Integrated Catchment Management for the Motueka River: bridging the gap between hydrology and the human dimension

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Abstract

There is a global trend towards managing natural resources more holistically. Holistic approaches consider not only the biophysical aspects of hydrological research, but also the social, economic, and political ramifications from such studies. This paper describes a new research programme based in the Motueka catchment in the South Island of New Zealand. The programme includes process-oriented experimental work as well as promoting better use of science information in decision making. It also seeks better involvement of stakeholders in setting scientific agendas. This has led to the project being identified as a model basin for the new international UNESCO/WMO sponsored HELP catchments programme.

The goal of the Motueka Integrated Management Programme is to improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting uses of natural resources. This is being achieved through historical research, biophysical experimentation, simulation modelling, and social learning. Combining these approaches will improve interactions between science providers and community stakeholders and maximise the uptake and use of new knowledge and tools developed from scientific research.

Integrated Catchment Management

Rather than focussing on small-scale processes or isolated activities, Integrated Catchment Management seeks to provide a framework for understanding the cumulative interactions of past, present, and possible future land use activities on land, freshwater, and marine resources. This 'ridge tops to the sea' perspective addresses the large-scale, regional environmental issues in a holistic manner.

Prof Ian Calder in his book 'The Blue Revolution' (1999) describes Integrated Catchment Management as an effort to develop a satisfactory solution, not necessarily the optimal solution, to environmental management problems. This integrated approach makes us aware of the need to step beyond plot-scale research to catchment or system scales. It requires a shift from past engineering approaches to water management, to take into account the whole ecosystem as well as social and economic factors.

Integrated Catchment Management also means building research and catchment management teams which include scientists from many disciplines, as well as resource managers, policy makers and community representatives. Water issues - in fact, resource management issues in their broadest sense - are not just technical issues, they are also emotional and political issues.

The UNESCO-IHP Programme *Hydrology for the Environment, Life and Policy (HELP)*

The Motueka River catchment described in this paper is one of a number of operational basins selected for an international programme dealing with hydrology and people as part of the HELP programme[1] - a UNESCO funded initiative.

HELP is a joint UNESCO/WMO programme which is designed to establish a global network of catchments to improve the links between hydrology and the needs of society (HELP Task Force, 2001). The overarching goal of HELP is to: C*ontribute social, legal, economic and environmental benefits to communities through sustainable and appropriate use of water by deploying hydrological science in support of improved integrated catchment management.*

The vital importance of water in sustaining human and environmental health has been recognised in numerous national and international fora (e.g. the 1997 UN General Assembly Special Session). Several recent international conferences culminating in the Second World Water Forum have highlighted 'water' as the most critical environment issue of the 21st Century (World Water Council, 2000). The Third World Water Forum will discuss solutions to this very issue in Kyoto in March 2003.

HELP aims to integrate water resource research with policy and management needs, to address critical issues such as pressure from increasing population, climate change and water quality and quantity reduction. Current water resource management often suffers from

- Poor links between policy makers/ resource managers and scientists in setting research agendas
- Poor uptake of research information into resource management
- A significant time lag in implementing scientific outputs
- Policy based on outdated knowledge and technology.

This *"Paradigm Lock"* has come about because the two main groups have become isolated: scientists by the lack of proven utility of their findings, and stakeholders by legal and professional precedents and poor responsiveness to issues from institutional structures. Figure 1 shows how this Paradigm Lock can be resolved through Integrated Catchment Management (ICM).

