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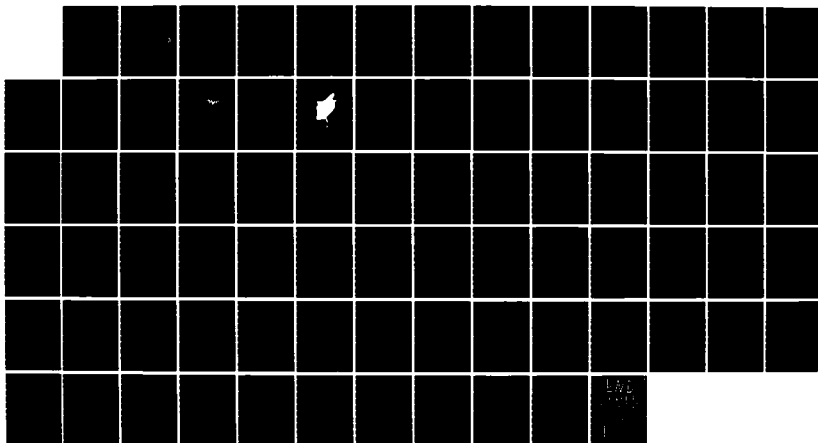
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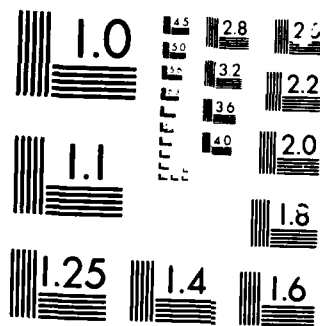
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ACID RAIN AND THE ENVIRONMENT:

AN ETHICAL PERSPECTIVE

by

James William Greig II

B.A., Cornell University, 1974

M.A., Ball State University, 1980

A thesis submitted to the
Faculty of the Graduate School of the
University of Colorado in partial fulfillment
of the requirements of the degree of
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Department of Philosophy

1985

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Acid Rain and the Environment: An Ethical Perspective

Thesis directed by Associate Professor Dale W.

Jamieson

In this thesis, I discuss the acid rain problem currently facing the United States. I show the severity of the problem and discuss several technologically possible solutions to it. I then discuss several values that are affected in the acid rain controversy, and show how they are affected by the possible courses of action. I also discuss several interest groups which are concerned about the outcome of the acid rain problem, and how different solutions might affect them. Finally, I suggest some directions for U.S. policy to take regarding acid rain controls, and show how these suggestions allow the preservation of our values and acknowledge the valid claims of the various interest groups.

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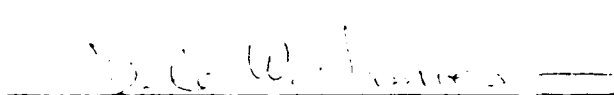
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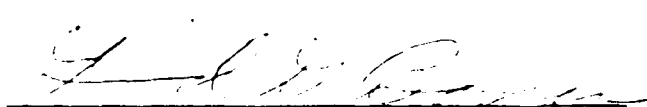
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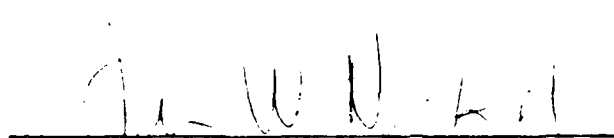
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CHAPTER I

INTRODUCTION

In this thesis, I examine the acid rain problem and the conflicts in values and interests that it precipitates. I do this in order to formulate some suggestions for U.S. policy regarding the acid rain problem. I believe that there is action that can, and should, be taken to control acid rain. The aim of this thesis is to suggest what that action might be.

Chapter II will be a detailed discussion of the acid rain problem: what acid rain is, where it comes from, and what it does. I will discuss the different sources of acid precursors, and which are more significant. Then I will see what the effects of these pollutants are on aquatic and terrestrial ecosystems.

Chapter III will be a brief review of the different possibilities for the control of acid precursor emissions. I will discuss the various types of controls that are possible, including the option

of doing nothing at all. Measures both to mitigate the effects of acid rain, and preventive measures will be discussed.

In Chapter IV, I will look at the values involved in the acid rain controversy and what these values might suggest regarding policies for controlling acid rain. There is a great deal of controversy over acid rain and what should be done about it. This is at least in part due to the differences in values that we have. I will consider the nature of value, discuss several values that might be involved in the controversy, and then see what kinds of trade-offs the different solutions might require. I think the discussion of values may provide some helpful insight when I attempt to formulate policy recommendations for dealing with the acid rain problem.

Chapter V will be concerned with the interests affected by acid rain. As is the case with values, there are a number of different interests that might be affected by acid rain. I want to discuss some examples of these interests, and show how they might be affected. As I look at the effect of acid rain on these interests, I think it will be apparent that many of the values I discussed in the preceding chapter are involved in the interests affected. Interests and values are closely connected, and I think it will

be obvious that the values and interests that we have are related, and that they both provide significant guidance for our actions and our moral choices.

The final chapter will be a conclusion based on the discussion in the preceding chapters. I hope to provide some concrete recommendations for U.S. policy based on the discussion of values and interests affected by acid rain. I think that the information on the problem, together with this discussion, will provide a foundation for some specific recommendations for U.S. policy, and will offer an opportunity to choose a moral course of action in dealing with acid rain.

CHAPTER II

THE ACID RAIN PROBLEM

During the past 25 years in Europe and the past 10 years in North America, scientific evidence has accumulated suggesting that air pollution resulting from emissions of oxides of sulfur and nitrogen may have significantly adverse effects on ecosystems even when the pollutants or their reactive products are deposited from the air in locations remote from the major source of the pollution.¹

This is the opening statement in a report published in 1983 on the subject of Acid Rain. What is the scope of the problem that we actually face here in the United States? What is the acid rain debate actually about? Why should we be concerned about it? These are the questions I hope to answer in this chapter.

Acid rain, first of all, is an issue of international significance. The phenomenon is not limited by national boundaries, and it may not be limited even by oceans. It is an issue of concern in industrialized areas of the world, and in areas near them. It is likely to become an important issue in developing areas as they become more heavily industrialized. In the not-too-distant future, I expect that it will become an issue for nearly everyone, in some way.

For U.S. policymakers, acid rain is currently an issue in U.S.-Canadian relations, and since the Mexican government has approved the construction of a large copper-smelting facility near the U.S. border, it is becoming an issue in U.S.-Mexican relations. Acid rain is, of course, an issue within the U.S. as well. There is already evidence of significant damage from acid rain in some areas of the Eastern U.S., and there is great potential for environmental damage in the West. There is, in fact, some evidence that damage from acid rain has begun in some sensitive areas of the West.²

What is it, exactly, that is causing all the fuss? Acid rain is just what its name implies: rainfall (or other precipitation) that is more acidic than normal. Rainfall normally has a pH of around 5.6. In some cases, acid rainfall can be more acidic than the juice of a lemon or an orange, or even than vinegar, having a pH of less than 4.0. Acid of this strength is capable of killing plants. When it falls into lakes and streams, although diluted, enough of it over a period of time can result in such an increase in the acid level that fish and other aquatic organisms cannot survive.

The process that causes acid rain is atmospheric deposition. Pollutants, not in themselves acidic, are released into the atmosphere, and carried by air currents possibly as far as several hundred miles from their point of origin, and then deposited on the earth's surface through one of two methods. The pollutants might simply settle out of the air (dry deposition), or they might be precipitated out in rain, snow, fog, etc. (This is wet deposition which is what we normally think of when we talk about acid rain.) In any case, once the pollutants have been released into the atmosphere, they react with atmospheric elements, become acids, and eventually acidify the water and land they come in contact with. This can cause serious problems.

The primary pollutants seem to be sulfur dioxide (SO_2) and various oxides of nitrogen (NO_x). These are produced primarily through the combustion of fossil fuels. There may be other pollutants involved besides SO_2 and NO_x , but these are the ones which have been identified at this point, and which seem to be the major contributors to the problem.

