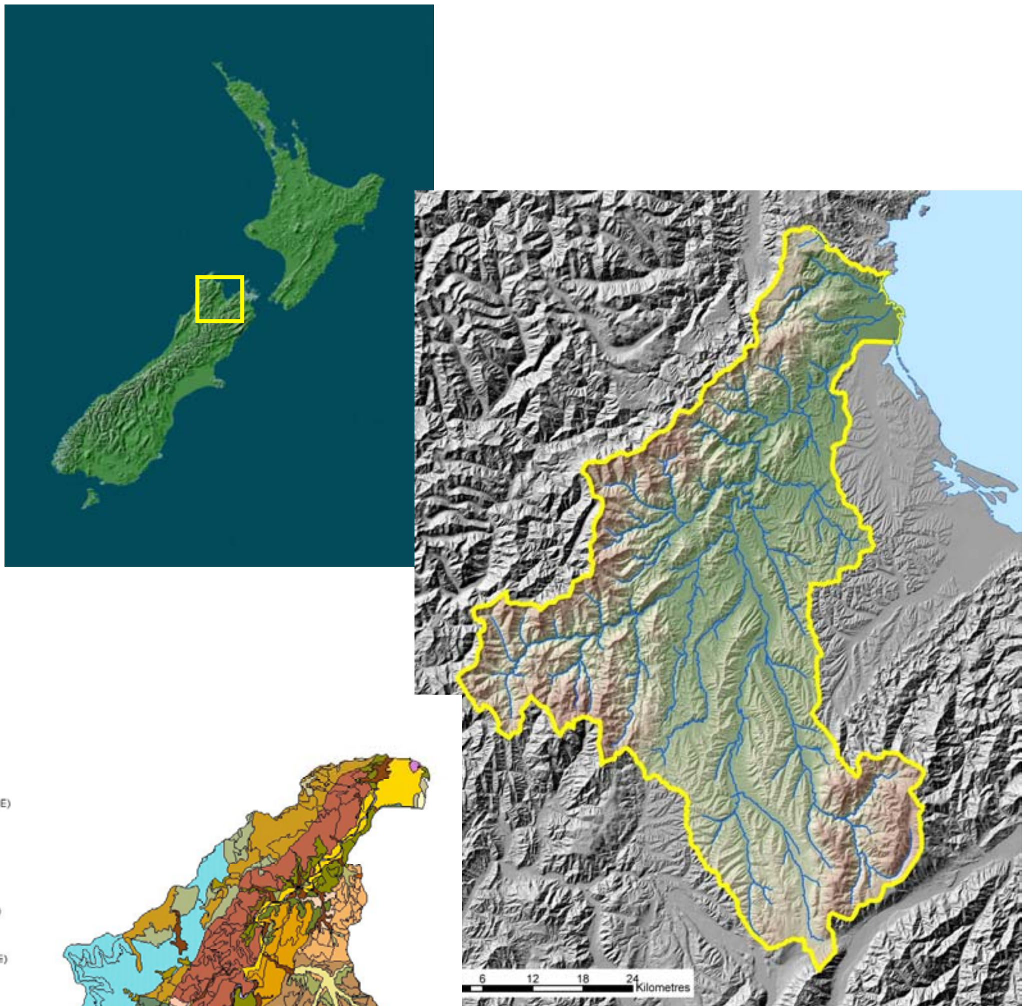
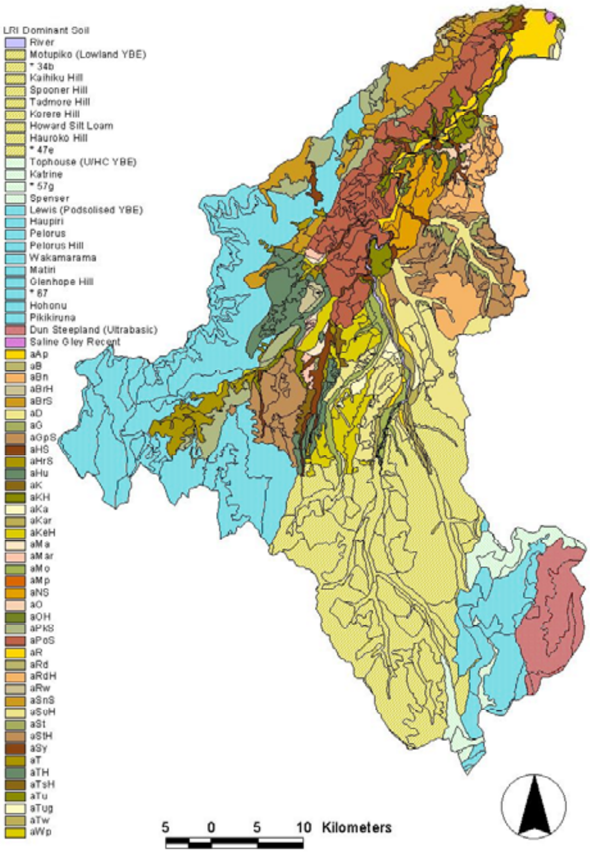
Integrated Catchment Management (ICM)
Research in the
Motueka Catchment & Tasman Bay

