



Integrated Catchment Management Workshop



Landcare Research
Manaaki Whenua



26 - 28 April 2010 : Rutherford Hotel : Nelson

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Registration Desk

If you require any assistance throughout the conference please see Lea Boodee or Tracy Young at the registration desk in the foyer area outside the Waimea Room. The registration desk will be open on Monday from 9.00 – 10.30am and Tuesday 7.45 – 10.30am. If you require assistance when the registration desk is unattended please leave a message for non-urgent matters, call the contact number below or find a local delegate to assist you.

Cell Phones

Please ensure that cell phones and/or pagers are turned off, or silent, during all presentations.

Conference Rooms

All sessions are to be held in the Waimea Room on the second level of the hotel (first floor), please use the lifts or stairs near the fountain, to access this room.

Breaks

Morning and afternoon teas and lunches will be served in the Waimea Foyer on the first floor. Please refer to the venue floor plan for further details.

Special Dietary Requirements

If you have advised us of your special dietary requirements then these have been forwarded to the caterers at the Rutherford Hotel and the Boathouse (workshop dinner venue). For morning tea, lunch and afternoon tea breaks at the Rutherford Hotel please look out for specially marked meals.

For the workshop dinner at the Boathouse, please make yourself known to the serving/waiting staff and they will make the necessary arrangements for you.

Presentations

Please ensure presentations are loaded with the Audio Visual technicians or registration desk well in advance of your session. The technicians can be found at the AV desk in the Waimea Room. Please ensure that you are ready to start your session on time and that you pay attention to your session convenor when they indicate that time is up. In order to get through the day's programme it is vital that sessions do not run over time.

Field trip

The bus for the field trip leaves from the Rutherford Hotel at 8.00am sharp on Wednesday morning. If you are late it will leave without you! There will be pick up from the main entrance of the TDC in Queen St, Richmond at 8.15am. Again it will only be stopping here to pick up those who are waiting so don't be late.

If you are planning to take your own vehicle and you have not notified the workshop organizer please tell Tracy or Lea at the registration desk.

One bus will be stopping at the Nelson airport on the way back from the field trip at approx. 5.50pm. Please tell Les Basher (field trip organiser) if you need to be dropped off so that you can be on the right bus.

Contacts

Andrew Fenemor – programme leader fenemora@landcareresearch.co.nz ph. 03 545 7710

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Phone: 03 546 6330, Fax: 03 929 5512, Email: tracy@on-cue.co.nz

Lea Boodee – mobile phone: 021 117 0916

Tracy Young – mobile phone: 021 164 7820

Monday 26 April

9 – 10am

Registration and morning tea – Waimea Foyer, Rutherford Hotel

10am

Workshop begins – Waimea Room – see programme for details

7.30pm

Cafe Scientifique – The Granary, Founders Park, Atawhai Drive

Tuesday 27 April

7.45 – 8.30am

Registration - Waimea Foyer, Rutherford Hotel

8.30am

Workshop begins – see programme for details

7.00pm

Workshop dinner – The Boathouse, Wakefield Quay

Wednesday 28 April

8.00am

Buses depart for Field Trip – Rutherford Hotel

8.15am

Pick up in Richmond – TDC offices, Queen St. Richmond




See programme for Field Trip details

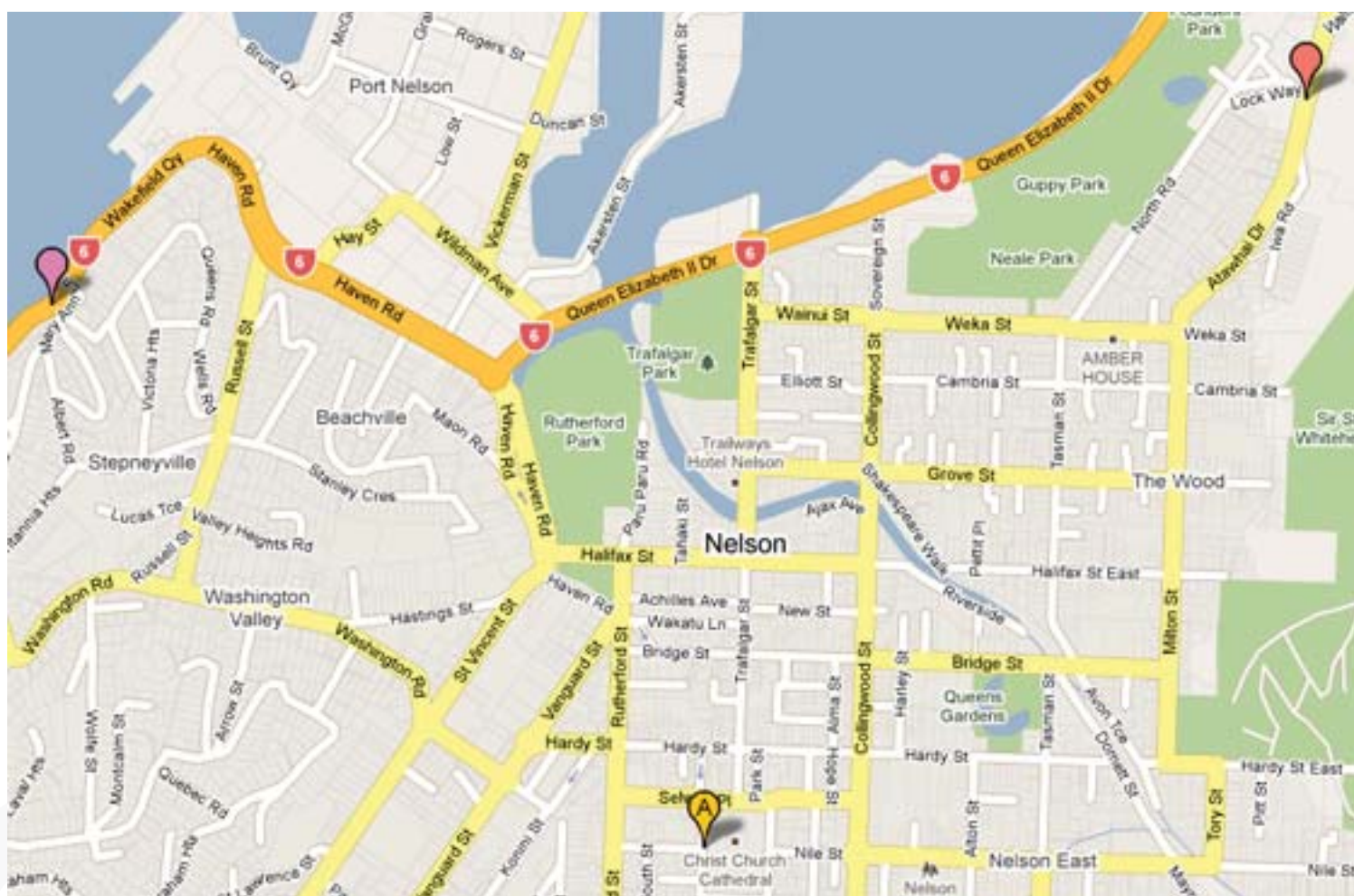
6.00pm

Bus returns to Rutherford Hotel



Nelson CBD Map

-  Rutherford Hotel, Trafalgar Square, (03) 548 2299
-  The Boathouse, 326 Wakefield Quay, (03) 548 7646
-  The Granary, Founders Park, (Milton St turns into) 87 Atawhai Drive, (03) 548 2649



Presentations - Waimea Room, 1st Floor (level 2)



Programme

Monday 26 April: 10.00am - 5.00pm

Mobilising-Moderating-Motivating: Engaging People in Collaborative Environmental Management

Convenor: Dr Will Allen, LearningForSustainability.net

Waimea Room, Rutherford Hotel (opposite Landcare Research, Nile St, Nelson)

This forum looks at what lies at the heart of integrated catchment management – working with multiple interests and bringing together diverse knowledge. It will include presentations and discussions of innovative ways to build collective capacity for effective environmental management. The three themes are

- Systems thinking - identifying leverage points for action in complex catchment situations (Dr Will Allen)
- Dialogue processes to promote effective engagement across layers and players (Margaret Kilvington & Maggie Atkinson)
- Respecting Māori world views – How to engage with iwi, and support the inclusion of different worldviews in plans and activities (Garth Harmsworth)

7.30 - 10.00pm - Café Scientifique at The Granary, Founders Park, Atawhai Dr.

