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Contents

Energy and environment: a coming collision?

Robert W. Fri

Environmental problems associated with the production and use of energy are growing more urgent. Yet cutting energy consumption in the interest of environmental protection poses difficult questions. Will developing countries risk retarded economic growth? Will developed countries give up some of the amenities that energy provides? Some familiar management principles may offer the answer to balancing energy and environmental interests.

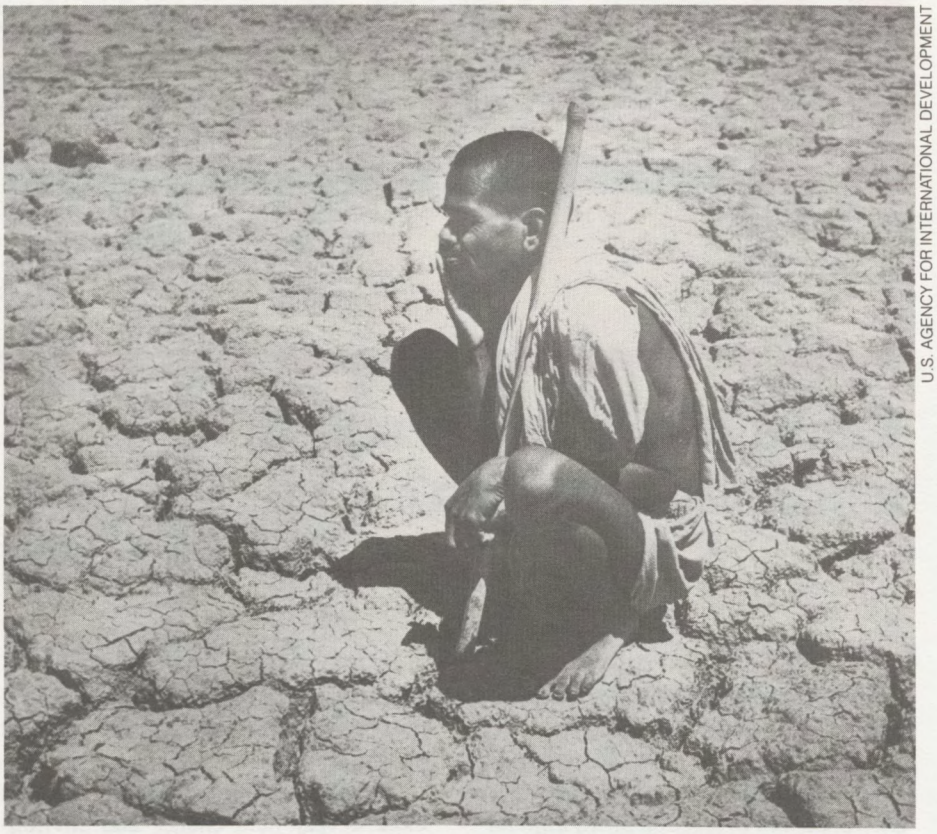
Nearly twenty years ago, Earth Day put environmental issues firmly on the public policy agenda in the United States. The environment now occupies a place on the world's political agenda as well, as even a casual reading of the daily news will show. And among global environmental issues, none are more prominent than those associated with the production and use of energy.

Both energy and environmental problems arouse strong feelings. We object to—even fear—acid rain, global warming, nuclear waste, smog, and oil spills. That the names of these energy-induced environmental problems are so familiar only underscores our concern about them. But energy evokes equally visceral reactions, especially when we cannot get it cheaply and easily. Nothing concentrates our minds so much as a good power blackout or a long line at the gas pump.

The prospect of a collision between these deeply held energy and environmental interests is a disturbing one. It is certainly one that increasingly troubles policymakers, both in the United States and elsewhere. Not surprisingly, opinions differ on whether the collision will occur. No less polarized is the debate about what we can do to prevent the collision, or failing that, to cope successfully with it.

Conflicting interests

As a starting point for understanding this debate, it is safe to assume that the chances of a collision are growing. This is because energy-environment problems are evolving in a way that suggests that something has to give. For example, in the United States most of the easy things have been done to protect the environment. From here on it gets harder, and the hardest part is the prospect of giving up some of the amenities that energy provides. Thus the authorities in southern California recently proposed a smog abatement plan that is not only costly but would also restrict the freedom to drive in that region. Taking on the automobile in Los Angeles is a



U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Greenhouse warming could lead to desertification, but efforts to curb global warming might delay economic growth in developing countries.

challenge, possibly a quixotic one, of no mean proportions.

The growing need for energy to sustain economic growth in developing countries is another precursor of a possible collision of interests. Over three-quarters of the world's people live in these countries, but their per-capita energy use is less than one-tenth that of people in the developed countries. Moreover, the population of the developing countries is growing six times faster than that of the wealthy nations. A little multiplication and even less imagination suggest both the size of the potential energy demand and the extent of the associated environmental problems that could accompany rapid economic growth in the developing nations.

