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Weak retention of dissolved organic phosphorus in mineral soils is a major contributor to phosphorus loss from forest ecosystems

Klaus Kaiser (1), Dominik Brödlin (2), Robert Mikutta (1), Pauline Winkler (1), and Frank Hagedorn (2)

(1) Martin Luther University Halle-Wittenberg, Soil Science and Soil Protection, Halle (Saale), Germany, (2) Swiss Federal Institute for Snow, Forest and Landscape (WSL), Birmensdorf, Switzerland

Phosphorus leaching from soils may contribute to the phosphorus impoverishment of forest ecosystems but quantitative estimates of the leaching of dissolved inorganic and organic phosphorus are limited. Our studies of dissolved phosphorus over a 48-month period revealed that the release of inorganic phosphorus in the forest floor decreases along a soil gradient of decreasing phosphorus stocks, suggesting increasingly recycling of secondary organic sources with increasing phosphorus scarcity. Also, the release of organic phosphorus decreased but far less strongly than that of inorganic phosphorus. We assume this to result from a increasingly larger portion of organic matter that needs to be processed for maintaining the ecosystems' phosphorus supplies. The increasing release of dissolved organic carbon, and thus, increasing DOC-to-DOP ratios along the gradient support that idea.
Upon entering the mineral soil, the water percolating from the forest floor becomes depleted in dissolved phosphorus. The abrupt decrease is likely due to sorption by reactive mineral phases, especially hydrous aluminium and iron oxide phases. The decrease is much more pronounced for inorganic than for organic phosphorus, which is in agreement with sorption tests showing that the organic phosphorus in the forest floor solutions is far less effectively sorbed by goethite, an iron oxyhydroxide, than the inorganic phosphorus. The decrease in dissolved phosphorus upon contact with the mineral soils becomes weaker along the phosphorus gradient, which reflects the decrease in reactive mineral phases in upper mineral soils. Again, the retention of organic phosphorus is more affected.
With increasing soil depth, the concentrations of dissolved inorganic phosphorus decrease gradually. Nevertheless, dissolved inorganic phosphorus is still detectable in the subsoils. No such gradual decrease with depth occurs for dissolved organic phosphorus, suggesting that the phosphorus-containing compounds remaining in solution are either non-sorptive or that desorption re-supplies dissolved phosphorus. Repeated sorption tests with dissolved organic phosphorus not initially sorbed by goethite showed that most of the compounds not sorbed are indeed not sorptive. In result, the dissolved organic phosphorus concentrations remain largely constant throughout most of the studied mineral soils.
In consequence, organic phosphorus becomes the most prominent form of dissolved phosphorus in the deeper mineral soils. It is, thus, a major contributor to the phosphorus leaching from soils. This tendency increases along the studied gradient of decreasing phosphorus stocks and suggests that leaching of organic forms increases the more an ecosystems needs to rely on the re-use organic than on the acquisition of inorganic phosphorus.