October 2004





The Motueka Integrated Catchment Management Research Programme

Manaaki Whenua Landcare Research
CAWTHRON
TDC Tasman District Council

Integrated catchment management: from the ridgetops to the sea

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.

What are the big questions?

How do individual, local land uses affect the availability of ground and surface water over the entire catchment? Have these effects differed over time? What is the most defensible way to plan for the allocation of water resources among alternative uses in the event of shortages?

How is sediment mobilised to reach rivers, and what impacts does it have? What are the values of near- and in-stream habitats and how are these values affected by land and river management decisions? Why has the trout population declined? Will native fish be able to survive in the river? What are the benefits of riparian management?

What are the risks to marine farming from activities on land? How do rivers modify the transport of sediment and pollutants from land to sea? What are the factors that increase or decrease the production and values of fish and shellfish?

How do people acquire and use scientific knowledge to make personal decisions about difficult resource management issues? What tools and approaches can we use to promote effective interaction between scientists, resource managers, and the community? What can we learn from iwi about the environment? What factors affect the uptake of science in resource management decision-making? How can we tell if we are making a difference? What are preferred development pathways to ensure continued sustainable management at catchment scale?

What has the ICM research programme achieved so far?

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 based on the ~450 references and other data sources. ICM research results are updated regularly on the programme website http://icm.landcareresearch.co.nz. Planning for our future ICM research direction includes development of a strategic visioning or planning framework which we call IDEAS: Integrated Dynamic Environmental Assessment System. Following workshops with Prof Hans Schreier (University of British Columbia), and the ICM Sector Liaison Group, the initial product from IDEAS is a prototype CD-ROM integrating existing knowledge of the catchment. Modelling capability is planned to be added later.

Water Allocation: Allocation of river flows for irrigation vs the nationally recognised trout fishery has been a focal point of the Motueka Water Conservation Order. Models to be incorporated into IDEAS will include a linked whole catchment flow and contaminant transport model, and the coastal circulation and ecosystem models being developed by our Cawthron partners. The USDA SWAT flow and contaminant model has tested scenarios of the impacts of land cover change on summer and annual river flows at large catchment scale. We have also developed a catchment water balance model (the Andrew/Dymond model) to compare results using different methodological approaches, and will compare results from a third model, NIWA's TOPNET model.

Groundwater Dynamics: There is increased pressure on groundwater resources in the Upper Motueka valley that requires knowledge of how this shallow groundwater is interacting with the Motueka and Motupiko rivers. This is being investigated through the development of a numerical model of the upper Motueka. Fieldwork is providing river levels within the modelled area and an understanding of the role of hillslopes as contributors to groundwater flow. There is also work on dating the groundwater to ascertain how long it stays underground. Background information has been incorporated into the model so that it is currently running in a steady state condition (no variability in inputs). Development continues and it will be used to gain an understanding of how possible irrigation scheduling will influence river flows and what impact a changing river bed level might have on the groundwater table.

