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Integrated Water and Catchment Research for the Public Good: The Motueka River–Tasman Bay Initiative, New Zealand

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ABSTRACT *The goal of the Motueka Integrated Catchment Management (ICM) Programme is to develop integrated, multidisciplinary research approaches to address water resource management issues defined by strong stakeholder consultation. This programme, initiated in 2000, is focused on the Motueka River catchment and Tasman Bay. The Motueka catchment is sparsely populated, but is a heavily used and highly productive landscape at the top of South Island, New Zealand. Important land uses include commercial forestry, irrigated berry and pip fruit production, dry land pasturing (sheep), and, increasingly, irrigated dairy farming. Large portions of the headwater areas are recreational park and conservation lands. The Motueka River itself is internationally known as a trout fishery and reaches of the river are an important habitat for native and threatened Galaxiid fish. Tasman Bay, which receives 65% of its freshwater inflow from the Motueka River, is a commercially important scallop and mussel fishery, contains a nationally important marine sanctuary, and is widely used as a recreational resource. Currently, water quality in the area is generally high, although it is threatened by some land uses. Water quantity has been a persistent concern in this seasonally dry region of New Zealand and is the subject of a Water Conservation Order that has focussed attention on the need for a stakeholder-driven, integrated approach to water resources management. The purpose of this paper is to summarize the authors' early experiences, as scientists and managers, in developing an integrated biophysical and social research programme to support sustainable water resource management in the Motueka catchment. However, the framework for dialogue and action that the authors have developed is one that is relevant to other areas of New Zealand and beyond. The long-term goals of the ICM programme are consistent with those of the United Nations Educational, Scientific, and Cultural Organization/Hydrology for the Environment, Life and Policy (HELP) programme and may be of use to other communities, especially in areas where protection of existing values in a productive landscape is the key issue, as opposed to restoration of degraded values in a damaged landscape.*

Introduction

The objective of the Motueka River Integrated Catchment Management (ICM) Programme is to improve the understanding of—and social learning about—land, freshwater and near-coastal environments in catchments with multiple,

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interacting and potentially conflicting land uses. The primary programme partners include a consortium of research institutions (led by Landcare Research and the Cawthron Institute), the local environmental management authority (Tasman District Council) and community stakeholders from the Motueka catchment, including representatives from local Maori groups. Primary funding is from the New Zealand Foundation for Research, Science & Technology.

The initial motivation for this research programme arose from concerns about the demands for water caused by different land uses—specifically forestry and irrigated horticulture. This important, but somewhat limited, perspective might have been addressed using a straightforward, small-watershed, applied research approach with traditional means for knowledge transfer (e.g. reports and presentations). However, the issues of water demand stemming from different land uses are inextricably linked to a series of other critically important issues, including the effects of land use on in-stream values and the cumulative effects of land and river management practices on coastal processes and values. Furthermore, implementation of new (or even existing) policies regarding land and water resources affects people as well as the environment and almost invariably requires changes of some sort (e.g. in practices, in attitudes, in perceptions). This integrated perspective demands a different approach, one that includes not only biophysical and ecological research, but also social, economic and political research. In addition, it demands a different approach to knowledge transfer, one in which science providers, resource managers and stakeholders form partnerships—or at least agree to interact—through the processes of 'shared learning' and 'adaptive management' (Allen *et al.*, 2002).

The purpose of the present paper is to describe the reasons leading up to the formation of the Motueka River/Tasman Bay ICM programme and to document how and why we expect this approach to benefit the environment, economy and communities of the catchment.

Environmental Setting

The Motueka catchment (Figure 1) occupies 2170 km^2 in the north-west of the South Island of New Zealand. The Motueka River flows 110 km from an elevation of 1600 m to sea level, where its mean flow of 82 m^3/s delivers 65% of the fresh water to Tasman Bay. Average annual precipitation ranges from 1000 to over 3500 mm in the western ranges. The climate is cool and humid with dry (austral) summers.

The geology is mixed with clearly defined terrains, which include erodible granites (mid to lower basin), clay-bound gravels (mid-basin), ultramafic mineral formation (eastern headwaters), sandstone–siltstone (eastern headwaters), and complex limestone, marble and calcareous mudstone (western headwaters). Groundwaters include alluvial aquifers in the valleys and deltaic plains.

