ACID RAIN AND DRINKING WATER DEGRADATION

PAULETTE MIDDLETON and STEVEN L. RHODES
National Center for Atmospheric Research*, Boulder, CO 80307, U.S.A.

(Received August 7, 1983)

Abstract. Acid deposition-induced drinking water degradation is discussed with respect to the geographical extent of and the potential for dealing with possibly adverse human health impacts. Qualitative evidence from the northeastern United States and Sweden strongly suggests the existence of a linkage between these two environmental concerns. It is argued that water treatment and reduction of acid rain as solutions to the problem of water toxicity need closer evaluation. More research into the causal link is warranted since the addition of human health impacts to acid rain's environmental insults could have a significant bearing on discussions relating to acid rain controls.

1. Introduction

Amid current international concerns about acid rain and drinking water quality, there is growing evidence that the two problems may indeed be linked in some regions. Drinking water supplies in some areas of the world may be vulnerable to degradation due to acidic deposition. While the evidence may be relatively sparse and limited at present to only a few geographical sites in North America and Scandinavia, this potentially important acid rain result to human health deserves attention.

The impact of acid rain on drinking water quality involves the potential for acidified waters to leach toxic and other metals (e.g., lead, mercury, cadmium, aluminum, and copper) from watersheds (e.g., soils) and water distribution systems (e.g., copper pipes). The presence of these potentially toxic metals in drinking water can result in a number of serious human health impacts, such as neurological disorders associated with high levels of aluminum ingestion [1].

Whether this acid pathway to water degradation is a major environmental problem depends on: (1) its geographical extent, and (2) the prospects for managing the problem. These factors are discussed for the eastern United States and Sweden, regions where evidence of water degradation due to acid rain is indicated.

2. Extent

Quantitative demonstrations of a cause-and-effect link between acid deposition, metal leaching due to acid water, contamination of drinking water, and human health effects are not yet available. However, qualitative evidence is mounting in support of the linkage.

The most striking evidence directly relating health effects to metal leaching by acid water has been found by the New York State Department of Health [2]. The Depart-
ment investigated three episodes in which increased lead absorption among children and adults was traced to contamination from lead pipes used to transport highly corrosive private drinking water. All three incidents involved relatively shallow drinking water supplies. At the source these waters showed high acidity (pH range 4.2–5.8) and acceptable levels of lead (< 10 μg l⁻¹). After transport through lead piping, the water samples demonstrated lead levels up to 100 times greater than the existing U.S. drinking water standard for lead, which is 50 μg l⁻¹.

On a broader scale in the eastern United States, recent data show that the standards for many metals in drinking water are being exceeded in certain areas where the water supplies have low alkalinity and are exposed to acid precipitation [3]. In one of the more recent investigations in New York State, it was found that the pH in surface springs and shallow wells (0–3 m) is typically in the range of 5.0 to 5.5 [4]. In these waters lead and copper levels at the faucet were in violation of the standards. In some cases lead levels were over a hundred times the standard, and copper over ten times the standard. Although there are no standards for aluminum, the concentrations found were high enough (up to 1.5 μg l⁻¹) to make the water unsuitable for prospective home kidney dialysis and toxic to fish. In some of these studies, acid leaching of plumbing and of granite Adirondack bedrock were implicated as potential sources of elevated levels of copper, lead, and aluminum [5].

In addition, recent studies of 40 roof-catchment cistern systems in rural Clarion and Indiana Counties, Pennsylvania, show that precipitation from the cisterns, sediment water at the bottom of the cisterns, and standing tapwater coming from the cisterns, all had high toxic metal concentrations [6]. The bulk samples failed to meet drinking water standards for lead on several occasions (being up to almost ten times the standard) and were consistently quite corrosive (pH range from 3.40 to 5.29). Seventy percent of the systems exhibited sediments on one or more occasions with lead or cadmium concentrations that exceeded drinking water limits (with lead being the greater offender). In nine of the 40 systems studied, lead concentrations in the tapwater on the average were above the well drinking water standard. It was concluded that lead resulting from infusion into tapwater as a corrosion product posed a significant health threat to users of roof-catchment cistern systems in western Pennsylvania.

One of the most extensive investigations of the drinking water-acid rain connection is currently in progress as a cooperative research project between the U.S. Environmental Protection Agency and the New England Water Works Association [7]. As part of this study, samples of drinking water have been collected from over 300 surface and groundwater supplies in the New England states, New York, New Jersey, Pennsylvania, West Virginia, Virginia, and North Carolina. Adverse effects of acid rain on human health through consumption of the surface waters could not be quantitatively demonstrated for the public as a whole. It was found, however, that the aluminum content in many supplies, if untreated, could be a problem to kidney dialysis patients. The study concluded that the highly corrosive nature of New England surface and groundwater (pH as low as 4.11) could dissolve harmful elements from pipe materials and become a serious problem. It was also concluded that acidic deposition exacerbates this corrosive