"10 Scary & Wonderful Discoveries about Catchments"

Convenor: Dr Glen Lauder, Common Ground Ltd

A public discussion about catchment science drawing on insights from the Hubbard Brook Ecosystem Study (New Hampshire USA) since 1963, and the Integrated Catchment Management (Motueka-Tasman Bay) research programme since 2000.

Panellists:

- Dr Gene Likens, Director Cary Institute of Ecosystem Studies (CIES), New York and currently a visiting Fellow at the Australian National University developing a long-term ecological monitoring network for Australia.
- Andrew Fenemor, Programme Leader Integrated Catchment Management, Landcare Research, Nelsonwith scientists from the Motueka ICM programme

Bring your thoughts and provocative questions about how our land, water and coasts interact, and how humanity can draw on science to better manage our catchments for the future.



Tuesday 27 April: 8.30am - 5.00pm

The Legacy of ICM Science from the Motueka catchment

Convenor: Andrew Fenemor, Landcare Research Nelson

Waimea Room, Rutherford Hotel (opposite Landcare Research, Nile St, Nelson)

Summarising and discussing what we have learned about catchment science, how it has enlisted greater community and stakeholder involvement, and how it can enhance management opportunities, including for other regions. Presentations of ICM research findings from Landcare Research, Cawthron Institute, NIWA, GNS Science, Scion and others.

Introducing ICM & ICM Research (Andrew Fenemor, Landcare Research)

- Barney Thomas, Mihi Whakatau
- Welcome & Introductions (Gillian Wratt, CEO Cawthron Institute)

Genesis of ICM Research in an international context (Dr Gene Likens, Cary Institute of Ecosystem Studies New York & one of the original ICM programme designers)

A Conceptual framework for Integrated Catchment Management and overview of Motueka ICM research issues (Andrew Fenemor, Landcare Research Nelson)

Theme#1 – Managing land uses in harmony with freshwater (Roger Young, Cawthron Institute)

Stakeholders identified declines in the trout fishery, sediment impacts, river gravel allocation, water quality and riparian management as research issues in the Motueka. Theme#1 discusses research results for these issues

- Catchment water quality & trout responses Roger Young
How do climate, geology, land use influence water quality and river health?
Why did the Motueka trout population crash in the mid 90's?
- Faecal Contamination Rob Davies-Colley
How much faecal contamination reaches streams and the bay, and how can it be reduced?
- Fine sediment & gravel movement and impacts Les Basher
How can we, or do we need to, manage sediment better?
How do we best manage gravel resources in the river?
- Riparian management Chris Phillips
Is riparian vegetation the "silver bullet" for improving water quality?
How can farmers restore native riparian vegetation and what plants are best?
- Cultural indicators for river health Garth Harmsworth, Dean Walker
How can we reconcile Maori and Pakeha values for improved water quality?

10.00 - 10.20am Morning Tea

Theme#1 ctd including questions & comments

Theme#2 Water Allocation & Governance for Resilient Catchments (Andrew Fenemor, Landcare Research)

Water allocation is reaching catchment limits, with balancing required between irrigation and instream values/uses, between river and groundwater availability, and recognition of water yield effects of different land cover.

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| <ul style="list-style-type: none">Catchment & river-aquifer modelling for water allocation | Tim Davie | Exploring what researchers and stakeholders have learnt about Integration in the ICM research programme, seen in the context of integrated management under the RMA, current water and land management issues (New Start for Freshwater, OnePlan, ECan reviews etc) and upcoming research programmes |
| How do local land uses affect the availability of ground and surface water over an entire catchment? | | |
| How can spatial and temporal variability of river flows and ground water levels be modelled for defensible allocation of river/aquifer waters in regional plans? | | |
| <ul style="list-style-type: none">Aquatic ecology limits | Dean Olsen | <ul style="list-style-type: none">Lessons for maximising participation in ICM, and for effective ICM projects |
| How can water quality and isotope data inform water allocation? | | |
| <ul style="list-style-type: none">Economics of water use | Paul White | <ul style="list-style-type: none">Recap on ICM research findings |
| How do economic returns affect irrigators' uses of water? | | |
| <ul style="list-style-type: none">Water governance | Andrew Fenemor | <ul style="list-style-type: none">Galvanising stories from ICM research stakeholders |
| What governance and policy approaches would improve effectiveness of water management plans and planning processes? | | |
| Lunch 12.00 - 1.00pm | | |
| 1.00 p.m | Theme#3 – Catchment-Coastal Interactions (Paul Gillespie, Cawthron Institute) | |
| Catchments extend offshore. River plumes containing water, sediment, nutrients and contaminants affect coastal ecosystem characteristics. Fisheries and aquaculture resource managers need to be aware of these effects. | | |
| <ul style="list-style-type: none">Nutrient enrichment/coastal productivity | Paul Gillespie | <ul style="list-style-type: none">Synthesis & future opportunities for integrated research (Dr Gene Likens, CIES New York) |
| Are nutrient discharges from the Motueka River good or bad for Tasman Bay? | | |
| <ul style="list-style-type: none">Seabed indicators of catchment influences | Deanna Clement | |
| How big is the influence of the catchment? | | |
| <ul style="list-style-type: none">Suspended sediments effects on the benthic environment | Paul Gillespie | |
| How do suspended sediments affect scallop habitat quality? | | |
| <ul style="list-style-type: none">Faecal impacts on shellfish | Chris Cornelisen | |
| Are coastal shellfish resources impacted by faecal contaminants and what are the primary sources of contamination? | | |
| 2.00 p.m | Theme#4 – Integrative Modelling for ICM (John Dymond, Landcare Research) | |
| Catchment-scale modelling offers an opportunity to provide councils and sector groups with strategic advice on scenarios which assess impacts not only of future land use mixes, but other types of development impacts as well (e.g. population growth, subdivision) | | |
| <ul style="list-style-type: none">Overview of IDEAS modelling | John Dymond | |
| What are the opportunities for using modelling to predict cumulative effects of land use scenarios? | | |
| <ul style="list-style-type: none">Catchment futures modelling | Anthony Cole | |
| What development scenarios for the Motueka catchment 'environment - economy - social system' are sustainable? | | |
| <ul style="list-style-type: none">Agent based modelling | Oscar Montes | |
| How can cultural impacts of land use change be modelled for use in resource management decision-making? | | |
| <ul style="list-style-type: none">Land use and the marine environment | Ben Knight | |
| What risks do intensified land uses pose to the marine environment and how can they be avoided in the marine environment? | | |
| Afternoon Tea 3.00 - 3.15pm | | |
| 3.15 p.m | Theme#5 – Learning about Integration (Chris Phillips, Landcare Research) | |
| Exploring what researchers and stakeholders have learnt about Integration in the ICM research programme, seen in the context of integrated management under the RMA, current water and land management issues (New Start for Freshwater, OnePlan, ECan reviews etc) and upcoming research programmes | | |
| <ul style="list-style-type: none">Lessons for maximising participation in ICM, and for effective ICM projects | | |
| <ul style="list-style-type: none">Recap on ICM research findings | | |
| <ul style="list-style-type: none">Galvanising stories from ICM research stakeholders | | |
| <ul style="list-style-type: none">Synthesis & future opportunities for integrated research (Dr Gene Likens, CIES New York) | | |
| Closing observations (Dr Richard Gordon, Landcare Research Lincoln) | | 4.50 p.m |
| 7.00pm - Workshop dinner (including invited stakeholders) The Boathouse,326 Wakefield Quay | | |
| Wednesday 28 April- 8.00am - 6.00pm | | |
| Ridgetops to the Sea: ICM Field Trip with Stakeholders, Motueka catchment | | |
| Convenor: Dr Les Basher, Landcare Research Nelson | | |
| A practically oriented field trip from the upper Motueka to the sea, to discuss | | |
| <ul style="list-style-type: none">The relevance of a ridgetops-to-the-sea perspective in studying catchment behaviour | | |
| <ul style="list-style-type: none">The legacy that large events or intensive land use in the headwaters have on downstream catchment behaviour over time (e.g. sediment and faecal contaminants) | | |
| <ul style="list-style-type: none">How a community ICM process has worked in the Motueka catchment (using the Sherry example) and the benefits of interaction between science, resource management and land owners | | |
| Leave Nelson (pick-ups the by bus at Tahuna & Richmond can be arranged) | | 8.00 a.m |
| Arrive Jansons Bridge | | 9.00 a.m |
| At Jansons bridge | | 9.00 - 10.00 a.m |
| Welcome to catchment, introduction to the field trip, sediment, upper catchment influences on Tasman Bay | | |
| Jansons Bridge to Sherry River (Matariki bridge) | | 10.00 - 11.00 a.m |
| At Matariki bridge | | 11.00 - 12.00 p.m |
| Managing water quality at farm and catchment scale, landowner management initiatives | | |
| Sherry River to Pokororo Hall | | 12.00 - 1.00 p.m |
| LUNCH At Pokororo Hall/Motueka River | | 1.00 - 3.00 p.m |
| The value and significance of the river to the local community. river health and trout, ICM and sports fishery management | | |
| Pokororo Hall to Puketawai | | 3.00 - 4.00 p.m |
| At Puketawai | | 4.00 - 5.00 p.m |
| River influence on the coastal ecosystem and commercial aquaculture, tracking faecal coliforms from catchment to sea, science/resource management/community partnership as the future for catchment management | | |
| Puketawai to Nelson | | 5.00 - 6.00 p.m |