The increasingly global nature of energy and environmental problems means that both the developed and developing worlds will share in any collision of interests, wherever they may occur. Fossil fuels burned to advance economic growth exacerbate our common problem of global warming, just as expanding the use of refrigerators in China can add ozone-depleting chlorofluorocarbons to the atmosphere. The growing demands of the developing world will not make it easier for any of us to have cheap, secure energy.

This global interdependence of energy and the environment poses difficult economic and political dilemmas. It is hard to tell a poor country not to put its environment at risk if that would only slow its climb from poverty. But to have both environmental protection and economic growth may impose costs that such nations are unwilling or unable to bear themselves. And if, as some have suggested, developed countries should throttle back their energy use to make room for others, the interests at stake are no less difficult to reconcile.

Of course, none of these arguments demonstrates that an energy-environment collision is inevitable. In fact, such a collision has yet to arrive, even in the United States where we have had a reasonably vigorous environmental protection program since 1970. And the reason for this avoidance of conflict is instructive in helping judge the potential for a future collision of interests.

It is fair to say that the United States has avoided the encounter by making the energy costs of environmental protection more or less invisible to most of us. Our environmental policies generally impose these costs on producers of goods and services who later pass them along to consumers, together with other increased costs, in the prices they charge. Thus a car or a kilowatt costs more, but we are neither much surprised by that, nor particularly aware of how much environmental protection is embedded in the higher price.

In a complementary way, we have largely sidestepped imposing costs that are harder to hide. Our lawmakers have not required us to drive less, or to be warmer in summer or colder in winter, for environmental reasons. We did these things for a while when energy prices were rising rapidly, of course. Our alacrity in returning to our old habits when prices stabilized only reveals our preference for having the amenities energy provides.

Cause for optimism?

If we can continue to resolve energy-environment problems at little or no apparent cost, then it is likely that the collision of interests that worries policymakers will not occur or, more precisely, will not be noticed. And there is a seductive argument abroad that says, in effect, that just such an accommodation is possible. It is an argument based on technological optimism.

The argument asserts that there is technology in hand, or nearly so, that allows us to have environmentally benign energy. Central to this argument is the belief that greater energy efficiency is possible. In addition, less polluting forms of energy production—especially production of electricity—are said to be available. Proponents of this view favor renewable forms of energy, like solar power, over nonrenewable ones.

In a curious reversal of past positions, this technological optimism

has become the province of the conservation-minded. A leading advocate, Amory Lovins, notes in a recent paper for the Hoover Institution the "charming historical irony" of his becoming a "born-again technological optimist." This is a critical rhetorical shift in the energy-environment debate. One need not argue that the environment is priceless, but only that its protection is relatively painless.

Although this outcome would be welcome, a note of skepticism is in order. For one thing, the real costs of environmental protection are not trivial, even if they are fairly well disguised. The Environmental Protection Agency reports that the cost of enforcing its air and water pollution regulations averages over $60 billion per year. Our scholars at Resources for the Future have suggested that, when properly accounted for, even this estimate may be well below the true social costs. At some point, these costs become large enough to be noticed, however thoroughly they are diffused throughout the economy.

More important, perhaps, is the increasing difficulty of avoiding actions that plainly have a cost. Should the southern California smog plan be implemented, people in the affected area are likely to notice that mandatory carpools are less pleasant than solitary commuting. Likewise, poor countries will be sensitive to trading a bit more poverty for improving the global environment, if it comes to that.

None of this is to say, however, that the energy-environment problem is not urgent, nor that the inevitable cost of dealing with it is not money well spent, nor that we should fail to place considerable faith in technology's capacity to mitigate the pain. Rather, it is only to suggest that the chances of a collision are fairly good and that we should not pretend otherwise. And so, as with so many other resource and environmental problems, we might as well prepare to manage this conflict as best we can.

