RISK GOVERNANCE FOR SUSTAINABLE MANAGEMENT OF WATER

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ABSTRACT

For more than a decade, New Zealand has sought a successful model for collaborative governance that could be used at the catchment scale, to deliver integrated catchment management. The country now has an emerging crisis in governance of water, especially where expansion of dairying places pressure on both water quality and quantity, and creates demand for irrigation infrastructure.

Corporate risk governance provides a useful starting model for risk governance of collaborative networks that operate within urban and rural catchments. Both corporate and catchment-scale risk governance, would, however, be more effective if based around a generic, axiom-based sustainability model. Benefits of this approach include improved accountability, a sharper focus on sustainability, a more robust platform for research and innovation, and the provision of a common language that can facilitate community-wide debate and collaboration.

Using the axiom-based approach, a water services provider can contribute to building, within a community, the collaborative competencies and trust required for sustainable management of water. The axiom-based model also provides an efficient, ethical interface with the science community, that can underpin a strengthened partnership between communities and government, that delivers cost-effective and timely information and decision support infrastructure, and a credible regime of audited self-management.

KEYWORDS

Governance, risk, sustainable development, collaborative networks, axiom-based model

1 INTRODUCTION

In recent years, sustainable development has been reframed as the capacity for organisational and community resilience (e.g. Blackmore & Plant, 2008). This has provided a platform for embedding the concept within core management processes. Since managing for resilience depends on effective risk management, risk governance provides the delivery mechanism. With strong engineering and business risk management cultures, water utilities are positioned to be at the forefront of moves to create resilient, sustainable organisations.

Decades ago when risk management processes were first conceived, organisations were more likely to employ a command-and-control approach to management, they were more stable, and improvement concerns were more likely to revolve around internally-generated concepts of quality management. Now, organisations must deliver sustainable water services and be accountable not just to owners and customers, but to a range of stakeholder groups, in a very demanding, dynamic, business environment. They also increasingly function as collaborative networks, working hard to deliver, at reduced cost, the expected levels of service. Risk management and accountability systems, typically focusing on discrete, individual risks and implicitly based on the idea that an organisation functions as a machine, are no longer adequate, and companies have recognised that risk management is achieved by "governance" processes in which a variety of interacting, collaborating units collectively deliver the decisions that determine resilience and sustainability (Van Asselt & Renn, 2011).

At another level, water-related issues are now becoming more important nationally, in New Zealand, and major deficiencies in water governance are being exposed, especially as dairying spreads over the country, and urban centres experience major population growth. In principle, corporate risk governance provides a model for collaborative governance of catchments and sustainable management of water. In practice, this model needs to be more robust, and more closely aligned to sustainable development, before it can be of real use in these areas.

This paper contends that an improved and more structured, governance framework for integrated catchment management and sustainable management of water is possible if governance is built around an axiom-based model for health and sustainability. This model can also strengthen risk governance in water utilities, raise the profile of sustainability issues, facilitate research and innovation, and provide a bridge or common language with the wider community.

To demonstrate these points, we first describe how, by adopting an axiom-based sustainability model as their values model, water utilities can achieve more effective risk governance and accountability. We then review the country's more general governance needs for management of freshwater, and the difficulties that have been experienced in developing a reliable model for integrated catchment management. Finally, we describe how the enhanced corporate risk governance model can facilitate integrated catchment management, and sustainable management of water in both urban and rural environments that are undergoing development and land use intensification.

2 RISK GOVERNANCE FOR WATER UTILITIES

Risk is the possibility of loss, whether of something of value that we have now, or an anticipated future benefit. MacGillivray et al. (2006) reviewed the risks faced by water utilities and noted that risk is generally considered to involve:

1. An agent with the potential to cause either harm and/or benefit (e.g. a chemical contaminant, or an investment opportunity);
2. Uncertainty of occurrence and outcomes (expressed by the probability or likelihood of occurrence);
3. Consequences (the possible outcomes);
4. A specified time frame.

Water utilities are charged with delivering safe, affordable, reliable water services in a manner that engenders the trust of customers and is socially and environmentally responsible, and that recognises the utility's own need for financial viability. A range of pressures on the utility contribute to the existence of a large number of risks, which MacGillivray et al. (2006) grouped as strategic, programme, and operational risks. Examples of strategic risks were regulatory risks, business process re-engineering risks, new technology, and outsourcing. Examples of programme risks were asset management risks, and catchment management risks, while operational risks included compliance risks, and reliability issues.

In keeping with standards for risk management (e.g. Standards Australia and Standards New Zealand, 2004), water utilities currently have formalised procedures for assessing and analysing risks. The size of a risk and its importance are typically assessed with reference to an impact-likelihood matrix. Prior assessments of the magnitude of the consequences of the risk event, and of its likelihood or frequency, are used to directly establish a risk severity level, which determines the level of oversight it receives within the organisation. These assessments are made in the presence, and the absence, of risk controls, the measures taken to reduce the risk to more acceptable levels.