Do these pollutants come only from anthropogenic sources, or are there natural sources for these pollutants? And how significant are the natural sources in comparison with the anthropogenic sources, such as cars, industry, electrical generating facilities, etc. If the majority of these pollutants arise from natural sources, it would seem unlikely that the human contribution to their supply would be the reason for the current acid rain problem. In fact, if the majority of the pollutants come from natural sources, then we would be dealing with a natural process which was altering the natural environment, and not with a human-generated process. On the other hand, if a significant proportion of the pollutants arise from anthropogenic sources, we might well conclude that the environment is being changed by human alterations of the natural environment.

There are, in fact, several natural sources of the pollutants in question, including volcanic activity, sea-spray, soil, and vegetation. The contribution of the known natural sources to the overall levels of these pollutants is, however, rather small. For example, the contribution of the

known natural sources of SO_2 is estimated to be less than 1% of the total amount of SO_2 released into the atmosphere in the eastern U.S. and the amount of NO_x is variously estimated at between 0.4% and 14% of the total.³ It is clear that, even using the highest estimates of the contribution of natural sources of these pollutants, this contribution is only a small percentage of the total amount of these pollutants released into the skies above the eastern U.S. each year. Only 1/100th of the SO_2 and no more than 14/100ths of the NO_x released into the atmosphere come from natural sources. The total amount of these substances released into the atmosphere is 22.5 million tons/year of SO_2 , and only slightly less NO_x .⁴ Natural mechanisms are able to neutralize a portion of the annual acid production, and possibly the entire natural production, but they do not appear to be able to neutralize the tremendous additional amounts of acid generated by human sources. Neutralization is the process whereby harmful elements (such as SO_2 and NO_x) are rendered harmless by chemical reactions. The natural environment has varying capacities for neutralization depending on soil type, vegetation, etc. Much of the anthropogenic

pollutants can be accommodated by these natural processes along with the naturally produced pollutants. But too much of these pollutants simply overwhelms the capability of the system to cope, resulting in the problems we are now seeing with acid rain damage. There are ways to augment the natural neutralization capabilities, which we will discuss later.

How widely is acid rain distributed? We have already discussed the means of acid rain distribution, atmospheric deposition. But how much area is affected by acid rain from one locale? Are the effects limited to the area near the pollution site(s), or are the acid rain precursors distributed over a wider area? Figure 2-1 indicates that the stationary sources of acid rain precursors, particularly SO_2 , are concentrated especially in the Midwest. There are sources of these pollutants throughout the country, and in the Northeast in particular, but the greatest production is from the Midwestern states. Mobile sources, such as cars, are also heavily concentrated in these areas due to the high population density, but mobile sources are estimated to contribute much less than half the total amount of these

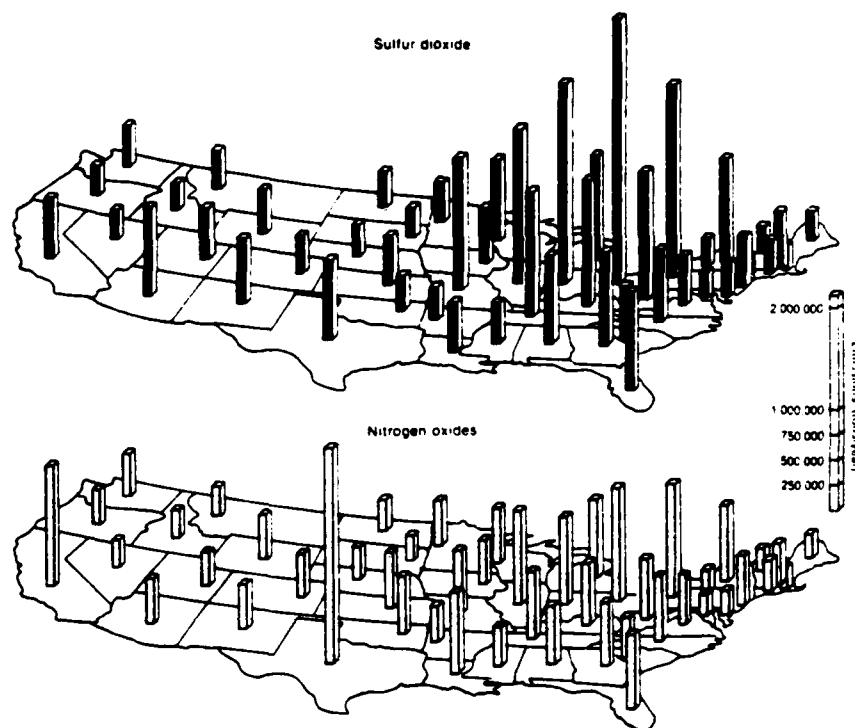


Figure 2-1. Acid Rain Sources 1980

Source: Acid Rain and Transported Air Pollutants: Implications for Public Policy, U.S. Congress Office of Technology Assessment, Washington, D.C., 1984, p. 7.

pollutants nationwide. Stationary sources are estimated to contribute more than 85% of the total amount of pollutants.⁵

Is acid rain concentrated in the same area as its sources? Figure 2-2 shows where the greatest concentration of acid precipitation falls. Most of it falls not only near the sources in the Midwest, but in the East and Northeast downwind (by the prevailing weather patterns) from the sources in the Midwest. As a result, one group of people is involved in the production of acid rain, and a different group receives the effects. This makes it somewhat more difficult to control the problem, as those who are involved in creating the acid rain precursors are not as likely to be on the receiving end or to understand the problems of those who are. This also raises some important issues of distributive justice. But more about this later.

What effect does all this acid have on the environment? The answer to this question is surely important in any decision-making concerning acid rain controls. If the effects are minimal or none, then there would be no problem. But if the effects are as dramatic as some suggest, then there may be much more reason for action.

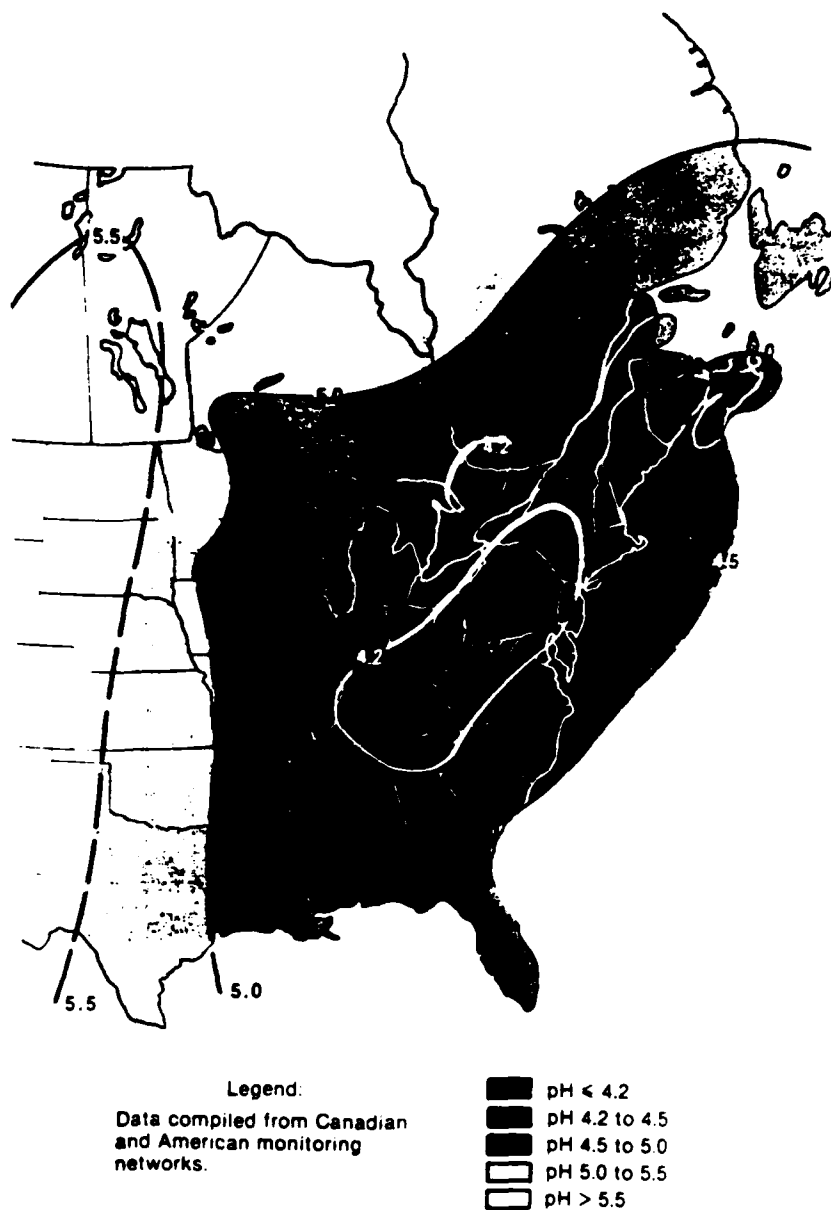


Figure 2-2. Areas of Acid Rain in the Eastern U.S.

