

Phosphorus chemistry in managed forest soils: effects of whole-tree harvesting, wood ash fertilization, and climate change

Background

Phosphorus (P) is an essential nutrient that plants need to build their biomass. Although levels of total P in the forest soils can be relatively high, the largest P fraction is immobile due to fixation to secondary aluminum (Al) and iron (Fe) mineral phases. In acid forest soils such as boreal Podzols, the primary mineral apatite (the main source of P in soils), is rapidly depleted. The dissolved P is then retained by Al and Fe. Thus, P availability is generally low, even more so after forest harvesting and when N availability is high e.g. due to N deposition. In particular, whole-tree harvesting, which is commonly practiced in Sweden, has been reported to remove soil P and other nutrients. The lost P pool can be restored by recycling the wood ash following the harvest of logging residues. Yet, the mechanisms that affect the fate of ash-P in soil are less well known. N is often a limiting nutrient in temperate and boreal forest ecosystems. However, recent research has reported increasingly P limitations although the soils in these regions are still young. To fully understand the processes leading to nutrient limitation in boreal forests, detailed knowledge of P chemistry is required. This knowledge will further help in the current forest management and mitigate P-related eutrophication.

Aim

The overall aim of this project is to explore how P cycling and speciation are affected by weathering of soil minerals, forest management, and wood ash and N fertilization. I assess P distribution and speciation in soil profiles up to 1 m depth including organic horizons. Insights from microscopic to macroscale.

Methods

Nine forest soils from the north, central, and south of Sweden are used in this study. These soils encompass a variation in geochemical conditions. Experimental methods include bulk XANES and micro-XRF/XANES generated by synchrotron radiation, and chemical extractions. I also quantify P stocks to help assess the extent to which mineral weathering, podsolization, and wood ash application have redistributed and shifted P pools.