Many risks are managed by well-established engineering standards and codes of practice, provided these are followed. However there are many risks that are less well covered, and require ongoing vigilance on the part of the utility. Identifying these risks, assessing them, cataloguing them in risk registers, and nominating a risk owner for accountability purposes, is generally much easier than ensuring that the risk has been reduced to the levels that the assessment process would suggest. In the areas of asset management and planning, for example, there are a large number of interrelated risks such that identifying a single risk owner can be problematic, and raise questions about the validity or fairness of supposed accountabilities. One such issue might relate to damage to pipe assets by external third parties. This may arise through negligence on the part of the third party, but also from errors in the asset data held in the GIS. This in turn can be affected by the efficiency and effectiveness of the asset handover process, the promptness and accuracy with which asset data are entered into the GIS and subsequently shared with the city council, the extent and accuracy of asset data gathering by maintenance staff, and the degree to which the activities of these staff have been programmed effectively by supervising engineers. A single risk can have multiple causes, and a risk register can faithfully delineate all these failure pathways, yet have limited value in actually managing the risk and ensuring that it is minimised.

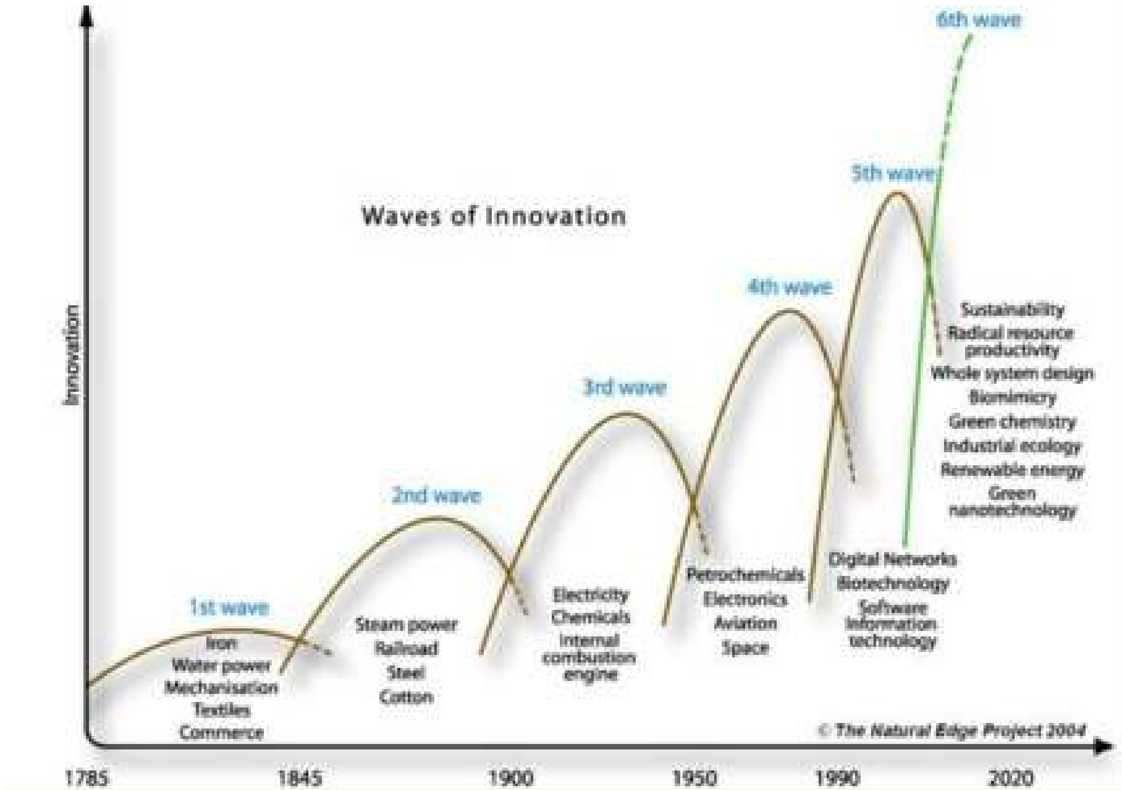

Figure 1. Waves of innovation (The Natural Edge Project, 2004).

Similarly, there are the risks of poorly conceived capital works projects. These might, for a company working under pressure, arise through deficiencies or process failures in regional planning, securing adequate base asset data and resource data, investing adequately in flow monitoring to calibrate models and verify issues, or exploring sufficiently adequately operational alternatives, and those, such as inflow and infiltration (I&I) remediation, that involve the complexities of sharing responsibility with the community. Other possible process failures relate to coordination within and between organisations, weak alignment of plans for wastewater and stormwater, the robustness with which options are evaluated, the skill with which modelling tools are used, or even selected, and misperceptions of the level of social or environmental acceptability of pollution of receiving environments.

Thus, a water utility can have a significant risk exposure that conventional risk management tools and processes fail to address adequately. Risk registers, which encourage a careful focus on individual risks, are less suited to managing correlated, interacting, or systemic risks. These latter types of risks are much more prevalent in many modern organisations, which are characterised by complexity, continual change, and some fragility.

A response to these issues, adopted by publicly-owned water utilities, is to employ forms of governance built around values (e.g. Henderson, et al. 2006). In this approach, companies overtly embrace sets of values they believe will help them deliver on their mission or vision. Translating these values statements into actions and targets is left in part to individual staff members, perhaps aided by managers. However, this has two problems. The first is that important systemic risks can be subject to weak governance. The second is that it conveys only weakly the imperative to pursue sustainability, or even the older idea of corporate social responsibility. Few substantial companies, in New Zealand and elsewhere, have bought into sustainability imperatives that have been articulated convincingly by many commentators (with recent contributions from Bell and Morse, 2008; Friedman, 2009; Von Weizsacker et al. 2009; and Senge et al., 2010). Until recently, global processes and the global environment have been characterised as being dominated by the warming that followed the last glaciation. This is the Holocene epoch, which began about 11,000 years ago. Now, such has been the change in earth surface processes as a result of human activities and population growth, geologists have petitioned for the current period to be termed the "Anthropocene" – that is, defined fundamentally by man's activities. As reported by *The Economist* (2011), "A planet that could soon be supporting as many as 10 billion human beings has to work differently from the one that held 1 billion people, mostly peasants, 200 years ago. The challenge of the Anthropocene is to use human ingenuity to set things up so that the planet can accomplish its 21st-century task."

