N-Trader – a simulation model to explore possible trading schemes for diffuse sources of nitrogen

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Since the 1940s the intensification of livestock farming has increased nitrogen exports from pasture and contributed to a deterioration in Lake Rotorua water quality. A major point source of nitrogen, treated sewage, was reduced in the early 1990s by spray-irrigation. A 'target' has recently been set for nitrogen input to the lake (435 tN/yr) that will require significant reductions in diffuse source nitrogen, mostly from pasture. A nutrient trading scheme is being considered (Lock et al. 2008). In theory, trading should minimise the total cost of meeting the 'cap' and it offers the advantage over regulation of giving land owners more flexibility. However, some question whether a trading scheme is suitable for Lake Rotorua. The simulation model, N-Trader, has been developed to explore alternatives, compare their efficiency and effectiveness in terms of both environmental and economic outcomes, and help identify a suitable scheme.

A significant proportion (c. 50%) of the total nitrogen input is transported from pasture or forest to Lake Rotorua in deep groundwater (Rutherford & Palliser 2011) and the mean age of groundwater (measured using tritium) varies from 16-127 years (Morgenstern et al. 2005). Groundwater lags have been quantified in the nearby Lake Taupo catchment, a nitrogen 'cap' has been set and trading is permitted, but no account is taken of groundwater lags. N-Trader helps identify the advantages (realism and accuracy) and disadvantages (complexity and, potentially, added cost) of including 'lags' in the scheme by trading 'vintages' (viz., nitrogen allowances 'date stamped' with the year they arrive at the lake). Properties close to the lake have shorter groundwater lags than those in the headwaters, and N-Trader explores the effects of varying the number of lag zones. Reported groundwater lags are 'mean residence time' (t_m). However, not all the nitrogen exported from a property in year n travels as 'plug flow' and arrives at the lake in year $n+t_m$. N-Trader explores the advantages and disadvantages of using either single or multiple time lags for a given property. There are many small (<10 ha) properties in the catchment and including them in the trading scheme risks increasing compliance costs. However, markets with a small number of buyers and sellers is potentially 'inefficient' and so N-Trader investigates the effects of varying the minimum size of properties included in the trading scheme.

References

Lock, K., Kerr, S., Cox, T.J., Rutherford, J. C. (2008) Assessing design options for a nutrient trading system using an integrated model. NZ Assoc. Ag. Res. Econ. Conf. 28-29 August 2008. Nelson, New Zealand

Morgenstern, U.; Reeves, R.; Daughney, C.; Cameron, S.; Gordon, D. (2005). Groundwater age and chemistry, and future nutrient loads for selected Rotorua lakes catchments. GNS Science Report 2005/00. Geological & Nuclear Sciences, Lower Hutt.

Rutherford, J.C., Palliser, C.C., (2011). Prediction of nitrogen loads to Lake Rotorua using the ROTAN model. Rotorua Lakes Water Quality Society Symposium, 7-8th April 2011.