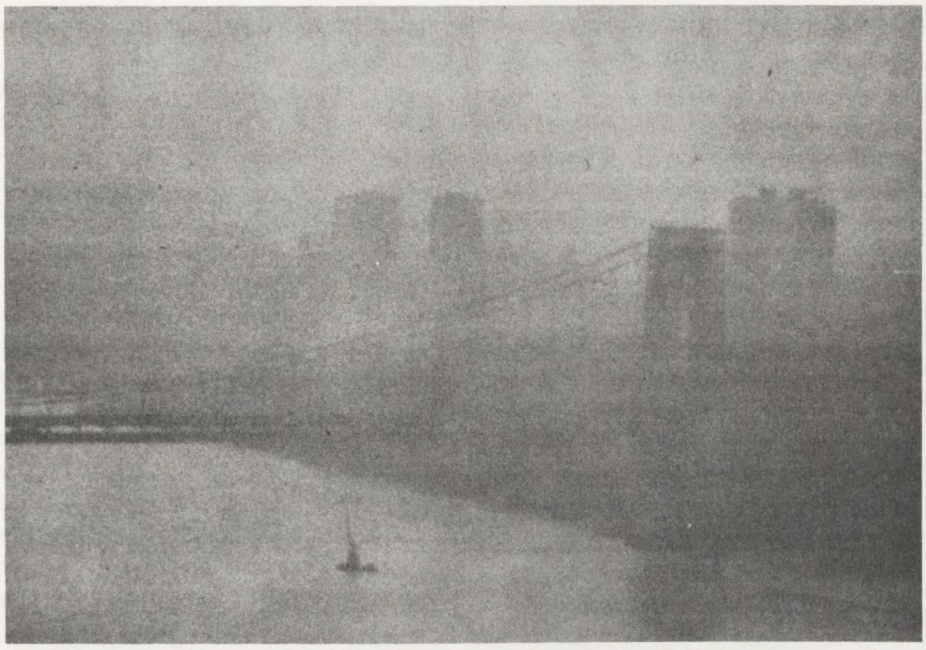
Management principles

Some of the principles that can help guide the management of energy-environment problems are familiar ones, but are no less valuable for that. For example, economists advise balancing benefits and costs as explicitly as possible. Many who place a special value on the environment raise vigorous methodological and ethical objections to the balancing idea; however, among those who pay the cost of environmental improvement, the balancing principle is more popular. They rightly point out that in some cases the cost of action vastly outweighs any conceivable benefit.

In the future, the nature of energy-environment problems will not allow us to deal so imprecisely with the balancing of benefits and costs. To the extent that the worsening potential impact of such problems makes the benefits and costs of dealing with them more transparent, a more explicit balancing seems inevitable. And in the case of truly global issues, where costs and benefits fall unequally among nations, it is hard to imagine how we can balance interests across borders unless all parties have a firm grip on what they get for what they must give.

Similarly, decentralized decision-making is a familiar prescription for improving the efficiency of resource use in meeting public policy goals. The importance of resource efficiency becomes apparent when we realize the extent of the resource commitments at stake. Because the developed nations have already taken the cheaper actions to mitigate the impact of energy production and use on the environment, those actions that are left tend to be expensive. For example, the proposed smog reduction plan in Los Angeles could cost each family in the area something like $2,400 annually.

As a general rule, decentralization of decision-making improves efficiency. Increasing the number and freedom of economic agents tends to enlarge the range of options, to make their relative costs and effectiveness transparent, and to provide a reward for doing what consumers do best—select the least costly option, all things considered. There are also more specific reasons for relying on decentralized decision-making to implement energy-environment policy goals. One is that when technology is a critical element, as it is for solving global energy and environment problems, decentralization tends to foster innovation. A second is that cultural and other societal differences pose major obstacles that preclude one-answer-for-all solutions when dealing with supranational problems.



NATIONAL CLEAN AIR COALITION

Improving environmental quality may mean giving up some amenities that energy provides, but are people willing to restrict their driving to reduce smog?

Finally, the principle of compensation must be applied if all parties are to cooperate in resolving energy-environment problems. Economists warn that, even when the total societal benefits of a policy exceed the policy's total cost, there are still individual winners and losers. Consider, for example, the problem of climate change in which acceptance of environmental constraints could well result in retarded economic growth for developing countries. About half of the so-called greenhouse effect, the possible warming of the planet's temperature, is attributable to carbon dioxide emissions, most of which are associated with energy production and use. Since developed countries account for about 75 percent of the world's energy consumption, they have been called upon to reduce carbon dioxide emissions by 20 percent by the year 2005.

Suppose that the developed world agrees that such a reduction is worth the cost it entails and is willing to pay for it. The question now arises of how most effectively to meet the reduction goal. In particular, should we cut energy production in the already energy-efficient developed world? Or would it be cheaper to help developing countries meet their energy needs more efficiently, thereby avoiding an increase in their carbon dioxide emissions equivalent to a 20 percent reduction in such emissions from developed countries? Given the potential for energy growth in the developing world, spending some money on the latter would probably be a good investment.

However, we cannot reasonably expect a poor country to spend its own money to limit its increase of carbon dioxide emissions for the good of society at large. Nor is it helpful to evoke the familiar principle that the polluter should pay. Simple equity suggests that if developed countries want carbon dioxide emissions limited, they should pay, in some way, for limiting them, even though this poses grave problems. Of course, our political leaders will note that this payment requires transferring resources from someone who can vote for them to someone who cannot. Yet without such compensation, many energy-environment problems will simply go unsolved.

These principles—balancing benefits and costs, decentralizing decisions, and compensating the losers—are neither easy nor without expense to apply. In fact, their application depends on institutions and methods that need improvement and, in some cases, invention. Application will not be easy because existing political and social institutions are uncomfortable with these ideas, our propensity to obscure environmental protection costs in the United States being a leading example. And there are those who simply disagree that the above principles have merit, especially those who prefer to see a strong tilt toward either environmental or energy values built into the system.

