COMMENTS AND LETTERS TO THE EDITOR

Comments on “Thirty Years of Change in Forest Soils of the Allegheny Plateau, Pennsylvania”

Bailey et al. (2005) found substantial declines in exchangeable base cations over a 30-yr period in soils of the Allegheny Plateau. They cannot attribute these changes to uptake and sequestration by vegetation and therefore ascribe the changes to “off-site leaching,” and note that these changes are “consistent with studies that have suggested that acid deposition has induced significant losses of exchangeable base cation pools by hydrologic leaching” (p. 688). Close examination of Table 3 in their manuscript does not support this speculation, however. If the observed changes in exchangeable Ca$^{2+}$ and Mg$^{2+}$ are converted to kmol ha$^{-1}$, the changes in Ca$^{2+} +$ Mg$^{2+}$ (M$^{2+}$) that cannot be ascribed to vegetation uptake are 581.3, 184.0, 19.8, and −9.0 kmol ha$^{-1}$ for the Dewdrop (DD), Fools creek (FC), Heart’s Content (HC), and North Branch (NB) sites, respectively. On an annual basis (dividing by 30 yr), this amounts to 19.4, 6.1, 0.7, and −0.3 kmol ha$^{-1}$ yr$^{-1}$, respectively. The values for DD and FC appear to be well beyond what could be attributed to total S and N deposition, equivalent to 310 and 98 kg ha$^{-1}$ yr$^{-1}$ of S or 271 and 86 kg ha$^{-1}$ yr$^{-1}$ of N. According to NADP maps, wet deposition of S for this region appears to be on the order of 12 kg ha$^{-1}$ yr$^{-1}$ as S (35 kg S ha$^{-1}$ yr$^{-1}$ as SO$_4^{2-}$) and (NO$_3^-$ + NH$_4^+$)–N deposition is on the order of 8 kg ha$^{-1}$ yr$^{-1}$ as N (21 kg ha$^{-1}$ yr$^{-1}$ as NO$_3^-$ and 4.1 kg ha$^{-1}$ yr$^{-1}$ as NH$_4^+$) (NADP, 2003). Even if major N inputs occurred by dry deposition, it seems extremely unlikely that atmospheric deposition contributed substantially to the observed changes at DD and FC. Nor would natural leaching rates, typically on the order of 0.5 to 2 kmol ha$^{-1}$ yr$^{-1}$ (Johnson and Lindberg, 1992), contribute this much to base cation leaching, unless limestone parent material is being weathered. The value for HC is within the range of what might be expected due to leaching processes, but the value for NB is in fact negative, implying that weathering exceeded base cation loss because soils did not lose as much base cations as were sequestered by vegetation.

Thus, the changes in soils documented by Bailey et al. (2005) are not consistent with what could be expected due to leaching or to acid deposition. Given their careful and extensive quality assurance program, the observed changes have to be accepted as real until proven otherwise, and further investigation is definitely warranted to uncover the causes of these changes.

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Response to “Comments on ‘Thirty Years of Change in Forest Soils of the Allegheny Plateau, Pennsylvania’”

In our paper (Bailey et al., 2005) we documented substantial reductions in exchangeable Ca and Mg at four forested sites over a 30-yr period. Expressed on a soil mass basis are remarkably consistent between and within sites. We expressed these results on a landscape area basis and suggest that the changes in base cation pools are large to be accounted for by forest growth. We further suggest that long-term loss of exchangeable cations was consistent with mass balance, modeling, and experiment studies. We did not attempt an exact assessment of losses by uptake versus leaching due to uncertainties associated with estimates of soil pools, biomass uptake, and leaching processes.

Conversion of the observed soil changes to a landscape area basis is necessary for an evaluation of nutrient cycling but introduces uncertainty, primarily due to local variation in rock content. For example at Dewdrop, the site with the five sampling pits rock content varied between 42 and 44% from 5 to 50% by volume. Use of quantitative techniques would improve the accuracy of measurements within individual sampling pits, but the pits needed to precisely address rock content variation would have been prohibitive here as it is in many forest sites.

Johnson (2005) argues that the estimated declines in a landscape area basis are much too large to be accounted for by acid deposition. However, the uncertainty in the total acid deposition levels for this region for the period between 1967 and 1997 at the nearby Kane Experimental Forest did not begin until the early 1980s and cannot be considered significant. The estimate Johnson (2005) cites is not the one used because it is based on wet-only deposition for a single year, or to acid deposition. Given their careful and extensive quality assurance program, the observed changes have to be accepted as real until proven otherwise, and further investigation is definitely warranted to uncover the causes of these changes.

References