Source: Acid Rain and Transported Air Pollutants: Implications for Public Policy, U.S. Congress Office of Technology Assessment, Washington, D.C., 1984, p. 6.

Of course, acid rain is only one part of the total air and water pollution problems. It does not exist alone, and controlling acid rain will not solve all our pollution problems.⁶ Why, then, should we concentrate resources on this particular problem? What is there that sets acid rain apart? Unlike many pollution problems, acid rain is cumulative.⁷ It is not the only pollutant that is cumulative, certainly, but it is one that definitely is. Because of this factor, it is important that acid rain not be ignored. As acid rain accumulates in the ground and water supplies of affected areas, we can expect that the problem will become more severe over time, and that even partial reductions of 25 to 50% of the emitted precursors will not slow the effect on the environment, but that the effects would continue to grow even as the pollutant levels decreased. To make any real headway against the acid rain problem, the levels of emitted pollutants need to be drastically reduced. The problem will likely be solved more easily and more economically if dealt with now instead of waiting until acid concentrations in the soil and water reach such high levels that severe

economic and environmental damage has occurred and possibly become irreversible.

In 1982 the Swedish Ministry of Agriculture published a report entitled Acidification Today and Tomorrow.⁸ They cited relatively high levels of acidity in lakes and streams, and a gradual reduction of normal aquatic populations in those watercourses as one of the early indications of acid rain damage already in progress. If allowed to continue unchecked, the eventual destruction of all normal aquatic life in the watercourses involved is likely to result, and they discussed lakes and streams in Sweden where this destruction had actually been observed. In the lakes in question, the Swedish scientists noted a complete absence of the normal life forms found in that area, and their replacement by a few strains of algae suited to highly acidic environments. Once a neutralization program was begun to correct the highly acid pH, they documented the return of normal aquatic life to these areas, although larger species, such as fish, had to be reintroduced to the waters. They were able to survive, however, once the acid content of the waters had been lowered. The report went on to mention other problems resulting from acid rain,

including progressive forest destruction, ground-water contamination, and suggesting the possibility of eventual global climatic disturbances. Such disturbances might include increased polar temperatures resulting from heat trapped by airborne pollutants, and melting of the polar ice caps brought on by these higher temperatures. (Such effects could be particularly devastating in conjunction with a CO₂ buildup worldwide. The reduction of forested areas, either through acid rain damage or through harvesting and development, could also add to the problem, since trees function as chemical factories consuming CO₂ and CO and releasing oxygen and other beneficial substances.) This temperature rise would raise sea levels worldwide, flooding large areas, and might have other impacts unspecified in this report.

A report published by the U.S. Congress, Office of Technology Assessment sounds no less alarming. Stating that the effects of acid rain can extend hundreds of miles from the source of the pollution, the report says that these pollutants can damage aquatic ecosystems, crops, and man-made materials, and pose risks to forests and even to human health.⁹ The OTA report goes on to cite evidences of these where

they have already been observed in the Eastern United States. Let's look at some of these in more detail.

Probably the best documented and best understood effects of acid rain are those on aquatic ecosystems. The Congressional report says that "when the waters of a lake or stream become more acid than about pH 5.0, many species of fish die, and the ecosystem changes dramatically."¹⁰ The average pH of rainfall in the Eastern U.S. (the 31 states bordering or east of the Mississippi River) is 5.0 or less,¹¹ which thus poses a significant danger to aquatic ecosystems throughout the Eastern U.S., as the acidity of the rainfall is causing an increase in the acidity of the watercourses. In fact, in some areas of the Midwest and East, the average pH of rainfall is 4.2 or less, significantly more acidic than the pH of normal rainwater, and well beyond the danger point cited by the report as causing changes in aquatic ecosystems. Additionally, 25% of the land in the eastern states allows acid transport.¹² When acid precipitation falls on this land, it is not neutralized, but allowed to flow into streams, lakes, and rivers still acidic. Where this occurs, generally due to soils with low lime content, the damage to the

watercourses and forests from acid rain is much more pronounced and occurs more swiftly.

Because of these facts and others, the Office of Technology Assessment report says,

We estimate that about 3,000 lakes and 23,000 miles of streams (or about 20% of those in sensitive areas) are now extremely vulnerable to further acid deposition or have already become acidic.¹³

(That is roughly 5% of the watercourses in the Eastern U.S.). If the current levels of acid deposition continue unabated, it is not clear how much additional area could eventually be affected, though it would undoubtedly be a significantly larger area than at present.

The Office of Technology Assessment report says:

Any program to reduce emissions significantly would require about 7 to 10 years to implement. If no further action is taken . . . 30 to 45 years will elapse before most existing pollution sources are retired. . . .¹⁴

Delaying implementation of action to control these pollutants, or not controlling them at all, will allow the levels of emissions to remain high for at least the next 10 to 20 years. This seems to be a dangerous policy to follow, however. In the words of the Office of Technology Assessment, "Predicting the magnitude and

geographic extent of additional resource damage while waiting is not possible."¹⁵

Aquatic ecosystems are not the only ones affected by acid rain, however. The pollutants of concern also affect other types of ecosystems. Forests are a prime example. The report of the Office of Technology Assessment cites reduced yields from forests (particularly spruce) in areas of heavy acid precipitation, and suggests two ways in which acid rain can harm trees directly. Acid rain, as it falls, can remove nutrients from the leaves, and it can alter the chemical composition of the soil so as to prevent trees from absorbing needed nutrients. In either case, the net result is a slowdown in the tree's growth rate, and its eventual death. The first of these effects is most likely caused by acids formed from acid precursors while still airborne. Almost paradoxically, there is evidence suggesting that the nitrogen compounds in NO_x pollutants may damage trees by fertilizing and leaves and stimulating excessive growth late in the year, which leads to extensive frost damage to the trees. This ultimately kills the tree as well. Similar problems can occur with plants under cultivation, though the evidence suggests that

crops are not as susceptible to acid rain damage as natural ecosystems. This may partly be due to the efforts of farmers, who control soil pH through liming and other measures.¹⁶

Finally, there is potential danger directly to human health. Acid rain interferes with the natural food chain by killing species of plant and animal life, thereby reducing the populations of those that depend on them for food also. But it also affects human food supplies. First, acid rain reduces the populations of game fish and animals used for food. However, it also, and perhaps more significantly for human populations, may have an impact on water quality in our drinking water systems. The Office of Technology Assessment report states, "Acidified water can dissolve metals and toxic substances . . . and subsequently transport them into drinking water systems."¹⁷ This poses a direct danger to humans, as well as to other animals and plants. It may even be a cause of Alzheimer's disease, though the evidence is not yet conclusive.¹⁸

Acid rain, then, may threaten us in many ways. It is known to be a threat to the survival of aquatic ecosystems, and to those which depend on these

ecosystems. There is clear evidence of harm to forests and potentially to croplands. Finally, there is potential danger to the water supplies of animals and humans. Clearly, this is a problem warranting our concern.

The established problems in the Eastern U.S. are not the only ones of concern to us, of course. There are dangers to land that has not yet been (significantly) affected by the problem. These dangers must also be considered in any thorough examination of the acid rain issue.

Much of the Western U.S. is highly vulnerable to acid deposition. Large areas of the Pacific Northwest, California, Nevada, and the Colorado mountains have a very limited capacity to neutralize acid precipitation.¹⁹ Much of the area in question is at high altitude and has thin soil cover. This, plus the low lime content of the soil, creates an environment where even very low levels of acid precipitation could cause serious harm to ecosystems, and alpine ecosystems, such as those in the Colorado mountains, are notoriously fragile. These areas are, for the most part, not currently at risk. The average pH of precipitation in this part of the country is 5.5 or

greater. Yet there are some areas where the average precipitation has been measured to be less than pH 5.5,²⁰ the level at which some harm to the environment has been observed to occur, though not yet below the 5.0 level mentioned by the Office of Technology Assessment report.