The entire catchment was originally covered in native podocarp and southern beech (*Nothofagus*) forests. However, two-thirds of the catchment has been cleared, with roughly one-third in exotic conifer forest and one-third in dryland pasture or crops. Horticulture (apples, kiwifruit, berryfruit, hops and—historically—tobacco) is restricted to valley bottoms and the Motueka Plains, and is mostly irrigated from rivers or groundwater.

The Motueka River supports an introduced brown trout fishery, which attracts anglers from around the world. The rivers are also used for canoeing, rafting,

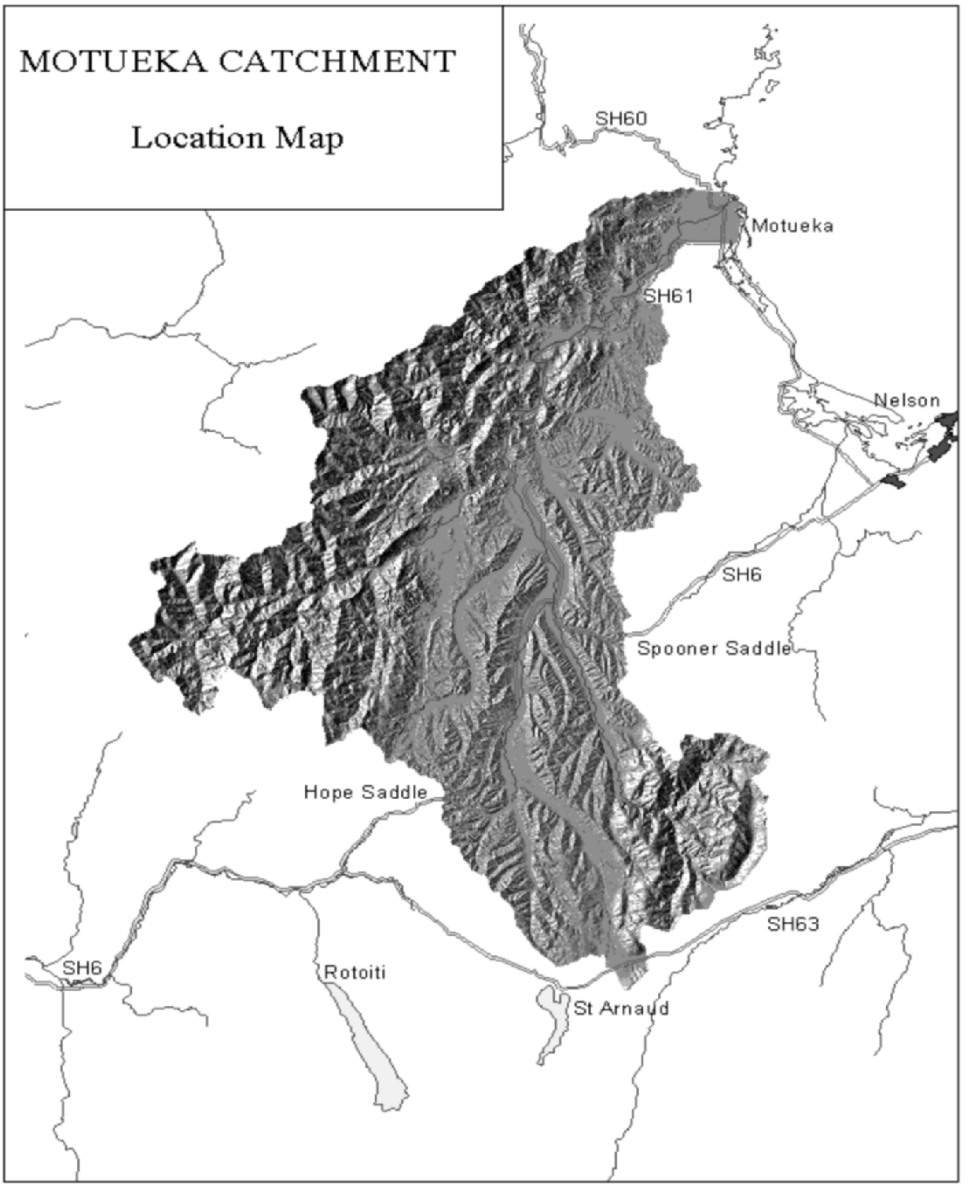

Figure 1. Motueka River Catchment and Tasman Bay.

picnics and gold panning. Scallop and cockle harvesting are key activities in Tasman Bay and there is a rapidly expanding interest in mussel farming and other marine farming opportunities, without the benefit of scientific knowledge about potential impacts.

