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LAND AND WATER

Landcare Research
Manaaki Whenua

LAND USE AND WATER QUALITY

>> LAND AND WATER ARE INSEPARABLE ELEMENTS OF OUR NATURAL ENVIRONMENT. WHAT HAPPENS WITH OUR WATER – BOTH QUALITY AND AVAILABILITY – GENERALLY STARTS WITH WHAT'S HAPPENING ON THE LAND.

CONTENTS

Front Cover: Scott Bartlam (Landcare Research) with Waikato-Tainui tribal members and Waikato Raupatu River Trust Wetland Scholarship recipients, Joshua Ormsby (Puurekireki Marae) and Jonathan Brown (Maurea Marae) discussing the colour of the harakeke (*Phormium tenax*) leaf edge, which was traditionally thought to be an indicator of the quality of the flax fibre by weavers.

Good land use may contain demands for irrigation within environmental limits; it may avoid excess nutrients that end up in groundwater or streams; it may reduce sediment from erosion and reduce the chance of flooding; and it may moderate the availability of water further down a catchment. All of these interactions mean that when we try to manage water quality and availability we have to look carefully at the land uses. Good land-use practice can address many of the challenges we face with water.

This issue of *Discovery* focuses largely on the work of Landcare Research at the interface between land and water at a range of spatial scales from paddock through to national, where our knowledge and tools can be applied to developing policy and implementing management actions in the field.

At the national scale, the launch of the National Land Resource Centre (p5), fills a significant gap in making soils and land information and services more readily available, through a single portal regardless of its source. The NLRC is a collaboration between providers, with informatics technology and leadership from Landcare Research.

At the regional scale we describe how the New Zealand Forest and Agriculture Regional Model (NZ-FARM, p3), developed by Landcare Research, is being used to model the benefits of water storage, water quality caps, good management practices, tax and trading systems, and land-use options. Importantly, NZ-FARM links economic and environmental aspects of policy challenges.

At the regional down to farm scales our collaborative work with the Aquifer-Sim model and S-map (spatial soils information) has improved the ability of land managers to assess the impacts of land use on leaching and water quality (p4). The project has contributed to Environment Canterbury's work on land use and water quality and thinking around nitrate limits.

At the farm scale Landcare Research's work on variable-rate irrigation (p8) has shown that water savings of up to 36% can be achieved without impact on yields, making water available for other uses on-farm. This collaboration with Precision Irrigation-Lindsay Corporation, Streat Instruments, Hydroservices and leading farmers uses detailed soil mapping information to program the variable rate irrigation equipment.

Wetlands provide vital ecosystem services – cultural, aesthetic and functional, cleaning up waterways and storing carbon – but more than 90% of pre-settlement New Zealand's wetlands have been lost. We describe the exciting developments in our wetland restoration programme (p6); and our cover photo shows two Waikato-Tainui trainees who have been engaged in the programme.

We also highlight our involvement in the Treaty of Waitangi settlement for the Tūhoe iwi (p7). This breaks new ground internationally, taking Te Urewera National Park out of the park network and putting it under its own legislation and governance by Tūhoe and government. Landcare Research has been proud to work with Tūhoe, helping to engage stakeholders in the park and explore governance models.

Dr Richard Gordon
Chief Executive

ASSESSING IMPACTS OF ENVIRONMENTAL POLICY

>> ASSESSING THE ECONOMIC AND PHYSICAL IMPACTS OF ENVIRONMENTAL POLICY HAS LONG PERPLEXED DECISION MAKERS BUT A NEW TOOL FROM LANDCARE RESEARCH LOOKS SET TO CHANGE THAT.

The New Zealand Forest and Agriculture Regional Model (NZ-FARM) was developed to allow central government agencies, regional councils and industry to systematically assess the economic and environmental impacts of environmental policy – including limits, allocation options, taxes and resource constraints such as water availability.

Researcher Suzie Greenhalgh says that the model can be used, for example, at catchment-level to simultaneously assess impacts on farm income from meeting different regional water quality limits and implementing the NZ Emissions Trading Scheme.

The model optimises potential farm income across a catchment against the environmental impacts of land use (pastoral, arable, horticultural, forestry, scrub or conservation) and land-use and management change. The model also includes soil and weather variability across the catchment.