I believe that the current problems posed by acid rain are serious. And the potential problems may be even more serious than we now imagine. We need to take some action. The question is, what kind of action should we take? The remaining chapters will be devoted to attempting to answer this question based on the values and interests that are affected by acid rain.

Chapter II Notes

¹Acid Deposition, Atmospheric Processes in Eastern North America (Washington, D.C.: National Academy Press, 1983), p. 1.

²Neal Karlen and Mary Hager, "Pollution: Now the Bad News," Newsweek, 105, No. 14 (1985), 26.

³"The Acid Deposition Phenomena and Its Effects," Critical Assessment Review Papers, Vol. 1 (Washington, D.C.: Environmental Protection Agency, July 1984), pp. 2-14.

⁴Steven J. Marcus, "Acid Rain: Technology Exists to Flush the Problem Away," Audubon, 86, No. 2 (1984), 120.

⁵Eugene Garfield, "Acid Rain, Part II. Issues and Proposed Solutions," Current Contents, March 11, 1985, p. 4.

⁶Steven Rhodes and Paulette Middleton, "Acid Rain's Gang of Four: More Than One Impact," The Environmental Forum, 6, No. 6 (1983).

⁷Kay H. Jones, "Acid Deposition Precursors," The Environmental Forum, 7, No. 2 (1984), 11-13.

⁸Acidification Today and Tomorrow, trans. Simon Harper (Stockholm: Swedish Ministry of Agriculture, 1982).

⁹Acid Rain and Transported Air Pollutants: Implications for Public Policy (Washington, D.C.: U.S. Congress, Office of Technology Assessment, June 1984), p. 3.

¹⁰Ibid., p. 9.

¹¹Ibid., p. 6.

¹²Ibid., p. 10.

¹³Ibid., p. 11.

¹⁴Ibid., p. 3.

¹⁵Ibid., p. 3.

¹⁶Eugene Garfield, "Acid Rain. Part I. What Is It and What Does It Do?" Current Contents, March 4, 1985, p. 6.

¹⁷Acid Rain and Transported Air Pollutants, p. 13.

¹⁸Garfield, pp. 7-8.

¹⁹Acid Deposition, p. 22.

²⁰Ibid., p. 14.

CHAPTER III

PROPOSED SOLUTIONS

There are several possibilities for dealing with acid rain. Each of these involves trade-offs with different values and interests. In this chapter, we will look at some of the possible solutions, and how well they might solve the acid rain problem. Then, in the next two chapters, we will see how each of the different types of solutions might affect the values and interests that are involved when we deal with acid rain. This will not be a technical evaluation of all the possibilities. I want to examine the types of solutions that are available to us, and the general advantages and disadvantages of each. To that end, there are three broad avenues of action available to us.

Inaction

Although inaction hardly sounds like a solution to the acid rain problem, given the information we looked at in Chapter II, this is the direction in which

we have been heading. To date, the federal government has declined to take any action to curb the production of acid precursors, suggesting that more research is needed and that the evidence to date is inconclusive. The result is that no one has limited the production of acid precursors. To be sure, some of the pollution control technology required on new coal-burning facilities by the Clean Air Act has reduced some of the acid precursor emissions. But the older facilities unaffected by the regulation are still emitting the precursors. In fact, acid precursor emissions have been reduced to roughly mid-1950's levels by the application of current technologies in new coal-burning installations.¹ However, as we saw in the last chapter, just reducing the level of emissions will not stop the damage since acid rain is a cumulative problem. Even maintaining emissions at the 1950's levels will result in a net increase in acidity in the areas affected by acid rain.² In other words, even with a 50% reduction in acid deposition, the problem will continue to worsen. Unlike some other pollution problems, such a reduction in emissions will not stop the damage, but will allow it to continue to increase.

Receiving-End Countermeasures

Receiving-end countermeasures are means used to mitigate the adverse effects of acid rain at the location where these effects are felt. Such countermeasures are not a means of reducing the emissions of acid precursors. They are merely a means of neutralizing the acid in selected areas.

Liming

Perhaps the best-known countermeasure is liming. This procedure has been used for a long time by farmers and gardeners to reduce the acidity in soil under cultivation. Acid rain has widened its application to areas beyond farms, lawns, and gardens. As an acid rain countermeasure, lime is applied to areas which have been damaged by excess acid, or which are likely to be. The lime reacts with the acids as they are deposited (or as they are formed after dry deposition), neutralizing them. It has proven successful in use in Sweden, and has been used fairly extensively in several areas in the U.S., particularly New York State.³ Liming is not always possible, however. It cannot be used unless the area to be limed is accessible. It must

be repeated on a regular basis to be effective. The actual frequency depends on the rate of acid deposition, the sensitivity of the particular area involved, and other factors. Liming might be required annually, or as infrequently as every three to four years. And liming is not a 'cure-all' for the problems caused by acid rain pollutants. Late season fertilization by NO_x compounds is not at all affected by liming. Liming only counters the effects of acids by neutralizing them when it comes in contact with those acids.

Pollution Controls

The last broad category of possible actions to control acid rain is the one which has the most promise of effectiveness. It is probably also the most expensive to implement. There are several possibilities for control of acid precursor emissions, but I want to mention just the most promising ones.

Scrubbers

The method that has been used most in new installations for pollution control is probably scrubbers. Scrubbers could also be retrofitted in older coal-burning facilities, and would result in a roughly 90% reduction in sulfur emissions.

A retrofit of scrubbers on existing SO₂ sources would cost approximately 5 billion dollars. This would average about 75 cents per month per household according to some estimates.⁴ For these reasons, scrubbers might be one of the best near-term solutions. Scrubbers are not without problems, of course. They require regular maintenance and daily monitoring to ensure their effectiveness. Scrubbers operate in a very harsh environment, and they are subject to failure if not carefully maintained. And not all coal-fired facilities can have scrubbers easily installed. Extensive modifications might be required in many instances.⁵

Fluidized Bed Combustion

There are other control technologies under development, however. One of the most promising is a technique called fluidized bed combustion. This technique involves burning coal with a mixture of lime and water. The lime reacts with the acid precursors, neutralizing them, and can then be washed out of the exhaust gasses.⁶ While successful demonstration projects of fluidized bed combustion have been constructed, successful commercial applications are probably still four or five years off.⁷ However,

this technique is really only useful on new installations. It is not likely that it can be economically retrofitted on older installations.

Coal Switching

Another control measure that has been suggested is the switch to low-sulfur coal. Such a switch would require a substantial shift in the coal mining industry from the Eastern coal mines to the West, where the low-sulfur coal is located. As we will see, such a switch would have many implications. It would, however, make a substantial reduction in the emissions of acid precursors, particularly SO_2 , especially in combination with scrubbers.

Coal Washing

Coal washing is a relatively cheap and effective means for removing up to 40% of the sulfur from coal before it is burned.⁸ This would yield a net reduction of the same proportions in the amount of SO_2 and other sulfur compounds released into the atmosphere. Coal washing is also easily adaptable to existing coal-burning facilities without major renovations or expensive retrofits. These advantages may be outweighed, however, by the fact that 40% reduction

in SO_2 is not sufficient to stop the damage from acid rain. Such a reduction might, however, delay the onset of permanent damage enough to allow full development of some of the other systems we have discussed, most notably fluidized bed combustion.

One last point worth mentioning. Virtually all of the control measures we have discussed are aimed at the reduction of SO_2 emissions. These techniques are not directed at reducing the emissions of NO_x . Since SO_2 has nearly three times the acid-forming capacity per ton as NO_x ,⁹ this emphasis is not really misplaced. But there is little that has been done to reduce the NO_x emissions, even though they are a significant contributor to acid precipitation and to related problems. Fluidized bed combustion may be a partial solution to this problem, too. This type of burner operates at lower temperatures than conventional burners do and releases less NO_x than conventional burners.¹⁰ So use of fluidized bed combustors can reduce NO_x emissions as a fortunate side effect of reducing SO_2 emissions.

Chapter III Notes

1. Kay H. Jones, "Acid Deposition Precursors," The Environmental Forum, 7, No. 2 (1984), 11-13.

²Ibid.

