Long-term Chronic Precipitation Change Did Not Modify Biogeochemical Feedbacks in an Upland Oak Forest

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- 12 years of sustained increased (+33%) or decreased (-33%) precipitation did not alter the cycling or availability of major plant essential elements (N, Ca, Mg, P, S).
- Measurements of element availability with resin membranes did, however, show higher values in wet and lower values in dry treatments compared with ambient conditions for N, K, Mn, Zn, and Al, but the opposite for B, Ca, and Mg.
- Long-term, cumulative experimental results differed from model predictions and suggest the need to add alternate sources of elements to terrestrial biogeochemical cycling models (e.g., deep rooting).

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To investigate the potential effects of changing precipitation on forest ecosystems, the Throughfall Displacement Experiment (TDE) was established on Walker Branch Watershed, Tennessee, in 1993. Three different throughfall amounts were tested: 33% (DRY); ambient (no change, AMB); and 133% (WET). Throughfall manipulations had no statistically significant effects on total C, N, exchangeable Ca^{2+}, Mg^{2+}, bicarbonate extractable P, or extractable SO^{4}- in soils after 12 years of sustained treatments. Increased K^{+} inputs in the WET treatment resulted in relative increases in exchangeable K^{+} compared with the AMB and DRY treatments. Soil C, N, and extractable P declined in all treatments over the 12-year study, and the declines in N were inexplicably large. Field observations contrasted with earlier simulations from the Nutrient Cycling Model (NuCM), which predicted greater decreases in exchangeable K^{+}, Ca^{2+}, Mg^{2+}, and extractable P in the order WET>AMB>DRY, and no change in C, N, and extractable SO^{4-}. The failure of the NuCM model to accurately predict observed changes is attributed to the lack of mechanisms for deep rooting and the transfer of throughfall K^{+} from one plot to another in the model. Measurements of element availability using resin membranes during the final years showed higher values in wet and lower values in dry treatments compared with ambient conditions for mineral N, K, Mn, Zn, and Al, but the opposite for B, Ca, and Mg. In the cases of Ca and Mg, the patterns in resin values were similar to those at the soil exchange sites (greatest in the dry treatment) and appeared to reflect pretreatment differences. This study showed that while longer term changes in soil nutrients are likely to occur with changes in precipitation, potential changes over this 12-year interval were buffered by ecosystem processes such as deep rooting.

Johnson DW, Todd DE Jr., Hanson PJ (2008) The effects of throughfall manipulation on soil nutrient status: results of 12 years of sustained wet and dry treatments. *Global Change Biology* 14:1661-1675.