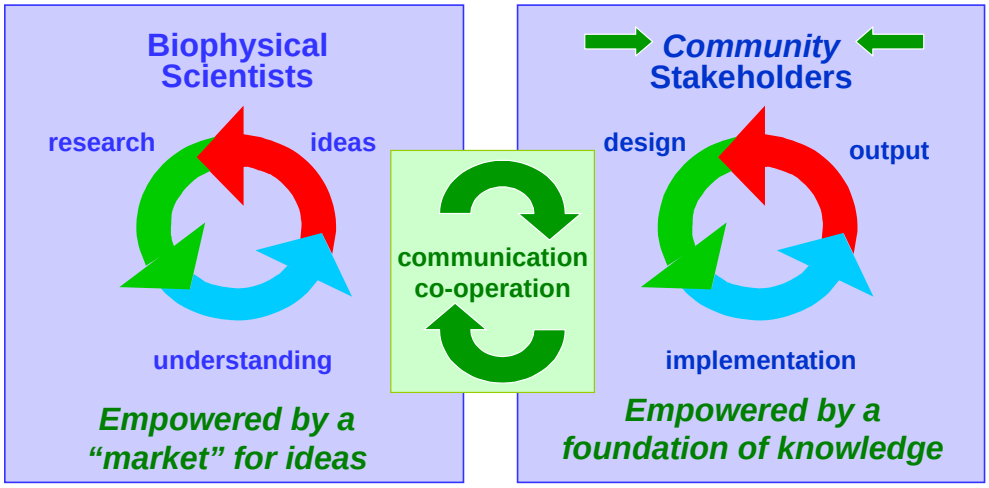

Figure 1: ICM as a solution to the 'Paradigm Lock' (J.Shuttleworth and M.Bonell, pers comm)

The HELP initiative has a practical rather than theoretical focus. It uses real catchments, with real water related problems as the environment within which hydrological scientists, water resources managers and water law and policy experts can be brought together, especially for setting research agenda and promoting free flow of information for use in management and policy making.

The Motueka Catchment project goes even further than HELP's objectives by integrating these approaches for land and marine resource management, not just freshwater resource management.

[1] http://www.unesco.org/science/HELP

The Motueka Catchment

Geography, Geology and Hydrology

The Motueka River catchment (Figure 2) covers 2,170 km^2 and is located in the northwest of the South Island of New Zealand. The Motueka River flows from an elevation of 1600m to sea level where it delivers 65% of the fresh water to Tasman Bay, a productive and shallow coastal body of high cultural, economic, and ecological significance.

Average annual precipitation is about 1300-1550 mm, ranging from 1000 to over 3500 mm in the western alps. The annual discharge of the Motueka River in its lower valley is 844 mm, and mean annual flow is 58.1 m^3 s^{-1} with a 5-year flood flow of 2050 m^3 s^{-1}. The climate is cool and humid with dry (austral) summers. Motueka town is one of the sunniest places in New Zealand.