The Motueka Integrated Catchment Management Research Programme



Landcare Research
Manaaki Whenua



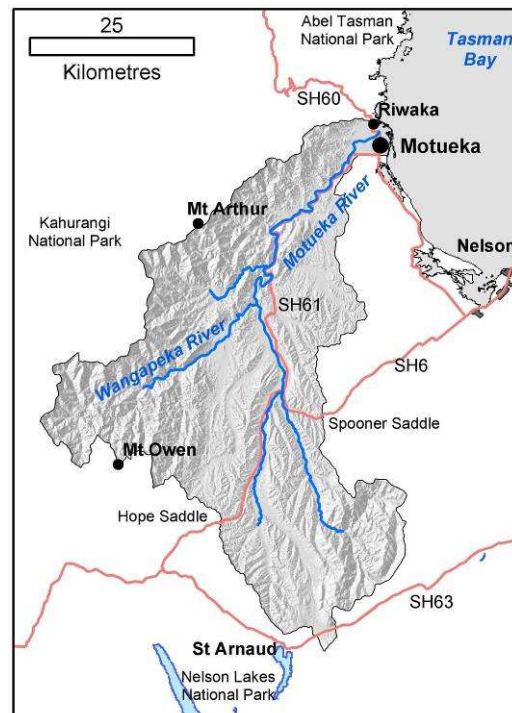
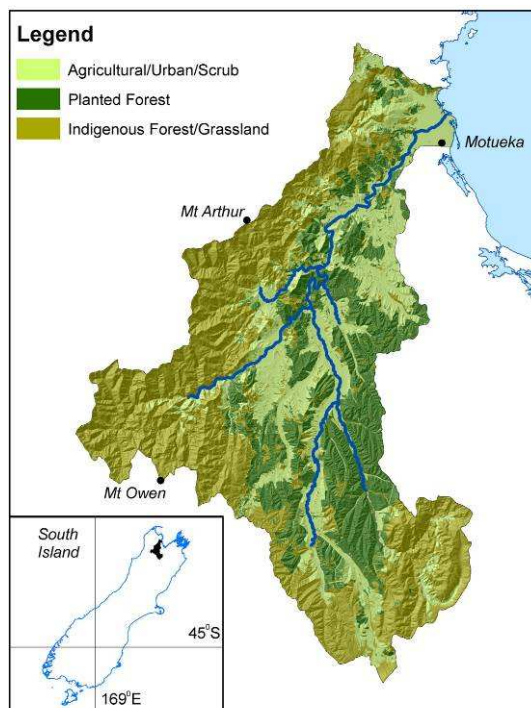
Tasman
District Council



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What is the expected outcome?

Improved understanding of - and social learning about - land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land and water uses.



Who is involved?

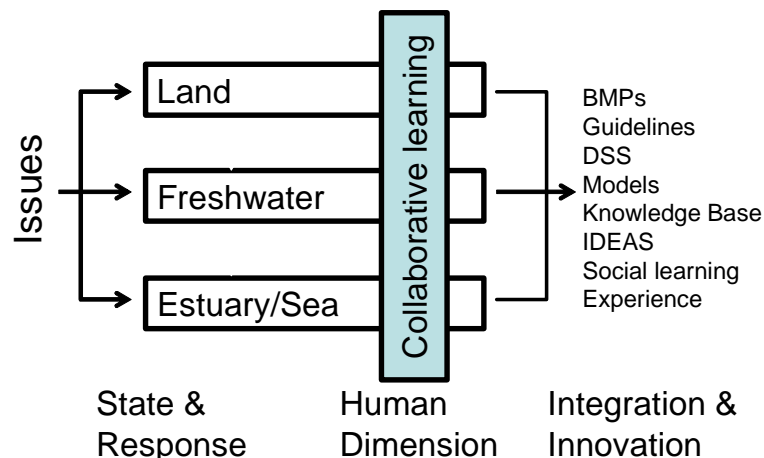
Partners

- **Landcare Research:** programme manager, land/water research, and social learning
Andrew Fenemor, Chris Phillips, Will Allen, Les Basher, Garth Harmsworth, Margaret Kilvington, Maggie Atkinson, John Dymond, Oscar Montes de Oca, Marc Dresser, Jagath Ekanayake, John Payne, Alex Watson, Ron DeRose, James Barringer, Mike Marden
- **Cawthron Institute:** freshwater and marine research
Roger Young, Paul Gillespie, Chris Cornelison, Chris Batstone, Jim Sinner, Ben Knight, Dean Olsen, Reid Forrest, Karen Shearer, Joe Hay, Weimin Jiang, Aaron Quarterman, Rowan Strickland, John Hayes, Barrie Forrest

- *Tasman District Council*: river/groundwater research, resource management
Rob Smith, Steve Markham, Joseph Thomas, Trevor James, Mary-Anne Baker, Andrew Burton, Eric Verstappen, Neil Jackson, Martin Doyle, Lindsay Vaughan

Contributors

- *Institute of Geological & Nuclear Sciences*: groundwater research
Timothy Hong, Mike Stewart, Paul White, Chris Daughney, Gilles Minni
- *NIWA*: riparian and river sediment research
Rob Davies-Colley, Murray Hicks, Rob Merrilees
- *Scion*: riparian restoration research
Lisa Langer, Nick Ledgard, Dave Henley
- *Common Ground Ltd*: institutional learning
Glen Lauder
- *Pansophy Ltd*: socio-economic modelling
Anthony Cole
- *NZ Landcare Trust*: landowner liaison and action
Barbara Stuart
- *Te Atiawa, Ngāti Rarua, Ngāti Tama (Tiakina Te Taiao)*: iwi environmental monitoring, cultural values
Dean Walker, Barney Thomas, Cherie Tawhai, Mick Park and others
- *The Motueka Community Reference Group*: community liaison
- *The Foundation for Research, Science & Technology*: funding
- *International interest groups (UNESCO Hydrology for the Environment, Life and Policy)*: international linkage
- *Sector organisations*: fisheries, forestry, agriculture, aquaculture...



What's the big picture for this ICM research?

The Integrated Catchment Management (ICM) research programme asks the question “What factors under human control will achieve sustainability from ridge tops to the sea in a catchment context?”.

