

# IRAP: INTEGRATED RESEARCH FOR AQUIFER PROTECTION

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The Integrated Research for Aquifer Protection (IRAP) programme aims to produce software tools that can predict likely impacts of land use change on the quality of groundwater underlying the relatively flat alluvial plains of New Zealand. It brings together the expertise of eight organisations, and covers plot-scale experimental work on the root and vadose zones, as well as development of computerised simulation models. This presentation focuses on the development and description of the software tools. Key questions that the tools will answer are:

- How does existing land use affect the quantity of nutrients that move through the soil to the aquifer and then through the aquifer system?
- What impact will land-use changes have on the quality of groundwater in the future?
- Will using best-practice farm management techniques be enough to maintain acceptable groundwater quality?

The primary stakeholders are the regional councils, responsible to the public for environmental management, and the landowners themselves. The IRAP research was proposed and designed to deliver the tools for policy-making purposes.

A multi-scale approach has been adopted in which two primary modelling tools are being developed: FarmSim and AquiferSim. FarmSim is a farm scale model that comprises a number of software components including plot-scale models of crop response, a soil-water transport component, water supply, irrigation, fertiliser, stock (cows and sheep), and grazing management and a vadose zone model which simulates the transport of nitrate (NO<sub>3</sub>) from the root zone through to the saturated zone (Good and Bright, 2005). The water supply manager simulates the farm-scale constraints on water use and application. The soil-water and plot-scale crop response models are also components of the LUCI framework which produces specialist decision support tools for land managers such as WheatCalculator, PotatoCalculator, AmaizeN (Li et al., 2007). This means that regional councils and farmers can use the same science-based principles incorporated in the modelling tools to develop land use policy, or manage their farm operations to comply with policy rules.

FarmSim operates at a daily timestep but the outputs include the annual amounts of water drained and NO<sub>3</sub> leached below the root zone. These annual outputs are key inputs into a regional-scale simulation model of the aquifer catchment (called AquiferSim). This tool comprises groundwater

models (vertical and horizontal), a stream function and flow path finder, a contaminant transport model, and a geographical information system (GIS) to manage the data inputs and ground water model outputs (Bidwell and Good, 2007, Bidwell et al., 2005). The GIS layers include soil data, rainfall zones, irrigation and land use, river recharge, as well as layers on aquifer properties (depth, transmissivity, porosity).

The AquiferSim tool is required to simulate areas of up to several thousand square kilometres at 1-ha resolution in minutes rather than days so that many potential future land-use scenarios can be assessed. Fast computational performance is also required for undertaking uncertainty analysis of model results. To achieve this, various scaling strategies have been employed ranging from development of a steady-state model, to specific simulation exercises to identify key processes and factors, and appropriate simplifications (e.g., (Snow et al., 2007)).

Early versions of both tools have been developed and presented to end-user groups. Industry groups are currently involved in verifying the management parameters used in FarmSim, and testing simulation model outputs. The AquiferSim software has been installed at Environment Canterbury as part of the development process. Initially the two tools are likely to be used by council staff tasked with putting together regional management plans. By running different land-use scenarios, they will be able to determine the likely effect on groundwater quality due to NO<sub>3</sub> leaching, and thereby develop appropriate policy to contain these effects. An integrated assessment of effects that includes all land uses, and links above- and below- root-zone processes has not been available till now.

## References

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