Non-point source pollution: what happens between the root zone and the groundwater?

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Non-point source pollution due to land use intensification is considered the main reason for early signs of deterioration in the water quality of Lake Taupo. However, little is understood about the pathways and the transformation processes of contaminants on their way from the land surface through the subsurface to streams and the lake. As part of the investigations into this deficiency an experimental facility has been installed to measure and analyse the fluxes of water and solutes moving under pastoral land use through the vadose zone and into the groundwater. This facility uses a relatively new measurement technique of large porous sintered stainless steel plates (0.20 m^2) to measure fluxes at the field site (Barkle et al. 2011). Fifteen Automated Equilibrium Tension Lysimeters (AETLs) were installed around the outside of a 2.3 m diameter caisson down to 5.2 m below the ground surface (three AETL at each of five depths). The 5.8 m deep central caisson provides access to the AETLs for regular leachate collection and maintenance. A vacuum equal to the tension measured (+/- 2.5 hPa tolerance) in the undisturbed vadose zone, adjacent to the AETL, is continuously applied under the porous plate. This operating procedure ensures that the water and contaminant fluxes measured by the AETLs are unaffected by the instrumentation and representative of the fluxes occurring in the vadose zone. (Wöhling et al.2009)

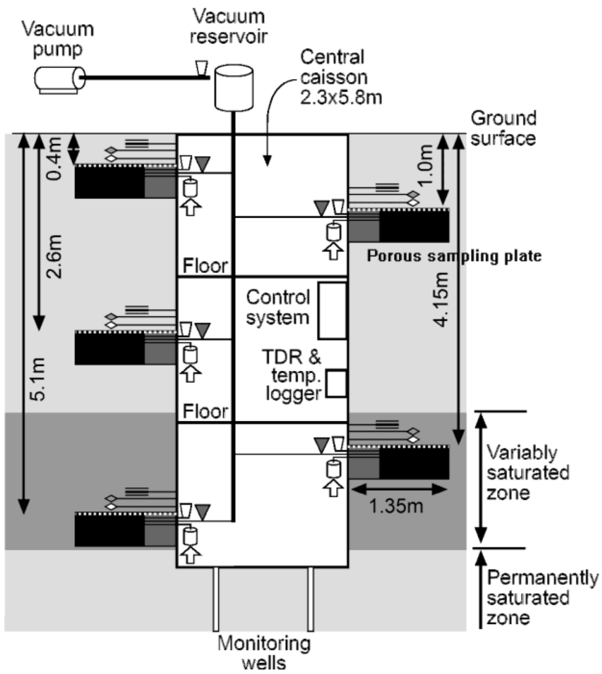

Figure 1.1 Schematic of the “Spydia” facility

Transport through the vadose zone. To investigate the transport through the vadose zone, a bromide solution (5 mm application depth), was sprayed onto the ground surface in June 2009 (equivalent to 663 kg Br/ha). The average Bromide cumulative flux recovery in AETLs through the vadose zone is shown in Figure 1.2 and summarised in Table 1.1. Due to damage to the facility suffered from a lightening strike, and the watertable rising, complete break-through data could not be recorded in the AETLs installed at 2.6, 4.2 and 5.2m depths. The variability in the fluxes measured in AETLs at the same depth was generally high. However, where complete data could be measured, the average at a depth tended to be close to unity. At the 4.2 m depth, no bromide was detected in the AETL installed in a Palaeosol (buried soil) layer. This is in comparison to the two plates in the ignimbrite material, at the same depth, which recovered 74% (incomplete) of the bromide tracer applied.