Our multi-disciplinary team answered this question by defining ICM as integrated land and water management requiring a combination of ecosystem resilience and community resilience, rather than being simply a rational technical process. We have integrated research on biophysical processes (water, sediment, nutrient and contaminant fluxes) from ridgetops to the sea with research on social processes (social learning, community engagement, Māori values, policy relevance) at large catchment scale.

The programme provides processes, tools, methods, models and insights for regional councils, catchment groups and sector groups to tackle the complex challenges of managing cumulative effects of land, water and coastal uses. Its primary proving ground is the Motueka catchment linked to Tasman Bay, but with some research also carried out in the Gisborne and Waikato regions. It began in 2000 and wraps up in September 2010, funded mainly by the NZ government through FRST.

We defined a generic ICM learning and policy development process, and applied this process starting with stakeholder meetings and surveys in the Motueka to define these main five research issues, which are also common to many NZ catchments:

1. Allocation of Scarce Water Resources among Competing Land & Instream Uses
2. Managing Land Uses in Harmony with Freshwater Resources
3. Managing Land and Freshwater Resources to Protect and Manage Marine Resources
4. Integrative tools and processes for managing Cumulative Effects
5. Building Human Capital and Facilitating Community Action

The ICM programme has shown the rich and often unexpected benefits of researching practical problems across these interfaces: land/water, people/land, catchment/coast, river/aquifer, council/community, science-policy-community action, Maori-European science and across disciplines. It has particularly focussed on the integration challenges of managing multiple issues across the catchment-coastal continuum. Thanks especially to our links with Tasman District Council, we see the programme as showing the benefits of practical grounded integrative science.

What issues are being researched? – some examples

1. Allocation of Scarce Water Resources among Competing Land & Instream Uses

- How do local land uses affect the availability of ground and surface water over the entire catchment?
- What is the most defensible way to plan for the allocation of water resources among competing alternative uses?
- How much water is required to maintain instream values?
- How do economic returns affect landowners' and recreational uses of water?

2. Managing land uses in harmony with freshwater resources

- How is sediment mobilised to reach rivers, and what impacts does it have?
- What information is needed to best manage river gravel allocation?
- Why has the Motueka catchment trout population declined then partially recovered?
- How can water quality be maintained or improved with intensifying land use?
- Are there simple solutions to water quality contamination?
- Is riparian re-vegetation the 'silver bullet' for improving water quality?

3. Managing Land and Freshwater Resources to Protect and Manage Marine Resources

- What are the risks to marine farming from activities on land?
- What are the factors that increase or decrease the production and values of fish and shellfish?
- Where are the faecal bacteria affecting marine farms coming from?
- What are the relative effects of river flows (especially floods) on scallop and mussel production compared to activities like dredging and marine farming?

4. Integrative tools and processes for managing Cumulative Effects

- What are preferred development pathways to ensure continued sustainable management at catchment scale?
- What are the opportunities for using modelling to predict cumulative effects of land use scenarios?
- How can models help decision-makers balance environmental impacts alongside social, economic and cultural benefits when planning for further development?

5. Building Human Capital and Facilitating Community Action

- What methods would best motivate environmental stewardship by catchment and community groups?
- What methods can we use to promote effective interaction between scientists, resource managers, and the community?
- How can iwi build their capability in the resource management process?
- What are some 'off the wall' examples of innovative and enduring community engagement that we could use to facilitate community action?

What has the ICM research programme achieved?

1. Allocation of Scarce Water Resources among Competing Land & Instream Uses

Water Allocation: Allocation of river flows for irrigation vs the nationally recognised trout fishery was a focal point of the negotiated agreement on the Motueka Water Conservation Order, gazetted in 2004. Water allocation limits were set for the Upper Motueka catchments in TDC's Resource Management Plan and will be updated when river-aquifer modelling (see below) is completed.

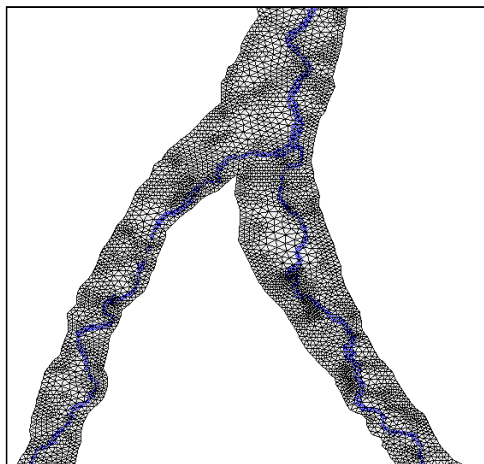
ICM research with the Ecologic Foundation and water stakeholders used the Motueka catchment as a case study to identify how water use flexibility can be enhanced and security of supply better understood, through changes to NZ's Resource Management Act or water allocation policy. Options include flow sharing and water quality management through catchment farmer groups, changes to water permit specifications and proposals to encourage transfers of water permits. This work addressed issues raised in the MfE Water Programme of Action. Models predicting how in-stream habitat will change with flow have been used to assist flow management decisions.



Water governance remains a priority issue for the new Government and the TDC. In 2008-09 we completed a survey of 56 stakeholders from 4 South Island regions and 5 catchments about their RMA water plan development process, and proposed a 'straw man' for improving RMA performance for water allocation and water quality management.

Contacts: Andrew Fenemor (Landcare Research), Jim Sinner (Cawthron Institute), Mary-Anne Baker (TDC)

Groundwater Dynamics: Managing increasing demand for irrigation from groundwater in the Upper Motueka valley requires knowledge of how these alluvial aquifers interact with the Motueka and tributary rivers, and how groundwater pumping indirectly impacts aquatic ecology.



With GNS and TDC, a FEFLOW spatial model has been calibrated to predict changing groundwater levels and river flows for the upper Motueka, based on geological mapping, river flow gauging and well monitoring. Soil moisture experiments on Korere and Waiwhero farms are showing the contribution of hill slopes to groundwater recharge. Dating the alluvial groundwater shows it has been underground only 1-3 years. Irrigation scenarios are being run through this model to understand how different levels of irrigated land use influence river flows and ecology, how climate change may affect river flows and groundwater yields, and what impact a changing river bed level might have on the groundwater table.

Contacts: Chris Daughney (GNS), Joseph Thomas (TDC), Andrew Fenemor (Landcare Research), Jagath Ekanayake (Landcare Research), Mike Stewart (GNS)

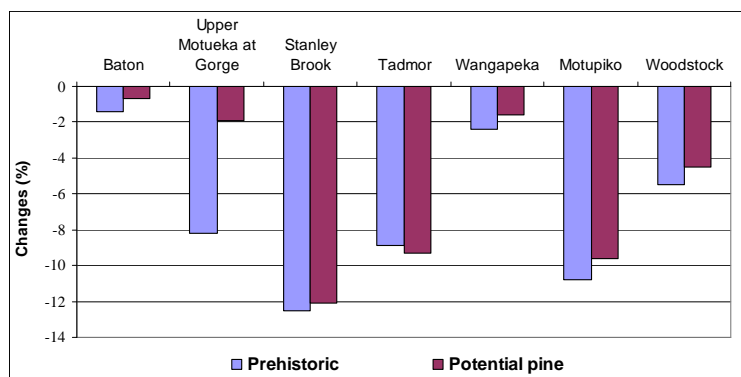
Water Use Economics: Out-of-stream water allocation for irrigation is driven by returns for primary production. The ICM programme is supporting Paul White's 5-year survey of 17 agricultural users of groundwater in the Waimea Plains, to assess the economic drivers of groundwater use. This work shows the influence of lifestyle block demand and changes in apple prices on groundwater use.

The costs and benefits of the Tadmor water augmentation scheme (Hope River diversion) were evaluated, and indicate net positive financial returns for irrigation water users of diverted water. A companion study of ecological costs and benefits concluded that the river diversion has not affected water quality or river ecology in the Tadmor River.

Contacts: Andrew Fenemor (Landcare Research), Paul White (GNS), Dean Olsen (Cawthron)

2. Managing land uses in harmony with freshwater resources

River and coastal hydrology: Changes and intensification of land use have impacted stream flows and water quality. Computer models help us understand why these changes occur. We have calibrated a SWAT catchment water balance model to compare the effects of different vegetation cover throughout the catchment on river flows. We have also developed a simple water balance model WATYIELD for unmonitored catchments to estimate how streamflows will change if land cover is changed (eg planting or cutting down forests).