Sediment Impacts in River and Coastal Ecosystems: Sediment is blamed for deteriorating fish habitat and has major impacts on aquaculture potential in Aquaculture Management Areas designated within the coastal plume of the Motueka River. With NIWA, we have set up a monitoring network of suspended sediment samplers in the catchment and are developing a riverbed substrate monitoring protocol to link fine sediment occurrence with aquatic habitat suitability. In the coastal discharge, sediment and salinity profiles following large floods have been shown to cause die-off of scallops and benthic and water column micro-organisms upon which fish and farmed mussels depend for food.

Sustainable River Gravel Extraction: Catchment stabilisation works and revegetation since the bush clearance days are now leading to a gradual decline in riverbed levels, and the need to limit gravel extraction from riverbeds. A recent study with TDC reviews riverbed level changes based on 40+ years of river channel cross-section surveys in the upper and lower Motueka rivers. It confirms the general degradation trends but finds that more information is needed on gravel transport mechanisms, especially during floods. Future work will also look at the influence of flood protection works on river channel behaviour.

Dairy Cattle Crossing Impacts on Water Quality: ICM water quality research led to 3 of 4 fords in the Sherry River being replaced by bridges for dairy herds to cross. This work has been followed by further water quality sampling which shows an improvement in river water quality. It has also led to a proposal with Sherry River landowners and NZ Landcare Trust to trial riparian restoration methods to further improve river habitat.

Riparian Typology Classification and Vegetation Mapping: Regional councils developing Riparian Management Strategies and landowners are faced with the challenge of how to prioritise riparian protection and revegetation works. A classification system developed at NIWA has been applied to the Motueka catchment but requires further refinement to make it useful at detailed reach scale. This is happening in the Sherry River catchment where a vegetation classification methodology has been developed and trialled. The overall aim is to combine this classification with that of the riparian typology to provide guidance for management and rehabilitation of areas with identified biodiversity enhancement opportunities.

The Food Chain in the Motueka River: The productivity of a river for supporting fish and aquatic biota depends on the balance between terrestrial food sources like tree leaves and instream sources like algae which are themselves dependent on nutrient inputs to the river. Cawthron research on Motueka River ecosystem metabolism shows that the upper reaches rely on terrestrial sources while the lower more open reaches have high algal production (food for invertebrates) which is limited by nitrogen concentrations rather than sunlight.

Tools for Managing Water Allocation in Small Streams: Expensive methods such as IFIM (Instream Flow Incremental Methodology) are available to predict changes in instream habitat in large rivers following water extraction, but simple methods for small streams do not exist. Cawthron research in the Rainy River and more recently the Tadmor and Brooklyn Rivers has developed a ‘quick smart’ method for assessing impacts on aquatic life when water is allocated for extraction. The method was compared with the standard IFIM approach and found to reproduce its results well, for a fraction of the cost. The method is being developed for different substrate types and could be extended to apply to other instream values such as iwi, recreation and landscape values.

The Condition of River Delta Habitat: River outflows to the coast affect initially the stability, productivity and ecosystem health of the river delta, and this has a flow-on effect on marine fisheries and aquaculture potential. Cawthron has adapted their national protocol for monitoring barrier-enclosed estuaries to include river delta systems. Having completed broad-scale mapping on GIS, they are now completing fine-scale assessment of key habitats.

Effects of the Motueka River Plume on Aquaculture Management Areas: Water quality and productivity in the 4200ha of designated Aquaculture Management Areas in Tasman Bay is affected by the Motueka River discharge. Cawthron is mapping the extent and magnitude of freshwater effects on seawater temperature, salinity, density, chlorophyll a, clarity and nutrients to provide a basis for understanding the nature and spatial extent of catchment effects on wild, enhanced and farmed shellfish resources. An oceanographic field programme and numerical ocean circulation modelling study suggests large floods will impact mussel farming in the AMA off the Motueka river mouth. It also indicates movement of suspended sediment from the river mouth around Separation Point into Golden Bay.

