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Canopy-atmosphere interaction in forests: a key process in nutrient cycling and pollution interception

An efficient way for assessing the nutrient status of an ecosystem is the establishment of nutrient input-output mass balance budgets at the catchment scale. For example, outputs (i.e. losses in streamwater, through havesting etc.) greater than inputs (i.e. weathering, dry and wet deposition, fertiliser) indicate that a depletion of the given element is taking place. In forest ecosystems, element input via throughfall is an important pathway in nutrient cycling. Precipitation interacts with the stand canopy, resulting in increased/decreased solute inputs to the forest floor. For example, acid deposition (H, N) may be substantially increased through the filtering action of the tree canopy. Indeed, canopy throughfall chemical composition includes wet deposition (rainfall), dry deposition intercepted by the canopy and elements leached from the foliar tissue (canopy leaching). Moreover, interactions between canopy and atmosphere or precipitation depend on several factors such as: season, tree species and physiology, stand structure and health. However, canopy leaching results from an internal nutrient cycling process. Ignoring this component in throughfall measurements thus leads to an overestimation of the inputs to the ecosystem.

In this paper, main results of studies performed in the Belgian Ardennes at the watershed (80 ha) and plot scale are summarised. The aim of this research was to quantify long-term nutrient budgets in a forested watershed, within a context of sustainable management. In this area, soils are naturally acidic and poor in magnesium, so that forest dieback symptoms reported from 1983 onwards were related to increased pollution exacerbating magnesium deficiency. There is concern that acid (S and N) deposition, together with sylvicultural management (harvesting, spruce monocultures etc.) could deplete the available cation pool and that soils would not be able to support intensive sylviculture on the long term.

We measured concentrations and fluxes of major ions in bulk deposition, throughfall and stream water over 13 years. Throughfall deposition under coniferous (*Picea abies* (L.) Karst.) and several deciduous tree species was also compared. A canopy budget method was used for distinguishing between external (dry deposition) and internal (canopy leaching) sources of ions in the throughfall flux. The contribution of canopy leaching in throughfall measurements and consequences for mass balance calculations will be discussed. Furthermore, nutrient fluxes through the ecosystem will be examined with regard to the long term nutrient status of the system.

Keywords.
Canopy interactions, forest ecosystem, catchment, input-output budget, throughfall