changing land use leaves something to be desired. For example, there is no explanation in the report of data showing that (i) in the watersheds studied that lacked dairy farming, 78 percent of the lakes were fishless; (ii) in watersheds with abandoned dairy farms, 60 percent of the lakes had no fish; and (iii) in watersheds with active farming, only 30 percent were fishless (*33*). Furthermore, acidification predates the occurrence of acid rain with a *p*H less than 4.7, or the 40 years mentioned by Wright. Acidification and loss of fish from mountain lakes in Norway dates back to at least 1900 (*29, 34*). Where losses of salmon have been reported in rivers of southern Norway, most of the decline occurred between 1910 and 1920, with great fish kills after heavy rains and snowmelts (*35*). Acidification and fishing losses were public concerns in Norway by the 1920's (*35*).

Despite Wright's assertion, soils are not uniform over all of Norway. Soils in southernmost Norway are generally more acid, thinner and rockier than those further north (*36, 37*). Thus, edaphic and hydrologic conditions are more favorable for acidification of runoff and surface waters in the south of Norway (*38*). Careful examination of maps of soil, *p*H of rainfall, and acidity of surface waters clearly show that the distribution of acid waters (*4*) is much better correlated with the distribution of acid podzols, peats, and thin lithic associations (*37*) than with the distribution of acid rain (*4*).

The comment by Johnson *et al.* that deforestation produces nitric acids, not organic acids, misses the point. First, foresters did not follow clear-cutting with herbicides as was done at Hubbard Park: they wanted vegetation to return. It is the recovery of the forest that results in the gradual acidification of soil by the accumulation of acid humus, a process that requires many years. We used Rosenqvist's biomass data to illustrate the accumulation of organic acids, but we criticized estimates of net cation uptake in biomass as being incomplete estimates of mineral weathering. Although it is necessary to distinguish between acid soil and the acidity that drains from it, we believe that there is now more than sufficient evidence that water draining from acid soils will be acid.

The recognition that naturally occurring acid soils can contribute to the acidification of lakes and streams represents a significant advance in our understanding of this serious environmental problem which heretofore has been attributed to acid rain. It is clear, however, that the relative roles of acid soil and acid rain need closer scrutiny. We hope that some of the resources now devoted to documenting the extent of the problem can be redirected toward determining its cause.