The efficiency gains that industry seeks to achieve through current systems of management and innovation are modest contributions to the goal of sustainability, which is capable of driving a new wave of innovation (Figure 1). Current values statements all too easily translate into "business as usual", and the experience of working in organisations today is not so different from the pre-recession experience. In the wake of considerable public education on sustainability issues and the need for more responsible business, young sustainability champions should be at the forefront of a raft of innovative, values-driven companies. That they are not shows that companies continue to be governed by boards and owners who prefer to frame sustainability as a distant threat, rather than an imperative loaded with business opportunity. It also suggests, however, that potential leaders lack the necessary game-breaking tools.

To catch the next wave of innovation, companies in general need to be much more motivated by factors other than efficiency. Crucially, values statements typically say very little or almost nothing about the world that the company is helping to create. Without this overarching sense of a public utility's involvement in a civic mission, values-based management and exhortations are of limited usefulness. Water utilities are, however, now in a position to build on the progress that has been made, strengthen the focus on sustainability, provide clearer accountabilities, and provide a stronger platform for innovation and research.

3 AN IMPROVED RISK GOVERNANCE

With greater clarity regarding the meaning of sustainability (or resilience), and evidence of its centrality to management concerns, managers could confidently create a system of risk governance appropriate to the times.

For the purpose of facilitating mutually supportive relationships between an economy and the natural world, an organisation can be thought of as an ecosystem, that is a dynamic complex of interacting living organisms and their non-living environment, interacting as a functional unit (UNEP 1992). Like all ecosystems, an organisation is a complex, adaptive, evolving, living system. To be sustainable it has to be healthy, and, in the face of changes in its operating environment, maintain its internal systems and processes, and continue to carry out its functions. Following directly from this, there are seven fundamental axioms that describe the behaviour of a healthy organisation or ecosystem (Luckman, 2006). These are summarised in Table 1.

Table 1: *Axiom-based requirements for healthy, sustainable systems*.

Requirement	Underlying themes
Nurturing	Regenerating, safe, caring
Supportive	Respectful of roles of components, non-inhibiting, fulfilling, maximising potential, equitable
Stable	Strong, not fragile, continuing, protective, respectful / honouring of traditions, not capricious
Contributing	Providing goods and services, not wasteful or draining, or a source of harmful constituents or activities
Responsive	Reactive and resourceful, having a strong capital base
Directed	Energetic, inspired, motivated, self-sustaining, confident, purposeful, self-organising
Adaptive	Resilient to change, accommodating change, innovative

The axioms of Table 1 are universal, applicable to all kinds of ecosystems, whether they are organisations, businesses, farms, households, streams, rivers, lakes, wetlands, riparian forests, coastal ecosystems, industry sectors, neighbourhoods, cities, regions, or nations. They reveal the kinds of systems that must be created to build a new more sustainable society, economy and environment – and the characteristics of a sustainable water utility. They provide a common language which an organisation can share with its stakeholders to identify