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. We are currently involved with the Tasman Areas Natural Enhancement Group (TNAEG) in a supportive evaluation role. This research directly supports catchment-based social learning activities in the $US40 million Water and Food Challenge research programme. The cross-case study learning framework developed for this research will be used by the United Nations Dialogue on Water, Food and Environment.

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 2-3 months. During a series of 4 meetings in 2002, the CRG developed an Influence Matrix which identifies and links the critical factors that they believe affect future sustainability of the catchment. The most highly scored of the critical factors were: primary industries, water quality and supply, and policy-plans-rules-legislation. Three factors were shown to play an important role in changing the catchment: climate variability, non-local influences (like exchange and interest rates) and social institutions. Overall, the model highlighted the importance of key ecological and social factors; this will help policy makers who are seeking to understand how heavily to weight economic decision-making with ecological and social factors.

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 will identify the extent to which the economic health of the Motueka catchment depends on the natural resources and ecosystem components of the catchment. The model will later incorporate social and environmental constraints, so that the effects of various catchment-scale development scenarios can be assessed. This component, along with the IDEAS framework, are our major integrating projects – 'putting it all together'.

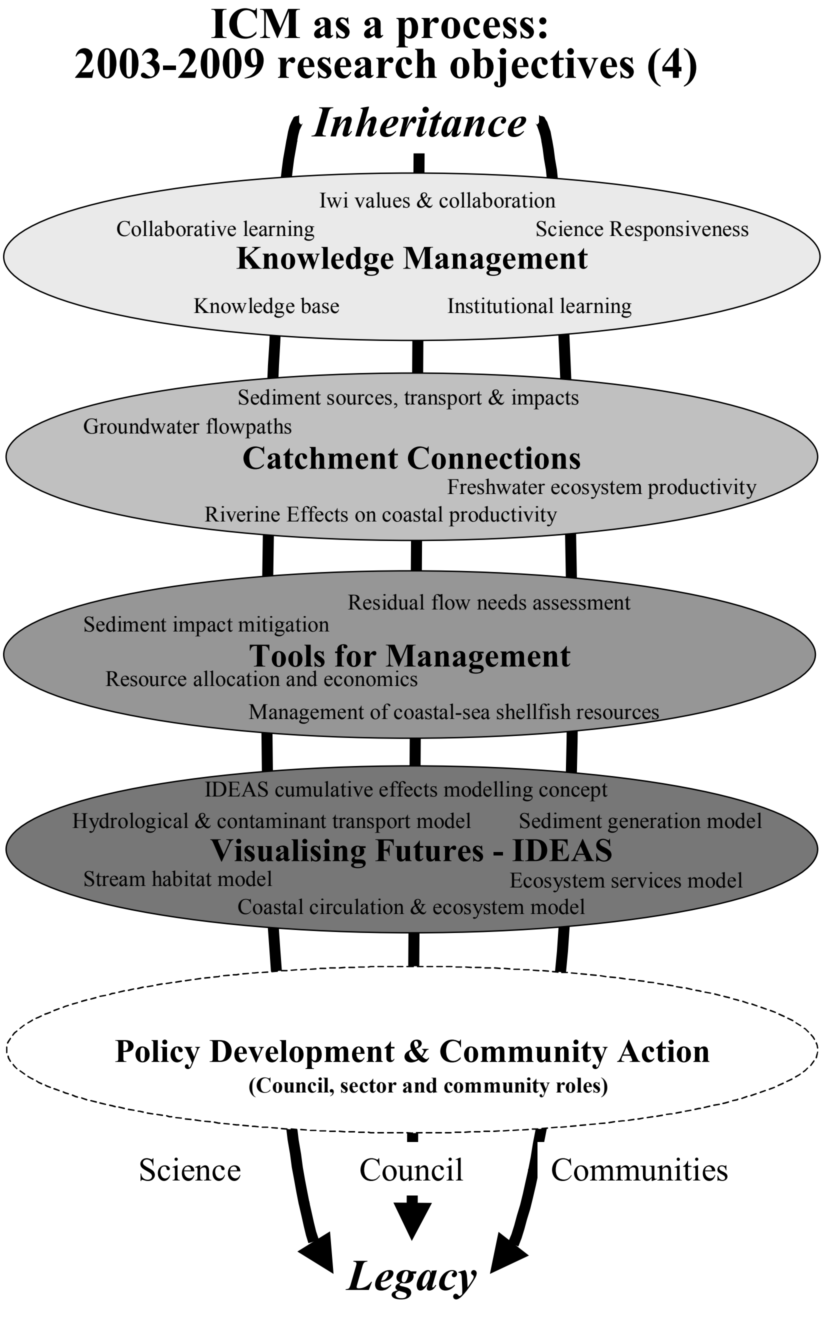
Iwi Values in Integrated Catchment Management: Motueka iwi Te Atiawa, Ngāti Rarua, Ngāti Tama have a keen interest in building information systems for addressing catchment and economic issues. We have built a relationship with these iwi, and developed guidelines for iwi consultation. The iwi have identified their current 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 are working with the ICM programme on 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.