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References and Notes

1. N. M. Johnson, paper presented at the 185th American Chemical Society National Meeting, Las Vegas, Nev., 28 March to 2 April 1982.
2. M. H. Pfeiffer and P. J. Festa, *Acidity Status of Lakes in the Adirondack Region of New York in Relation to Fish Resources* (New York State Department of Environmental Conservation, Albany, 1980).
3. T. A. Haines, J. Akielaszek, P. Rago, *Air Poll. Acid Rain Rep.* **15**, 1 (1983).
4. R. F. Wright *et al.*, *SNSF Proj. Int. Rep. IR 33/77* (1977). Color reported on 142 of the 155 headwater lakes and 25 of the 28 lakes with a *p*H of less than 5.
5. A. G. Everett *et al.*, in *Proceedings of the Second National Symposium on Acid Rain* (Greater Pittsburgh Chamber of Commerce, Pittsburgh, Pa., October 1982).
6. J. R. Colquhoun, J. Symula, M. Pfeiffer, J. Feurer, *Preliminary Report of Stream Sampling for Acidification Studies 1980* (Technical Report 81-2, New York State Department of Environmental Conservation, Albany, 1981).
7. E. C. Krug and P. J. Isaacson, *Soil Sci.* **137**, 370 (1984).
8. ——, C. R. Frink, *Appraisal of Some Current Hypotheses Describing Acidification of Watersheds* (Paper 84-22.5, 77th Annual Meeting of the Air Pollution Control Association, San Francisco, 27 June 1984).
9. K. Molvaersmyr and W. Lund, *Water Res.* **17**, 303 (1983).
10. C. S. Cronan, *Plant Soil* **56**, 301 (1980).
11. S. Thunmark, *Sveriges Geol. Undersokn.* **410C**, 1 (1937); J. K. Underwood *et al.*, *Acidification of Nova Scotia Lakes II: Ionic Balance in Dilute Waters* (Paper P-5-7, Nova Scotia Department of the Environment, Halifax, 1982).
12. J. W. Hornbeck, G. E. Likens, J. S. Eaton, *U.S. For. Serv. Gen. Tech. Rep. NE-23* (1976), p. 597.
13. N. M. Johnson, *Science* **204**, 497 (1979); N. M. Johnson, C. T. Driscoll, J. S. Eaton, G. E. Likens, W. H. McDowell, *Geochim. Cosmochim. Acta* **45**, 1421 (1981).
14. T. Wood, F. H. Bormann, G. K. Voight, *Science* **223**, 391 (1984).
15. W. M. Smallwood, *Am. Nat.* **52**, 322 (1918); C. E. Johnson, *Roosevelt Wild Life Bull.* **4**, 495 (1927).
16. W. C. Kendall, *ibid.* **2**, 205 (1924).
17. G. E. Likens, F. H. Bormann, R. S. Pierce, J. S. Eaton, N. M. Johnson, *Biogeochemistry of a Forested Ecosystem* (Springer-Verlag, New York, 1977).
18. L. J. Zeman, thesis, University of British Columbia, Vancouver (1973); M. C. Feller and J. P. Kimmins, *Water Resourc. Res.* **15**, 247 (1979).
19. G. E. Likens, F. H. Bormann, N. M. Johnson, R. S. Pierce, *Ecology* **48**, 772 (1967).
20. B. Heimath, *Z. Pflanzenernahr. Dueng. Bodenkd. A.* **31**, 229 (1933); J. S. Joffe, *Soil Sci.* **35**, 239 (1933); H. J. Atkinson and R. R. McKibben, *Can. J. Res.* **11**, 759 (1934); E. Gorham, *Ecology* **39**, 770 (1958); G. E. Hutchinson, *A Treatise on Limnology*, vol. 1, *Geography, Physics and Chemistry* (Wiley, New York, 1957).
21. A. S. Lefohn and G. O. Klock, *The Possible Importance of Naturally Occurring Soil Processes in Defining Short-Term pH Depressions Observed in United States' Surface Waters* (draft, Environmental Protection Agency, Washington, D.C., 1983).
22. R. A. Parnell, *Environ. Geol.* **4**, 209 (1979).
23. N. M. Johnson, G. E. Likens, F. H. Bormann, R. S. Pierce, *Geochim. Cosmochim. Acta* **32**, 531 (1968).
24. M. P. Billings, *Bull. Geol. Soc. Am.* **48**, 463 (1937); M. T. Heald, *ibid.* **61**, 43 (1950); G. E. Moore, *ibid.* **60**, 1613 (1949).
25. H. M. Seip, G. Abrahamsen, E. T. Gjessing, A. Stuanes, *SNSF Proj. Int. Rep. IR 46/79* (1979).
26. R. T. Buckney and P. A. Tyler, *Aust. J. Mar. Freshwater Res.* **24**, 267 (1973).
27. D. D. Richter, *Environ. Sci. Technol.* **18**, 632 (1984).
28. A. Skartveit, in *Ecological Impact of Acid Precipitation*, D. Drabløs and A. Tollan, Eds. (SNSF Project, Oslo, 1980), pp. 242–243; A. Skartveit, *Nord. Hydrol.* **12**, 65 (1981).
29. L. N. Overrein, H. M. Seip, A. Tollan, Eds., *SNSF Proj. Res. Rep. FR 19/80* (1980).
30. P. L. M. Veneman *et al.*, *Geoderma* **33**, 89 (1984).
31. I. Th. Rosenqvist, *Sci. Total Environ.* **10**, 271 (1978).
32. H. Dost, Ed., *Acid Sulfate Soils* (Publ. 18, International Institute of Land Reclamation and Improvement, Wageningen, Netherlands, 1973), vols. 1 and 2.
33. D. Drabløs, I. Sevaldrud, J. A. Timberlid, in *Ecological Impact on Acid Precipitation*, D. Drabløs and A. Tollan, Eds. (SNSF Project, Oslo, 1980) pp. 367–369; P. F. Duhaine, A. G. Everett, W. C. Retzsch, *Adirondack Land Use: A Commentary on Past and Present Impacts on Terrestrial and Aquatic Ecosystems* (American Petroleum Institute, Washington, D.C., 1983).
34. I. Th. Rosenqvist, *Sci. Total Environ.* **10**, 39 (1978); in *Advances in Environmental Science and Engineering*, J. R. Pfafflin and E. N. Zieler, Eds. (Gordon & Breach, New York, 1980), vol. 3, pp. 56–79.
35. K. Dahl, *Salmon Trout Mag.* **46**, 35 (1927); H. Leivestad, G. Hendrey, I. P. Muniz, E. Snekvik, *SNSF Proj. Res. Rep. FR 6/76*, 87 (1976).
36. H. Bergseth, *Acta Agr. Scand.* **27**, 269 (1977); S. Oden, *U.S. For. Serv. Gen. Tech. Rep. NE-23*, 1 (1976).
37. J. Låg, *Jordsmonnkart over Norge* (Scale 1:2,000,000) (Norges Landbruks., As, 1979).
38. ——, in *Fresh Water on the Sea*, S. Skreslet *et al.*, Eds. (Association of Norwegian Oceanographers, Oslo, 1976), pp. 21–25.

Boiling Drinking Water

The timely and important letter by P. J. Isaacson, L. Hankin, and C. R. Frink (17 Aug., p. 672) showing that boiling drinking water removes ethylene dibromide residues comes as no surprise to knowledgeable Washingtonians. Our public water supply, consisting at times of much of the flow of the Potomac River, contains many elements that can be significantly reduced by boiling. Volatile halogenated hydrocarbons, the result of either pollution or de novo synthesis upstream are efficiently removed by boiling, as judged by samples spiked with ethylene dichloride (*1*). Chlorine, sometimes approaching breakpoint concentrations, is effectively decreased by boiling, at least by organoleptic test. In many ground waters, seasonal blooms of algae produce peculiar flavors that may be partially eliminated by boiling. Finally, boiling may reduce the risk from infectious contaminants that have escaped treatment.

Most carcinogens are unaffected by simple boiling of ground water, but as an alternative to home filtration systems, distilled or deionized drinking water, or imported mineral water, boiling is the most cost-effective and pragmatic step the individual can take to avoid the effects of at least a few of the environmental insults with which one is faced.

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References

1. C. H. Fox, unpublished gas-liquid chromatography determinations.