

## **Quantifying plant-available pools of Ca, Mg and K in forest soils by stable isotopic dilution**

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The plant-available pools of Ca, Mg and K in the soil are assumed to be stored as exchangeable cations adsorbed on the cationic exchange capacity and are conventionally measured by ion-exchange soil extractions using a concentrated salt. However, our understanding of how trees cope with very low exchangeable pools is still incomplete. Between soil minerals and exchangeable cations exists a gradient of Mg, Ca, and K storage forms that have not been fully characterized and may play an important role in plant nutrition and biogeochemical cycles. We hypothesize that sources of Mg, Ca and K in the soil other than the conventionally measured exchangeable pools are plant-available on very short time scales

In this study, we quantified the pools of Mg, Ca and K that contribute directly to equilibrium reactions between the liquid and solid phases of the soil for 196 soil samples covering a wide range of pedo-climatic contexts (22 sites covering tropical, temperate and boreal contexts) using an innovative stable isotopic dilution approach (<sup>26</sup>Mg, <sup>44</sup>Ca & <sup>41</sup>K). Four sequential ammonium acetate or nitric acid soil extractions were then performed on the soil to recover the isotopic tracers in the solid phase.

For our dataset, the conventional exchangeable pools underestimated the plant-availability of Mg, Ca and K in 52%, 44% and 60% of all the measured soil samples by a factor ranging up to 3.7, 3.4 and 2.2 respectively. Our results also show that isotopic tracers in the soil solution were in equilibrium with soil phases (extracted with nitric acid) that are not commonly considered as plant-available on short-term time scales.

The isotopic dilution method is a relevant tool to quantify the plant-available pools of Mg, Ca, and K on short time scales (source and sink pools) and is a very promising approach to characterize and quantify the processes responsible for the depletion and/or replenishment of these pools over longer time scales.