"To enable the agricultural sector to respond to policy changes and resource constraints, farmers can change land use or adopt management practices with lower environmental impacts," Dr Greenhalgh says.

"Lower-impact practices available to farmers currently include altering stocking rates and fertiliser regimes, applying nitrogen inhibitors, and using feedpads for dairy operations."

Researcher Adam Daigneault says the model focuses on greenhouse gas and water environmental constraints, accounting for greenhouse gas emissions from agriculture and forestry, forest carbon sequestration, water use and water constraints, and nutrient (nitrogen and phosphorus) losses. The water quality impacts are modelled using OVERSEER®, an agricultural management tool that assists in examining nutrient use and movements within a farm to optimise production and environmental outcomes; while greenhouse gas emissions and carbon sequestration are based on the methods used to derive the annual national inventory of greenhouse gases.

"Over time more ecosystem services, environmental constraints and farm management options will be added to the model. Currently, water yield and pollination services are being incorporated," Dr Daigneault says.

The model was developed for the Hurunui and Waiau catchments in Canterbury and the Manawatu River catchment in the North Island but is relatively straightforward to customise for other catchments. To date, NZ-FARM has been used to assess the benefits and impacts of:

- Potential increases in water storage from capital improvement projects such as water storage infrastructure
- Proposed water quality caps or limits such as those on nitrogen and phosphorus loads, and the allocation of these limits within a catchment
- Mandatory good management practices for agriculture
- Input and output taxes
- Implementation of NZ-ETS on the forestry and agricultural sectors
- Regional afforestation schemes
- Implementation of new farm technology and good management practices,
- Increases in farm input costs and/or product prices, and
- Combinations of the above options.

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MONITORING AND MANAGING REGIONAL WATER QUALITY

>> THE QUALITY OF NEW ZEALAND'S FRESH WATER AND CONCERNS ABOUT THE IMPACT OF CHANGING LAND USE ON WATER ARE INCREASINGLY AT THE FOREFRONT OF NEW ZEALANDERS' THINKING.

Regional councils are responsible for managing the cumulative effects of land use on water quality. In a collaborative project with Environment Canterbury, Landcare Research staff have developed more effective mechanisms for managing land use (and associated nitrate leaching) to meet water quality limits for the region.

We've been doing this work at farm, catchment and regional scales.

At the farm-scale, in a simulation study, we showed that current methods and technology for measuring leachate under grazed pasture are inadequate. Impractical numbers of measuring devices are needed to gain an accurate estimate of average leaching from a field and this is critically important given these data are used by researchers to develop and evaluate farm-scale leaching models. Also, some regional councils are hoping to ensure compliance with nutrient discharge limits through such measurements.

Meanwhile, the spatial model AquiferSim (developed with Lincoln Ventures) assesses the impact of potential land intensification options on water quality in aquifers and spring-fed streams and takes only minutes rather than weeks as with more complex models. It can be used where there is limited geo-hydrological data (good information is only available for a few aquifers in New Zealand).

Researcher Linda Lilburne says AquiferSim was tested in the Central Canterbury Plains (where good data are plentiful) and in the Hurunui River area (where data are few). The modelling work contributed to Environment Canterbury's Land Use and Water Quality Project, a collaborative process with stakeholders that resulted in the Hurunui and Waiau River Regional Plan. We are now working with Environment Southland to apply AquiferSim to the mid-Mataura River basin.

Our new spatial model of contamination risk at the regional scale draws on data in S-map (http://smap.landcareresearch.co.nz/home) and relevant research on contaminant pathways. This helps land managers determine where mitigation practices are needed, and enables regional councils to apply more appropriate consenting rules for effluent disposal and septic tank discharge fields.

We used an updated regional nitrate-leaching map to provide statistics on the impact of nitrate thresholds being considered for the draft Canterbury Land and Water Regional Plan. We also developed a new method for allocating a catchment-scale nutrient limit between farms. This focuses on more intensive mitigation practices for land where there is a nitrate contamination problem, i.e. intensive land use on leaky soils in catchments known to have poor water quality.

