Acid Rain

A Billion-Dollar Solution to a Million-Dollar Problem?

S. Fred Singer

The prevailing scientific opinion holds that a major reduction of sulfur emissions in the Midwest will lead to a proportionate reduction in the acidity of rain over the Northeast and eastern Canada. This, in turn, will slow the depletion of fish stocks in lakes, as well as reduce other ecological damage. On the basis of this opinion, legislation has been introduced that would cut sulfur emissions from coal-burning electric power plants in the Midwest by more than 50 percent, at an annual cost to electricity customers there of $5 billion to $8 billion.

It is by no means clear, however, that there is a proportionate relation between Midwestern pollutants and the disappearance of Northeastern fish. On the contrary, there is a real scientific risk that a major cleanup of the suspected emissions would yield only a minor, less-than-proportional reduction of the damage. There is, in addition, a strong possibility that a crash cleanup would be an economic calamity: a multibillion-dollar solution to a million-dollar problem.

Natural rain is weakly acidic and has been so for millions of years. But its acidity increases wherever the burning of fossil fuels releases sulfur to the atmosphere; in addition, winds can carry acid-rain pollutants over long distances. Acid rain certainly does not threaten human life, and we don't believe it can harm human health. It does kill fish in sensitive lakes: More than 10 years ago, acid rain began to be blamed for the depletion of fisheries in Scandinavia and, more recently, for the same problem in the Northeast and Canada, where lakes are already naturally prone to acidity. It may affect trees in sensitive areas. And acid rain, or its precursors, also damages man-made structures.

Scientific understanding of acid rain declines rapidly as we deal successively with three basic topics: the emission of pollutants, the transport and deposition of acidic material (rain is only one form of deposition), and the effects that are ascribed to acid deposition.

The principal emissions implicated are sulfur dioxide (SO_2) and nitrogen oxides (NOX). Electric power plants burning coal and oil are the principal emitters of SO_2, with metal smelters and other industrial sources making a substantial contribution. Power plants and industries contribute a little over half of the NOX, with automobiles, trucks, and buses furnishing the rest.

The source of the SO_2 is the sulfur in oil, coal, and mineral ores. Most of the NOX comes from nitrogen in the atmosphere, which can combine with oxygen at the high temperature encountered in combustion.

The United States and Canada are now emitting more than 20 million tons of SO_2 and a comparable amount of NOX. In the United States, strict air pollution regulations already limit SO_2 emissions from new power plants (but not from old ones) and NOX emissions from new private automobiles (but not from power plants or old cars). Sulfur emission rates, after growing rapidly until about 1970, declined slightly in the last decade and are not expected to increase. NOX emission rates are expected to increase somewhat, depending on the degree of pollution control applied to industrial and utility boilers.

There are also natural sources. For example, NOX is created in the atmosphere by lightning. Sulfur is released to the global atmosphere from biological processes in the ocean in amounts about equal to the total human contribution. Volcanoes release sulfur but in smaller amounts. These natural sources are more uniformly distributed or episodic; man-made emissions are continuous and concentrated. Where people live and work, they swamp natural emissions by factors of 10 or more.

What goes up must come down. In the old (but not so good) days combustion products came out of chimneys and landed in the neighborhood of the boiler: ash from mineral matter in coal, soot from incomplete burning, and of course, SO_2 and NOX. Then two things happened. The industries installed filters, either electrostatic devices or cloth filters, to eliminate particulates, like ash and soot. These filters couldn't remove the noxious gases, so tall smokestacks were constructed to disperse them.

Although these changes benefited the immediate neighbors and reduced urban pollution, they caused

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That the fish are no longer jumping may not be principally the fault of sulfur emissions. The relation between the two is still poorly understood.

problems elsewhere. Removal of the alkaline ash particles eliminated a means for neutralizing the acid-forming gases. And the tall stacks put the polluting gases well above the atmospheric boundary layer, making long-range transport possible.

The details of the acid-forming process itself are not well understood. We believe that a large fraction of SO_2 is converted to sulfuric acid, probably in atmospheric water droplets; NOX is converted to nitric acid. In the presence of sunlight, NOX may even be a key factor in the conversion of SO_2—a potentially important synergistic relationship. The data show that acid rain has affected a wider area of eastern North America in the last decade or so, but that there has been hardly any increase in the peak acidity.

A comparable amount of the pollutants returns to the ground surface in dry form, either attached to particulates or as gases that are absorbed by the soil and converted into acids. It is extremely difficult to measure this "dry deposition."

Two technical issues of great importance hinder the search for a solution to acid rain. One is the exact quantitative relation between emissions and total deposition. Will cutting emissions in half really reduce deposition by 50 percent? The other issue is transport. Can we target the sources that produce the greatest damage in ecologically sensitive regions? The jury is still out on both questions.

A recently released report of the National Research Council of the National Academies of Sciences and of Engineering found essential proportionality between emissions and deposition when averaged over eastern North America and over the whole year. But the deposition rate falls during the winter, partly because stronger wind systems sweep pollutants over the Atlantic Ocean. An important (and unknown) additional factor may be a reduced transformation rate of SO_2 into sulfuric acid during the winter. The limiting factor may be oxidants (partly originating from NOX), and in winter less sunlight is available for the production of such oxidants. If this hypothesis is correct, then reducing SO_2 emissions alone will not reduce acid rain proportionately, especially during winter.

