Soil properties and hydrological processes on Moutere gravels, Nelson

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The Moutere gravels are an extensive Pliocene-early Pleistocene gravel sheet that fills the Moutere depression. A long period of fluvial erosion has resulted in the original gravel sheet now forming hill country characterised by a fine-textured "herringbone" dissection pattern. The alluvial sediments are deeply weathered to form a clay-bound gravel capped by a climosequence of strongly weathered and leached soils (Mapua, Rosedale, Stanley, Spooner, Korere, Hope soils). This hill country covers about 10,000 ha in Nelson. Since the original broad scale soil survey of the Moutere gravels by Cawthron Institute in the 1930s and 40s there has little mapping or characterisation of the soils. Because of relatively low rainfall and high evapotranspiration, water supply (from surface and ground water) is a key land use issue in the drier areas of Moutere gravels soils.

As part of investigations of water use by pasture and pine forest on Moutere gravels, Rosedale soils were characterised and soil water dynamics studied in two zero-order drainage basins with comparable topography and soils. Thirty sites were instrumented with neutron probe access tubes and recording tensiometers to characterise soil water dynamics in all slope positions under both pine trees and pasture. Soil physical properties and root distribution were measured by core sampling and *in situ* measurements at eight sites. Transpiration by pines was measured by sap flux gauges.

The soils are characterised by: slightly to moderately stony upper horizons overlying very to extremely stony subsoils; highly weathered to completely weathered clasts in upper horizons becoming less weathered with depth; a subsoil maximum in clay content in a Bt horizon, with common clay and silt bridging between clasts; high silt content in all horizons; weak subsoil structure and firm consistence; common mottling in the subsoil (both high chroma and low chroma). Chemical analysis of four soils indicated two under pasture were Mottled-acidic Orthic Brown soils (backslope and hollow), while under pine forest one was an Acid Firm Brown soil (backslope) and the other was a Mottled Acid Brown soil (footslope). Soils on ridge crests and upper slopes tend to have higher stone content in the upper 0.5 m of soil and less mottling than those on lower slopes.

Soil dry bulk density increases rapidly with depth, exceeding 1.5 t/m^3 in all B horizon samples from depths greater than 0.3 m. Macroporosity is less than 10% of soil volume in B horizons. Roots under both pasture and pines are abundant in A horizons and few in B horizons, with root concentrations less than 0.5 cm^{-2} below 0.3 m depth. K_{sat} exceeds 10 mm/h in A horizons, but is typically less than 2 mm/h in B horizons.

These physical characteristics dominate the hydrological behaviour of the soils, both in summer when potential evaporation exceeds rainfall and dry soil conditions limit transpiration of pines and pasture, and in winter when rainfall exceeds evaporation and surplus water drains to streams and to groundwater. Although most rainfall infiltrates at the soil surface, soil surface runoff occurs on dry surfaces in summer. A water table is often present in B horizons in winter on lower slopes, and for short periods during rainfall on upper slopes. The soil physical constraints on rooting depth result in similar water extraction patterns under pines and pasture in summer.