The World Commission on Environment and Development foresaw these difficulties in saying that "a safe, environmentally sound, and economically viable energy pathway that will sustain human progress into the distant future is clearly imperative. It is also possible. But it will require new dimensions of political will and institutional cooperation to achieve it." Among the new dimensions that the commission calls for will be the familiar principles set forth here. The task at hand is to get on with applying them. ■

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Supplying the environmental values of agriculture

Pierre R. Crosson

In the United States the demand for clean water, biological diversity of plants and animals, and other environmental values affected by agricultural production is growing faster than the demand for food and fiber. Yet for technical and institutional reasons the supply response of environmental values is more sluggish than the response of commodity values. The emerging challenge is to recognize this situation and to take action to correct it.

We generally think of agriculture as the set of activities through which societies combine land, labor, fertilizers, pesticides, farm machinery, and other resources to supply demands for food and fiber—the commodity values of agriculture. Only within the past couple of decades have we begun to recognize that the way we manage these resources to produce food and fiber inevitably affects the supply of environmental values that societies also hold important. Such a value is river water—water in which farmers dump sediment and pesticides that must be removed before the water can be used for household consumption. Other environmental values affected by agricultural production are the flood-moderating services of agricultural wet-

lands and the biological diversity of wild plants and animals found on farmland. Drainage of wetlands and clearing of wooded land reduce the supply of environmental values, just as soil erosion may decrease the supply of commodity values by reducing the productivity of the land.

Throughout most of human history, the main task of agriculture has been to increase food and fiber production enough to stave off famine and hardship. Even in the United States, where agricultural surpluses are common, concern is still expressed about the country's capacity to meet long-term domestic and foreign demands for food and fiber.

It now seems clear that this concern is misplaced. Instead, the main challenge to American agriculture in coming decades is likely to be meeting a rising demand for the environmental values of agriculture. By comparison, meeting the demand for commodity values should be a relatively easy task.

This assertion rests on two propositions. First, the demand for the commodity values of U.S. agriculture will grow much more slowly than the demand for environmental values. And second, the supply of environmental values rises less rapidly in response to increased demand than the supply of commodity values. Thus conditions on both the demand and supply sides of commodity and environmental markets suggest that American agriculture will have more difficulty meeting future demands for environmental values than for commodity values.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Developing countries have boosted food production with the help of research to increase the yield of grain crops such as wheat.

Commodity values

The demand for food and fiber grows primarily in response to population and per-capita income growth, as well as to changes in consumer preferences among various kinds of food and fiber. In the United States most people already consume at the biologic limit, so future demand for food will grow at about the same rate as population—0.6 percent annually from 1990 to 2025, according to recent United Nations projections. For the last couple of decades most of the increased demand for U.S. food production has come from abroad, particularly from the developing countries of Latin America, Africa, and Asia. In these countries demand for food grows not only with population but also with per-capita income, because many people still are malnourished. United Nations population projections for these countries and plausible assumptions about their rates of per-capita income growth suggest that demand for food in these countries could increase 2.8 percent annually over the next several decades.

What does this scenario of future demand for food in the developing countries imply for agriculture in the United States? There is no certain answer, but some useful speculation is possible. If the developing countries continue to increase food production at the rate of the last few decades—slightly more than 3 percent annually, according to U.S. Department of Agriculture figures—by the 2020s they not only will be producing enough to satisfy their own demand, they likely will have substantial surpluses for export. In this scenario, U.S. exports of food probably would fall sharply. Indeed, it could be to the economic advantage of the United States to become a net food importer, although for political reasons the coun-

try might choose not to do this. Even so, pressure on American agriculture to produce food would be less than it is now, and the country would have the option of using the resources released to respond to rising demands for the environmental values of agriculture.

Resources released from food production might be used to meet rising demand for the environmental values of agriculture.

In another scenario, the developing countries would fail to maintain the relatively high rate of food production that they have over the last couple of decades, perhaps because of increasing stress on their land and water resources. Assuming that their per-capita income growth is not adversely affected by this—admittedly a strong assumption—their demand for food would increase more rapidly than production and their demand for food imports would increase substantially. The United States would not likely be the sole supplier of this increase (Canada, Australia, and Western Europe are also important food exporters), but demand for U.S. food exports would almost surely rise significantly from present levels. With domestic demand also growing because of population growth, U.S. food production would rise from present levels. However, even if production growth in the developing countries lagged well behind recent performance—say 2.5 percent per year instead of the 3 percent plus of the last two decades—demand for U.S. food production likely would increase considerably less than the roughly 2 percent annually achieved since the end of World War II. Given the strength of the U.S. agricultural research establishment and a policy environment favoring adoption of new technology by American farmers, the country could readily meet the increased domestic and foreign demand for food suggested in this scenario.

Environmental values

Unlike the commodity values of agriculture, environmental values are not typically reflected in market transactions. Therefore we have little, if any, price information about these values or about the quantities of them produced and consumed. However, scattered evidence strongly suggests that in the United States and other developed countries the demand for environmental values, unlike that for food and fiber, rises as per-capita income increases. Although comprehensive estimates of the relationship between the growth of per-capita income and the growth of demand for environmental values are not available, indirect evidence suggests that the relationship may be proportional. In this case, or even if the relationship is less than proportional, the demand for the environmental values of agriculture in the United States could grow 100 to 150 percent more than the demand for commodity values over the next several decades. The relatively higher growth of demand for environmental values would occur even if food production growth in the developing countries lags, as in the scenario sketched above.