³Steven L. Rhodes and Paulette Middleton, "The Complex Challenge of Controlling Acid Rain," Environment, 25, No. 4 (1983), 32.

⁴Steven J. Marcus, "Acid Rain: Technology Exists to Flush the Problem Away," Audubon, 86 (1984), 121.

⁵Bruce A. Ackerman and William T. Hassler, Clean Coal/Dirty Air (New London, Conn.: Yale University Press, 1981), p. 71.

⁶Marcus, p. 120.

⁷Ibid., p. 122.

⁸Ackerman, p. 67.

⁹Jones, p. 11.

¹⁰Marcus, p. 122.

CHAPTER IV

VALUES AFFECTED

As we have seen, acid rain and its control pose distinct problems for us in the United States. The choice of what action to take in dealing with the problem is not an easy one to make. But the values we hold may help us to make this choice. We generally act so as to preserve those things we consider to be of greatest value, as opposed to things of lesser importance. So our values, or what we perceive to be our values, tend to guide our actions. In this chapter, I want to discuss the nature of value and the values that are at stake in the controversy over acid rain.

What are Values?

It is not my purpose to debate here the origin of value, whether it is inherent in a thing or assigned by humans. That debate has been going on for a long time. I do, however, want to explore the concept of what value is so that we can see how the concept of value might apply to discussions of what actions are called for in the control of acid rain.

On a very basic level, I suppose we could say that values are abstract things. Things like freedom, justice, fairness, health, beauty, and others are values. Things which we consider to be good are things which we call our values. They are also things which we generally consider to be of some importance in our beliefs and actions. Not all values are on the same level of abstraction, of course. Some seem to be less abstract than others. Health might seem to be fairly concrete, especially when we are talking about some particular person's health. But even in a case such as this, the value we are concerned with is abstract. My health is an abstract concept, even though it is the health of a particular individual. I cannot point to health and say, "here is health." I can only illustrate the concept of health by reference to my own healthy or unhealthy state at a given time. There is no one thing, or group of things or conditions which we can say with certainty constitutes health. It can only be measured by reference to an abstract idea.

It is, I think, obviously true that not everyone has identical value systems. Some people value

unspoiled nature very highly, for example. Others consider economic development to be more valuable. Such differences in the way each of us orders the importance of different values create difficulties when we try to deal with problems that are highly controversial. Often, the controversy is over differences in the relative importance of different values.

What each of us holds to be the most important of our values are the things which we will most want to support. If I believe that the most important value is justice, I might be willing to sacrifice many other things to obtain it. But because someone else doesn't rank justice as highly does not mean that such an individual is unconcerned about justice, just that there may be something else of greater importance to that individual. Such differences in values lead to differences in action. People who value one item more highly might choose one course of action, while those who have a different hierarchy of values might choose the opposite course of action, even though they also believe that the value motivating the first group is an important one.

Values Affected

What sorts of values might be affected by acid rain? This is an important question, one which we must answer if we are to consider these values in choosing a course of action to deal with the acid rain problem. Acid rain is a serious problem, one which is not likely to go away in the near future. If it has an effect on values, or on things we value, we must consider this in choosing our course of action. So what values are involved in the acid rain controversy?

Justice and Fairness

Two closely related concepts which are certainly involved in the acid rain controversy are justice and fairness. Fairness is, I think, a form of distributive justice. Justice need only involve one person, while fairness involves a comparison of the treatment of more than one person. Justice might be characterized as "getting what is our due." "Getting our due" does not depend on capriciousness or inconsistency of treatment, but on some reasonable connection between our actions and what we receive as a result of these actions. This consistency

of treatment must be impartial, without favoritism, although appropriate and relevant differences may be considered. In some societies, for example, there are class differences which might be considered in resolving questions of justice. But our emphasis here is on American society and U.S. policy, so I will not consider such class distinctions. According to the American concept of justice, there should be equal treatment for all. No individual citizen or group of citizens should be treated differently from any other. So for our purposes here, justice involves getting what is due to us, being treated equally with others, and being treated impartially. If any of these should be denied, we all suffer the loss to a certain extent. A fear, however small, that we might be victims of a similar miscarriage of justice may color our thoughts and actions. We might then encourage further injustices in order to protect what we feel is justice for us.

The question of justice, and particularly the issue of fairness, comes up in the acid rain controversy. Some of the key issues here revolve around the distribution of acid rain itself and the question of who should pay for attempts to control the problem. We all contribute to the problem in some small degree.

But we do not contribute equally. The major contributors, the coal-fired industries, do not suffer the effects of acid rain to the same degree as the people who live downwind. In fact, since the effects of acid rain are often felt many miles from the source of the pollution, the people who suffer the ill effects of acid rain may stand to gain nothing from the continued production of the pollutants. The people who benefit from the lack of controls, on the other hand, suffer relatively few of the ill effects. Of course, the people responsible for the pollution might inquire as to whether they would benefit from the controls that might be imposed. They might ask if they should not be getting some benefits themselves from the controls which they might have to finance at great cost.

Aesthetic Beauty

Somewhat different from justice and fairness, aesthetic beauty is also important. I suppose we might characterize aesthetic beauty as that which excites in us a feeling of appreciation or awe or wonder. These feelings may be important themselves, or they may help us to understand ourselves, the world around us, and our relationship to that world. Aesthetic beauty is one thing that sets humankind apart from other animals.

I think it is fairly obvious what the effects of acid rain are on aesthetic beauty. Acid rain causes the destruction of things which are of great beauty, both things in nature and things of human origin. There are some individuals who might argue, however, that a ruined and austere landscape also has great aesthetic beauty. And it is certainly true that many great works of art have had their inspiration in very austere surroundings or in the ruins of great natural beauty. So to some extent it would be proper to argue that controlling acid rain might limit some places of potential beauty. Perhaps we must choose between the beauty of an unnaturally ruined and austere landscape and that of the natural environment. This is a choice that will have to be made.

Health and Survival

We depend on the environment for our very lives. Without air and water that are substantially free of poisons, we would die. We cannot live without the environment, and for our own sake it must be relatively free of pollutants. At the very least, any pollutants that are present must be reduced to levels that will not cause us harm. The environment

is our home. We depend on it, but we cannot entirely control it. The environment, in its broadest sense, is a source of genetic diversity. That diversity is needed for the health of the animals and plants which we, in turn, depend on for many things, including medicines, food, and shelter. The natural environment is very important to our well-being.

Acid rain, uncontrolled, has very serious effects on the environment, as we have already seen. Our health and survival depend on the quality of our environment. The continued deterioration of that environment may lead to a deterioration in the quality of our lives, or it may ultimately lead to the loss of life itself. This is one area where the damaging effects of acid rain are quite clear, and where potential adverse effects on us from a violation of this value are particularly great.

Economic Development

Humans have always sought the means to improve their situation. Economic development is the means which seems to have the most to offer along these lines. Through economic development, the resources have been developed that enable us to provide food to more people, and in greater amounts, than would

otherwise be possible. Medical care, and other necessities of life, as well as many luxuries, are available because of economic development. And they are available to a greater percentage of the population. Generally, the higher the level of development, the greater the proportion of the population that receives the benefits. Certainly economic development is valuable to us.

Economic development is not unrelated to acid rain, however. Much of the development in this country is because of industries that are now major producers of acid precursors. And we all need electricity, which is produced by an industry that produces a large amount of acid precursors. Allowing acid rain to continue uncontrolled certainly might not have immediate adverse effects on economic development. There is a possibility, however, that the effects of acid rain might become so great that whole areas might become uninhabitable. This would have an adverse effect on economic development. But in the meantime, acid rain mitigation and control measures might well have an adverse effect on economic development. Whether we are talking about receiving-end countermeasures or pollution control, someone must pay for these. These

resources might be used for further development (or for something else entirely) if not committed to acid rain controls. It is possible that controls on acid rain could slow or stop development in some areas, or that some industries could be seriously hurt by the expense. This would also harm economic development.

Freedom

We might characterize freedom as the ability to pursue the goals and desires that interest us. It is not being controlled in our thoughts and actions by others. Certainly, we all have limitations on our freedom, but these limitations are often justified by a need to protect our freedoms. Without some limitations, there would be nothing to prevent someone else from limiting our freedoms. There are, of course, many varieties of freedom. There is freedom of thought and freedom of action, for example. These kinds of freedom allow us to grow and flourish as individuals, and to contribute to the well being of others. And, particularly in the United States, we consider freedom to be one of the most important values. We are often willing to make great sacrifices to preserve it. We are even willing to sacrifice freedom itself, temporarily.