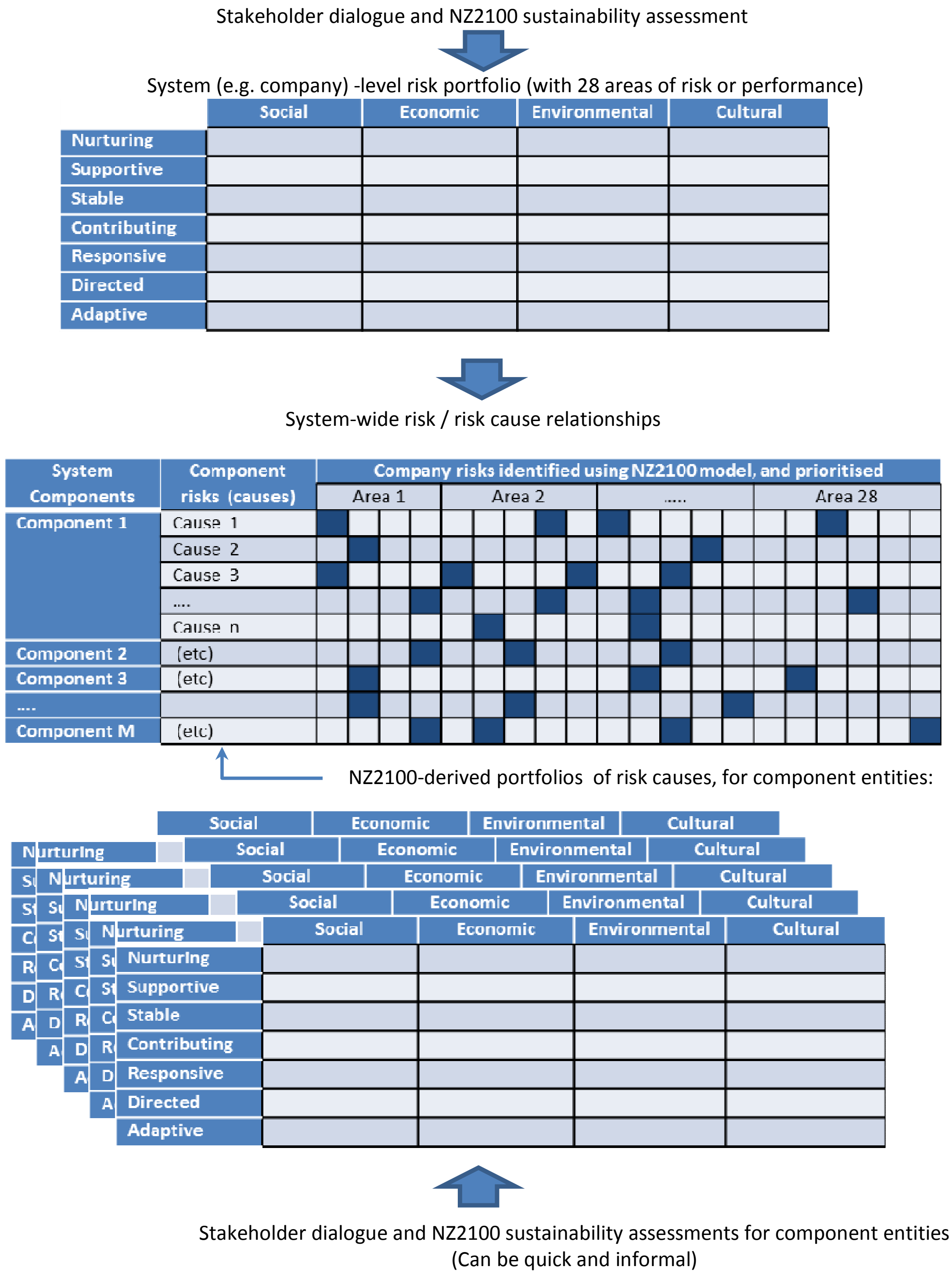

***Figure 2**: Using the NZ2100 model to build a system wide risk portfolio, and underlying portfolios of component-level risks. System can be, for example, organisations or catchments; Components of these systems are then teams, farms, urban subdivision developments, etc. Coloured squares denote significant causative relationships.*

parameters and issues of concern, define standards of behaviour, and draw up targets and priorities for management.

These axioms apply irrespective of whether we view the organisation as a social system, an economic system, environmental -ecological system, or a cultural system with a particular body of knowledge, beliefs, values, and ways of communicating. A healthy organisation, must simultaneously take all of these perspectives, which leads to a matrix of 28 (7 x 4) areas of performance. Luckman (2006) described this as the Universal Ecosystem Health Model. More recently, and acknowledging its potential for use alongside other international reporting standards – such as the AA1000 standard for accountability (AccountAbility, 2008), the SA8000 standard for social accountability (SAI, 2008), and the Global Reporting Initiative guidelines for triple bottom line reporting. (GRI, 2011) – the model has been termed the NZ2100 standard for sustainable development reporting. NZ2100 has been in the public domain since mid-2009, and underpins the KiwiGrow® Network approach to sustainable development being promoted for New Zealand by Creative Decisions Ltd). It provides a robust platform for conducting an organisation-wide scan of sustainability performance, issues and risks. As with other values models, it may be applied not only to the water utility as a whole, but to internal entities, such as departments, groups, programmes, or teams.

Risk governance using NZ2100 proceeds as follows (Figure 2). The company or organisation, in consultation with stakeholders, identifies companywide risks with reference to the NZ2100 matrix, perhaps by aggregating risks identified on a departmental basis. These will be strategic, programme, or operational risks, as grouped by MacGillivray (2006), and they will be prioritised by the company using standard impact-likelihood matrix risk assessment procedures. At this point, the NZ2100 model serves as a tool for ensuring:

1. important risks are not omitted;
2. the risks identified relate not only to results of the company's interactions with the world, but to its internal capacities, regenerative potential, and plans for the future;
3. managing for the risks will deliver health and sustainability for the company.

A corollary of (3) above is that, in a changing world, sustainability is impossible if risks in any cell in the NZ2100 matrix are neglected. Based as they are on a set of axioms, cells are of equal importance.

An area where the NZ2100 approach differs markedly from current practice is in the management and apportioning of risk accountabilities. For every risk that the company chooses to prioritise, each team within the company identifies the social, economic, environmental, and cultural contributory risks that exist within the team's general areas of accountability. These team risks represent risk "causes" and provide a very fundamental way of managing risk. Teams understand risk at a very fine grained level, and are able to identify, by applying the NZ2100 model to themselves, the ground-level factors that are crucial to the management of the company level risk. These team risks then become items of accountability at an individual level, thus delivering meaningful accountability. Company-level residual risks are then assessed taking into account all the controls put in place by the teams. The overall result is a dynamic process for managing a company's risk portfolio, since individual accountabilities can be revised periodically, and, as time passes, each team will see different opportunities for organisational improvement and risk reduction. Individual performance assessment then takes account of progress in managing elements of the company's risk portfolio.

These innovations provide the basis for effective collaborative governance of risk. For water utilities especially, the changes required are minor, and these entities are in a position to lead the introduction of a new governance for sustainability that has real accountability.