The catchment is sparsely populated with less than one person per km^2 and a total population of 12 000, of which 7000 live in the town of Motueka. Population growth is among the highest in New Zealand at about 2% per annum. Vineyards, marine farming and tourism are adding to the diversity and productivity of the local economy. There are 132 permits to extract surface water

from the Motueka River and 335 permits to extract groundwater from aquifers in the catchment. Point source discharges are limited, being mainly from storm water and dairy effluent ponds.

Water Management Issues in the Motueka Catchment

Despite its low population, the Motueka catchment has some contentious resource management issues, many of which focus on water allocation in this productive and popular landscape (Fenemor & Bowden, 2001). Historically, sources of tension have included the following concerns:

- commercial afforestation could reduce streamflows and groundwater recharge necessary to support valuable horticultural interests in the area;
- forestry and irrigated agriculture may threaten the in-stream habitat values necessary to protect a nationally important brown trout fishery;
- sedimentation, particularly from forestry and agricultural activities, affects river water quality and freshwater and marine fisheries;
- best management of river gravel resources in relation to flood control and river management; and
- allocation of sea space for mussel and scallop shellfish harvesting in Tasman Bay.

These issues are intimately interconnected, affecting both the environment and the economy—and thus the community—of the Motueka catchment.

A broad spectrum of stakeholders has been engaged over several years and multiple venues to identify and prioritize these issues (Bowden & Wilkinson, 2000; Cole, 2003). By consensus, the issues of greatest concern to these stakeholders are population dynamics, economic drivers, primary industries, tourism, local policies and family wellbeing. Some aspects of these issues are amenable to research, while others are policy matters. All the issues are of fundamental social concern, and so integrating these human aspects with the biophysical research is a key focus of the Motueka ICM research programme.

New Zealand Legislative Setting

Land and water resources have been managed in New Zealand since the 1940s by regional government agencies defined by large catchment boundaries (Fenemor, 1992). The Tasman District Council, which serves 45 000 residents in the north-western South Island, is one of four 'unitary councils' acting as both regional and district councils, i.e. as an environmental agency, local service provider and district governance body. While this combination of roles can lead to conflicts of interest, it has the advantage of combining all resource management activities in one agency and should provide strong links between service delivery and environmental management. Local governments in New Zealand manage the environment under a single law: the 1991 Resource Management Act, which has the objective of 'promoting the sustainable management of natural and physical resources'. The act places particular emphasis on protecting the life-supporting capacity of resources, safeguarding the foreseeable needs of future generations, and avoiding, remedying or mitigating the effects on the environment. Rather than controlling activities such as land use, the act emphasizes avoiding or limiting the environmental effects of those activities.

To achieve sustainable resource management, councils develop statutory plans through a consultation process. The Tasman Resource Management Plan is being developed through an extensive public consultation process to set objectives, policies and rules guiding or controlling land, air, water and coastal activities across the district. Part V sets groundwater allocation limits within the alluvial plains of the Motueka catchment, based on a regional groundwater flow model, for example (Tasman District Council, 2001).

In addition to regional initiatives, there are national policy instruments that address key water resource management issues in New Zealand. These include Water Conservation Orders, which seek to protect outstanding freshwater values such as wild and scenic rivers. The central role of this important piece of legislation to the development of the Motueka ICM programme will be discussed below.

Finally, New Zealand's Treaty of Waitangi (1840) defines the governance relationship between Maori and European settlers, and has become a focal point for recent claims by Maori groups over various land and water resources. These claims are often a source of tension, requiring resolution. They also offer an opportunity to re-examine water-management policies from a different cultural context. Four Maori tribes (or *iwi*) have interests in the Motueka area and their views are an important part of the Motueka ICM programme.

Development of the Motueka ICM Programme

The Motueka ICM framework (Figure 2) was the product of a 2-year, multistep design process (Table 1) (Basher, 2003). However, the Motueka ICM research programme was preceded by more than a decade of debate and litigation over water resource management in the area.