Testing the Proposition

Indeed, Great Britain, which is blamed for acid rain in Scandinavia, has reduced sulfur emissions more than 30 percent since 1970, largely by using cleaner fuels. Yet the condition of Norwegian lakes has not improved, nor has acid rain perceptibly diminished—indicating that other factors may be involved here. In essence, this European experience constitutes a real-life experiment that seems to show that simple sulfur removal may not be the whole answer.

The council's report also examined the influence of local and distant sources on receiving areas. Unfortunately, neither available data nor meteorological transport calculations are good enough to allow a decision. The highest concentrations of acid rain clearly occur in regions where emissions are highest, that is to say, locally. There is no simple transport trajectory to help trace pollutants to any particular distant source. Joint U.S.–Canadian experiments will soon be under way using tracer substances to establish air-flow patterns for acid rain.

Probably the greatest scientific uncertainty clouds the ecological effects of acid deposition. Nor do we have reliable estimates of the dollar amounts of damage: Is it millions of dollars per year or less, billions or more?

Least controversial are effects on man-made limestone structures, such as monuments, bridges, and buildings. Acid rain, and even SO_2 combining with moisture on the surface of the structure can dissolve the stone.

Effects on sensitive lakes are more controversial. More small lakes in the Northeast are becoming acidified, but it does not follow that reducing acid rain will slow the trend substantially. The reason may be that the soils surrounding these lakes are naturally acidic and any flow of water through them will carry acids into the lake. If the geology of the region is granite (which is acidic) rather than limestone (which is alkaline), the lake cannot neutralize all the acid. Eventually, with high acidity, metals

toxic to plants and fish are liberated from the soil and lake sediments. The lakes become beautifully clear, but fish die. Adding ground-up limestone will restore the biota, but frequent liming can be costly.

The Dying Forest

Most uncertain are the effects of acid rain on soils and forests. Agricultural soils receive so many chemicals, including lime, that acid rain should produce no deleterious effects on cash crops. In fact, both nitrogen and sulfur are good fertilizers.

Many unmanaged soils, especially forest soils, are naturally acid. The prevention of forest fires may speed acidification, since fire adds alkaline ash to the forest soil, while its intense heat causes the evaporation of volatile soil acids.

Still, there is concern that increasing acid precipitation can cause irreversible changes in soils—even if all acid rain were stopped, the soil would not recover for many decades. If soil damage were strictly cumulative, then reducing emissions (and acid rain) would not avert the destruction but simply stretch the time until irreversible damage occurs. If, for example, as some believe, we must act within five years, then cutting emissions by half will only stretch the critical time to 10 years. A 95 percent reduction could be required to stretch the time to 50 years; no one has yet suggested such a radical step.

Currently, *das Waldsterben* (the dying forest) is at the top of the political menu in West Germany, where the government has proposed drastic (and expensive) steps to cut emissions of SO_2 and NOX. Unfortunately, the evidence that these could help is simply not credible. For example, the German data show that within the last two and a half years the percentage of dead and sick spruce trees increased from 15 percent to 90 percent in certain areas. If the data are correct—that is, if they are not caused by a change in criteria—then there must be other causes, perhaps other air pollutants (such as ozone, toxic heavy metals, or herbicidal chloro-organic chemicals from industries or incinerators), or even biological agents.

The Fish and Wildlife Service of the Interior Department has tried to separate the effects of acid rain from those of other pollutants. They can find no evidence for acid rain effects on forest growth, although other pollutants are definitely harmful. A thorough study by the Environmental Protection Agency has found no clearcut effects of acid rain on forest growth. Some effects were positive, some were negative.

The legislation to cut sulfur emissions in the Midwest would involve retrofitting flue gas desulfurization (FGD) equipment to old plants. Until now these plants have been exempt from statutory new-source performance standards—although they were required to burn low-sulfur coal. (Sulfur is the important target because it contributes twice the acidity that nitrogen does.)

People supporting such legislation believe, contrary to all scientific evidence, that the crucial emission regions can be targeted. They also believe that depositions can be reduced by 50 percent and that damage will be reduced correspondingly. Most important, they believe that the damage is somehow commensurate with the control costs and that these costs will be borne by others.

The opponents, quite naturally, point to the uncertain state of our scientific knowledge and ask time for more research. In addition to the great cost of installing FGD equipment, there is the environmental hazard in disposing the large quantities of sulfate sludge generated in the operation. The go-slow approach has been the administration's posture till now, although we may expect to see a change announced by William Ruckelshaus, the new EPA administrator.

Bureaucratic Solutions?