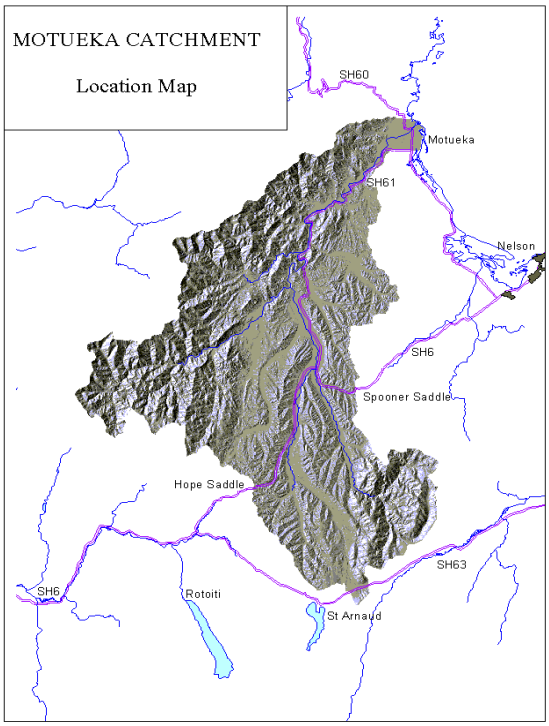

Figure 2: Motueka catchment, NZ

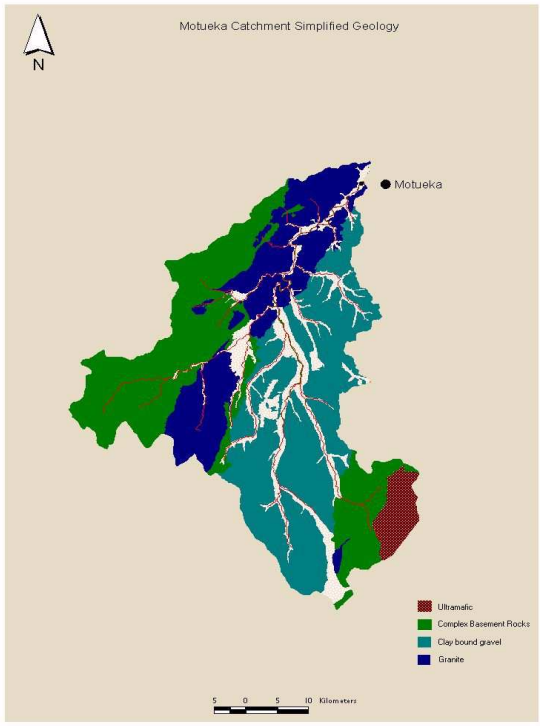

Figure 3: Motueka catchment geology

The geology (Figure 3) is mixed with clearly defined terranes 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 Motueka-Riwaka Plains aquifers have been modelled to develop water allocation limits in the Council's resource management plan.

Land, Water and Marine Resource Use

The alluvial plains in the catchment support horticulture (e.g. apples, kiwifruit, nashi, hops, berryfruit, olives), dairy farming, and other stock farming, much of which is irrigated from the gravel aquifers. Rolling and steep hill country in the lower basin contain low-fertility soils and are grazed or in pine forest while the rugged mountainous terrain in the headwaters with a mixture of thin-infertile to thick fertile soils are mostly in native 'bush' conservation estate.

The Motueka River supports a nationally significant brown trout fishery, which attracts anglers from around the world. The rivers are also used for canoeing, rafting, picnics and gold panning. The marble terrains contain the deepest cave system in the Southern Hemisphere, which also attracts international speleological

exploration. Water permits for extraction total 132 for surface water and 335 for groundwater. Point source discharges are limited, being mainly from stormwater and dairy ponds.

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 underpinning scientific knowledge about potential impacts.

Human History

The catchment is sparsely populated with less than one person per km^2 and the biggest town, Motueka, containing 12,000. Population growth is among the highest in New Zealand at about 2% per annum. The local economy has developed from an early reliance on pastoral and tobacco farming to pipfruit, berry fruit, hops and exotic pine forestry. More recently, vineyards, marine farming, and tourism have added to the diversity and productivity of the local economy.

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. Five Maori tribes (iwi) are active the Motueka area and their views are an important part of the integrated catchment management programme.

The resource issues described above have important impacts on employment, lifestyle, security, health and wellbeing of the people of the Motueka catchment. People's lives are affected by the ways that these resources are managed. Integrating these human aspects with the biophysical research into these resources is therefore a key focus of Integrated Catchment Management research.

The Motueka Integrated Catchment Management Research Programme

History of the Project

The Motueka Integrated Catchment Management project originated from a workshop on Integrated Ecosystem Management held in March 1998 in Nelson. Presentations on environmental issues facing the upper South Island were given by 14 industry sector and interest groups. A brainstorming session on a collective vision for the region in 2020 led to the theme 'Blue Water with Life'. The workshop identified that holistic and sustainable management of land, river, and coastal resources was a top priority. A major research issue arising from this vision was to understand the effects of land use on freshwater and coastal processes.

Despite its relatively low population, the Motueka catchment has some contentious resource management issues. These include:

- An application for a Water Conservation Order aimed at protecting the nationally important brown trout fishery, but which would limit water able to be taken for future irrigation and industry development
- Concerns about sedimentation from forestry activities, affecting river water quality and fisheries
- Afforestation reducing streamflows and groundwater recharge
- Litigation over the allocation of sea space for mussel and scallop shellfish harvesting in Tasman Bay, which has so far generated 13 weeks of hearings before New Zealand's Environment Court.

The detailed research proposal was developed after a visit during summer 2000 from two international experts, Prof Tom Dunne from the University of California and Dr Gene Likens of the Institute for Ecosystem Studies in New York. Three meetings were throughout the catchment with interested parties in the Motueka catchment, to gain local views of resource management issues. Specific research issues were also prioritised using responses to a questionnaire sent to farming, forestry, fishery, environmental and community stakeholders.

In July 2000, the NZ Government approved funding for this ICM research programme involving research institutions Landcare Research, Cawthron Institute and others[2], plus the local resource management agency Tasman District Council. The programme is focussed on the Motueka River catchment and has five research objectives:

1. Knowledge integration and delivery for integrated catchment management
2. Land use influences on water quantity and quality
3. Nature, distribution and functions of riparian-stream interfaces
4. Land use effects on coastal-sea ecosystems
5. Social learning for integrated catchment management.

