

WATER AND CONTAMINANT FLUXES IN A TAUPO VADOSE ZONE

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Introduction

Changes in land use over the last 50 years have been suggested as the primary reason for early signs of deterioration in water quality of Lake Taupo. The primary pathway for contaminant fluxes from land use changes to the Lake is via the vadose zone-groundwater continuum. However, understanding the fate of the contaminants along this pathway is hampered by difficulties in obtaining reliable data on these fluxes. To address this knowledge gap a field experiment designed to measure water and contaminant fluxes leaching through a vadose zone has been installed in the Tutaeuaua sub-catchment northwest of Lake Taupo.

Vadose zone description

The modern soil belongs to the Oruanui loamy sand series (Podzolic Orthic Pumice soil) and is underlain to a depth of ca. 4.5 m by Taupo ignimbrite from the ca. 1.8 ka BP Taupo eruption. As found often in volcanic zones, palaeosols (buried soils) are present below the parent material of the modern soil at approx. 4.5 to 5.8 m depth. The palaeosols are then followed by Oruanui ignimbrite material derived from an eruption ca. 26.5 ka BP. The depth to the groundwater varies between approx. 6.5 and 3.8 m below GL. The vadose zone materials has been described in terms of physical, chemical and biochemical characteristics from intact cores and samples collected during the installation of the monitoring system.

Experimental system

A relatively new measurement technique that uses large porous sintered stainless steel plates (0.23 m²) is being used to measure fluxes through the vadose zone at the field site. Fifteen Automated Equilibrium Tension Plate Lysimeters (AETLs) were installed around the outside of a 2.3 m diameter caisson down to 5.1 m (three AETL at each of five depths). The central caisson provides access to the AETLs and allows for leachate collection. 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 procedure ensures that the fluxes measured by the AETLs are equivalent to those occurring in the vadose zone.

Tension Results

The experimental site became fully operational in mid-February 2008. Tensions recorded in the vadose zone are shown in Fig. 1 from February through to June. While the tensions at the 0.4 m depth responded strongly to a rainfall event at the end February the tensions at 1.0 m depth did not respond and continued to increase until mid-April. By this date, the

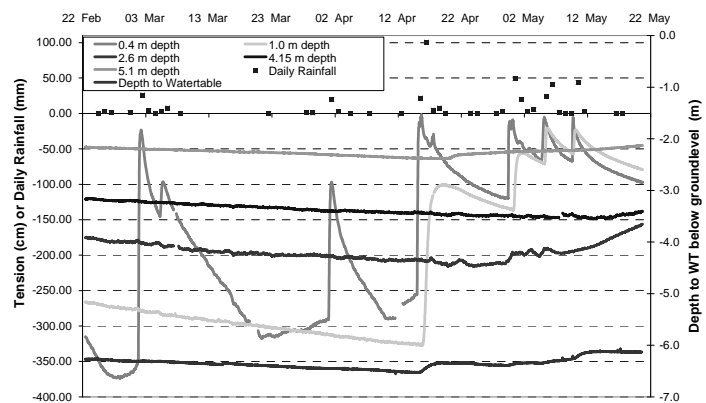


Fig1: Daily rainfall, tensions and depth to watertable measured through the vadose zone from Feb. to June 2008.

tension at 1.0 m had reached a maximum of 325 hPa before it decreased to 100 hPa, when the 130 mm rainfall event wetted the profile up. The measured increase in the watertable, for the same event, was due to the catchment wide response to the rain that fell as it could not be explained solely by vertical recharge measured at the site.

Flux Measurements

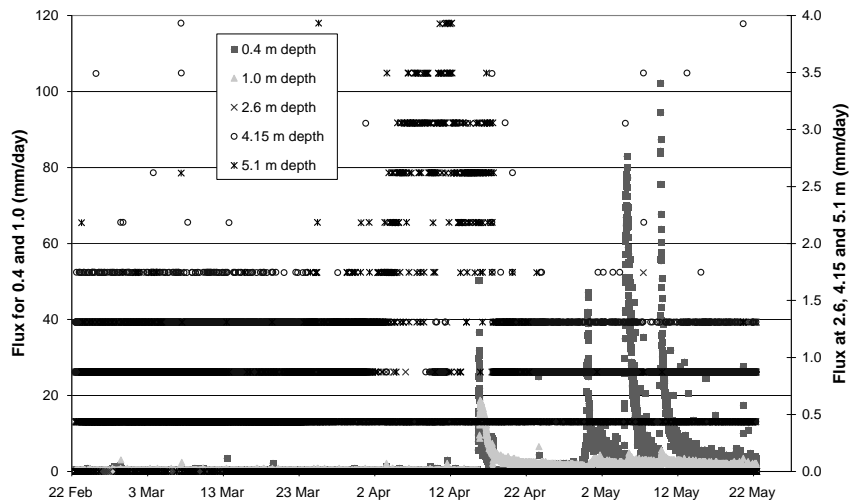


Fig 2: Flux measured through the vadose zone from Feb. to June 2008

The corresponding fluxes for the same period are shown in Fig 2. The maximum fluxes and most dynamic response were recorded at the 0.4 m depth. The maximum flux measured at this depth increased with each rainfall event up to a maximum rate equivalent to 100 mm/day (measured over 15 min.). This response reflects the increasing hydraulic conductivity of the material above the plates as it gradually

wetted up over the autumn period. The second-highest fluxes were measured at the second AETL depth (1.0 m). However, after the initial wetting up event in mid-April, the fluxes were more uniform at this depth than the episodic fluxes measured at 0.4 m. In agreement with the tension data, fluxes tend to be more uniform over time with depth.

Gas Measurements

The vadose zone average N_2O and CO_2 concentrations from Dec. 2007 to April 2008 were relatively stable as shown in Fig 3. The N_2O concentrations increased with depth below 1.0 m. The CO_2 concentrations showed a similar response also increasing with depth below 1.0 m. However, CO_2 concentrations peaked at the 4.15 m depth which is the top of the Palaeosol, as opposed to the N_2O which continued to increase down to 5.1 m.

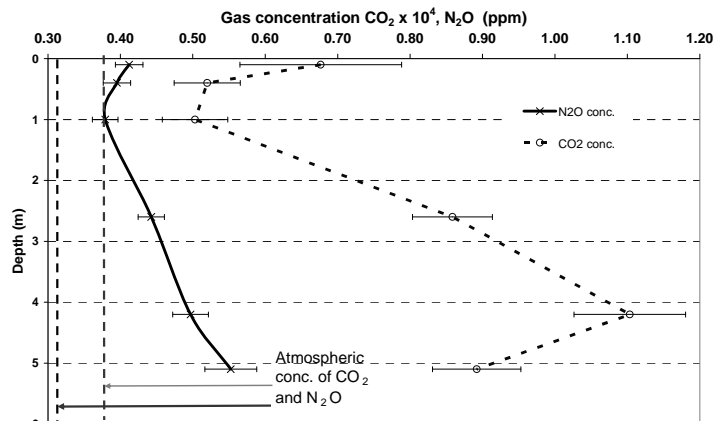


Fig 3: Average N_2O and CO_2 concentration measured through the vadose zone from Dec. 2007 to April 2008.

Nitrogen, Carbon and Phosphorus Measurements

The concentrations and fluxes of nitrogen, carbon and phosphorus that have been measured moving through the vadose zone at the field site will be discussed in this presentation.