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Soil-atmosphere interface: the impact of depositions on forest soils in Italy

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Acidification is a major soil-forming process. Emission of nitrogen (N) and sulphur (S) compounds has exposed forest ecosystems to acidifying anthropogenic deposition for several decades. Since the 1980s, the reduction of air emissions following the environmental regulations has been resulted in a decline of pollutant depositions. Nevertheless, in Italy, N depositions are still high, among the highest in Europe. Nitrogen from depositions has been found to favour plant growth, contributing to organic carbon uptake. However, a continuous accumulation of deposited inorganic N causes plant nutrient unbalances, and likely contributes to soil acidification more than commonly reckoned. At the same time, depositions of buffer elements are high and constant in Italy due to the proximity of the Saharan source. Within this context, our researches aim to explore the specific impacts of peculiar atmospheric deposition, hypothesising a strong influence of aeolian dusts, on forest soil ecosystem in Italy. Our main objectives are a) to evaluate the long term trends in soil solution elemental fluxes in relation to depositions trends; b) to investigate the soil response to pollution change and recovery, individuating whether soil acidification is, or not, an active process; c) to identify sites where the transfer of reactive N from atmospheric N pollution to fresh- or ground-waters is a real concern. We analysed data on deposition and elemental concentrations in soil solutions recorded at forest plots of the ICP Forests intensive monitoring network in Italy. We used a conceptual model based on input-output budgets estimating atmospherically derived fluxes of elements that enter terrestrial ecosystem through deposition and losses of elements through drainage water. For the base cation (BCE) budget, an estimate of rock-derived elements due to chemical weathering were also included in the model.

As for other countries in Europe, the concentration of SO_4 in soil solutions significantly decreased concomitantly with decreasing SO_4 deposition, while, differently from the European trends, an increase in BCE concentrations was found. The observed increase in soil solution pH in northern sites followed an increase of BCE with a decrease of SO_4 and no change for NO_3. In Central-Northern Italy, trends in soil solution pH were no significant; a neutralising effect on acidification was likely due to concomitant increases of NO_3 and BCE in soil solution. Further, the estimation of the overall BCE budget, comprising canopy and soil fluxes, evidenced a regular accumulation of K and Cain all sites, except for a site where soil base saturation is very high and a depletion of Ca was found. For Mg, depletion was strongly slowed down by the influence of deposition. It appears that in Italian forest soils, deposition of basic exchangeable cations is a major process, influencing both forest nutrition conditions and soil development. Our results suggest that soil acidification should not be considered an active process in forest sites of Italy. However, high inorganic nitrogen concentrations in soil solutions were found in sites with high N deposition loads, where regular N flux out of the rooting zone can represent a risk of ground- and fresh-water pollution.