The Motueka River supports an internationally recognized brown trout fishery and a decline in trout numbers as measured by drift diving during the mid-1990s caused concern to anglers and the fishery manager (Fish & Game New Zealand). To recognize and protect the fishery from incremental or cumulative loss of fish habitat, Fish & Game applied for a national Water Conservation Order in 1989. This prompted community concerns about potential constraints on development, especially the potential for irrigation. Community explanations for the trout fishery decline vary greatly depending upon the interest of the stakeholder. These include the effects of reduced flows due to irrigation for horticulture and pastoral farming, the effects of large floods, over-harvest of fish, the reduction in recruitment from spawning tributaries and sedimentation of the riverbed from land-use activities such as plantation forestry. The diverse geomorphology, climate and land use within the catchment means any or all of these explanations may be at least partially valid. While different parts of the river have since seen a recovery in trout numbers, the formerly most productive lower gorge section has a smaller trout population than during the 1980s.

The community debate that followed the promotion of the Water Conservation Order indicated a readiness and community need for better information about the effects of different land use options. The Water Conservation Order has recently reached a negotiated settlement (New Zealand Environment Court Decision W7/2003) over a low flow regime for the river, the major issue of community concern. This settlement will enable further development, but with increasing irrigation it is likely that constraints on water abstraction during

Table 1. Brief chronology of the development of the Motueka Integrated Catchment Management programme

Initial 2-day meeting of 40 stakeholders and end users to scope regional issues and research opportunities (March 1998). Report sent to attendees
Follow-up discussions in 1998 and 1999 to confirm identified issues
Consensus emerges on key issues and Motueka Catchment as a research focus
Tasman District Council (TDC) supports the proposals (1999)
International experts (T. Dunne and G. Likens) undertake a review and design project (January 2000)
Four interest-group meetings to check and refine issues (January 2000), including upstream farmers, downstream farmers, *iwi*, economic sector groups, marine industry representatives
Questionnaire sent to 160 community stakeholders to prioritize catchment research issues (March 2000). Final report circulated to stakeholders
Expert panel report on issues, researchable questions and proposed research (February 2000)
Meetings with research staff of the Cawthron Institute, Landcare Research, TDC, and five other collaborating research institutes to define key researchable questions (January–June 2000)
Research plan agreed with the Foundation and funded (July 2000)
On-going refinements to the programme through continuing stakeholder interaction and annual general meetings (2000–02)
Second-stage meetings with stakeholders, the New Zealand Foundation for Research, Science & Technology, and institutional administrations to define a course and strategy for future research (2002)
Submission of a bid to renew and expand the ICM programme (February 2003)
New, 6-year programme funded by the New Zealand Foundation for Research, Science & Technology (October 2003)

droughts will increase. The solution provides incentives for irrigators to look at alternatives such as groundwater sources remote from the river, water augmentation from outside the catchment or water harvest during times of high river flow. However, the discussions leading to the negotiated settlement of the Water Conservation Order raised many questions about future management of the catchment.

An integrated approach to research in support of water management at a catchment level provides an opportunity to investigate not only the most likely causes of the depleted trout stocks, but also the likely effects of other changes in land use on the river and Tasman Bay into which the Motueka River flows. Without better information and the means to ensure that the community acts on that information, it is unlikely that appropriate steps would be taken to ensure that various potentially competing interests of the community are maintained and provided for into the future.

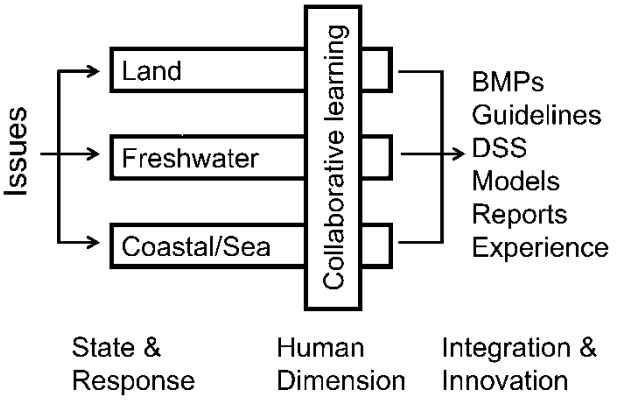

Figure 2. Basic framework for the Motueka River and Tasman Bay Integrated Catchment Management research programme.