The Motueka catchment SWAT flow and contaminant model showed that river flow at Woodstock is about 21% higher now than under prehistoric bush land cover, and with maximum possible afforestation would be about 16% higher. Nutrient flows down the river systems have been modelled using SWAT and bacterial inputs to the bay have been predicted

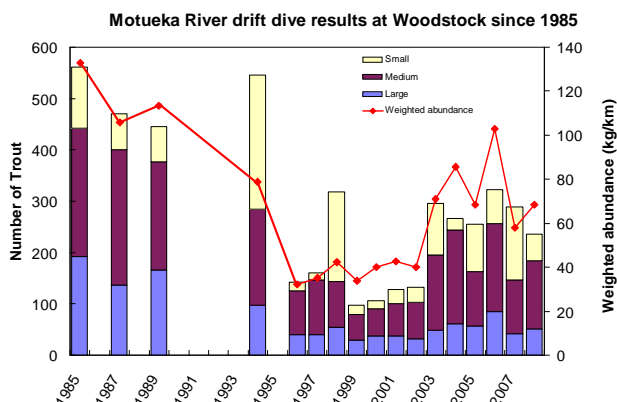
using a faecal die-off model. Simulated Motueka river and contaminant flows feed into the Tasman Bay coastal circulation and ecosystem models to understand catchment impacts on the

bay. Model results from the IDEAS model (see below) predict the in-stream and marine impacts of future land use and aquaculture scenarios.

At a more detailed scale, PhD student Kiran Kumar has shown that the average daily transpiration (February to April) rate of crack willows in the Waiwhero wetland was more than four times that estimated for pasture, i.e. willows consume huge amounts of water!

Contacts: Jagath Ekanayake (Landcare Research), Tim Davie (Environment Canterbury), Andrew Fenemor (Landcare Research)

Sediment Impacts in River and Coastal Ecosystems: Sediment is blamed for deteriorating fish habitat in rivers, and has major impacts on scallop resources in areas off the river mouth in Tasman Bay.



Using a monitoring network of suspended sediment samplers in the catchment, set up in conjunction with TDC and NIWA, we have shown the importance of localised large, infrequent floods for sediment generation and dispersal and have also been documenting how sediment generation varies during the forest harvest cycle.

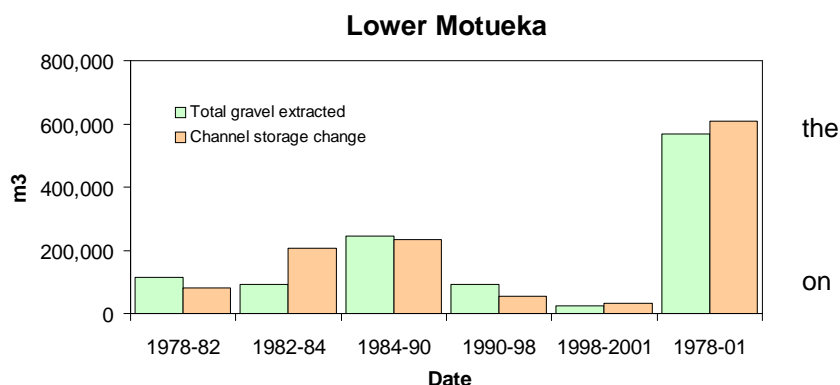
A 50 year storm at Easter 2005 in the upper Motueka/Motupiko raised sediment yields by 10 times in the affected area and by 2-3 times at the coast. This effect has persisted for the last 4 years with yields slowly returning to pre-storm levels. Heavy metals from a mineral belt in the upper catchment have been tracked from that storm down-river into the seabed sediments of Tasman Bay with their concentrations exceeding criteria for ecosystem health within the coastal river plume. These infrequent storms have a profound influence on long-term sediment yields.

We have developed a riverbed substrate monitoring method to quantitatively link fine sediment occurrence with aquatic habitat suitability. It provides data on fine sediment abundance that complements biological surveys such as drift dives to measure trout numbers. It has been adapted by Environment Canterbury in their state-of-the-environment monitoring in Canterbury and will be part of a national Envirolink tools project on habitat characterisation.

Contacts: Les Basher (Landcare Research), Murray Hicks (NIWA), Chris Cornelison (Cawthron)

Sustainable River Gravel Extraction: Catchment stabilisation works, revegetation since the bush clearance days and gravel extraction have led to a gradual decline in riverbed levels, and the need to limit gravel extraction from rivers.

An ICM study with TDC reviewed bed level changes based on 40+ years of river channel cross-section surveys in Motueka river. It confirms the general degradation trends but finds that more information is needed gravel transport mechanisms, especially during floods.



Periodic river cross-section surveys are the primary tool used by most regional councils to monitor river bed levels and to help set gravel extraction limits but these have significant limitations for accurately establishing gravel supply rates. Annual GPS surveys ('3 beaches') have better defined gravel volume changes, and are being used to assess how well the present river cross section network reflects bed level and gravel volume changes. They show that the cross sections underestimate the changes in gravel volumes stored in the river bed, but the work confirms the continuing lowering of riverbed levels. This type of investigation can establish an average sustainable gravel supply that can be adjusted following large flood events. It also shows how constraining the width of gravel-bed wandering rivers leads to channel degradation and limits replenishment of the gravel resource on bars where gravel is typically extracted from.

Contacts: Les Basher (Landcare Research), Ian Fuller (Massey Univ), Eric Verstappen (TDC)

Land Use Impacts on Water Quality: Early water quality research identified areas of concern in one part of the catchment, particularly related to the daily crossing of streams by cows.



Through working collaboratively with the dairy farmers, sheep and beef farmers, and forestry companies the bacterial water quality of the Sherry River has been improved by more than 50%, initially through bridging dairy crossings and forestry crossings. This work has been followed by further water quality sampling in conjunction with TDC which shows an improvement in

river water quality, though not to swimmable standard at times.

Close ties with the local community and with the NZ Landcare Trust and TDC staff have built trust and a collaborative approach. This resulted in a Transpower grant to provide plants to be used in our riparian restoration trials, and a research partnership 2007-2010 with SFF funding for whole catchment Landowner Environmental Planning to improve water quality beyond the current 50% improvement.



Best management practices (BMPs) for the range of land use types in the Sherry have been developed and a BMP library established on the ICM website <http://icm.landcareresearch.co.nz>. These have been used in a partner project with TDC on whole catchment nutrient budgeting in the Motupipi catchment, funded through Envirolink. Expected improvements in water quality in response to implementation of best management practices (BMPs) on farms in the Sherry Catchment are being monitored through additional river flow, water quality and hydrometric monitoring ('storm chasing') during 2008-10.

A farmer-maintained riparian restoration trial at Matariki has provided guidelines for farmer-friendly riparian restoration with native plants in weedy environments, aimed at providing stream shade and excluding stock from riverbanks. Aligned with the Sherry work is the database of the stabilising potential and growth characteristics of New Zealand's indigenous plants developed from 2 field trials in Gisborne. Together with riparian condition mapping, riparian restoration trials with the Sherry River farmers, and assessment of river bank styles, this work is advancing riparian restoration method development nationwide.

At a whole catchment scale we have developed and calibrated a model that tracks faecal bacteria movement and die-off. In 2009-10, this is being linked into the IDEAS model in which impacts of land use change in the river and bay are being assessed for 6 land use scenarios.

Contacts: Andrew Fenemor (Landcare Research), Barbara Stuart (NZ Landcare Trust), Roger Young (Cawthron Institute), Rob Davies-Colley (NIWA), Chris Phillips (Landcare Research), Lisa Langer & Nick Ledgard (Scion), Trevor James & Rob Smith (TDC)

Effects on freshwater fish of changing river flows: Decisions on water allocation are often made at a reach scale and neglect the fact that fish populations move throughout a river catchment. Flows that are adequate to protect ecosystem health in one part of the catchment at one time of the year may not be adequate at other times of the year or in other locations.