A major reason that the project is government funded is that the Foundation sees national benefits in developing a template for integrated catchment management which can be applied in other NZ catchments. We expect this approach can also be applied in catchments beyond New Zealand. This is why the project has been adopted by the UNESCO International Hydrological Programme as a HELP catchment.

District Council Role

An innovative aspect of the programme is the partner role of local government in the research. Tasman District Council is the local government agency responsible for both environmental management and infrastructure development in the catchment. The Council sees considerable benefit in being a partner in the Motueka ICM project. Council has helped identify the major resource management issues, and is the link between the scientists and people in the community. In conjunction with Council's own environmental investigations programmes, the ICM programme is already providing not only the Council, but also sector and community groups, with a better idea of the causes and solutions for some of the environmental issues arising in this catchment. The project will also provide knowledge to assist the Council's management of these issues through its Tasman Resource Management Plan.

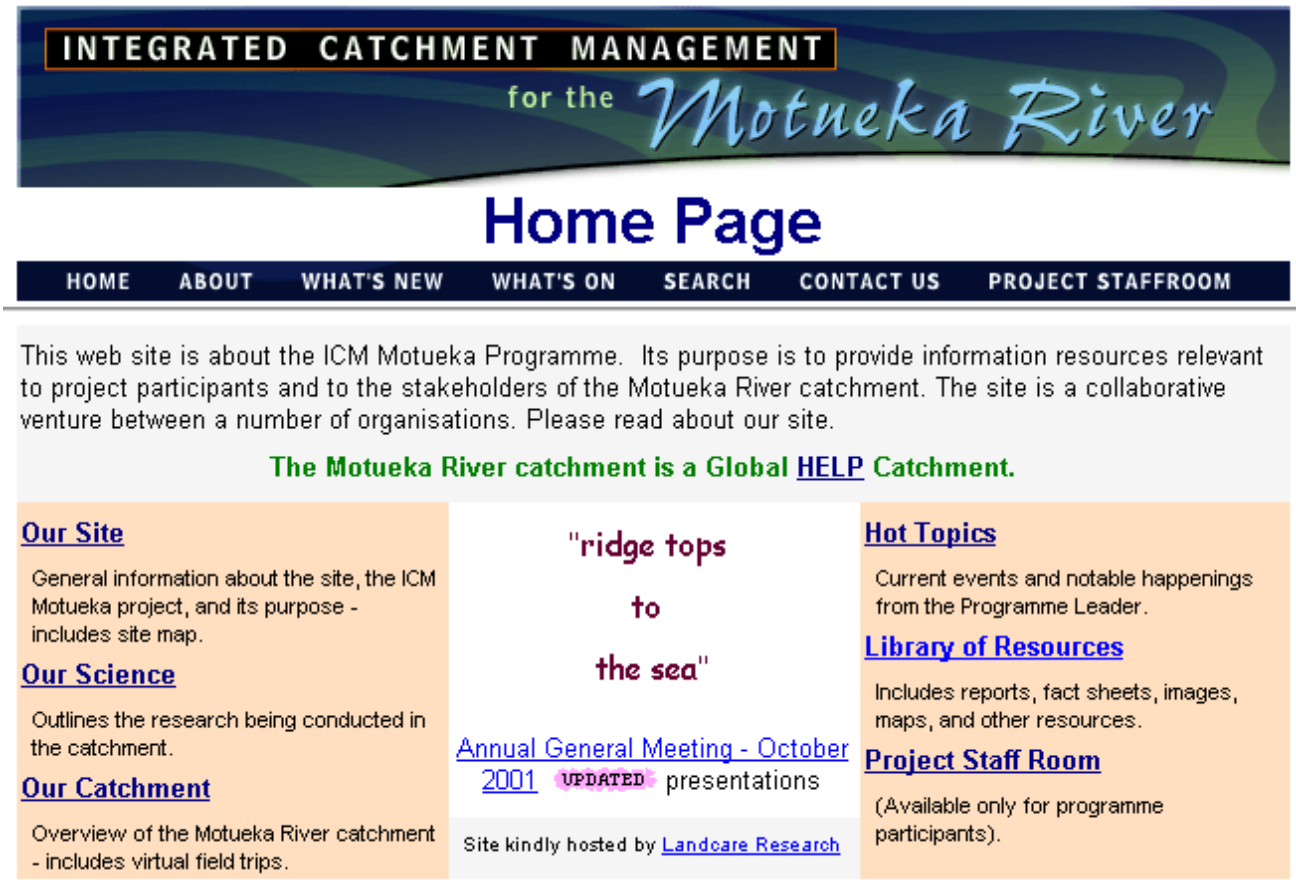

Figure 5: Motueka ICM website homepage: http://icm.landcare.cri.nz/index.htm

[2] Including the Institute of Geological and Nuclear Sciences, Forest Research, Otago University, Lincoln Environmental, NIWA

Stakeholders' Roles

The ongoing involvement of stakeholders in helping refine future work in the programme is seen as a priority. A "Community Reference Group" (CRG) meets quarterly to act as a sounding board for the research direction and dissemination of results. Direct contact also occurs with individual stakeholder interests such as forestry, farming, environmental and community groups.

The research partners held an 'Annual General Meeting' in Nelson in October 2001 to report progress in the first year of the research programme. This included a public day at Tasman District Council to review present programme directions, and a second day discussing future programme directions[3].

The linkages between the ICM programme and the community – such as the Community Reference Group, the Annual Meetings, and the project website[1] (Figure 5) – enable local people to not only become informed of the results but to comment on the issues and the way these are being researched. Research results will enable local people, for example, to make changes to their own land and water management practices. It is anticipated that the researchers participating in the programme will report back to the community through the Tasman District Council's monthly newsletter "Newsline", community meetings, and through the website.

Research Themes