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 pilot group within Tasman District Council is working with Dr Glen Lauder to develop a 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.

What is planned for the next 6 years?

- estimate the loadings of sediment and nutrients over the catchment
- determine how key land uses affect aquatic biota in streams
- model impacts of groundwater pumping on river flows and values
- quantify the dynamics of sediments and gravel in the rivers
- compare sediment generation and fate in Motueka and Raglan catchments
- estimate limits on the productivity of the coastal environment
- develop simple tools for assessing residual flow needs and riparian management

- refine and link computer models to integrate biophysical, economic and social models for evaluating whole catchment sustainability (the Integrated Distributed Environmental Assessment System) and make catchment information accessible
- develop more holistic estimates for the values of surface and ground waters
- recommend improved resource policy for water allocation and augmentation
- refine processes that encourage community participation in decisions about resource management and underpinning environmental research
- identify means to incorporate Māori views (kaitiakitanga) in science and planning
- synthesise the knowledge developed into a book and conference on ICM science
- improve uptake through collaboration with community, sector and landcare groups
- develop an integrative framework for ICM through collaboration in the UNESCO HELP programme and comparative studies with overseas ICM projects.



Who is involved?

- *Landcare Research*: programme manager, land/water research, and social learning
- *Cawthron Institute*: key partner, freshwater and marine research
- *Tasman District Council*: key partner, river/groundwater research, resource management

- *Institute of Geological & Nuclear Sciences*: groundwater research
- *NIWA*: riparian and river sediment research
- *Forest Research*: riparian biodiversity research
- *Otago University*: research on pathogens (Campylobacter)
- *Common Ground Ltd*: institutional learning
- *NZ Landcare Trust*: landowner liaison
- *Te Atiawa, Ngāti Rarua, Ngāti Tama*: iwi environmental monitoring
- *The Motueka Community Reference Group*: community liaison
- *The Motueka Sector Liaison Group*: sector liaison
- *The Foundation for Research, Science & Technology*: funding
- International interest groups (*UNESCO/WMO Hydrology for the Environment, Life and Policy*)

What are some key performance indicators?