Movements of radio-tagged trout throughout the Motueka have been characterised by Cawthron ICM researchers to understand more about habitat requirements in different parts of the river. A 50+year flood upset the study to some extent, but resulted in an interesting finding – more than half of the adult trout population in the tributary most affected by the flood perished during the flood. The results indicated the importance of flow and water temperature for controlling fish movement, the importance of deep pools for providing refuge from low flows and warm water temperatures, and also the dramatic effects of that large flood on adult trout survival.

Many fish species move throughout catchments to complete their life history, especially those that require access to and from the ocean. ICM research has confirmed the potential of using fish otolith microchemistry – the chemistry of fish earbones - for tracking how fish have moved throughout a catchment. It is now possible to distinguish between fish reared in different parts of a catchment and to determine where a fish has been throughout its life by looking at the chemical signatures laid down in its otoliths. This powerful tool has subsequently been used in several Conservation Order and consent hearings to demonstrate the need for unrestricted movement through catchments to support valued fisheries.

We also conducted a test of a 2-D hydraulic model (River 2D) for defining how habitat availability for different species will vary with flow at several sites throughout the catchment including in some small streams where traditional models have proved problematic. These studies provided advice on appropriate environmental flows throughout the catchment, were presented to the TDC Resource Management Policy Committee, and have been incorporated into a framework for flow management in the Upper Motueka River.

Contacts: Roger Young & Joe Hay (Cawthron Institute), Ricky Olley (Otago Univ), Trevor James (TDC)

3. Managing Land and Freshwater Resources to Protect and Manage Marine Resources

The Condition of River Delta Habitat: River outflows to the coast affect the stability, productivity and ecosystem health of the river delta, and this has a flow-on effect on marine fisheries and aquaculture potential. A national protocol for monitoring barrier-enclosed estuaries has been adapted to include river delta systems. Both broad-scale mapping on GIS, and fine-scale assessment of seabed habitats of the Motueka River delta have now been completed for comparison with future repeat surveys.

Contacts: Paul Gillespie (Cawthron Institute)

Catchments Extend Offshore: Our research has shown that the Motueka 'Catchment' effectively extends offshore encompassing more than 400 km² of the marine environment of Tasman Bay. Physical and chemical (nutrient) characteristics of the water column within the plume have been shown to stimulate the growth of micro-algae upon which shellfish (including farmed mussels) depend for food.

Suspended sediment from the river mouth has been shown to generate chronic high turbidity conditions in near-bottom waters that can interfere



with the feeding of scallops and potentially other commercially and ecologically important benthic suspension feeding animals. This mechanism has been suggested as a major contributor to the poor performance of the Tasman Bay scallop resource in recent years.

Of this 400km² of catchment influence, about 50 -90 km² of seabed has a demonstrable terrestrial signature arising from the river outwelling plume. Naturally high heavy metal levels (Ni, Cr, Cu) within the sediment flushed from the Red Hills at the head of the catchment may be affecting marine and freshwater life, because they are beyond ANZECC levels for ecosystem health. These catchment-coastal connections demonstrate that management of coastal ecosystems, fish and shellfish resources need to take account of activities across the entire land/sea continuum comprising our redefined "catchment". This is a major deviation from current coastal management practice.

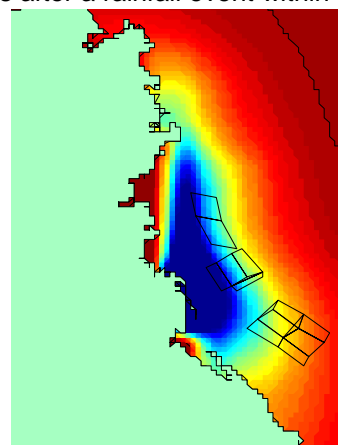
Contacts: Paul Gillespie & Chris Cornelison (Cawthron Institute)

Effects of the Motueka River Plume on Aquaculture Management Areas:

Water quality and productivity in the 4200 ha of designated Aquaculture Management Areas off the Motueka river mouth is affected by the river discharge, particularly during large floods. The extent and magnitude of freshwater effects on seawater temperature, salinity, density, chlorophyll-a, water clarity and nutrients has been mapped to provide a basis for understanding the nature and spatial extent of catchment effects on wild, enhanced and farmed shellfish resources.

Information generated through the ICM Programme has proven critical to consenting of a large offshore mussel farm in western Tasman Bay. The first stage of development achieved marketable product size/quality within seven months. High mussel growth rates occurred during spring and autumn 2008/09 with a slowdown, particularly in the upper water column, during summer. This is consistent with predicted chlorophyll-a maxima and minima and water column stratification characteristics that are influenced by the river plume. Mussel growing conditions and catchment implications are being tracked over time using long term *in situ* data and nutrient load estimates.

Harvest conditions are presently being developed by the mussel industry using ICM data demonstrating elevated concentrations of faecal indicator organisms after a rainfall event within a plume extending at least 7 km offshore. Contaminant sources were linked to ruminants using genetic markers. This is the first observation in New Zealand of ruminant faecal contamination from a river plume extending well offshore. The new microbial source tracking (MST) technology used to track the source and fate of land-derived faecal contaminants in waterways and coastal environments, is now being commercially developed by the Cawthron Institute.



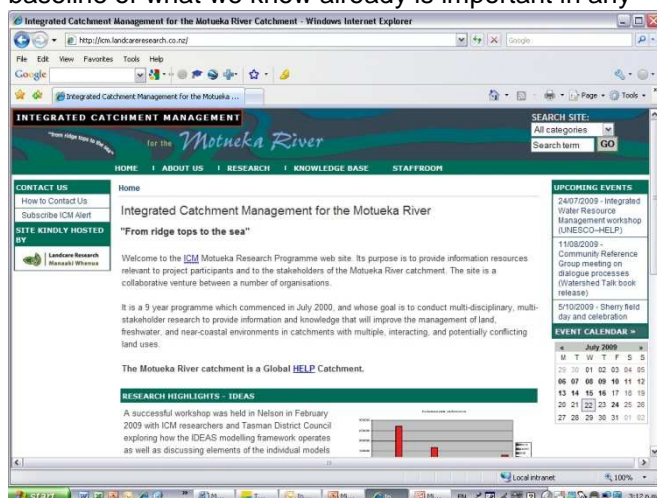
The management applications of our river plume monitoring buoy have strengthened over time with the trialling of new and more robust components. Seasonal and flood-related events shed light on the variability of food for mussel and scallop growth and can now be linked directly to aquaculture responses. Nutrient loading from the catchment to Tasman Bay (reported annually to stakeholders, 2005-2008) varies seasonally and between years with resulting ecosystem implications. We hope real-time data collection can be continued to advise shellfish industries on bacteriological water quality, the fluctuating prospects for successful spat collection/survival, and food availability for shellfish. This work paves the way towards cost effective usage of remote *in situ* data collection for environmental research and monitoring.

Baseline data described above has been applied in models of hydrodynamics (currents and tides), water quality distribution across the bay and with depth, phytoplankton growth and decline (chlorophyll-a), and the marine foodweb from algae up to finfish. These models allow evaluation of trade-offs between large-scale land use change onshore and aquaculture scenarios offshore.

Contacts: Paul Gillespie & Chris Cornelison & Ben Knight & Weimin Jiang (Cawthron Institute), Neil Jackson & Steve Markham (TDC)

4. Integrative tools and processes for managing Cumulative Effects

Knowledge Base: Establishing a baseline of what we know already is important in any research programme. The ICM programme has published “The Motueka Technical Report, a comprehensive summary of knowledge about the Motueka and Riwaka catchments”. ICM research results, new findings, upcoming events, and all reports, presentations, and published articles are updated regularly on the programme website <http://icm.landcareresearch.co.nz>.



The ‘Motueka Toolbook’ CD-ROM has also been developed. This integrates existing and new knowledge of the catchment and links it to global catchment management knowledge. The CD-ROM is dominated by figures and photos, rather than text, and is designed to spread the ICM message to a variety of audiences.