The research in the ICM Motueka initiative is organised around four science themes. Themes include information and research activities related to:

- *land use* - which primarily addresses issues of land use effects on water resources, including surface water and ground water
- *freshwater* - addresses issues of water quality and habitat as well as riparian management issues
- *coastal marine* - addresses the issue of the catchment's effects on Tasman Bay and the implications for marine farming and marine habitat
- *human dimensions* - addresses issues of why and how stakeholders manage the conflicting resource needs within the community.

Initially, the programme is summarising and interpreting existing knowledge, especially regarding water availability and sediment generation. Over the remaining five years of this programme, the specific research objectives will evolve to include work on nutrient and pollutant dynamics, the values and opportunities for riparian management and restoration, the impacts of gravel extraction, and the development of new models to describe land-river-coastal interactions.

The focus of this programme will increasingly shift from understanding individual catchment processes to development of holistic management strategies based on a catchment perspective that includes cultural, economic, and political as well as scientific considerations. This emphasis on the human dimensions of managing the biophysical environment is one of the most innovative aspects of this new programme.

Research Theme 1: Land

The purpose of this theme in our programme is to develop a firm understanding about the influences that past, current, and future land uses have on the quantity and quality of water in the Motueka River.

Research issues

- How does land cover affect groundwater recharge?
- Does groundwater withdrawal affect stream flow?
- Has water availability changed substantially from past conditions?

[3] Abstracts of presentations are on the Motueka ICM website at http://icm.landcare.cri.nz/index.htm.

- Is water availability likely to change substantially with future development?
- How do land form and land use interact to influence water quality?

Research Theme 2: Freshwater

Good management of water resources requires an understanding of the effects of adjacent land management on water quantity and quality, the equitable allocation of water for out-of-stream and in-stream uses, and potential connections between freshwater and coastal ecosystems.

Particular concerns have been raised over the condition of the Motueka River catchment in the last few years. Annual surveys of brown trout over the last 6 years have shown that the observed number of adult trout were about one third of the numbers seen in 1985 (Figure 6). The reasons for this decline are unclear but could relate to changes in physical habitat suitability for adult trout in the main river, spawning success in the tributaries, and/or declines in food availability.