Acid rain has adverse effects on freedom. Uncontrolled, acid rain limits how we can spend our resources. We cannot go fishing in some places. We cannot do some of the things that we might choose to do. The possibility of harm to our health as a result of acid rain limits us. If our health is harmed, our freedom of action has been limited. And the possibility of serious, permanent damage to the environment may limit the freedom of future generations.

But controlling acid rain imposes limits on freedom as well. Any governmental regulations and imposed standards have a limiting effect on freedom. Such regulations mandate the ways in which individuals or corporations can allocate their resources. Industry might well object to the imposition of such controls as restricting the freedom they need to compete effectively in a free market system. They object also on the grounds that they would be forced to allocate resources of theirs for the benefit of people who are in no way connected with them. Such an encroachment on the freedom of industry may have adverse effects in other areas, such as economic development, as well, by causing strain on the

resources of an industry to the point where it is no longer able to compete, and must withdraw from the marketplace. But perhaps most significantly, the industries might argue that regulation represents a form of coercion that restricts their freedom in a significant way. If such restrictions can be imposed on corporations, could they not also be imposed on individuals in society? Representatives of industry might argue that they could, and probably would.

I think it should be apparent from these few examples that acid rain can and does have a significant impact on values. Important values are at stake, and I think it is apparent that some trade-offs will be necessary. It does not seem likely that all of these values can be protected fully. We are certain to run into conflicts between these values no matter what course of action we might choose. The problem of choosing which values to protect is a difficult one, and various interests tend to promote different values. What these interests are, and what values they might want to promote is the subject of the next chapter.

CHAPTER V

INTERESTS AFFECTED

One of the reasons that we have different values is because we have different concerns. The values that we support tend to be ones which support our concerns. We orient our values around our concerns, the things that we perceive to be beneficial to us or to others in one way or another. Those involved in business tend to place higher value on things such as economic development, while those involved in other things may place higher values on the environment or on other things.

There are a number of interest groups affected by acid rain. Some would be adversely affected by attempts to control the production of acid rain pollutants; others would be or are affected adversely by the failure to institute control. Our economic interests and our concerns to live in a certain kind of society are both affected by the kinds of decisions we make regarding our choice of action in dealing with acid rain. In this chapter, I will look at some representative interests that

are affected by acid rain, and what kinds of costs might be involved for these interests.

As we look at interests affected by acid rain, there are a few things we should consider. First, I am not trying to provide an exhaustive list of all interests that might be affected. Such a listing, if not impossible, would certainly be quite long. Instead, I think we can get an idea of the issues and concerns involved by examining what I hope will be a few representative interests. Each of these might be affected whether we act to control acid rain or not. Some will be affected adversely by not controlling acid rain, and benefitted by putting controls in place, while the opposite will be the case for the others. In some cases, an industry might be adversely affected whether controls on acid rain are implemented or not.

What are some of the interests which might be affected by acid rain? One is the lumber industry. As I pointed out in Chapter II, acid rain has already reduced yields of some types of trees and does kill many of them. In areas with high concentrations of acid rain, growth of several varieties of commercially harvested trees has been reduced 40% in the

last twenty years. In a few areas, the growth reduction has been as high as 60%.¹ In West Germany, where acid rain has been evident for about ten years longer than in the U.S., scientists and forestry experts estimate that at least 25 to 30% of the trees have now been adversely affected by acid rain.² As acid rain becomes more widespread, the lumber industry, along with related industries such as housing, may have greater difficulties. We have long regarded lumber as a renewable natural resource. Much effort has been spent on developing strains of trees that are disease resistant, grow straight, and which grow quickly so as to replace the trees which have been harvested. But if acid rain continues, the industry may well have to invest additional dollars in developing strains of trees that are resistant to acid damage, if that can be done. In the meantime, there are other costs that will have to be borne by the lumber and related industries. Losses of new growing trees can be expected. If liming should be used by the tree growers, lumber and related industries would have to either absorb the cost of such operations, or else pass this cost on to the rest of us in higher prices for lumber, homes, etc. But even the best

receiving-end countermeasures will not stop all the damage to forests. As we saw in Chapter II, there is a problem with late season fertilization and frost kills. This problem can only be stopped by removing the NO_x pollutants before they reach the trees. Since air filtration for entire forests seems highly unlikely, the only place to stop these pollutants is at the point of origin.

Another industry which stands to lose significantly if acid rain is not controlled is the outdoor recreation industry. There are a number of fishing streams that are no longer being stocked due to the effects of acid rain. Pennsylvania, for example, has closed four additional streams this year due to acid rain pollution.³ As we mentioned before, approximately 20% of the watercourses in the Eastern U.S, have already been affected to some degree by acid rain. As the effects continue, and as more and more streams and lakes are harmed to the point where aquatic species can no longer survive, the outdoor recreation industry will be harmed. The loss of streams and lakes will result in a loss of revenue for those involved in the fishing industry, for states in reduced revenues from fishing licenses, etc., as

fewer individuals go fishing, and for other travel-related industries as well. While some people will undoubtedly take different kinds of vacations, those who prefer an outdoor vacation, including camping, fishing and other outdoor activities will find their choices limited and the available locations more crowded. And the people whose income depends on these vacationers will be forced to either relocate or find alternate means of employment. The reduction of watercourses available for fishing is likely to result in overcrowding and overfishing at those remaining open. This will again reduce revenues, reduce participation, and have an overall adverse effect on a number of people whose livelihood comes from this segment of the outdoor recreation industry. And sport fishing is only one segment of this large industry.

There is a rather large environmental interest which is probably not unrelated to the outdoor recreation industry. Many people enjoy the outdoors, and are interested in its preservation. This group may not be a deeply involved environmental group, though such people might be included. I think, rather, this interest encompasses all those who

use the outdoors, which is almost all of us. This environmental interest stands to be adversely affected by a failure to act so as to control acid rain. Whether we are of the group which regularly participates in outdoor activities in wilderness areas, or of those who only go for an occasional walk in the park, the damage that acid rain can do to the forests, including parklands, may limit our ability to participate in these activities.

There is one other 'industry' I would like to consider briefly before we move on to those which might be adversely affected by the imposition of controls on acid rain. This last is water treatment by cities, water districts, etc. As we have seen, acid rain can affect the water quality in our drinking water systems. This will necessitate additional equipment to filter out or remove, by whatever means might be necessary, the additional pollutants, most of which are not removed by current equipment; these pollutants include heavy metals and some other toxic substances. Certainly, this might be good business for those involved in the manufacture of water treatment equipment. But for the various municipalities and water districts that will have to

install this equipment, this could be a very expensive proposition. Ultimately the burden will fall on the taxpayer. Facilities capable of removing the kinds of impurities we are concerned about are not cheap. A good household system for use only in the kitchen might well run from \$100 to \$300 initially, and \$75 to \$100 per year to maintain.⁴ Such a system would treat only cold water used in food preparation, which is only a small part of a household's daily water consumption. To treat all the water for a domestic water system serving thousands of homes, while not as expensive per gallon of purified water, might still end up costing the taxpayers hundreds of thousands of dollars. I would guess, and this is just a guess, I have not been able to find any figures to support or deny it, that it might ultimately cost upwards of \$100 per year per household to effectively remove the contaminants that acid rain can introduce into our water supplies. This burden would be borne, of course, by those in areas most heavily affected by acid precipitation, which may not be the same as those producing the acid rain precursors, as we have seen.

The interests we have already discussed are ones which might be adversely affected by not controlling acid rain. The lumber industry might also

be adversely affected by some methods of control, depending on how they might be financed. If the lumber industry had to pay for liming to mitigate the effects of acid rain, for example, the adverse effects on the lumber industry would not be limited to not controlling acid rain.

Other groups which might be adversely affected by measures such as liming, again depending on how it was financed, might include parks, wilderness areas, and farmers. If they were to have to pay to control the effects of acid rain within their boundaries, it could well be a severe financial strain on already small budgets. Farmers have a very small profit margin, and the funds to take care of parks, etc., would have to come from already tight public funds.