The ICM research programme was the subject of *Country Calendar*, shown on primetime television (TV1) on 21 June 2008. This highlighted ICM as an organising concept for land and water management, and also the benefits of scientists, landowners and communities working together. Research results are also made available through the ICM newsletter *Catchment Connections* which regularly goes to over 700 subscribers. Another integrating tool for ICM knowledge is a catchment-scale modelling framework which we call IDEAS.

Contacts: Chris Phillips & Andrew Fenemor & Les Basher (Landcare Research)

IDEAS: Catchment-scale modelling offers an opportunity to provide councils and sector groups with strategic advice on scenarios which assess impacts not only of future land use mixes, but other types of development impacts as well (e.g. population growth, subdivision).

The first foundation for this research was an integrative Triple-Bottom-Line modelling approach trialled using a participatory process (Influence Matrix) with the ICM Community Reference Group. The process identified these critical factors likely to affect the group's vision for future sustainability of the catchment:

- Nature and extent of primary industries,
- Measures of water quality and supply, and
- Available mix of policy-plans-rules-legislation.

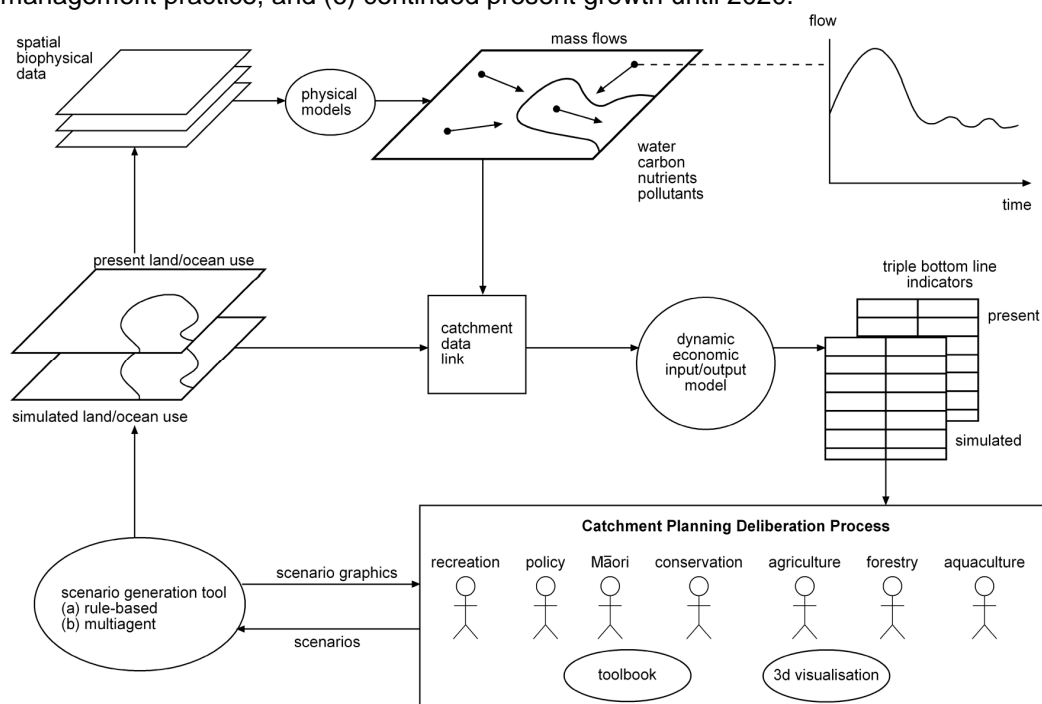
The process and its results raised awareness of the value of such tools which may be useful for informing Long Term Council Community Plans, and for framing up ratepayers' own perspectives on sustainability.

The second foundation was development of component models: catchment water yield and water quality, catchment transport of faecal pathogens and sediment, exchange of water between rivers and groundwater, coastal productivity and foodweb models, an ‘agent-based model’ which simulates peoples responses to policies, and the Motueka Futures economic input-output model with associated population growth module.

Together these models provide the third foundation, a large-scale modelling framework called IDEAS (Integrated Dynamic Environmental Assessment System). IDEAS is a scenario modelling system comprising a set of linked models that allows us to assess cumulative effects of broad-scale development (eg. land use changes) over a 20-50 year timeframe and do this by looking not only at environmental outcomes (eg water quality) but also social (eg. employment), economic (eg.

GDP) and cultural consequences. It synthesizes learning from all parts of the research programme to postulate how the system would respond all the way out into Tasman Bay if major changes are made within the Motueka catchment.

An IDEAS stakeholder group and the ICM Community Reference Group have identified and prioritised the types of issues they see for the catchment in future, and these form the basis for 6 Motueka catchment scenarios. These are: (1) pre-human (2) present land use (3) present land use with best management practice (4) very intensive agriculture (5) very intensive agriculture with best management practice, and (6) continued present growth until 2020.



IDEAS has been applied to assess and compare the environmental and socio-economic impacts of these scenarios, including most recently the incorporation of Maori cultural values. IDEAS is being developed as a integrative tool for adaptive management from catchment to regional scales, and to map trends which define acceptable vs non-sustainable land-water-coastal development options.

Contacts: John Dymond & Oscar Montes de Oca & Andrew Fenemor (Landcare Research), Ben Knight & Roger Young (Cawthron), Anthony Cole (Pansophy), Steve Markham (TDC)

Modelling Catchment Futures: The Influence Matrix research described above is being extended into an ecological economics model of the whole catchment, beginning with an economic input-output model. This identifies the extent to which the economic health of the Motueka catchment depends on the natural resources and ecosystem components of the catchment. The model, in conjunction with the agent-based model ENVISION, is part of the IDEAS framework, allowing a quadruple bottom line evaluation of various catchment-scale development scenarios.

Contacts: Anthony Cole (Pansophy), Oscar Montes de Oca (Landcare Research)

5. Building Human Capital and Facilitating Community Action

Collaborative learning: Management is a distinctly human process. Social research is developing tools and approaches which can be used by research groups, agency staff and other community leaders to support more effective multi-stakeholder processes for learning and decision-making. Topics worked on include knowledge management, integration, stakeholder analysis, social capital, evaluation and cross-case learning. For example, we developed a methodology labelled Social Spaces for evaluating collaboration among different groups in integrative projects, and for the Auckland Regional Council we applied a logic model to evaluate

ICM plans across multiple timescales – an ‘Orders of Outcome’ approach. A Sediment Learning Group helped stakeholders reach a common understanding of sediment loss and impacts in rivers.

A community resilience project called *Watershed Talk* explored what different people care about and feel a sense of responsibility towards in the Motueka catchment. Often there is a set of practices or values that underpin our wanting to leave the land in better shape, whether it is the people who work and live, who manage or who do science about this place. The *Watershed Talk* project distinguished how resilience approaches to problem solving differ from traditional approaches (eg of some RMA statutory processes), and the 2009 book from Manaaki Whenua Press on this project documents techniques for cultivating ideas and community action for better stewardship of the environment.



Contacts: Will Allen & Margaret Kilvington & Maggie Atkinson & Andrew Fenemor & Chris Phillips (Landcare Research)

Communicating Research Findings: Design and facilitation of community engagement processes is an important Council function, and vital for catchment research to make a difference. One major method has been through our ICM Annual Meetings held at the council and in the catchment around October-November, and including public participation.