4 FRESHWATER GOVERNANCE ISSUES IN NEW ZEALAND

Higher sediment and nutrient loads, reduced water clarity, and the associated ecological effects, have long been a feature of freshwater bodies affected by pastoral land uses in New Zealand, when compared with streams and lakes in catchments with indigenous land cover (e.g. Ballantine & Davies-Colley, 2010; Verburg et al., 2010; MfE, 2011). Similarly, over the last 15 years the impact of urbanisation on streams and associated coastal ecosystems has been documented (e.g. Lohrer et al., 2003; Reed & Webster, 2004). Against this backdrop of degradation, there is considerable concern for the health and sustainability of the nation's waterways, as dairying expands across the country, and urban centres such as Auckland expand over catchments with sensitive ecosystems.

Poor or declining water quality has already led to direct costs to communities. Cleaning up or arresting further agriculturally-derived pollution of Lake Taupo, the Rotorua Lakes, and the Waikato River, will cost nearly $450M over the next 10-20 years (NZ Government, 2009). Economic impacts also extend to reduced opportunities for tourism, fishing, and aquaculture. As a major stakeholder in freshwater management, New Zealand's dairy producer, Fonterra, signed the Dairying and Clean Streams Accord with the Ministry for the Environment, Ministry of Agriculture and Forestry, and regional councils, in 2003 (Various, 2003). This non-legally binding Accord aimed to achieve clean, healthy water in dairying areas, by excluding cattle from waterbodies and their banks, bridging or culverting cattle stream crossings, treating dairying effluent, smarter use of fertilisers to minimise nutrient losses to streams and groundwater, and by fencing off and protecting regionally significant wetlands. However, this initiative has not been supported by effective accountability measures, and recent snapshots have shown that the environmental performance of the dairying industry is not improving as expected (Various, 2010).

Added to pressures on surface water quality are those resulting from increasing demand for water. In dryland areas of Canterbury, for example, there is pressure to expand dairying through use of irrigation schemes (NZ Government, 2009). The associated environmental and economic risks are not well understood, and irrigation proposals have often led to protracted, unproductive litigation.

Especially with regard to the potential for irrigated dairying, the New Zealand Government is concerned that the country does not lose a major economic opportunity. International demand for food products is virtually limitless, and it is important that the country has effective systems for resource management to avoid outcomes that are later regretted. Dairying industry representatives have argued that lack of national strategic direction and inadequate regional planning have encouraged proliferation of "first in, first served", small takes at the expense of larger, potentially more beneficial options (NZ Government, 2009).

One central Government initiative has been to fund a multistakeholder Land and Water Forum to advise on management options and a way forward. This group has seen management of freshwater in terms of setting and managing limits, and recommended adoption of a standards framework for New Zealand, which (Land and Water Forum, 2010), *inter alia*:

1. defines national objectives for the environmental state of water bodies and the overall timeframes within which to achieve them through National Policy Statements and National Environmental Standards under the Resource Management Act;
2. requires regions to give effect to this national framework at regional to catchment (or subcatchment) level, taking into account the spatial variation in biophysical characteristics of their water bodies and their current state;
3. within that framework, requires regions to engage communities, including iwi, about ways in which their water bodies are valued, and to work collaboratively with relevant land and water users and interested parties to set catchment-specific targets, standards, and limits.

The Forum's report also noted that there were a variety of tools that might be used to allow stakeholders, collaboratively, to set and achieve limits and targets. They were especially in favour of audited self-management schemes in conjunction with collaborative development of best management practices and guidelines. The Forum also noted that development of rural water infrastructure was a key area requiring improved, more collaborative governance.

In response to the Forum's report, the Government released a National Policy Statement on Freshwater *Management, in May 2011 (NZ Government, 2011). This NPS requires every regional council to establish* freshwater objectives and set freshwater limits, and environmental flows (and/or levels) for all bodies of water in their regions, and establish methods to avoid over-allocation. Councils are also required to specify targets and implement methods to assist improvement of water quality to meet those targets, within a defined timeframe. Best practicable options are to be used to minimise any actual likely adverse effects on the environment of any contaminant discharges. Councils are also required to include in their plans efficient mechanisms for allocation of water within their agreed limits. Furthermore, Councils are required to take a holistic approach that considers interactions between fresh water, land, associated ecosystems, and the coastal environment, and to manage water and land use development in an integrated and sustainable way, considering cumulative effects (NZ Government, 2011).

5 ACHIEVING WHOLE OF CATCHMENT MANAGEMENT RESPONSES

In 2010, the Ministry for the Environment funded a stock-take report on the status of integrated catchment management in New Zealand (Feeney, et al. 2010). It showed much variation in opinion on the meaning of integrated catchment management, and a vast catalogue of issues that affected delivery of one form or other of the concept. This contrasted with the consistency with which central and local government have called for the use of integrated management approaches. The RFP for the review stated (Feeney et al., 2010, p. 4) that:

> "Integrated management of natural and physical resources requires consideration of the complex relationships between natural and physical resources (flora and fauna, geology and hydrology, soils and the biosphere and the biosphere and the atmosphere) and social, cultural, economic and political matters. It can be a contentious and elusive task."

More helpful is Australia's Murray Darling Basin Commission, which has defined integrated catchment management (ICM) as "a process through which people can develop a vision, agree on shared values and behaviours, make informed decisions and act together to manage the natural resources of their catchment." (MDBC, 2009).