The supply response of environmental values, however, is likely to be more sluggish than the supply response of commodity values. This sluggishness results from the focus of U.S. agricultural research institutions on increasing agricultural commodity production (rather than on producing environmental values) and from the difficulty of establishing property rights in environmental values.

The success of agricultural research in the United States is measured by rapidly increasing production of food and fiber—the commodity values of agriculture. Scientists engaged in agricultural research are by training, experience, and professional interest oriented toward increasing agricultural productivity. And the leadership of these institutions, up to and including secretaries of agriculture, have a similar orientation. Therefore the agricultural research establishment will not find it easy to shift its emphasis from increasing production of commodity values to increasing production of environmental values.

Increasing the supply of environmental values is even more problematic because the absence of property rights in these values gives farmers little incentive to protect the values against actions that would diminish their supply or to take actions that would increase their supply in response to rising demand for them. For example, if people who value the biological diversity of agricultural wetlands had a secure property right in diversity they could charge farmers for draining wetlands or for otherwise diminishing diversity. The unit amount of the charge would be the price of diversity and the total amount would reflect the social value of the diversity lost by drainage. In making decisions about whether to drain the wetlands, farmers would have to balance the value of the increased commodity production after drainage against the cost to them that the loss of biological diversity drainage would entail. If, over time, the demand for biological diversity were to

Demand for environmental values in developed countries is likely to rise with increases in per-capita income.

rise relative to the demand for farm commodities, as seems likely, the price of diversity would rise relative to commodity prices, and farmers would have increased incentive to protect diversity or even to invest in management practices that would enhance it.

So why are property rights in environmental values so poorly developed or not developed at all? One reason is the lack of control of access to the thing valued—in the present context, an environmental "thing." Another is that in some situations the value of the thing is less than the cost of controlling access to it.

Control of access to the thing valued

THE NATURE CONSERVANCY—STEVE PACKARD

The Nature Conservancy's purchase of 900 acres of Illinois grasslands will protect the downy yellow painted cup (Castilleja sessiflora) from agricultural development.

is an essential condition for development of a property right to the thing valued. Control of access means that the person or institution holding the property right determines the terms under which the thing valued can be used. But control of access to environmental resources is often difficult. For example, water in rivers may move over hundreds or thousands of miles. Many people along a river may use and reuse the same water as it flows down the channel. All of these people may have a right to use the water, but no single right is exclusive of all other rights. Thus a supplier of municipal water does not have an exclusive right to all the water upstream from a treatment plant and so cannot deny upstream farmers access to the river as a dump for sediment and agricultural chemicals.

Even if access can be controlled, the cost of exercising control may be higher than the value of the thing to which access is desired. For example, hundreds of thousands, perhaps even millions of people in the United States may be willing to pay something to protect the biological diversity of agricultural wetlands. The nature of biological diversity is such, however, that there is no easy—that is to say, inexpensive—way for those people to express their demand for diversity in ways to which farmers can readily respond. Biological diversity is not something farmers can produce and send to market where those who value it can buy it.

To be sure, people who value diversity can form organizations to buy agricultural land rich in biological diversity or otherwise pay farmers not to use such land for commodity production. Organizations such as The Nature Conservancy do just this. They acquire a property right in biological diversity, the price of acquisition providing a measure of the social value of diversity. However, such organizations are few, and the amount of land rich in biological diversity acquired by them is small. A main reason for their modest success must be the high cost of organizing the many people who would be willing to pay something to protect biological diversity and of identifying the farmers, numbering perhaps in the hundreds of thousands, who own land rich in biological diversity. Unless these costs can be brought down, property rights in biological diversity will be difficult to establish, and farmers will continue to underestimate the social value of diversity relative to the social value of additional commodity production.

Science and policy challenges

Those responsible for agricultural research and policy in the United States should recognize that, over the next several decades, increasing the supply of environmental values in step with rising demand is likely to be a greater challenge than increasing the supply of commodities. This is not to say that increased capacity to produce commodities will not be needed; it will be, especially if the increase in food production in the developing countries lags much behind the performance of the last couple of decades. It is to say, however, that a redirection in agricultural research and a reexamination of current agricultural policies are essential if the United States is to meet the challenge of supplying increased demands for environmental values.

That research can enhance these values is not in serious doubt. For example, over the last fifty years programs undertaken by the federal government and by state governments have greatly increased the productivity of wildlife habitats, as measured by the number of animals supported per unit area. A major element of these programs has been research to augment knowledge of wildlife management. The success of these programs suggests that increased research along this line could have a high pay-off in habitat improvement.

