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Manganese cycling in European forest ecosystems: influence of tree species

ROMAIN DUQUENNE[1], MATTHIEU HERPOEL[1], PATRICK BOGAERT[1], PIERRE DELMELLE[2] AND YANNICK AGNAN[3]

[1]Earth and Life Institute
[2]Earth & Life Institute, UCLouvain
[3]UCLouvain

Presenting Author: romain.duquenne@uclouvain.be

Manganese (Mn) plays a key role in soil organic matter dynamics, through stabilization or destabilization reactions according to environmental conditions. Yet, it has been shown that Mn is one of the most intensively recycled elements by vegetation in forest ecosystems, much more than iron or aluminum. This recycling limits the Mn flux outside the critical zone, i.e., from the soil–plant system to hydrosystem, as soluble form. An accurate quantification of Mn fluxes inside the ecosystem is therefore required. Among them, litterfall (dead leaves falling to the soil) and throughfall (rain water that percolates through canopy) represent non-negligible compartments, both largely influenced by environmental conditions, including the considered tree species. In this context, we propose to quantify the influence of tree species on Mn fluxes in forest ecosystems.

For this purpose, we used the European ICP Forests database that consists in a large environmental data set in forest ecosystems, including periodic measurements (volume and chemical composition) on atmospheric deposition (bulk deposition and throughfall), litterfall, soil solution, etc. We considered 500 sampling plots in Europe from early 1990's to 2018. Annual Mn fluxes were calculated for each main tree species. In parallel, other environmental variables were included in the analysis, such as climate and soil, using international databases (Copernicus and LUCAS, respectively).

Litterfall Mn fluxes were about five-times greater than those in throughfall considering the four main tree species in Europe (*Fagus sylvatica*, *Quercus robur*, *Picea abies*, *Pinus sylvestris*). For deciduous trees, throughfall represented about 10% of the total Mn fluxes, while it reached 20% for conifers. Interestingly, litterfall and throughfall fluxes were correlated together for each species. The tree species, together with climate and soil variables, appeared as an important factor, the tree species influencing the Mn fluxes in forest ecosystems. Since modifications in tree species distribution are expected following the adaptation of forest management to climate change, Mn cycling and soil organic matter dynamics are likely to change in forest ecosystems.