A peer review panel set up by George Keyworth, the White House science adviser, has recommended a "meaningful" reduction in sulfur emissions in eastern North America—one just large enough to indicate whether precipitation acidity is reduced correspondingly—but using a "least-cost" approach. A least-cost approach means removing sulfur first in plants and processes where the cost is lowest, before introducing more costly pollution-control methods like FGD. With the low-cost approaches that are available, a pound of sulfur can be removed for a small percentage of the cost of FGD. Possible targets include large smelters that do not control SO_2 emission sufficiently. Also, "washing" coal before it is burned can often remove sulfur at low cost.

The least-cost approach could be taken automatically if the government were to permit those who now emit SO_2 to trade emission rights. The "bubble" concept was introduced by EPA during the Carter administration and allowed a firm to trade off emissions within a given facility as long as a certain total was not exceeded. Rather than legislate and control the emission from each smokestack, a giant bubble covering regions of the eastern United States (and perhaps Canada) could achieve a specified government-mandated reduction in total SO_2 emission at the lowest possible cost. Each industry would buy or sell pollution rights so as to minimize its own total cost—control costs plus costs of rights. Since the costs of the rights are not actual resource costs but transfer costs, such an arrangement would also achieve the lowest control costs nationally.

Instead, current legislation puts the burden of pollution control on electric utilities "because they can pass the costs along to the users." But this approach produces a national cost on the order of $10 billion a year. If a market approach were used, electricity users would still pay the cost, but the cost itself would be much lower.

The best long-term solution for acid rain may lie in reducing the use of fossil fuels. Energy conservation will probably continue simply because of higher prices. Hydro, solar, and wind energy are steps in the right direction, but they present us with their own environmental problems: building new dams and reservoirs, covering vast areas of the countryside with solar collectors, and noisy large windmills, not to mention the high costs.

In the final analysis it may come down to the careful use of more nuclear power as the cleanest and least intrusive form of energy available to mankind.

Therapy for the Budget

The Congressional Budget Process Is Only a First Step Back to Fiscal Sanity

Senator William L. Armstrong

It is easy to understand why so many fiscal conservatives proclaim the congressional budget process a failure.

- The budget has been in deficit *every year* since the Congressional Budget and Impoundment Control Act of 1974 took effect in 1977, and the deficits have been growing larger year by year.
- The projected deficit for the current fiscal year is about $200 billion. That's a mind-boggling sum by any measurement, but especially so when we remember that it wasn't until the 1971 fiscal year that the federal government even spent $200 billion.
- Those deficits have not occurred because Congress has been squeamish about raising taxes. Tax revenues have increased from $230.8 billion the year before the act took effect to $617.8 billion in fiscal 1982.
- Although a major argument for passing the budget act was the restraint it would impose on federal spending, outlays have risen from $269.9 billion in fiscal 1974 to an estimated $848.5 billion for fiscal 1984—a 317 percent increase in just a decade. With restraint like that, we had better hope we never see congressional profligacy.
- Furthermore, Congress has been unable to abide by its own rules. Budget resolutions are rarely passed by the required deadlines. Moreover, the day-to-day funding of the government lurches from one "continuing resolution" to another because of lawmakers' inability to pass the normal appropriations bills.

Yet despite this record of fiscal atrocities, I believe the budget process is working. Indeed, fiscal conservatives have gained the most from it, and they would have the most to lose if it were abandoned.

By setting aggregate taxing and spending levels and requiring legislators to work within the limits, the 1974 budget act has forced Congress to look at the budget as a whole. This has helped focus attention as never before on the macroeconomic consequences of deficits, taxes, and federal spending. Budget deficits are Topic A in congressional cloakrooms, on Wall Street, and in the media. The primary reason why deficits have moved off the business page and onto the front page is because never before in our history have deficits been so large, or their baneful consequences so evident. An ideological shift (gently to the right) in the American electorate has also contributed to the renewed interest in fiscal responsibility. But the contribution of the budget process itself to heightened public awareness of deficits and government taxing and spending should not be overlooked.

The budget process has also made it plain that there is no such thing as a free lunch. A lawmaker who wishes to spend more for some program—whether welfare or defense—must explain where he intends to get the money to pay for it: by reducing spending on other programs, by raising taxes, or by incurring a larger deficit. No longer can lobbyists for special-interest groups easily argue for their pet projects as if they existed in a vacuum. A subsidy or tax break for one special-interest group clearly must come at the expense of another—or at the expense of a responsible budget.

But the biggest success story of the budget act was the passage of the president's sweeping tax and budget cuts in 1981. Had Ronald Reagan's proposals been considered piecemeal, instead of a package on which members of Congress had to vote yes or no, very little of his program for economic recovery would have been enacted. Because of the budget process, there was less opportunity for special interests to divide and conquer.

There's another reason the president's program passed: The language of the budget act contains one sharp tooth, reconciliation. Under the act, only the aggregate ceilings for budget authority, outlays, and revenues are binding. But in 1981 the House and Senate Budget Committees led the Congress to include reconciliation instructions in the first budget resolution. Thus they required the 14 standing Senate committees and the 15 House committees to report legislative changes that would knock spending down to the limits they had set. The legal basis for this was the broad language contained in the act that permits the first resolution to include "any other procedure which is considered appropriate to carry out the purposes of the act." Fiscal conservatives were thus empowered to demand cuts. The Congress sup-

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