effects on nutrient and sediment generation and transport and effects on estuaries and coastal environments, including sublethal, synergistic (or antagonistic) effects of multiple stressors and interactions
Determine the assimilative capacity of estuarine/coastal receiving environments and ascribe land-based contaminant management standards and targets	• Need an empirical, evidenced-based approach to policy development that integrates management of contaminants at source (land-based) aligned to contaminant fate (transport mechanisms) and environmental consequence (ecological impact).

Critical Issue	Research Needs
Control tools for biosecurity pest management	• Development of new control tools for pest management – such as a replacement for 1080 and brodifacoum should their use be curtailed in the future (need for greater central Govt effort) • Characterisation and control methods for aquatic pests – both freshwater and marine
Cumulative effects of activities on ecosystem structure, function and resilience	• Improved understanding of natural ecosystem complexity, diversity and resilience, and the cumulative effects of on-site and off-site activities on NZ natural ecosystems (i.e. how to avoid 'death by a thousand cuts' in our ecosystems; are there 'tipping' points and if so, when do they occur?)
Urban stormwater management	• Address barriers to science and technology transfer on what is known about stormwater diversion, retention, treatment, and utilisation in urban areas; both greenfield and brownfield. Development of robust indicators identifying contamination issues and ecosystem changes (by stormwater) in natural systems.
Sustainability frameworks to evaluate community wellbeing and quality of life	• Development of innovative methods to evaluate community wellbeing and quality of life – for example, genuine progress indicators; and advice on how to achieve effective application of such methods in strategic community decision-making cycles.
Technologies to improve air quality	• Development, and/or technology transfer, to improve options to abate air quality emissions from existing home and industry sources in energy efficient ways (Note: the National Environmental Standard focuses on new sources, not existing ones)
Managing primary production systems under increasingly constrained inputs (water, soil, land)	• Techniques and tools for managing primary production systems under constrained inputs; what might 'constrained input' agriculture look like; what new environmental pressures might it bring, or existing pressures might it ease? • Optimising and integrating existing nutrient management tools. E.g., SPASMO etc. Improved agricultural nutrient models e.g., OVERSEER, to manage non-point source discharges and consequent effects, not just on-site nutrient balancing; need for greater reliability under a range of specific conditions. • Mechanisms for sustainable water management and allocation efficiency and equity; including valuing of water and understanding of social distributive issues etc

Critical Issue	Research Needs
Aquaculture impact on benthic systems	• Understanding the positive and negative impacts of aquaculture on benthic systems (both freshwater and marine) including the associated benthic invertebrate and fish communities.
Environmental performance evaluation including auditing and certification	• Robust defensible protocols for identifying, measuring and evaluating environmental performance, for the benefit of producers (accountability to consumers), their market/consumers (choice); and for environmental regulators (full environmental impact assessment).
High class soil management	• How can we value high quality lands (i.e., soil-climate systems) that are under pressure from non-productive land use development (e.g., urban sprawl onto highly productive lands)
Waste management	• Reuse or recycling of solid waste and wastewater. All waste types. Productive reuse, and integration with other values e.g. wastewater for carbon sequestration irrigation
Technological hazards	• Technological hazard and risk analysis – e.g., power outages- likelihood, vulnerability analysis
Climate change	• Planning for impacts of climate change – adaptation to risks including opportunities presented by climate change. • Impacts of climate change on indigenous biodiversity values and change including what are the biodiversity values and resources most at risk?
Community change	• Social science research - how to effectively promote highly targeted behaviour changes towards desired ends amongst particular populations, for particular issues. Including a mix of policy options. • Investigate impacts on, and ability for communities to adapt /respond to changes in their environment and the distribution of impacts including identification of equity issues and mechanisms to minimise negative consequences on well-beings. • Identify examples co-management models between Maori and Council and evaluate their effectiveness. • Identify links between social, economic, cultural and environmental well-beings and evaluate the effectiveness of their inclusion in council and other agencies decision making.

Themes or Cross-Portfolio Topics that Need to be Addressed

Introduction The Regional Councils have also identified a number of themes that cut across research areas and portfolios that need to be addressed primarily by Central Government. A "Comment" column is included that indicates the main audience for communication.