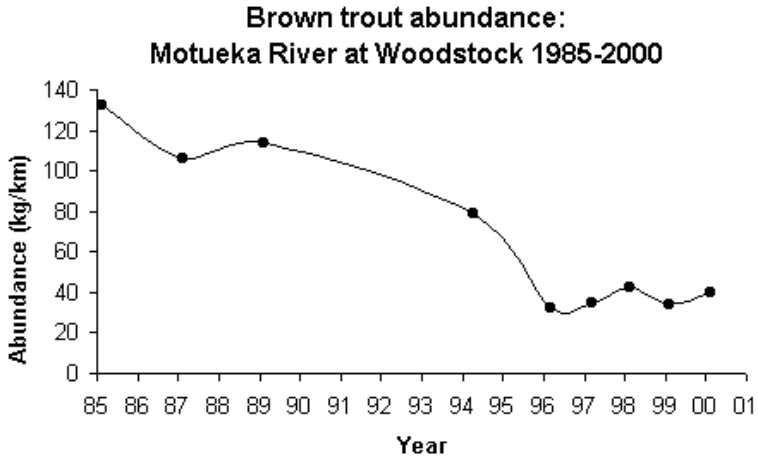

Figure 6: Decline in trout biomass in Motueka River

Water allocation from the catchment is also coming under increased scrutiny. Consequently, important decisions need to be made regarding the amount of water that can be abstracted from the river without having harmful effects on aquatic life in the river, while protecting opportunities for irrigation development and population growth.

Research issues

- What are the effects of natural low-flow on freshwater ecology?
- What are the effects of competing water uses on freshwater ecology?
- Does water abstraction reduce aquatic habitat value, especially at low flows?
- How does land use affect water quality and freshwater ecology?
- Does land use affect nutrient and sediment delivery to coastal ecosystems?

Research Theme 3: Coastal

Coastal processes are complex and have received less attention than water and land issues. Productivity – and therefore the economic value – of the coastal marine environment is dependent on an adequate but not excessive supply of nutrients, such as nitrogen and phosphorous. Discharge of freshwater and the terrestrial materials this water carries may affect essential ecosystem dynamics (like primary production) and characteristics (like biodiversity). Coastal productivity is also affected by sediment discharges which reduce the light available for plant growth and can smother the plant and animal communities of the benthic environment. Discharges of contaminants from freshwater sources also affect coastal productivity. For example, there is huge variability in the scallop harvest from year to year, so the research will attempt to identify the environmental drivers that cause this.

Research issues

- How do variations in the volume of the freshwater discharge affect the ecology of the coastal environment?
- How do variations in the quality of the freshwater discharge affect coastal ecosystems?
- Can we develop coastal hydrodynamic and ecosystem models for Tasman Bay capable of predicting the effects of variations in the quantity and quality of freshwater discharge from the Motueka River?

Research Theme 4: Social

The focus of this work is to understand how to create a favourable social environment - at district and regional levels - in which science can best be used to make decisions about resource management. This social environment aims to improve interactions between science objectives and end-user needs. We also aim to improve information flows using a process called *social learning*; for example, the Internet, community participation and stakeholder analyses. Finally, we want to improve the social environment for uptake of science information.

Research issues

- How can you improve the responsiveness of science research programmes to the environmental management needs of stakeholders?
- What mechanisms can be used to improve the integration of local and science research information to improve decision-making?
- What innovative mechanisms can we use to deliver existing information in a form that is readily available and most useful to end-users?

Observations after the First Year

The ICM approach is working. Our iterative approach of doing, reporting, then asking for reactions is getting us feedback. Sometimes the feedback is uncomfortable, but it allows us to steer the programme in the most productive directions. As an example, feedback at the Annual General Meeting indicated that some sectors want closer involvement with the project through better technical liaison. The Community Reference Group does not contain representatives of professional groups working in the catchment, such as staff from forestry, horticulture and aquaculture industries. This is now being addressed.

Relevance to Monsoon Asia Water Resource Management

Although the biophysical systems in temperate and Monsoon climates differ significantly, many aspects of our human systems are similar. So the approach we are taking in the Motueka project may well be useful in Monsoon Asia. We believe that the Integrated Catchment Management approach described in this paper will increasingly become the model which is applied to catchment management globally. Water resources research must address community needs more effectively. To do so will increasingly involve managing resources for environmental protection as well as for development.

While the detailed water issues are different in monsoon climates, the connections between land, water and marine resource utilisation are critical. The development of sophisticated catchment models and Decision Support Systems will allow the impacts of resource use to be predicted in a much more integrated fashion than ever before. The challenge is for our institutional and legal systems to provide the mechanisms to respond to this information by modifying resource use patterns and methods so that we can achieve a sustainable balance between economic production, social development and environmental protection.

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