Summary of the ICM AGM programmes

- 2003: Stakeholder Workshop: *Improving Community Engagement*; Public Field Trip: A Day in the Catchment, Science Workshop: *Delivering the Vision through ICM Research*; Open Workshop: *Creating an ICM art-science collaboration*
- 2004: Workshop: *Linking ICM Research to Management*; *Planning the Motueka ICM Toolbook*; Public Field Trip: A Day in the Lower Motueka; Science Workshop: *Linking Research into TDC Policy*
- 2005: National ICM Workshop: *Tools, techniques and lessons for ICM*; Pacific HELP Symposium: Hydrology for the Environment, Life & Policy. International ICM symposium sponsored by Landcare Research and UNESCO; ICM Coastal Workshop: *The river plume ecosystem of Tasman Bay*.
- 2006: ICM Stakeholder Workshop: *Gravel and River Channel Dynamics*; Tasman Bay ICM Field (Boat) Day: Land-Marine Interactions; Open Workshop: *How are we doing on the 4 BIG ICM research issues?*
- 2007: Public Workshop: *Celebrating ICM Success*; Stakeholder Workshops: *Integrated Catchment Modelling IDEAS*. Team Workshop: *ICM2-What are the outstanding issues for integrated land & water research across NZ?*
- 2008: Hosted and ran the NZARM National Conference: *Integrated Catchment Management – are we wiser than we were?* Themes: *Bold governance*; *Committed Communities*; *Out of the silos, into the landscape – science for ICM*; *Catchment Futures – Wisdom for the Transition*. Motueka catchment field trip.
- 2009: Interactive ICM Science day at TDC with US guest Breck Bowden. Integration workshop – *ICM as a process*; *Motueka Futures Model hands-on*. Field trip...knowing the river (by raft)

Contacts: Andrew Fenemor & Chris Phillips (Landcare Research), Roger Young (Cawthron), Steve Markham & Rob Smith (TDC)

Community Input to Sustainability Decisions: The ICM Community Reference Group is a touchstone for our research direction and research findings. These 8 catchment residents meet every 3-4 months. Recent meetings focussed on ‘Futures’ modelling, and a review of ICM marine research with a vigorous debate about the effects of scallop dredging and catchment runoff on the recent decline in scallop production. The CRG provided their insights into sustainability of the Motueka catchment described above for the IDEAS scenario modelling.

Contacts: Andrew Fenemor & Will Allen (Landcare Research)

Iwi Values in Integrated Catchment Management: Motueka iwi Te Atiawa, Ngāti

Rarua, Ngāti Tama through Tiakina Te Taiao Ltd have a keen interest in building information systems for addressing catchment and economic issues. We have built a relationship with these iwi, and developed guidelines for iwi consultation. The iwi identified their issues as information collation for iwi management plans, defining the process for undertaking Cultural Impact Assessments of development proposals under the RMA, improved input needed in resource consent decisions and contaminated sites management. The 3 iwi through the ICM programme have developed GIS-based information systems for environmental management. They are also keen to involve their young people in ICM projects relating to water quality, coastal issues and kaimoana.



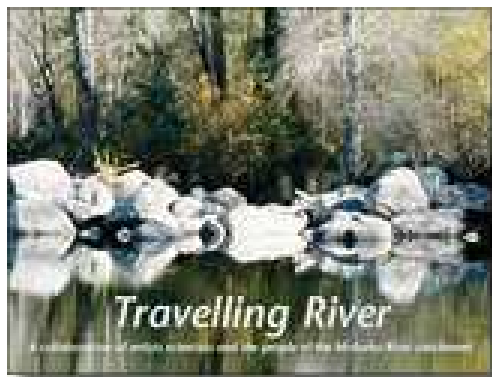
Cawthron researchers are leading development of new indicators of river ecosystem health. Comparative work between scientific indicators of river health and cultural indicators of river health determined by local iwi is ongoing in the Motueka and Riwaka catchments (and was profiled in a TVNZ *Rural Delivery* programme in May 2007). It shows that scientifically and culturally-based monitoring and assessment can provide an enriched and complementary understanding of freshwater systems. Each approach offers a slightly different worldview and can be used side by side by local government, community, iwi and hapū, and research agencies – for example in TDC's State-of-the-Environment monitoring of rivers.

Contacts: Garth Harmsworth (Landcare Research), Dean Walker (Tiakina Te Taiao), Roger Young (Cawthron), Trevor James (TDC)

Decision-making processes in resource management agencies: Decisions on resource consents and RMA plans do not necessarily follow an objective process utilising all available information. A group within TDC worked with us to develop an institutional learning approach to improve science uptake and information flows. Organisational structure, personal relationships, political influences, decision-making processes and access to information all influence resource management decisions. Improving hard information systems like GIS and databases will not by themselves necessarily result in better decision-making. This research has led to improved design of institutional learning approaches for NZ environmental management issues.

Contacts: Glen Lauder (Common Ground), Rob Smith & Steve Markham (TDC)

Art-Science Collaboration: The Mountains-to-the-Sea initiative began with a workshop

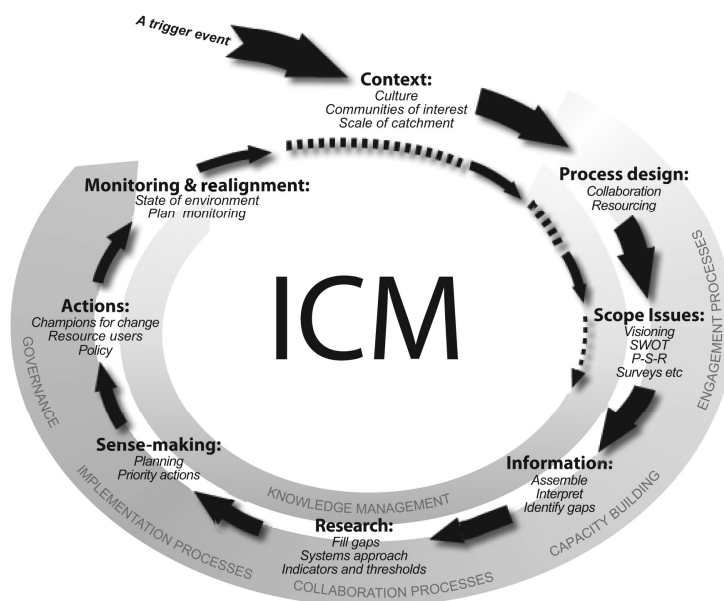


allowing a group of artists and scientists to explore the power of connections across the traditional art/science divide. This effort aimed to understand more about the collaboration process between people with different worldviews. The project – part-funded by Creative NZ and MORST - developed an art-science 'work' to raise awareness and share understandings of the social and environmental interconnections within the Motueka River Catchment. The *Travelling River* exhibition that resulted from this work has been exhibited at Nelson's Suter Gallery and in Motueka and has received national and international acclaim.

Contacts: Margaret Kilvington & Maggie Atkinson & Andrew Fenemor (Landcare Research), Suzie Peacock (Nelson Marlborough Institute of Technology)

Insights on Integration Relevant to Councils

- Land and water resources must be managed together because water is the 'sink' for what we do on the land (affecting water quality) and extraction of water primarily serves land uses (water allocation)
- Single issue policy can have unexpected side effects so integrated policy-making is required. Integrated policy must balance environmental, economic, social & cultural effects (the 4 wellbeings) of land and water uses
- Integrated land-water management is needed across scales from paddock >farm >catchment >region >nation. Impacts accumulate 'downstream'. Therefore landowners and resource managers need to be aware of the bigger scales within which their enterprises are managed
- Catchments (watersheds) are ideal organising units for managing flows of water, sediment, nutrients, contaminants because these flows occur within topographic boundaries. Therefore councils should manage land and water at subcatchment to catchment scale, while recognising the differing scales of communities, governance and the economy.
- Coastal catchments extend offshore – the Motueka affects 400km² of the Tasman Bay seabed. Therefore policy-making for coastal catchments should link land, water and coast
- ICM is a process, not just an outcome. Therefore it requires ongoing engagement among landowners, communities, interest groups, and policy-makers in working collaboratively towards agreed goals for sustainable land and water resource management
- We have summarised ICM as 3 interlinked processes: a catchment-scale Planning and Evaluation process (central spiral) underpinned by Knowledge Management processes (inner spiral) and Social Learning processes (outer spiral):
- ICM as a western construct mirrors *kaitiakitanga* processes for Māori, with sustainable management, environmental stewardship and managing for future generations as its aims
- In summary, ICM is about everyone understanding the Big Picture and managing land and water accordingly. Therefore it influences not just council policy, but environmental education, grants programmes, engineering works, community outreach, and consultation processes.



ICM Programme Contact List

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