Some of the other possibilities for acid rain control also suggest adverse effects on industries. The installation of scrubbers on existing coal-burning facilities would be quite expensive. If these facilities had to bear the whole cost of such a retrofit, many might not be able to continue in operation. The U.S. steel industry is a good example. Already facing stiff competition from lower-priced foreign steel manufacturers, the U.S.

steel industry might not be able to afford the cost of such new technologies, which would require extensive modifications to existing facilities. Similar considerations might apply to the Midwest power industry.

A switch to low-sulfur coal, while it might not have the same adverse effects on the industries which burn coal, might have other very serious adverse effects. The Eastern mining industry, located in one of the poorest areas of the United States, mines coal which is relatively high in sulfur content. A switch to low-sulfur coal could throw thousands of people out of work, close mines, cause the shutdown of whole towns, including the merchants who depend on the miners for their business, and raise the tax burden on the rest of us as we would have to pay for the retraining of these miners, and pay unemployment benefits. Additionally, such a switch to low-sulfur coal could have an adverse effect on environmental quality in the Western states, where low-sulfur coal is mined. Strip mining might increase, and the problems that accompany it.

There are interests who will clearly benefit from various methods of controlling acid rain, of

course. The pollution control manufacturing industry, for one, stands to gain a great deal by the imposition of new controls. The lime products industry also stands to gain, particularly if no other kinds of controls are implemented. There are many possibilities besides these, but I think these are some representative interests who fall on both sides of the acid rain control controversy.

I think it is obvious that whatever course of action we choose regarding acid rain, there will be interests that will be adversely affected, and interests that will be benefitted. The problem, of course, is in choosing a course of action that will be consistent with the values that we hold and which will not be an unfair burden on any interests or groups. Suggesting such a course of action is the task of the next chapter.

Chapter V Notes

¹Ronald A. Taylor, "Science Hot on the Trail of Answer to Acid Rain," U.S. News and World Report, 98, No. 1 (1985), 57.

²"Acid Rain," National Parks, 58, Nos. 9-10 (1984), 39.

³"Acid Rain," U.S. Water News, April 1985, p. 15. (I have not been able to determine how many streams had been closed to fishing prior to this year.)

⁴Sources for prices include Amway Corp. and Sears. Prices based on filter systems for home use which can remove the kinds of pollutants acid rain might introduce into water systems which conventional water treatment plants do not remove.

CHAPTER VI

POLICY RECOMMENDATIONS

There are, certainly, many things to be considered in formulating any plan of action to control acid rain. In this chapter, I want to see how we can use the information we have about the acid rain problem, the values, and the interests affected in formulating a policy to deal with the acid rain problem.

In Chapter II, we saw that acid rain is a serious problem in the United States. The adverse effects that we are already experiencing and the ones which are possible are quite serious. And the acid rain problem is not one which will go away if we can reduce emissions by as much as 50%. Because of the nature of the acid rain problems, a much larger reduction in acid precursor emissions is called for.

In Chapter III, I discussed some of the technologically possible solutions to the acid rain problem. The most promising of these technologies, fluidized bed combustion, not only reduces the

SO₂ content of exhaust gases from coal-fired facilities to nearly nothing, it also reduces the NO_x content of these same exhaust gases. While this technology promises to be highly effective in the next generation of coal burners, it is not practical to put it into use in currently operating plants. For these, alternate methods of pollution control should prove to be more effective. Coal washing, scrubbing, and a switch to coal lower in sulfur content have all been suggested. Of course, these are not equally effective, and some combination of these technologies may be called for.

I also discussed liming as a countermeasure to acid rain in the third chapter. I pointed out that while liming was effective in mitigating the effects of acid rain, its effectiveness was limited by areas where it could be applied, by the need for repeated applications, and by the fact that liming does not mitigate all the adverse effects of acid rain pollutants. Such countermeasures are very effective for reducing the impact of acid rain as a part of a complete acid rain control strategy, but they are not adequate alone to control the problem.

Chapter IV was an examination of the values that might be affected in the acid rain controversy. We saw that there are a number of values at stake here, and that no matter what course of action we might choose, there are likely to be value conflicts. And these value conflicts are related to the conflicts in interests that we discovered in Chapter V. The conflicts in both of these chapters are not easy ones to resolve. There are significant problems to be addressed, and particularly problems of justice. How we might hope to do this is the subject of this chapter.

Value Trade-Offs

One of the problems in dealing effectively with acid rain is the conflicts that arise between values. We need to make trade-offs of values, and it is not always easy to see how to do this. I think there are some guidelines we can use to help in making this decision, however.

While we may not be able to avoid sacrificing one value or another in our attempts to deal with acid rain, I think there are some values that are more important than others. Health and survival, for

example, seem to me to be of greater importance than any of the others. Should we have to sacrifice some freedom, for example, for the sake of health and survival, there is the possibility that we might recover that freedom eventually. If we sacrifice health and survival, however, we may never be able to recover them. In fact, we may not be here at all. This is not to suggest that freedom is never more important than health and survival. But I would suggest that when health and survival are threatened on a large scale, with the potential for world-wide effects, health and survival may take priority.

In general, I would suggest that the values we need to protect are those which will allow our continued survival, and the survival of other forms of life on Earth. I do not want to minimize the importance of the other values, but if we lose all life, then the other values are irrelevant to us.

Additionally, I would suggest that the trade-offs we must make should weigh the relative loss to the different values. It might be worth the loss of a little freedom to preserve life. The sacrifice of some fairness to preserve great freedom might be called for. The problem now, of course, is in

defining "a little" and "great" amounts of these values. Here I can only suggest that we can evaluate, and ultimately sense the right balance.

What are the Possibilities?

If we choose to do nothing to control acid rain, there are many costs involved. We have already seen that the values of justice, fairness, natural environment, and others might be affected by such a choice. Practically the only value that would not suffer from doing nothing is that of economic development, and even that is not certain. There may well be costs to economic development in choosing to do nothing to control acid rain.

Choosing to take any action also has its costs, and we have looked at some of these. The problem, of course, is in choosing a course of action which will satisfy our need to safeguard our values and protect the various interests involved. We probably will not be able to protect all the interests concerned, and we will have to make some value trade-offs. But we should be able to approach these difficulties sensibly.

We discussed the effectiveness of different possible choices of pollution control before, but let's review them briefly. Receiving-end countermeasures, while effective, are limited to small areas and to countering only some of the adverse effects of acid rain. Alone, receiving-end countermeasures are not sufficient to prevent the harms to values and interests that we are concerned with. Other pollution control methods are available, however, and the most promising seem to be fluidized bed combustion for new installations, and the retrofit of scrubbers and/or coal washing for older systems. As we saw, these systems can significantly reduce the amounts of SO₂ released into the atmosphere, and may reduce the NO_x content of emissions as well.

Specific Recommendations

There is a question in the minds of some as to whether or not we know enough about the acid rain problem to take effective countermeasures. I hope I have given enough information to suggest that we can take effective measures now. There have been other cases where regulations have been enacted to control pollutants when the full story was not known.¹

I think it is dangerous to delay action because we are not sure that we know enough about the problem. I think I have established that enough is known to be certain that the potential dangers are great. If we fail to control this problem now, it is not clear that later actions will be able to bring acid rain back under control. The dangers are clear. Even President Reagan's science panel has warned that if we "wait until the scientific knowledge is definite, the accumulated deposition and damaged environment may reach the point of irreversibility."²

I think that the severity of the acid rain situation calls for more government involvement than just establishing standards and writing regulations. Basically, I think the strategy of the U.S. government should follow the following guidelines. First, the government should encourage the development of acid rain emissions control systems and technology. Secondly, the government should support short-term treatment programs, such as liming, to help reduce the impact of acid rain now. Thirdly, as the technologies become available, laws should be written mandating reductions in emissions and providing

federal support so as to minimize the time to implement emissions reductions. Let's look at each of these recommendations in a bit more detail.

Systems Development

There are several possible ways that the government could support the development of acid rain emissions control systems. The most likely are direct federally supported research and tax incentives for private industry to encourage such development. Much research is already doing on, and some very promising systems, such as fluidized-bed combustion have been developed. I think the most logical course of action in this area is for the government to continue the research and development that is already going on. Federally sponsored programs must be adequately funded, and privately funded programs might be granted tax credits to spur further development. I do not think any new research programs are indicated at this time. But neither do I think that any delay in implementing at least some reduction in acid precursor emissions is justified.