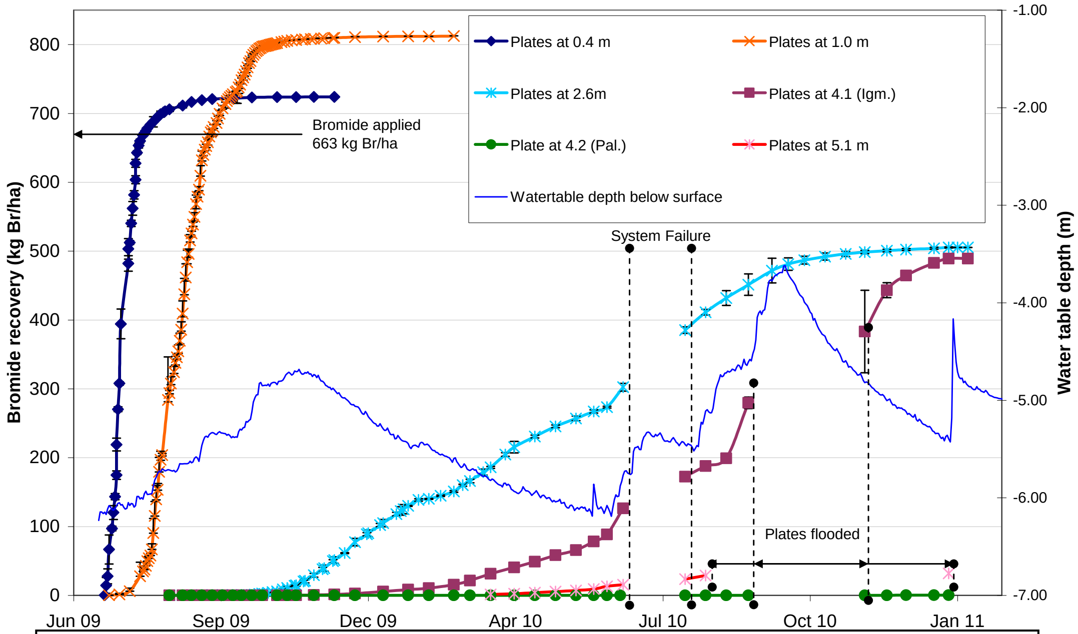

Figure 1.2 Average Br recovery (kg Br/ha) +/- standard error, at the five sampling depths through the vadose zone, and depth to watertable (m)

Table 1.1 Recoveries through the vadose zone from a surface applied bromide tracer. Applied 663 kg Br/ha

Depth of AETLs (m)	Average recovery kg Br/ha	% of app.	Standard error kg Br/ha
0.4	724	109	132
1.0	812	122	532
2.6	505*	76*	47
4.2 (Ign.)	489*	74*	176
4.2 (Pal.)	0*		
5.2	32*	5*	32
*incomplete collection due plates flooded and/or system failure			

Urine and tracer application. To investigate nutrient transformations through the vadose zone, a urine pulse (473 kg N/ha) with chloride added as a tracer was applied in August 2010. Initial results, adjusted for Cl. recovery (0.82 and 1.01, resp.) for the two upper sampling depths at 0.40 and 1.0 m are shown in Figure 1.3.

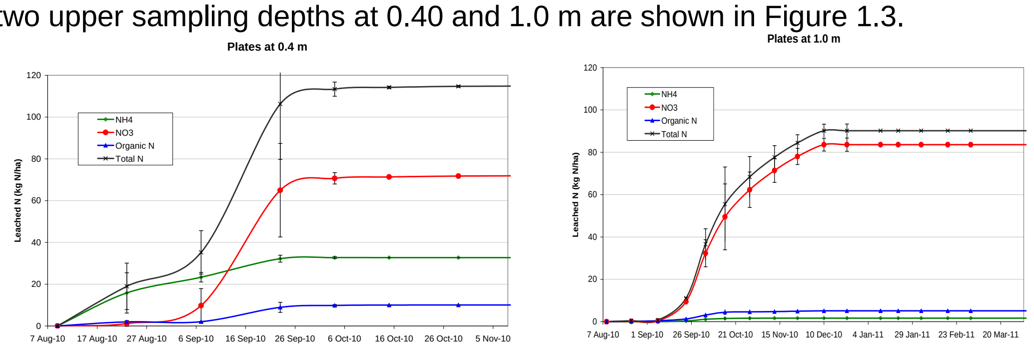

Figure 1.3 Nitrogen recovery and forms (kg N/ha) +/- standard error, at the 0.4 and 1.0 m AETL

The average reduction in the Total-N flux (kg N/ha/event) between the surface and 0.45 m depth is 76% (473 to 115 kg N/ha/event). The subsequent reduction at the 1.0 m AETL depth is then only 5% (90 kg N/ha).

References

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