- A significantly enhanced knowledge by stakeholders of the catchment, its resources and their interactions
- Recognition of the Motueka ICM programme as the core catchment research programme in NZ
- Completion of stakeholder-driven core research projects to their satisfaction
- Increased use of participatory processes in policy/research formation
- Productive alignment of Pakeha and Maori environmental views and agenda
- Reduced conflict in deliberations over Resource Consent applications and policy
- Increased satisfaction with the role of the Council as an environmental manager
- Eagerness to extend the approach to another site with new issues

An overview of the place

Motueka River Basin Physical Features

- Total basin area 2,170 km^2
- Located between 41°00' S and 41°45' S latitude, and
  172°30' W and 173°00' W longitude.
- Entirely within the boundaries of the Tasman District, South Island, New Zealand.

Motueka River Physical Features

- Elevation: sea level at Tasman Bay to 1800 m in alpine headwaters
- Length: 110 km
- Breadth: 18 km near the mouth to 50 km at the headwaters
- Average depth: <1 m
- Delivers 62% of the freshwater inflow to Tasman Bay

Major Lakes and Bays in Basin:

- No major lakes

- Motueka River discharges into Tasman Bay, a productive and shallow coastal body of high cultural, economic, and ecological significance.

Major Rivers and Waterways in Basin (* = long term flow data exists):

- Motueka River *
- Important west flank tributaries (Riwaka *, L. Sydney, Brooklyn, Shaggery, Rocky, Pokororo, Graham, Pearse)
- Important east flank tributaries (Waiwhero, Orinoco, Dove)
- Major headwater tributaries:
  - Baton *
  - Wangapeka *, including the Dart and Sherry
  - Tadmor *
  - Motupiko
  - Upper Motueka
  - Stanley Brook *

Hydrologic Budget:

- Average annual precipitation: 1040 - 4030 mm measured over catchment
  >4030 mm estimated in mountainous regions
- Number of rain days >1mm: 102-137
- 50-year, 24-h rainfall event: 141-229 mm
- Annual sunshine hours: ~2400 h
- Annual pan evaporation: 1105 mm
- Annual days of air frost: 31-92 days
- Annual discharge from the Motueka River at Woodstock: 844 mm
- Mean annual flow: 58.1 $m^3 s^{-1}$
- Mean annual 7-day low flow: 10.1 $m^3 s^{-1}$
- 50-year flood event: 2050 $m^3 s^{-1}$

Geology

- complex limestone, marble, and calcareous mudstone (Mt Arthur Group) volcanic rock (Riwaka complex) formations (western headwaters)
- clay-bound Pliocene-Pleistocene (Moutere Depression) gravels (dominant, mid-basin)
- erodible (Separation Point) granites (mid-basin)
- ultra-mafic (Dun Mountain) mineral formation (eastern headwaters)
- sandstone-siltstone (Maitai Group) formation (eastern headwaters)

Hydrogeology

- alluvial plains aquifers (horticulture):
  - upper aquifer (1-10 m depth, transmissivity 2000 m^3/day/m)
  - middle aquifer (10-16 m depth, transmissivity >4000 m^3/day/m
  - lower aquifer, (>16 m depth, transmissivity >2500 m^3/day/m)
- Moutere gravels (pasture, horticulture, forestry): 3-120 m^3/day/m
- Alluvial valley aquifers (dry land pasture, dairy, horticulture): like the upper plains aquifer (i.e., 2000 m^3/day/m, decreasing away from the river).
- Mountain calcareous complexes: high and unknown (sinkholes, caverns).

Topography

- Flat alluvial plains at mouth, sea-level, young relatively fertile soils
- Rolling and steep hill country in lower basin, low-fertility soils
- Flat alluvial terraces in upper basin valleys, young relatively fertile soils
- Rugged mountainous terrain in headwaters, with a wide range of fertility and permeability

Seasons & Climatology

- Cool, humid with distinct wet and a dry (austral summer) seasons
- Dry season can lead to water shortages on dominant Moutere Gravels
- Climate is affected by:
  - Air masses from Tasman Sea (westerly, warm), South Pacific (northerly and easterly, moderate), and Southern Ocean (southerly, cold).
  - Orographic effects are pronounced.
  - Location of the basin within a small island mass, situated within a temperate zone.
  - Shelter of the western mountains