People are evidently attracted to the idea of integrated catchment management for many different reasons, for example:

- Resource managers seeking to achieve equitable and sustainable management of water resources within a river catchment;
- Innovative urban water managers wishing to realise the benefits of synergistic management of the three urban waters: water supply, wastewater, and stormwater;
- Stakeholders who see that that improvements in catchment surface water quality, or in the health of coastal ecosystems, usually depend on multiple improving actions throughout a catchment;
- Policy makers who see catchment objectives as being achieved through the combined effects of various actions or instruments employed at different stages, by a range of actors, from politicians, to resource managers, to land owners;
- Ecologists or iwi who seek to reconstruct large elements of the earlier indigenous landscape, in part by planting efforts involving entire stream systems;
- Land or water managers aiming to provide a sense of collective purpose and a supportive community for individual innovative land owners committed to local improvements;
- Land and water scientists seeking sustainable platforms for long term ecological research, and avenues for the uptake of research results;
- Groups of land managers wishing to access funds available only for projects with community-scale benefits.

Many of these factors are interlinked, contributing to the view that ICM has multiple benefits. Broadly, Feeney et al. (2010) noted two main "camps" of thought about ICM. One saw it as a means for "community-building" in an environment where there is a divergence of views. Others have seen it as a device for securing agreement on a catchment-wide plan that provides a mandate for development, albeit with environmental conditions attached. Many environmental managers are of this view. They may wish to clean up a catchment as quickly as possible, and may see regulation or a greater investment in enforcement and managing to an agreed set of environmental bottom-lines as the most cost-effective ways for improving water quality. On the other hand, those interested in ecological restoration or rehabilitation, or in science, or in demonstrating benefits, argue that community and stakeholder involvement has to be sustained over a considerable period of time, and consequently, community-building is important. Similarly, land managers familiar with the way expectations for environmental performance typically evolve through time appreciate the value of a supportive and knowledgeable local community prepared to observe and learn, recruit new members, conduct their own outreach efforts, and so on.

For the purposes of this paper, and drawing on the findings of Feeney et al. (2010), integrated catchment management is taken as requiring –

1. A core group of action-oriented, technically-capable, ethical leaders who drive the process, including the involvement of affected parties, and who are instrumental in capturing social benefits of community-building, and in recruiting new membership.
2. A clear, overarching goal, with regard to efficient management of water resources within the catchment, or to surface water quality, or to the health of aquatic ecosystems. While the catchment management project may provide many other benefits, achieving this goal provides the bottom-line measure of success. Having met its initial goals, a successful action-oriented community may of course move onto other goals less strongly focused around management of water.
3. A systematic approach that is informed by sound science and consultancy efforts.
4. Long term support and involvement of a collaborating group of stakeholders.
5. The ability to work through disagreements, differentiate between what is desirable and what is necessary, and to develop a focused, fundable plan and strategy to achieve the main goal.
6. Long term involvement of local iwi or hapu, with Maori aspirations for social and environmental health being reflected in the management plan.
7. The ability and mandate to change the plan adaptively, as new knowledge is gained about the catchment or its community.
8. Access to funding that allows execution of a long term plan of improvements, and monitoring and evaluation of these.
9. Harmonisation of actions and policy settings from national-level, through to regional and local level.

New Zealand does not yet have the capacity to reliably form groups for the purpose of integrated catchment management, or to deliver the improvements in resource use efficiency, water quality, or the health of aquatic ecosystems that would make ICM a dependable policy instrument. National and regional managers and policymakers tend to be wary of investing in projects which appear too ambitious and too general in their focus to be dependable in terms of their benefits for sustainable management of water. Despite this, we are now seeing greater interest in integrated catchment and coastal management (Gustafson & Feeney, 2008) whereby land-based resource management activities deliver outcomes for the coastal zone. This follows, in Auckland, development of a significant industry around preparing integrated catchment management plans (ICMPs), to guide urban development, and especially the management of stormwater. Few if any of these plans have been evaluated, however, and many have not been implemented (Feeney et al., 2010).

The task of establishing integrated catchment management is indeed formidable. Some of the most serious challenges are as follows:

1. Integrated catchment management is effectively a new level of participatory community democracy, which has to operate within the context of contemporary democratic institutions.
2. Economic or political power imbalances typically exist within the community that can skew decision-making in favour of particular stakeholders.
3. Communities have few reference points. They may produce shared goals, or shared values, or agreed principles of sustainable development, but none of these is incontestable, and all have the potential to be revised or reprioritised.
4. Proponents of ICM are endeavouring to create something new and long-lasting out of a need which is more temporally-defined, and consequently their process is vulnerable to the unsustainable, politically expedient, “quick fix”.
5. With the possible exception of iwi, who may take pride in “always” being there, communities of all kinds are very volatile today, continually on the move, in a way that challenges the very idea of long term commitments.

Much of the effort to build sustainable, effective ICM processes can be seen as a search for an appropriate motivating force. While some groups come together under elevated notions of learning, ecological harmony, regeneration, equity, and so on, many of the participants are in reality motivated by more prosaic notions of securing a living, or securing some sense of control over an externally-driven push for change. Pervading the entire process is uncertainty – about the intentions of others, about goals, and about the links between cause and effect.

6 COLLABORATIVE NETWORKS FOR ENVIRONMENTAL GOVERNANCE

The search for means of delivering ICM is just one manifestation of a more general quest, worldwide, for systems of environmental and natural resource governance capable of handling today's resource and environmental challenges. Water governance (e.g. Tropp, 2007) is just one subset of these issues, albeit a critical one that has potential as a source of international and regional conflict. Recurring themes are (De Loe et al., 2009):

1. New strategies are needed to solve disputes;
2. Expert knowledge is limited;
3. Centralised bureaucracies are often limited in their ability to respond to environmental and social change, or to reflect the values and interests of citizens and non-state actors as economic conditions change and public opinion evolve;
4. Silo thinking may restrict integrated understanding, and usually limits the types of knowledge that are used for decision-making;
5. There are clear limitations to "command and control" forms of governance.