The Motueka ICM programme differs from previous 'experimental catchment' research approaches in New Zealand (and elsewhere), which generally focussed on small watersheds, with a single land use (e.g. forestry) and a single resource issue (e.g. water yield). In particular, the catchment is large and heterogeneous, with untidy issues related to water yield, use of groundwater and surface water, low flow and sediment impacts on freshwater fish, land-use effects on nutrients and pathogens, and land–coastal–sea interactions. More importantly, the 'experiment' is uncontrolled in the sense that there is no practical way for it to be replicated. Instead, the intention is to develop new knowledge through adaptive management, i.e. research by doing (Allen *et al.*, 2002). This approach provides a framework in which questions can be posed and addressed—with appropriate statistical rigour, as needed—in an environment in which research providers, resource managers and the stakeholder community work collaboratively.

What Can Scientists Contribute to the ICM Dialogue?

While no one disputes that technical knowledge contributed by scientific experts is valuable and necessary for dialogues on ICM, it is disconcerting for stakeholders to find that the 'experts' do not always agree on the technical details and are sometimes found to be wrong. Indeed, this confusion tends to reinforce the Paradigm Lock that is a central focus of the United Nations Educational, Scientific, and Cultural Organization (UNESCO)/Hydrology for the Environment, Life and Policy (HELP) programme (HELP Task Force, 2001). Scientists need to engage in discussions about ICM with all key stakeholders to help identify what to study, to justify why such studies are important, and to advise how these studies should proceed. As simple as these activities may seem at first glance, they lie at the heart of the scientist–resource manager–community partnership. When scientists presume to make these choices themselves, they run the risk of reinforcing the Paradigm Lock that isolates knowledge producers from knowledge users.

Resource management issues rarely have single, black-and-white solutions. Rather, these complex issues often generate many alternative solutions, each of which requires inputs from different disciplines. Science provides an important

means to integrate the knowledge needed to address these complex issues. However, science (biophysical and social) produces expectations, not absolute givens. People (society, communities and stakeholders) then have to decide if they are willing to risk those expectations. The decision (including planning and management) to take that risk generates policy. Understanding when and how to employ science in the decision-making process will lead to better science and a better integration of science into planning, management and policy.

Deciding how to study a problem is a task that most scientists would consider to be their key role and contribution to ICM. However, stakeholder input is also essential in this effort. At the very least, discussions with stakeholders will ensure that the data produced through scientific inquiry will actually be useful to address the questions the stakeholders have posed. At best, a dialogue with stakeholders can reveal knowledge and even data that the scientist may not have been aware of and that contribute substantially not only to a solution for the specific issues, but also to the general advancement of science itself.

In the Motueka ICM programme, the present authors have employed an extensive stakeholder consultation process (Table 1) to identify key environmental management issues. We then sought a match between what appeared to be the most pressing issues and the questions that we thought—as scientists—could be addressed. In some cases, it was decided not to pursue research that we as scientists thought was important, because its immediate value would be more theoretical than practical. In other cases, we decided not to address a particular issue because it was concluded that the issues actually required more input from stakeholders rather than 'more study'. The result is a programme of research tailored to stakeholder needs and that explicitly includes stakeholder input. A direct benefit of this approach is that it has generated important stakeholder involvement in our research.

Critical Success Factors

Water resource issues are not just technical issues, they are also political, cultural, emotional and even spiritual issues. Calder (1999) describes integrated water resource management as an effort to develop a satisfactory solution—not necessarily the optimal solution, of which there are many—to environmental management problems. Satisfactory implies acceptable to all those affected by the solution.