Current Measures

There are already large areas of the country that are feeling the impact of acid rain. Because of this, and the fact that receiving-end countermeasures such as liming are expensive to employ, I think some federal support of such measures is justified. Acid rain presents a clear danger to the environment, to wildlife, to various industries, and to human health in many areas. Because of the problems, and because the areas where acid rain pollutants are generated are often located in states other than those where the effects are most seriously felt, I think federal intervention is not only justified but required to equalize the burden of treating the problem. I think several specific measures can be undertaken, and are justified.

What can be done now to reduce the impact of acid rain? There are several possibilities. The first of these, coal washing, can provide an immediate reduction of 20 to 40% in the sulfur compounds emitted from most older coal-fired facilities. Such a reduction, while not adequate in itself, can be implemented immediately, and can be coupled with other technologies to produce even greater reductions in the sulfur released into the atmosphere.

Coal washing alone would cost between 2 and 9 cents per pound of sulfur removed (as opposed to 7 to 45 cents per pound for scrubbers).³ Coal washing could have a significant impact on the levels of pollutants released in a very short period of time. But alone, washing is not enough. As I pointed out in Chapter II, even a 50% reduction in the levels of SO₂ emitted will not prevent further damage to the environment.

In addition to the coal washing, I think scrubbers are called for where they can be installed. It may not be possible to retrofit this technology on older systems. However, the need to further reduce the levels of SO₂ emissions suggests that further measures are called for.

Future Measures

As the technology becomes commercially available, its use should be mandated in new facilities by the federal government. Because of the interstate and international travel of acid rain, I think the federal government is the most logical level of government to set the standards. As these technologies are available, such as fluidized bed combustion, some older technologies like scrubbing may no longer be required. For this reason I would suggest that

whatever laws are written impose standards on the maximum amount of SO_2 that can be released, rather than a percent reduction of sulfur removed. The eventual goal must be to remove at least 90 to 95% of the sulfur compounds, and to look for ways to achieve similar reductions in the NO_x levels. I think these are realistic and realizable goals.

Justification

Why should we adopt a program structured along the lines I have suggested? I think this program allows us to achieve the greatest benefits in terms of reduced danger from acid rain, while providing for the recognition of the needs of most interest groups. Coal washing is relatively inexpensive, and would not throw miners in the East out of work. The use of scrubber technology, where possible, while more expensive, would also recognize the needs of Eastern mining interests, but would also help to reduce the impact of acid rain on other interests and areas. Of course, the future technologies will be tremendously useful in preventing the adverse impact of acid rain. Additionally, as they are available, the indications are that

they will be less expensive to operate than some of the current systems, such as scrubbers, thus these improved technologies will be beneficial to the producers of acid rain pollutants as well.

But even if we can find a solution that will minimize the effects on different interests, what about the values we discussed in Chapter III? How can we pay for these measures, and spread the cost equitably? I think there are some reasonable possibilities. First, the greatest proportion of the cost should be borne by those who stand to benefit the most from the continued use of coal-fired facilities. This means that the Midwestern power industry, the steel industry, and any other coal users should have to pay a significant part of the cost of employing these controls. A tax on these industries could also be used to help pay the cost of liming in areas that require it. These costs would, of course, be passed along to the consumers. Since power is currently cheaper in the Midwest than it is in the Northeast, I don't think it is unreasonable to do this. But the coal-fired industries are not the only source of acid rain pollutants; we all contribute to some degree. Therefore, I think it

is fair that the federal government use federal tax monies to help defray the cost of implementing the control strategies I have suggested. This would allow the greatest share of the expense to be paid by those benefitting the most, the pollutant producers, while acknowledging that we all have a responsibility for the pollution and its control.

The solution I have proposed takes into account, I think adequately, the problems of justice and economic development. It attempts to treat the cost of acid rain controls proportionately, which would seem to be the most fair. This course of action also puts adequate emphasis on health and survival, considering that we need to take action in order to protect these. This leaves us with the questions of aesthetic beauty and freedom. What kinds of trade-offs are we required to make here? Aesthetic beauty is preserved in the natural environment, and only that beauty that might be found in an austere landscape might be lost. I would suggest, however, that there are other austere landscapes. But if we allow acid rain damage to continue, there might be none that are not austere. We cannot preserve the natural beauty of a lush landscape if these are all destroyed. But many austere

areas will remain. Areas burned by forest fires, damaged by war, or subject to other natural disasters will continue to abound, in all likelihood. So we may be able to preserve the interests of those who prefer both types of landscape. And as far as freedom is concerned, I think the program I have suggested will prove to be the least limiting of freedom of several alternatives. We have already seen that to do nothing to control acid rain will limit freedom. We could take far more severe steps to limit the freedom of those responsible for the pollution. But the course of action I have suggested will, I think, prove to be a limitation on freedom only to the point that it is needed to preserve the freedoms of all.

Summary

We have seen that acid rain presents a serious challenge to us in the United States today. It is a threat to the environment and our health. We must formulate a policy to control the problem without sacrificing things that we value or limiting benefits to (or denying them to) any one group of people. Acid rain affects our values and our interests. It will not be an inexpensive problem to control, particularly in the near term. But it can be controlled.

The actions I have suggested will, I think, reduce the impact of the acid rain problem on our values and interests. We will have to sacrifice a limited amount of freedom to preserve greater freedoms for ourselves and future generations. We can use justice and fairness by an appropriate structure for financing the pollution control measures. And values such as aesthetic beauty and health and survival can only be fully protected by choosing to act rather than to do nothing.

Finally, the various interests affected by acid rain will be only minimally affected, adversely, by choosing the course of action I have suggested. There are no guarantees that what I have suggested will be entirely successful, of course. But there does seem to be a guarantee that if we do nothing, the problem will get worse, and may become irreversible.

Chapter VI Notes

¹Steven L. Rhodes and Paulette Middleton,
"The Complex Challenge of Controlling Acid Rain,"
Environment, 25, No. 4 (1983), 9.

²"Acid Rain," National Parks, 58, Nos. 9-10
(1984), 39.

³Bruce A. Ackerman and William T. Hassler,
Clean Coal/Dirty Air (New London, Conn.: Yale
University Press, 1981), p. 67.

BIBLIOGRAPHY

Acid Deposition: Atmospheric Processes in Eastern North America. Washington, D.C.: National Academy Press, 1983.

"The Acid Deposition Phenomena and Its Effects." Critical Assessment Review Papers, Vol. 1. Washington, D.C.: Environmental Protection Agency, July 1984.

Acidification Today and Tomorrow. Trans. Simon Harper. Stockholm: Swedish Ministry of Agriculture, 1982.

"Acid Rain." National Parks, 58, Nos. 9-10 (1984).

Acid Rain and Transported Air Pollutants: Implications for Public Policy. Washington, D.C.: U.S. Congress, Office of Technology Assessment, June 1984.

"Acid Rain." U.S. Water News, April 1985.

Ackerman, Bruce A., and William T. Hassler. Clean Coal/Dirty Air. New London, Conn.: Yale University Press, 1981.

Garfield, Eugene. "Acid Rain, Part I. What is It and What Does It Do?" Current Contents, March 4, 1985.

Garfield, Eugene. "Acid Rain, Part II. Issues and Proposed Solutions." Current Contents, March 11, 1985, 4

Jones, Kay H. "Acid Deposition Precursors." The Environmental Forum, 7, No. 2 (June 1984), 11-13.

Karlen, Neal, and Mary Hager. "Pollution Now the Bad News." Newsweek, 105, No. 14 (1985), 26.

Marcus, Steven J. "Acid Rain: Technology Exists to Flush the Problem Away." Audubon, 86, No. 2 (1984), 120.

Rhodes, Steven, and Paulette Middleton. "Acid Rain's Gang of Four: More than One Impact." The Environmental Forum, 6, No. 6 (1983).

Rhodes, Steven, and Paulette Middleton. "The Complex Challenge of Controlling Acid Rain." Environment, 25, No. 4 (1983).

Taylor, Ronald A. "Science Hot on the Trail of Answer to Acid Rain." U.S. News and World Report, 98, No. 1 (1985).

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