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NEW CENTRE UNLOCKS THE POTENTIAL OF OUR VITAL LAND ECONOMY

>> THE LAUNCH OF A NEW SCIENCE-BACKED NATIONAL INITIATIVE IS A BIG STEP TO IMPROVING THE WAY SCIENCE IS USED TO ENHANCE ONE OF THE COUNTRY'S MOST IMPORTANT RESOURCES – THE LAND.

An initiative of Landcare Research, NLRC – the National Land Resources Centre (www.nlrc.org.nz) – will be a 'one stop shop' for providing information for policy, business and science practitioners, co-ordinating engagement and foresight into future issues, as well as undertaking capacity building across the sectors.

New Zealand's 'land economy' – agriculture, forestry, mining and tourism – provides more than 25% of the country's GDP and therefore our future prosperity is highly dependent on better understanding and managing this important resource.

"The science of the land resource seemed the perfect place to seek transformation given a history of fragmented capability and its low profile compared with its sibling resources of water and atmosphere," says Director of the NLRC, Dr Alison Collins.

"A new approach to the way we produce and use research could make a significant impact. And not just looking at today's issues but providing strategic leadership so we consider tomorrow's challenges and the science that might be needed to respond to them."

Technical Director of the NLRC David Medyckyj-Scott says the NLRC's development is in response to the CRI Taskforce recommendations that included calls for a more collaborative approach to solving national science challenges and a focus on creating maximum research uptake and therefore impact, by working strategically and in partnership with all stakeholders.

Dr Medyckyj-Scott says the centre has three main aims, which have been developed in conjunction with stakeholders.

"Firstly, engagement with all those interested in the land resource by providing a gateway into available research and resources, workshops, forums and best teams. Secondly, access to customised, easily consumable and fit-for-purpose information for policy, business and science users – for today and tomorrow's New Zealand. The NLRC will remove the barriers that sometimes prevent science being understood and used," he says.

The final aim is for an improvement in national capability to lift performance for those researching, governing and managing the land resource.

Minister of Science and Innovation Hon. Steven Joyce said the establishment of the Centre signalled an exciting new era for soil and land research by linking together the science community and end-users.

"Improving access to high quality land and soil knowledge will enable better management of our land resources. The Centre is also enabling agencies and organisations to easily share land management information, encouraging greater collaboration and co-ordination in this area."

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RESTORING OUR PRECIOUS WETLANDS

>> AWARENESS OF WETLANDS CONTINUES TO GROW THROUGHOUT NEW ZEALAND AND AROUND THE WORLD.

Given their importance that's hardly surprising but it's also somewhat ironic that we're only now beginning to understand their value and undo decades of abuse and exploitation.

More than 90% of pre-settlement wetlands have been lost and remaining wetlands are steadily degrading through fragmentation, decreased water supply, eutrophication and weed invasion. All this despite the fact that they sustain indigenous species, maintain water quality, sequester carbon and therefore provide large economic, social and cultural benefits.

However, Landcare Research staff, led by Beverley Clarkson, have worked with partners NIWA, DOC and the University of Waikato to deliver scientifically based guidelines, techniques and tools to improve management and guide restoration of wetlands. This isn't always easy because wetlands are complex and driven by many interacting physical, chemical and biological processes. This complexity helps to explain the gaps in scientific knowledge that have constrained their management and restoration.

Publication of our wetland restoration handbook (available free online as downloadable chapters at: http://www.landcareresearch.co.nz/services/biocons/wetlands/) represents the culmination of several years of research. This involved development of best practice techniques from restoration experiments, case studies, and collaboration from wetland partners and the wider community over the course of the programme.

Restoration techniques were developed through field experiments in wetlands that have been drained, burned, mined, invaded by weeds, or otherwise modified. These include restoration of a rare and threatened Sporadanthus bog type at a site that is being mined for horticultural peat.

When the bogs are restored using our patch restoration approach, nutrient balances are improved, leading to better growth rates, better decomposition patterns and increased storage of carbon. Under our technical guidance, end-users have introduced populations of Sporadanthus and rare invertebrates to three new private wetland projects at sites where the bog type once occurred.