And so, how should one gauge success in the context of integrated catchment management? The authors' experiences so far suggest eight critical success factors for effective dialogue to resolve environmental issues satisfactorily:

- Legal and institutional setting that facilitates resolution of the issues. Both the process and its outcomes need accountability so that the responsibilities upon each party to honour their commitments or to enforce outcomes are clear. Institutional and legal complexity can lead to agencies 'passing the buck' and a lack of accountability. Having a single resource management agency in Tasman District, and a clear direction established by the legislation and the Council's Resource Management Plan, provides this accountability.
- Strategic planning to anticipate the issues, collect relevant information and initiate dialogue before the issue becomes a crisis. Sound resource management needs forward planning. The information required to resolve defensibly

most of the environmental issues takes years to collect. Identifying looming issues likely to arise as a result of population growth, changing resource uses and other pressures allows us to plan environmental monitoring and consultation to address these issues. The costs of reversing environmental degradation and overuse of resources nearly always exceed the costs of finding a satisfactory solution in advance. Of course, environmental thresholds are seldom break points on a curve; rather, these thresholds are usually set by community decisions initiated by numerous forces, including legal processes, economic drivers and community advocacy.

- Vision, leadership and structure for the process. Resolution of local issues needs at least one party to drive the process. Local government may often best achieve this when seen as impartial, but genuine consultation driven by protagonists can also work. Mediated settlement of the Motueka Water Conservation Order litigation was only possible because the stakeholders were prepared to negotiate a compromise. This required leadership from all sides, plus pragmatism and time. Sometimes new participatory structures like a working party are needed to provide structure; at other times, the process simply requires good organizational skills to facilitate communication among existing parties.
- Involving all relevant stakeholder groups and engaging with stakeholder representatives who actually have decision-making power. All interested parties need an opportunity to participate to maximize acceptance of the outcome. However, identifying key stakeholders is not simple. For example, despite the small population in the Motueka catchment, it was found that the stakeholder community was diverse and that interactions among stakeholders were complex (Figure 3). In the most intractable conflicts, groups at the extremes often choose not to participate, thinking that participation would compromise their goals. Identifying and engaging the 'reluctant' participants can be critical to success. Stakeholder representatives need to bring to the discussion the mandate to commit their group to the decisions reached. Making this clear can help ensure that stakeholders are represented at the right level. While different stakeholder groups may hold differing views, there needs to be mutual respect and willingness to discuss all views openly. Building personal relationships among the parties will generate confidence and trust in the process. Adversarial legal approaches should be the fallback option and only undertaken when issues cannot be resolved directly and should be confined to the specific issues which have failed to be resolved. The time and financial costs for some stakeholders to participate can be a major barrier. Providing some rewards for involvement is one solution. Providing agency support for data collection and analysis is another. Keeping transaction costs manageable is a challenge for any ICM project because of its inevitable breadth.
- Adequate definition of the issue, including issue boundaries and spatial and time scales. Make the issue tractable, if necessary by breaking it into smaller sub-issues or constraining its scope. However, context for the issue must be kept in mind. A solution may set a precedent for the next issue, may not be compatible with management of other resources within the catchment, or may favour short-term benefit to the detriment of future generations. There is never sufficient information available to make a decision that is 100% robust. If the issue is pressing, a decision can be made based on current information. Where

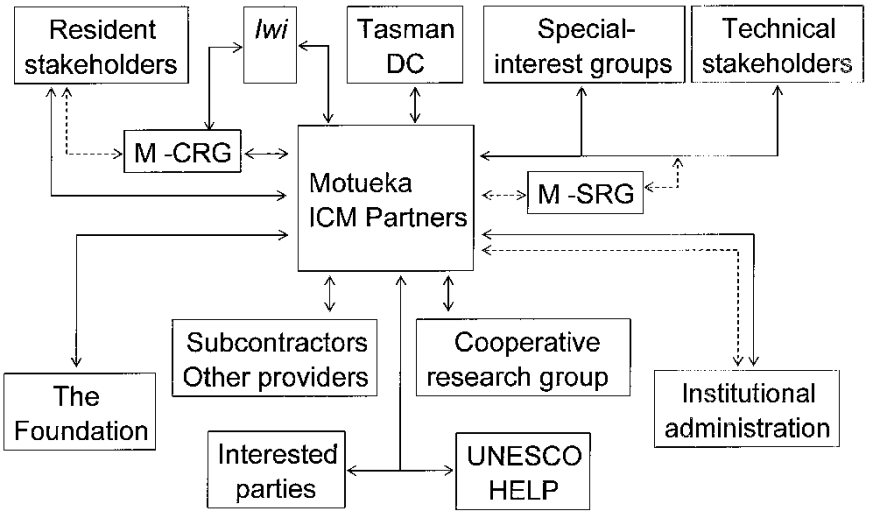

Figure 3. Stakeholder network in the Motueka catchment. The stakeholder groups include both institutional and community entities. Some entities have a stake because they are in a position to be affected by management decisions (e.g. farmers) and others because they are in a position to affect decisions (the Tasman District Council). M-CRG = Motueka Community Reference Group; S-CRG = stakeholder reference group that is more loosely defined and organized. These are typically key contacts in important agencies, industries and organizations that interact on an ad-hoc basis with individuals and subgroups within the Motueka Integrated Catchment Management programme.