Pesticides and nitrates in ground and surface water are a significant threat to the environmental values of agriculture. Research to develop technologies and management practices less dependent on these materials would reduce the threat. Integrated Pest Management (IPM) systems offer much promise. The goal of these systems is to achieve pest control by substituting increased knowledge—for example, about the life cycles of pests and their predators—for increased use of chemicals. Research on how to make these systems economically attractive to farmers deserves high priority.

Policymakers should also recognize that the country's ability to adequately supply increasing demands for environmental values of agriculture will be strongly affected by the developing countries' success in increasing food production. To recapitulate, should these countries continue to increase production at the rate of the last several decades, the United states likely would have the option of letting its production of food fall, supplying the population-induced increase in demand with imports from the developing countries. For political reasons the United States may not decide to exercise this option; but if it did, the reduced commitment of resources to food production would create highly favorable conditions for meeting rising demands for environmental values. Consequently, the United States has a strong interest in the success of the developing countries in increasing their production of food. Development of policies that support increased international agricultural research in institutions such as those comprising the Consultative Group for International Agricultural Research, and that further research in national agricultural institutions in the developing countries, would serve this U.S. interest.

Developing new technologies and management practices may be more politically palatable than applying regulatory policies.

The United States should also reconsider its current support of agricultural commodity prices above market clearing levels. Whatever their merits on other grounds, these policies induce farmers to use more agricultural chemicals and to farm more environmentally fragile land than they would otherwise. Consequently, the policies are an important part of the increasingly inappropriate bias against environmental values of agriculture relative to commodity values.

The United States now has in place policies to regulate the use of environmentally damaging materials such as pesticides and animal wastes. There is clearly a place for regulatory policies in situations in which the environmental costs of unregulated practices are high and in which farmers lack economical alternatives to the practices. However, the costs of regulatory policies may also be high. By definition, regulatory policies require farmers to act against their perceived economic interests. This results in political conflict, which drains social resources, and in the need for a public bureaucracy to enforce the regulations, an additional social cost.

Over the long run, a policy to develop less environmentally threatening and more economically attractive technologies and management practices such as those employed in IPM systems may well be both economically more efficient and politically more palatable than a regulatory policy. Such a technology-based policy would reduce, if not eliminate, the need for regulations by reducing, if not eliminating, the difference between the farmer's economic interest in commodity values and society's interest in environmental values. This is not to say that we can dispense with regulations. It is to say that, wherever they are needed, attention should be given to developing technologies and practices that eventually would make regulations unnecessary.

Development of policies that overcome the difficulty of establishing property rights in environmental values could also help to increase the supply of environmental values. Policies to acquire farmland of high habitat value are an example. Such policies already exist in North America. The United States and Canada have agreed to acquire several million acres of wetlands in the northern plains of the United States and the adjacent prairie region of Canada. Wetlands in these areas are of major importance as habitat for waterfowl and numerous other animals. The land is being lost at a disturbing pace as farmers drain and convert it to crop production. The objective of the Canadian-American plan is to preserve some of the habitat values of these lands against further conversion of them to production of commodity values.

So far the use of public and private institutions to acquire property rights in environmentally valuable land is on a small scale relative to the total amount of land under the threat of conversion to commodity values. The Canadian-American plan, for example, calls for acquisition of only five or six million acres of wetlands in an area where the total acreage is in the tens of millions. Over the next few decades policies aimed at greatly expanding these activities by both public and private agencies could go far toward overcoming the property rights obstacle to increasing the supply of habitat values in agriculture.

To meet the demand for environmental values, more research on wildlife management and pest control is needed.

The battle to increase food production in step with domestic and foreign demand has been won in the United States. Those responsible for advancing agricultural science and formulating agricultural policy in the country now face a fundamentally different challenge from that which has preoccupied them up to the present. The new challenge is to develop the technologies and institutions that will permit the supply of environmental values of agriculture to increase in step with demand. How well they respond will have an important bearing on the future welfare of the people of the United States. ■

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Environmental exposures and cancer risks

Michael Gough

Estimates of the proportion of cancers associated with environmental factors can be based either on epidemiologic data or on toxicologic data and risk assessment techniques. Two studies, one relying on the former and the other on the latter, reveal that environmentally associated cancer risks are a small percentage of total cancer risk—a conclusion that calls into question the idea that control of environmental pollution would have a major impact on human cancer rates.

One of the major justifications for environmental regulation is concern about the carcinogenic potential of air and water pollution, pesticide residues on foodstuffs, and other so-called environmental exposures. In the 1970s, it was common to hear claims that the environment was responsible for 80 to 90 percent of all cancers.

The term environment, however, has two quite different meanings. As used by epidemiologists—scientists who study the occurrence and causes of human disease—it refers to many of the things that humans come into contact with: food, drink, and anything smoked; drugs and medicines; and air, water, and soil. In this context, the environment means things outside the body as distinct from a person's genetic makeup. Thus, when epidemiologists say that 80 to 90 percent of cancer is associated with the environment, they mean that factors other than a person's own genetics are almost always involved in cancer causation, not that some particular exposures contributed to the onset of cancer.