Wetland restoration practitioners including DOC, regional and district councils, iwi, landowners, and community groups use the handbook at all stages of their restoration as it provides a comprehensive compilation of current knowledge on major aspects of wetland restoration.

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A LANDMARK TŪHOE SETTLEMENT

>> THE DETAILS OF THE CROWN'S RECENT TREATY OF WAITANGI SETTLEMENT WITH TŪHOE HAVE BEEN WELL REPORTED BUT A LESSER KNOWN DETAIL IS THE WORK OF MANAAKI WHENUA LANDCARE RESEARCH IN FACILITATING ASPECTS OF THE DEAL.

Our input in this process came largely as a result of 20 years of partnership with Tūhoe on conservation management research and advice particularly around indigenous forestry, predator control and the restoration of kiwi and kereru populations. Manaaki Whenua's work around the governance and management of Te Urewera emerged in recent years from those long-term relationships.

Together with Tūhoe and other iwi representatives, we assessed how other models of protected area governance and management have been implemented in Australia and Canada against Tūhoe's criteria for settlement.

Tūhoe noted that Manaaki Whenua's work identified both the positive and negative aspects of governance and management models in other jurisdictions, and summarised for Tūhoe the values, priorities and reservations held by some major stakeholders. It also demonstrated that a form of indigenous governance would better meet Tūhoe's criteria and vision for settlement, and that other stakeholders viewed Tūhoe's role in the management of the area positively.

We also extensively canvased the principles and priorities of many Te Urewera stakeholders by conducting interviews and holding a summit in May where these issues were thoroughly discussed. Manaaki Whenua researcher, Dr Phil Lyver says that by the end of the summit, there was a general agreement among park stakeholders and territorial and local authorities that Tūhoe should have a lead role in the future management of Te Urewera.

Tūhoe spokeswoman Kirsti Luke said Manaaki Whenua had assisted the Tūhoe negotiating team to access objective and tested independent opinion on key proposals now forming the design of the new Te Urewera legislation.

"Through their banked reputation Manaaki Whenua have helped Tūhoe build meaningful relationships with important stakeholders and contributers to Te Urewera. We see their involvement continuing to help strengthen the embryonic stages of increasing Tūhoe and community hands-on active obligation to the restoration of the special and protected area of Tūhoe homelands – Te Urewera."

Manaaki Whenua researcher Rob Allen says the company's experience with Tūhoe builds capabilities to assist other iwi during and after their Treaty of Waitangi claim and settlement process.

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IMPROVING IRRIGATION EFFICIENCY

Reduced costs and more efficient water use for farmers are a step closer with progress in the development of a specialised irrigation system.

Three two-year-long trials undertaken by Landcare Research staff led by Dr Carolyn Hedley (and supported by HydroServices, Streats Instruments and Waterforce) found that farmers who used variable rate irrigation (VRI) achieved up to 36% water savings with no negative impact on yield and a current return on investment of between one and five years.

VRI was developed by one of our partners, Precision Irrigation-Lindsay Corporation, who modified sprinkler systems so that individual nozzles can be programmed to switch on and off, thus enabling VRI to be matched to soil management zones within a paddock. These zones are defined using sensor mapping that provides high resolution quantification of soil variability.

Meanwhile, our prototype web-enabled wireless sensor networks (WSNs), developed by Dr Jagath Ekanayake of Landcare Research, continuously monitor soil moisture within each zone under the irrigator. The WSNs use mesh networking technology to transmit data along the most efficient pathway between nodes to a base station. If one node fails, the other nodes simply re-route along any other available pathway. The soil moisture data can be accessed remotely and used to assist variable placement and timing of irrigation to soil management zones.

Water saved at a Fairlie dairy farm was diverted to otherwise unirrigated parts of the farm to increase pasture production, which enabled the cost of converting three systems to VRI to be paid back within one year. This year, a 36% water saving was achieved at the Manawatu Sand Country VRI trial site, because lower lying areas, where the water table is relatively high, required no irrigation at all due to a wet season. The VRI system on an Ashburton arable farm, where soils vary from very stony to silt loams under one irrigator, achieved 20% water saving in both years.

The ultimate goal is complete automation of the VRI system using real-time soil moisture monitoring of soil zones for precision irrigation scheduling.

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