

Changes in carbon and nitrogen stocks following conversion of plantation forest to dairy pasture on Vitrandis (Pumice Soils), New Zealand

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Introduction

Between 1990 and 2010 some New Zealand plantation forests underwent deforestation to establish dairy farms. The main area of land-use conversion to pasture is to the north of Lake Taupo in the Central North Island (Figures 1 and 2). *Pinus radiata* (radiata pine) plantations were established in the late 1920s-early 1930s because the Vitrandis (Pumice Soils) predominant in the Central North Island were deficient in Co and other trace elements, causing a fatal stock disease in sheep and cattle known as ‘bush sickness’. Bush sickness was subsequently rectified in the mid-1930s with the regular addition of Co, so pastoral farming became viable. The high price of milk solids has recently led to renewed interest in dairying. Recent studies have shown carbon can accumulate following deforestation and establishment of pasture (Fearnside and Barbosa, 1998; Murty *et al.* 2002; Hedley *et al.* 2009). However, more information on the rate of accumulation of carbon after deforestation is needed. Increases in soil carbon can improve physical and chemical soil properties, and is an important store of global carbon.

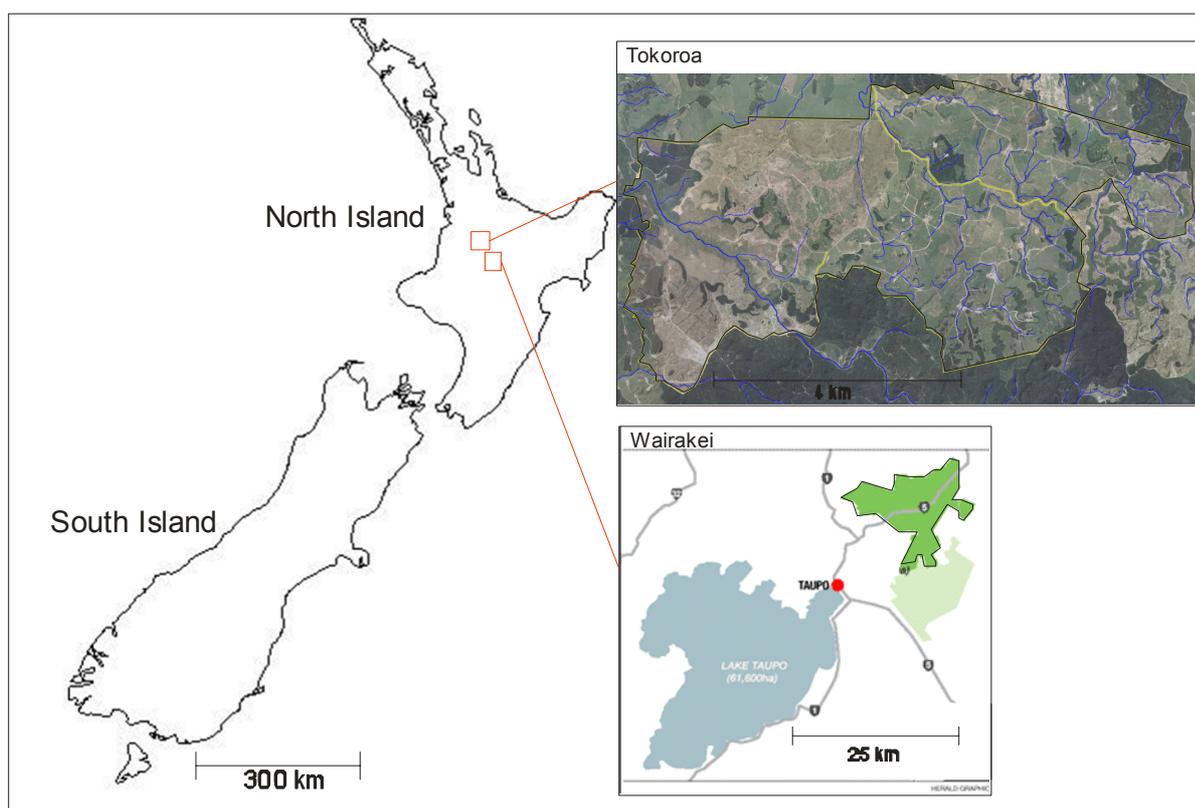


Figure 1. Location of study area, central North Island, New Zealand.

Hedley *et al.* (2009) found a mean rate of 4.07 mg cm^{-3} per year carbon accumulation in the central North Island at sites that had undergone deforestation and conversion to pasture. They sampled the top 150 mm of soils, at sites 1 and 5 years after conversion, as well as sites in pasture for over 20 years. The highest concentration of carbons was reported in long-term pastures (Hedley *et al.* 2009).

The objective of our study is to determine the rate and magnitude of change in soil carbon and nitrogen following conversion to pasture from plantation forest. Specific objectives include determining the carbon and nitrogen concentration for the soil profile down to 60 cm along with the change in carbon to nitrogen ratio with a change in land use.



Figure 2. Pasture establishment following deforestation, approximately 10 km north of Taupo, central North Island, New Zealand (a. land being prepared for pasture, b. land 3 years after pasture establishment).

Study sites and methods

My study examines two study areas in the Central North Island, one near Taupo and the other about 50 km to the north, near Tokoroa (Figure 1). Both areas have undergone conversions from second or third rotation *Pinus radiata* forest to dairy pasture. Soils are Udivitrands (Soil Taxonomy) or Pumice Soils (NZ Soil Classification) formed on the Taupo tephra deposited in 232 ± 4 AD, i.e., about 1780 years ago (Hogg *et al.* 2009), and are on either flat or rolling land under similar humid, temperate climates (udic moisture and mesic temperature regimes). Sites ranging from current *Pinus radiata* forest through sites that have been under dairy pasture for 2, 3, 4 and 5 years to over 50 years under dairy pasture have been identified at each study area, giving 14 sampling sites. All sites are on the same landscape unit, a terrace with an elevation of 300 – 400 m asl. Three soil pits were excavated and sampled at each site. Soil bulk densities were measured using 6 cm diameter and 5 cm deep rings. Samples were oven dried and weighed to determine the dry bulk density of soil. Soil carbon and nitrogen content is to be determined on bulk samples of soil taken from individual horizons from each soil pit, using an emission on combustion method. To capture some of the variability a 60 cm corer was used to take 18 cores from around each paddock in which the pits have been dug. Each core was split into horizons and the horizons bulked for a carbon and nitrogen sample. Samples will be taken down to 60cm where possible.

Preliminary results and discussion

There are distinct pedological differences between the soils under forest, recently converted sites, and longer term pasture. Soil bulk densities in the A horizon are lowest under forest. Soil A horizons are more strongly developed with stronger aggregate development under long-term pasture. Soil dry bulk densities for a site 2 years since pasture establishment had an Ap horizon ranging from 0.62 to 0.72 g cm^{-3} , Bw were 0.70 to 0.82 g cm^{-3} , and Cu were between 0.74 to 0.77 g cm^{-3} . Below 50 cm a paleosol was found. The paleosol had the most consistent results for bulk density with between 0.63 and 0.64 g cm^{-3} . Further analytical work is being undertaken at multiple sites to obtain bulk densities along with carbon and nitrogen concentrations.

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