In contrast, the term environment is more commonly taken to mean air, water, and soil in the sense conveyed by the focuses of the Environmental Protection Agency (EPA). Many people hear "environment" used in that sense and interpret the claim concerning cancer causation to mean that 80 to 90 percent of cancer is caused by exposures to substances in air, water, and soil.

In 1981, epidemiologist Richard Doll and statistician Richard Peto, both at Oxford University, clarified the two uses of the term with a comprehensive study that analyzed U.S. national cancer mortality records from 1933 through 1978. They attributed only about 2 percent of total cancer mortality to environ-

Photo courtesy of the AMERICAN LUNG ASSOCIATION®

Analysis of national cancer mortality data points to smoking as a greater factor in cancer causation than pollution.

mental exposures (or pollution, as they referred to it) and another 3 percent to geophysical factors, including sunlight and other kinds of natural radiation.

The Doll and Peto estimates, which have come to be regarded as conventional wisdom concerning environmental carcinogenesis, were based exclusively on epidemiological data. However, it is possible to use other methods to estimate cancer risks. In particular, cancer risk assessments can be based on knowledge of which chemicals have been shown to cause cancer in animals, estimates of human exposure to those chemicals, and the use of extrapolation procedures that relate exposures to human risks—methods referred to here as toxicology-based risk assessments. Researchers who dismiss such assessments assert that extrapolation from animal studies to humans is so uncertain that the estimates have little value.

Estimates based on epidemiologic data closely agree with those based on toxicologic data.

Other scientists who support the idea that there are quantitative similarities between cancer potencies in humans and laboratory animals place more faith in toxicology-based risk assessments. Recently, researchers compared the cancer potencies of 23 substances in both humans and animals. Using several methods to investigate the possible correlations between the potencies, they concluded that the correlations were statistically significant and that their findings supported the general use of animal data both to evaluate carcinogenic potency in humans and to quantify human risk.

Because toxicology-based risk assessments are commonly used in formulating public policies on such matters as setting exposure limits, it is important to know how an estimate of environmental carcinogenesis based on such an approach would compare to the approach used by Doll and Peto. In 1987, the EPA published a landmark study, *Unfinished Business: A Comparative Assessment of Environmental Problems,* which examines the risks presented by 31 different environmental threats such as air and water pollution, pesticides on food, indoor radon, worker exposures to chemicals, and pesticide application. For many of these 31 problem areas, the EPA relied upon toxicologic evidence to calculate cancer risks. A comparison of those assessments with the risks estimated by Doll and Peto reveals a notable similarity.

Comparing methods

Doll and Peto divided all exposures to carcinogens into twelve distinct categories. Two of these, pollution and geophysical factors, encompass the exposures that are subject to regulation by the EPA and that are discussed in *Unfinished Business.* Two more of Doll and Peto's exposure categories, occupation and industrial products—the latter is called consumer products in the United States—are also discussed in *Unfinished Business.*

Because of differences in the quality and quantity of data available, Doll and Peto relied upon somewhat different methods to estimate the cancer mortality associated with each of their exposure categories. Under the pollution category, for instance, they referred to others' work that compared the concentrations of known carcinogenic substances in urban air to concentrations of the same materials that were associated with cancer in workplace atmospheres. Assuming that a direct relationship exists between concentrations and cancer risk, Doll and Peto estimated that urban air pollution might cause 1 percent of cancer mortality, or 4,000 deaths annually.

In calculating risk from geophysical factors, Doll and Peto considered two kinds of radiation—ultraviolet (UV), the source of which is sunlight, and ionizing radiation, which is emitted by various natural sources such as cosmic rays and radon. Distinguishing between current and projected cancer mortality from UV radiation, they estimated that 1 to 2 percent of cancer mortality (4,000 and 8,000 cancer deaths, respectively) was associated with exposures to sunlight in 1981 and that fewer than 120 of those deaths were related to deterioration of the ozone layer. They also estimated that future depletion of the ozone layer, which filters out UV radiation, might increase the total of UV-related skin cancer deaths by 20 percent.

Doll and Peto estimated that 1.4 percent of cancer mortality was associated with ionizing radiation. They arrived at this estimate by calculating the background radiation dose for the entire U.S. population and assuming a direct proportionality between the carcinogenic potency of that dose and the higher doses of radiation found by researchers in people exposed in medical settings or at Nagasaki and Hiroshima during World War II.

In estimating risks to exposures under the occupation category, Doll and Peto studied the epidemiologic literature to determine what proportion of various cancers could be associated with workplace exposures. Based on their review, Doll and Peto attributed 17,000 annual cancer deaths to occupational exposures, 11,000 of which were lung cancer deaths.

Epidemiology- and toxicology-based estimates suggest that environmental pollution is associated with a small percentage of total cancer risk.