Land-use & Land cover

- Native "bush", scrub and grassland in headwaters: southern beech (*Nothofagus*), podocarps (40%)
- Commercial forestry on steeplands: radiata pine, Douglas fir (25%)
- Dry land pasture and scrub: pasture grasses, sheep
- Valley bottom riparian areas: berry crops, hops (35%)
- Coastal plains: fruit trees, hops

Freshwater resources

- Nationally important blue duck habitat, karst and wild & scenic features in Kahurangi National Park
- Nationally important recreational trout fishery in the Wangapeka and Mid-Motueka rivers
- Regionally important whitebait fishery
- Water supply for irrigators and townships
- The Water Conservation Order (Motueka River) was formally gazetted by the Minister for the Environment in April 2004

Marine resources

- Nationally significant (enhanced) scallop fishery
- Intertidal cockle fishery
- Rapidly expanding mussel farming: aquaculture
- Recreational and commercial fin fisheries
- Extensive delta system linking land, freshwater and marine ecosystems
- Nationally important coastal recreation areas (e.g. Abel Tasman National Park), marine mammals (e.g. Tonga Island Marine Reserve)
- Internationally recognised birdlife (e.g. bar-tailed godwits, pied and variable oystercatchers on Motueka sandspit)

Population

- Sparsely populated: less than 1 person per km2
  - ~12,000 in catchment, mostly in the town of Motueka
  - ~41,400 in Tasman District (2001 NZ Census)
- Moderate growth: ~2% per annum and probably faster now!

Pressures on Water Resources

- Water withdrawals (largely irrigation)
  - Surface water: 132 permits (761 $l\ s^{-1}$)
  - Groundwater: 335 permits (1,715 $l\ s^{-1}$)
- Permits for discharges into Motueka River:
  - Low: 10 of 136 in the greater region

    - Type: largely stormwater and dairy
- Activities relevant to Tasman Bay
    - Marine farming: structures, aesthetics, ecological impacts
    - Coastal subdivision and development
    - Coastal hazards: erosion, flooding
    - Coastal structures: marinas, jetties, warves, outfalls
    - Nuisance plants and animals, impacts on biodiversity

History of settlement in the Motueka River basin

Archaeological evidence suggests that Maori groups first settled the Motueka River area before 1350 A.D. and more permanent camps and fortifications (pa) were gradually established. Settlement was largely restricted to the coastal areas, although Maori travelled through the catchment in search of valued "pounamu" or greenstone (argillite). Inter-tribal conflicts decimated the local tribes (iwi) in 1828-1830, about 10 years before the first European settlers arrived. Early European settlers were largely interested in sheep grazing land and in gold. Gold operations existed in the area until the early 1900's.

A major flood in February 1877 transformed the shape of the catchment, as a consequence of widespread mass wasting. This event has left a legacy that is important even today. Subsequent flooding prompted local river boards to construct stop banks in the lower river in the 1950's.

Introduction of tobacco in the 1920's brought a period of growth and prosperity. Decline in the tobacco industry in the 1950's was followed by a rise in fruit tree, berry fruit, and hops and by a rise in commercial forestry. Plantation forests – stocked primarily with exotic species such as Monterey pine (*Pinus radiata*) and Douglas fir (*Pseudotsuga menziesii*) were established on less-fertile, steeplands abandoned and purchased from farmers. More recently, vineyards, marine farming, and tourism have added substantially to the diversity and productivity of the local economy, and lifestyle blocks are increasingly being developed.

Social & cultural setting:

New Zealand is a bi-cultural nation, recognising the contributions of both Maori and Europeans (pakeha). The legal document defining the relationship between Maori and pakeha is the Treaty of Waitangi (1840). After languishing for over 100 years, the treaty has been the basis for recent claims by Maori groups over various land and water resources. These claims are often a source of tension, requiring resolution. A number of Maori tribes (iwi) are active the Motueka River area and their view and interests are an important part of the integrated catchment management programme.

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