There appears to be emerging international consensus that collaborative or network governance mechanisms provide the way forward, and represent an important form of social capital (e.g. Carlsson & Sandström, 2008). Increasingly, policymakers are starting to get together the ideas and principles for improved systems of governance. For example, Australia has produced a proposed governance system for natural resource management (NRM), with the following principles (Ryan et al., 2010):

1. Continuity: For Australia to be sustainable, it needs an enduring, countrywide NRM delivery infrastructure.
2. Subsidiarity: Devolve decision-making to the lowest capable level. All devolved decision-makers need to be accountable for their decisions.
3. Integrated goal-setting: Base investments and governance mechanisms on coherent, nested and integrated goals.
4. Holism: Plan to address whole systems.
5. Systems approach: Match governance mechanisms to the nature of the linked social-ecological system.
6. Relationship orientation: Recognise that relationships are as important as organisations.
7. Resilience: Manage for resilience of ecosystems and communities. Aim to keep the system within thresholds, or to move beyond thresholds to a more desirable state.
8. Accountability: Base the case for investment and accountability on sound systems data and knowledge.
9. Responsiveness and adaptability: Regularly review and adapt the whole NRM governance system – analogous to the corporate governance requirement for regular strategic assessments.

Here in New Zealand, the Land and Water Forum (2010) has been especially in favour of collaborative governance, but has expressed concerns that the recommendations and decisions of collaborative groups need to be respected by higher levels of authority in local or central government.

When dealing with complex issues, communities and multistakeholder groups generally value reliable, objective, scientific information. While this can be provided, it comes at a price, and when it does, it is sometimes challenged as incomplete, and serving the needs of particular stakeholders. Collaborative processes have difficulty managing the interface with science, both in framing the questions, and getting useful answers in time to make a difference to the debate before it is reframed, or moves on to other issues.

While the times when central government partnered with science to deliver an optimal, authoritative solution to an appreciative community have long gone, past achievements attest to the power and vigour of former societies (and perhaps China today) which had clear aims and objectives, and that effectively marshaled the resources of science. It can be argued that many governance problems can be traced to an inability to direct science effectively. This in turn reflects ambivalence about the motives of science, the difficulty of achieving real objectivity, and the value-laden nature of progress. We are now, however, in a position to change this situation, and New Zealand can adopt innovative systems of governance that come with a built-in interface to ethical science.

7 GETTING CLARITY ON INTEGRATED CATCHMENT MANAGEMENT

The requirements for collaborative governance to achieve ICM are completely analogous to the collaborative risk governance that is now required by water utilities in order to effectively manage risks in an increasingly dynamic, challenging environment. The solution for ICM is therefore the same as that for risk governance in water utilities. It requires a focus on creating networks of entities (teams, departments, organisations, farms, subcatchments, etc.) that manage their performance in ways that are consistent with the axioms of health and sustainability. This provides a clear framework for collaboration and simultaneously addresses the need to create sustainable communities and sharpen the focus on performance standards and targets. Moreover, the solution brings with it the basis for a comprehensive set of leading, current, and lagging performance indicators necessary for a robust perspective on the sustainability of the way that water resources are being managed.

Ecologically-inspired axioms of sustainable development can provide the certainty and community reference points that have been lacking in the past. Stakeholders can work together to give practical effect to these axioms, irrespective of local geography and catchment characteristics. The NZ2100 model can give structure to the process of identifying stakeholder concerns, without privileging any particular party. Goals and objectives can be clarified, data gathering requirements determined, and decision-making aids identified. The model provides the ethical interface, or blackboard, for working with the science community. As a result, achieving ICM is less likely to be impeded by uncertainty regarding what it is and how to achieve it. The resources of the New Zealand science community, and its international connections, can be brought to bear on the overarching goal of achieving sustainable management of land and water through ICM.

With this philosophy in place, central and regional government can work with the science and consulting sectors to prepare a comprehensive toolkit that can be used to help launch and support ICM initiative across the country. Working to a common management framework will bring efficiencies in the design of indicator systems, databases, mapping systems, and decision support systems, compared with the task of separately and independently providing technical support for various communities, organisations and other entities, each with their own knowledge level, values framework, and performance measures.

While the National Policy Statement on freshwater, and the Land and Water Forum, have mostly been concerned with rural issues, the axiom-based approach is equally applicable to urban catchments, or, in Auckland's case, the jurisdictions of the new Local Boards. Management of water, wastewater, and stormwater is just one collection of issues that would benefit from the NZ2100 approach, which can become a pooling mechanism for engaging holistically on all the issues of urban development and intensification. Here, water utilities can play a leadership role in advancing a new governance approach that is simply an extension of their own, improved processes. Rurally-focused entities established to oversee development and management of irrigation infrastructure may also, like their urban water utility counterparts, lead rural communities in uptake of this new approach.

In all applications of the NZ2100 approach, decisions taken must be sufficiently restrained to preserve the opportunities for future adaptation, and not presume levels of certainty that do not exist. This has implications for large scale infrastructure projects, large urban developments, the debate about the value of metropolitan urban limits for managing growth, and for successful involvement of the science community.