possible, the decision should be revisited within a relatively short timeframe to allow time to gather the required information and better resolve the issue. For example, in each water-management area in the Motueka catchment, all water allocation permits expire on the same date so that they can be reviewed for renewal on a consistent basis, taking into account their cumulative effects on the water resource and new information.

- Adequate information upon which to base the dialogue, and strong, accepted science. A particular strength of the negotiation process for water allocation limits within the Motueka Water Conservation Order was that the farming group had time to assess long-term irrigation demands and place those on the table alongside the fishery agency's in-streamflow needs, and the council's assessments of available flows. Informed debate allowed a negotiated solution. Information to disseminate this type of dialogue may not exist. However, in many cases, useful information does exist but is not readily accessible to all parties. New tools, including geographic information systems, powerful databases and websites can help, but they require greater responsibility for information management and data quality assurance to maximize their utility.
- Accept local knowledge, including validated anecdotal knowledge, not just science. Rigorous biophysical science is needed to underpin resource management decisions. However, communities and indigenous groups may also hold knowledge that is important and useful for these decisions. Science is an important, objective way of understanding the world. However, cultural insights, based on decades and even centuries of observation and experience and sometimes transmitted only verbally, can be extraordinarily valuable.

While community 'knowledge' should not be accepted unquestioningly, just as science should not be, an ICM programme that makes a genuine attempt to take account of local knowledge, including indigenous knowledge, will gain greater community acceptance. Within the Motueka ICM, researchers are actively building relationships with the local Maori community, and this will lead into direct Maori involvement in research involving Maori aquatic food resources, sacred sites and resource management perspectives. Likewise, local knowledge about historical floods and land uses is helping build and validate a catchment water balance model to provide a historical context for predicting response to further land use change.

- Workable solutions expressed clearly and succinctly. ICM aims for holistic solutions instead of the more linear, discipline-focused solutions adopted in the past. The complexity of ecosystem interactions makes it a major challenge to find rational yet simple solutions to environmental management problems. Communicating the process of reaching these solutions—e.g. how the catchment models work—and communicating the outcome itself in simple terms is vital. In the Motueka ICM programme, a number of simple, common-sense tools and approaches have helped with critical communication and education activities. For example, each year the authors organize an annual general meeting (AGM). A portion of the AGM is open to the general public and is an opportunity for us to present to stakeholders the results of our most recent research efforts and ideas for the future. This is not a one-way communication as we often receive valuable feedback during the 'public' portions of the AGM to help guide research. Another portion of the AGM is reserved for the key project leaders and key stakeholders who are partners in the ICM research. Usually, there has been considerable preparatory work by small groups of researchers and stakeholders leading up to these meetings. This portion of the AGM is an opportunity to get feedback from other partners, refine project ideas and explore possible synergies. Thus, our research work plan becomes a living document in which researchers and stakeholders are equally involved. In addition to the AGM, a number of other mechanisms are used to explore stakeholder needs and to engage stakeholders in our research. Traditional, one-on-one meetings play an important role in our efforts, as do one-off workshops and field days that focus on specific topics. These more traditional avenues of communication and education tend to focus on key, well-known and vocal members of the research and stakeholder community. As a consequence, a Motueka Community Reference Group was formed to engage 'resident' stakeholders who might not otherwise have a strong voice in the ICM process. These resident members are ordinary only in the sense that they do not represent any particular professional interest group, although they may represent a personal interest group (e.g. recreational fishermen). They tend to be 'extraordinary' in that they have strong links with the community at large. Thus, they are in a position to relay the efforts and results of the ICM research programme in a way that we, as scientists, simply could not. The dialogue in the Motueka Community Reference Group meetings is truly multidirectional, with communication and education among all parties. The Motueka ICM website (http://www.icm.landcareresearch.co.nz) already serves as a vital communication link within the programme to local stakeholders and abroad at both national and international levels. The site is used not only to coordinate the activities of all the partners, but also to communicate the results of

