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Regional Groundwater Processes and Flow Dynamics from Age Tracer Data

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Age tracers are now used in New Zealand on regional scales for quantifying the impact and lag time of land use and climate change on the quantity and quality of available groundwater resources within the framework of the National Policy Statement for Freshwater Management 2014. Age tracers provide measurable information on the dynamics of groundwater systems and reaction rates (e.g. denitrification), essential for conceptualising the regional groundwater - surface water system and informing the development of land use and groundwater flow and transport models.

In the Horizons Region of New Zealand, around 200 wells have tracer data available, including tritium, SF6, CFCs, 2H, 18O, Ar, N2, CH4 and radon. Well depths range from shallower wells in gravel aquifers in the Horowhenua and Tararua districts, and deeper wells in the aquifers between Palmerston North and Wanganui.

Most of the groundwater samples around and north of the Manawatu River west of the Tararua ranges are extremely old (>100 years), even from relatively shallow wells, indicating that these groundwaters are relatively disconnected from fresh surface recharge. The groundwater wells in the Horowhenua tap into a considerably younger groundwater reservoir with groundwater mean residence time (MRT) of 10 – 40 years. Groundwater along the eastern side of the Tararua and Ruahine ranges is significantly younger, typically <5 years MRT.

Vertical groundwater recharge rates, as deduced from groundwater depth and MRT, are extremely low in the central coastal area, consistent with confined groundwater systems, or with upwelling of old groundwater close to the coast. Very low vertical recharge rates along the Manawatu River west of the Manawatu Gorge indicate upwelling groundwater conditions in this area, implying groundwater discharge into the river is more likely here than loss of river water into the groundwater system. High recharge rates observed at several wells in the Horowhenua area and in the area east of the Tararua and Ruahine ranges are accompanied by elevated nitrate concentrations, indicating quick transfer of nitrate from land use activities into the groundwater system. Extremely high recharge rates of >1 m/y for some wells indicate recharge from the river as the main source.

Elevated mean rates of oxygen reduction, as deduced from groundwater MRT, may indicate the presence of electron donors in the groundwater system to facilitate microbial reactions and therefore potential for denitrification reactions. Elevated rates of oxygen reduction occur in the upper Manawatu River catchment, consistent with a sample from there having excess nitrogen which is likely to originate from such denitrification reactions.