The adaptive approach, especially when built around management experiments, can lead to robust opportunities for science involvement and new knowledge acquisition. Some of this may simply be explorative work when risks are poorly defined or unknown. A short list of defined risks does not relieve industry or developers from responsibility to conduct or fund investigations to identify and assess other risks. In the Netherlands, the WRR (Scientific Council for Government Policy) has advised the Dutch Government that industry itself needs to shoulder more responsibility for "taming uncertainty" through initiatives such as setting up research programmes to reduce uncertainty or better define risks, detect vulnerabilities in the environment, instituting long-term monitoring systems and early warning systems, and conducting more comprehensive assessment of technologies (De Vries et al. 2011).

Through avenues such as the Land and Water Forum, land users have expressed a preference for audited, responsible, self-management approaches. This is also in line with the NZ2100 approach, which may eventually develop as part of a wider KiwiGrow® Network approach to sustainable development that has been advocated by Creative Decisions Ltd since 2006. With this approach, self-managing NZ2100 entities may be supported by a dedicated social networking website, incorporating spatial capabilities especially relevant to catchment management. This provides a natural pathway to a transparent auditing and certification regime (Luckman, 2006) and could provide the platform for a New Zealand-wide network of collaborating sustainable businesses and communities. In the event that a substantial KiwiGrow Network did develop, with demand for verification, auditing and related certification, some form of public ownership may become appropriate.

8 LESSONS FROM REMANENT MAGNETISM

Rocks have "remanent" magnetism (http://en.wikipedia.org/wiki/Paleomagnetism) arising from their content of magnetic minerals. How this adds to or diminishes the earth's local magnetic field depends on the type of rock, and the degree of alignment of the two fields. There are illuminating comparisons between remanent magnetism and a community's commitment to sustainable management of water (Table 2).

***Table 2**: Parallels between remanent magnetism and sustainable management of water.*

Remanent magnetism	Sustainable management of water
A rock's remanent magnetism can reinforce the local magnetic field.	A community's commitment to sustainable management of water is strengthened by the separate commitments of entities within it.
The rocks with the strongest remanent magnetism are igneous rocks, in which magnetite has acquired remanent magnetism during cooling following crystallisation.	The strongest commitments to sustainable development are likely to come when a community has had to reinvent itself.
Remanent magnetism can be acquired after lithogenesis (rock formation), by cooling following heating and metamorphism. But it is strongest when it is acquired during lithogenesis, when the fabric of the rock is established.	Commitments to sustainable management of resources are more easily achieved when an entity is being established. Commitments which come later will be more hard won.
Cooling of large subterranean igneous intrusions with high remanent magnetism can set up a recrystallised zone of "contact metamorphism" with remanent magnetism realigned to the contemporary magnetic field.	Motivated water utilities and other innovative organisations can influence the values and commitment to sustainable development of the communities they operate within.
Rocks with remanent magnetism acquired during an earlier geological period when the orientation of the earth's magnetic field was different from the present can diminish the intensity of the local magnetic field.	Entities which fail to align themselves with the ecological axioms can diminish a community's collective effort to achieve sustainable management of resources.
Remanent magnetism can be used to date rocks.	Communities and organisations that are more "recalcitrant" with regard to sustainable development may come to be seen by the rest of the country as dated in their outlook.

9 CONCLUSIONS

Organisational complexity and continual change are challenging the effectiveness of risk governance processes in water utilities, especially in large cities such as Auckland. Correlated and systemic risks are not handled well through conventional tools such as risk registers, that are best suited to management of clearly defined, individual risks. Even where risks can be adequately conceptualised, they are so multifaceted that achieving risk accountability can be problematic.

In the current dynamic business environment, organisations strive for resilience, which is in principle delivered through effective risk governance. A simple, axiom-based sustainability model provides a generic framework relevant to all entities in the organisation, and can provide the basis for improved risk accountability – and therefore for better management of performance improvements that ultimately deliver system health, resilience, and sustainability.

The same axiom-based sustainability model provides a means for securing participation, commitment, and accountability in collaborative integrated catchment management (ICM) processes to resolve issues arising from pressures on water quality and quantity. These processes are pivotal to natural resource management, but are currently fraught with difficulties that severely limit their efficiency and effectiveness. Axiom-based ICM promises to be much more efficient, and provides the key to operationalising the Government's recently released National Policy Statement for management of freshwater, which requires councils to facilitate collaborative processes that deliver catchment-level performance standards and targets for water quality and quantity.

These innovations for rural ICM can equally be applied in processes to produce Integrated Catchment Management Plans to guide urban development and intensification in areas such as Auckland. The axiom-based model, applicable to all kinds of systems from households, businesses and neighbourhoods to streams, estuaries, and coastal ecosystems, is especially suited to facilitating discussion and debate among disparate entities concerned with management of resources in a particular catchment or geographical area.

The generality of the axiom-based approach points to an opportunity for central and local government agencies to invest in developing tools and resources to facilitate efficient application and rapid uptake across the country. Marshalling the resources of science provides the key to moving forward purposefully and with momentum, and adopting the new approach has potential to be a major step forward for sustainable management of freshwater water in New Zealand. Competent, innovative risk management can turn potential failure pathways into pathways to sustainability.

Like the earth's magnetic field, belief in the axioms of sustainable development constitutes a field that encompasses organisations, neighbourhoods, and communities. How rocks acquire their own magnetic field has lessons for how we can encourage businesses and communities to align themselves to a new, creative way of thinking about management of natural resources. For water utilities, the most important of these lessons is that they, along with other innovative organisations, can influence the values and commitment to sustainable development of the communities they operate within.

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