our research efforts. The key purpose of the Motueka ICM website is to be a living 'knowledge base' for all stakeholders. The site has an on-line, searchable database of over 400 publications relevant to catchment management in the Motueka area. New references and outputs from the research programme are added regularly. In time, we expect to add tools such as decision support systems and best management practices, as well as educational resources for teachers and students. It has been found that even in the early stages of the Motueka ICM programme, the website has been a powerful tool to communicate the objectives and outputs of the programme. Even if most of the residents in the catchment do not access information on the Web, the website provides visibility to our efforts that draws attention and new collaborations that benefit the programme.

- Committed leaders willing to facilitate shared solutions. Leadership is vital, particularly from those who are respected in the community and are prepared to take personal chances to secure a desirable future outcome for the community. These leaders provide a catalyst that makes the difference between success and failure. This is a powerful observation, because it suggests that to effect real change, it is not necessary to convince everyone that change is good. Rather, it is sufficient to identify leaders who can provide an example that others will follow.

What Can Be Learned from the Motueka ICM Initiative?

The Motueka ICM initiative illustrates a number of lessons that are transferable. The vital roles of communication and education have already been mentioned. The critical role of enlightened leaders has also been suggested. Other lessons are also worth mentioning. First, effective dialogue about ICM should be directed 'up' as well as 'out'. While a major focus of the Motueka ICM research programme is to help inform water resource management policy at the level of the Tasman District Council, the programme also informs policy at the level of central government and, through the UNESCO/HELP programme, also at the international level. Being attuned to opportunities to share successes and challenges at these different levels is a transferable lesson.

Second, there is a special contribution that the Motueka initiative can make to the ICM dialogue. Pressures on the Motueka River and Tasman Bay environments are mounting and real. However, to many observers, this landscape probably appears relatively undamaged and they might ask: 'What's broken that needs fixing?' But this question misses the point entirely. Like a machine, failure of one ecosystem component is likely to indicate serious stresses on other components in the system and may cause direct failure of still other components. However, ecosystems are not just complicated machines that can be relatively easily and quickly fixed when a part wears out or is broken. Once an ecosystem component (e.g. groundwater) is 'broken' (e.g. contaminated or over allocated), it is difficult, expensive and time-consuming to repair it … assuming it can be repaired at all. One of the failings of an 'effects-based' approach to environmental management is that once an effect can be detected, it may be too late to do something about it. Across the world, there are sobering examples of the financial and human costs of repairing broken ecosystems (e.g. the Aral Sea in Russia, the Spree River in Germany, the Kissimmee River in the USA and the Murray–Darling Rivers in Australia).

One of the principal tenets of integrated catchment management is to take a proactive approach—rather than a reactive approach—to environmental management. This simple shift in perspective has profound influences on the way in which science is performed. In a reactive approach, the issue and goal are usually painfully clear, and repair and remediation are likely to be the key responses. These responses usually rely on applied sciences and engineering approaches led by experts, with input from technical stakeholders but relatively little input from communities. A proactive approach requires a more holistic response. While the issues and goals may be reasonably clear, the appropriate responses may be far from clear. Applied sciences and engineering technology certainly have a role to play. However, because the best way forward may be unknown, basic exploratory science and informed monitoring are also critical to success. What is most important, however, is that a wider spectrum of stakeholders must be involved in the process of setting goals and interactions among these stakeholders must be managed sensitively. It is this 'human dimension' of integrated catchment management that presents the greatest challenge—and consequently accounts for a significant part of our effort in the Motueka ICM programme. We believe that the best way to meet this challenge is through a variety of participatory processes that build 'social capital'—trust, understanding, cooperation—among stakeholders, from scientists and engineers, to regulators and policy-makers, to communities and interest groups.

This approach can be uncomfortable because the key hypotheses to test may not be clear to scientists, the appropriate technologies may not be available to engineers, the best practices may not have been developed for managers, and the best sources for relevant information may not be evident to stakeholders. Nevertheless, this shift in thinking from 'What's broken?' to 'How can one keep it in good repair?' is critical to the development of successful strategies for sustainable development.

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