Theme or Cross-Portfolio Topic	Comment
Mechanisms to identify, access and harness economic drivers that lead (knowingly or unknowingly) to desirable environmental change. Need to be able to counter short-run pricing positions by government or resource user sectors with sound science-based environmental policy; i.e. how to make environmental science more effective in policy formulation as a driver of societal change. Institutional ways of operating. How do you slow down what's going on – with science? Influence. Developing own economic drivers.	Links in with more than just FRST – should also be communicated to MED, MAF, and MfE.
Social science research - how to effectively promote highly targeted behaviour change towards desired ends amongst particular populations, for particular issues. Including a mix of policy options.	To be communicated to FRST and others.
Future proofing of science capability in NZ.	Communicate to FRST and MRST.
Integrating water quality and land-use research – but also in relation to community change.	Communicate to FRST and MRST.
Maintaining environmental (green image) integrity; proof of environmental 'acceptability'- robust, comprehensive, and practical certification of environmental quality of production, for consumer approval (e.g. an answer to the debate over 'food miles'), and as a regulatory tool describing environmental performance.	Broad policy issue to be communicated to MfE, MAF, MED, MRST, FRST
Better methodologies for balancing economic and societal/cultural values e.g. *balancing economic pressures from aquaculture, tourism and forestry industries, while taking regard of community aspirations to maintain tranquillity, attractive landscapes, clean air and water, heritage features and terrestrial marine flora and fauna.*	Discuss with MfE, MED, MAF etc.
Need to incorporate system complexity in the identification and understanding of links between land-use activities and receiving environments.	Mainly a FRST issue.
Biodiversity and pest management prioritisation setting technologies need to be developed to assist RC's Includes tools to assist RC's to make a stock take of biodiversity values and pests. Tools that could provide an inventory of values at sites with an overlay of pest impact, including the relationship between pests. A National biodiversity inventory, information and management system (including a database) is required; (LENZ would be a subset of this); lends itself to a Platform approach; Framework for thinking: what have we got, how does it work, how do we keep it?	This primarily concerns integrated tool development – and part of a theme that RC's need to communicate to FRST. It is of high importance for RC's but it's something RC's need to do with research provider assistance. Possibly recommend this as a Platform to FRST.

Theme or Cross-Portfolio Topic	Comment
National water monitoring methodologies.	Discuss with MfE.
A water platform might be from surface to estuary. Integration key. Something to discuss. SWIM.	Philosophical point to discuss with FRST.
Databases of national significance (water, climate etc) need to be connected – also National Hydrometric Network. Also consider national databases for pests and risk modelling tools.	Encourage FRST; another philosophical point to make
Biodiversity - how can we better measure what difference we are making?	Discuss with DOC, MfE and FRST/MRST.
The generic challenge is integrated assessment & dynamic modelling of systems (resource and ecosystems) for running and evaluating scenarios including the analysis of risk and uncertainty with each scenario	A complex topic to discuss with MfE, MRST and FRST.
Appropriate standards for contaminated land –e.g., for residential use in the context of high rises and apartments, instead of in context of '1/4 acres section' growing vegetables etc. Also, for ecologically-based environmental acceptance criteria for contaminated sites – as opposed to merely human health issues Bioaccumulation risk profiling and comparative risk assessment from older agricultural and horticultural sites still in production or under residential development scenarios: this work to underpin or support NES for contaminated sites.	To discuss with MfE.
Robust methods for improving our ability to predict consequences of different policy options and evaluate the effectiveness of management actions on the environment.	To discuss with MfE
Impacts of intensive agricultural practices on soil quality and water systems (surface and groundwater)	To discuss with FRST as part of the "platform" discussion
Options for enhancing soil quality/integration with other co-benefits such as carbon sequestration	Discuss with MfE, MAF.
Biosecurity - how can we better measure what difference we are making at reducing risk and managing pests? How can we best target limited resources?	Discuss with MAF and DOC.
Continued investigation of hazards and risks to the NZ community including work on NZ standard for Flood Risk Management.	Discuss with FRST.
The role of science to stimulate discussion on sustainable development. How can science play this role?	Discuss with MRST and FRST.