In contrast to Doll and Peto's reliance on epidemiologic evidence and techniques, the EPA used toxicology-based risk assessment methods to estimate cancer risks for many of the 31 environmental problem areas considered in *Unfinished Business.* For these areas, the EPA identified specific carcinogenic agents, either chemicals or radiation, and estimated the amount of human exposure to each agent. Multiplication

of the exposure estimate for each agent by the EPA's estimate of the agent's carcinogenic potency, as derived from animal studies, produced an estimate of the total cancer risk from the agent. To calculate the total cancer risk within a problem area, the EPA totaled up the risks from all the agents identified in the given area. For certain problem areas such as UV radiation from sunlight and indoor radon, the EPA considered human data to be reliable. In such cases the agency used epidemiologic data rather than data from animal studies to calculate cancer risks.

Comparing estimates

In comparing Doll and Peto's estimates with those of the Environmental Protection Agency, it should be noted that most, but not all, of the problem areas considered in the EPA report fit neatly into one or another of the Doll-Peto categories. Some EPA categories such as drinking water, which includes both chemical and radiation risks, must be subdivided in order to fit within Doll and Peto's categories of pollution and geophysical factors.

An additional adjustment is necessary because Doll and Peto used mortality data as the basis for their calculations, whereas the EPA generally estimated cancer incidence rather than mortality. For the purpose of comparing estimates, cancer incidence data can be converted into cancer mortality data by assuming that between half and all the people who develop cancer will die of that disease. The assumption that half of the people who develop cancer will survive the disease is based on the National Cancer Institute's claim that the overall five-year survival rate for cancer patients is 48 percent and the fact that five-year survival is considered a "cure."

The estimated number of cancer deaths derived from the EPA's analysis and grouped into Doll and Peto's four categories can be divided by 485,000—the annual U.S. death toll from cancer—and then multiplied by 100 to calculate percentages of cancer mortality. Agreement between the two sets of estimates is good.

Doll and Peto associated pollution and geophysical factors with 2 and 3 percent, respectively, of total cancers. Similar risk estimates are derived when the EPA's estimates of individual risks within these categories are added together, resulting in an association of 1 to 3 percent of total cancers with pollution and 3 to 6 percent with geophysical factors. The EPA's estimate that workplace exposures are associated with 1 to 4 percent of total cancers agrees with Doll and Peto's estimate for those exposures. Both the Doll-Peto and EPA estimates for cancer risks from consumer products are less than 1 percent (see table 1). In this case, neither estimate is based on extensive analysis.

Implications for pollution control

Doll and Peto's estimates of preventable causes of cancer in the United States do not support the idea that control of environmental pollution would have a major impact on human cancer rates. Instead of pointing to pollution as a major cause of cancer, their analysis of national cancer mortality data and trends finds that smoking is a greater factor in cancer causation, associated with 30 percent of all cancers. Their analysis also draws renewed attention to diet, which they estimate is associated with 35 percent of all cancers.

Reliance on data from human studies has been criticized for a number of reasons. For one thing, many small increases in cancer are undetectable by epidemiologic methods. Moreover, because many years may elapse between exposures and cancer manifestation, analysis of epidemiologic data cannot reveal the effects of recent exposures but only those of exposures years ago. Risk assessment methods, which depend on the results of animal tests for the prediction of human risks, circumvent these purported deficiencies of epidemiology.

The agreement between the Doll-Peto and EPA estimates of cancer risks associated with pollution and geophysical factors can be regarded as surprising because the basis of Doll and Peto's analysis is actual cancer deaths, in contrast to the EPA's toxicology-based risk assessment methods, which generate upper confidence limits on risk. The use

Table 1. Percentage of Annual Cancer Mortality Associated with Environmental Exposures

Source of exposure estimate	Exposure categories: Geophysical — Pollution	Geophysical — Factors	Consumer — Occupation	Consumer — Products
Doll and Peto[a]	2 (<1–5)	3 (2–4)	4 (2–8)	<1 (<1–2)
EPA, *Unfinished Business*[b]	1–3	3–6	<1[c]; 1–4[d]	<1

[a] Richard Doll and Richard Peto, "The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today," *Journal of the National Cancer Institute* vol. 66 (1981) pp. 1193–1308. For all Doll and Peto figures, a best estimate is followed by a range of acceptable estimates.

[b] Environmental Protection Agency, *Unfinished Business: A Comparative Assessment of Environmental Problems* (Washington, D.C., 1987). See especially Appendix I, *Report of the Cancer Risk Work Group.*

[c] In *Unfinished Business,* the EPA estimated cancer risks from workplace exposures to only four chemicals. The agency associated less than 1 percent of total cancers with workplace exposures.

[d] This percentage is based on the EPA's equal ranking of the cancer risks from indoor radon and from workplace exposures to chemicals, thereby associating occupational chemical exposures with an annual risk of 5,000 to 20,000 cancer deaths.

of these limits makes it unlikely that risks are underestimated, though they are likely to be overestimated. While the quantitative relationship between upper confidence limits and best estimates of risk would vary from chemical to chemical, we would expect that the accumulation of data from many chemicals would exaggerate the cancer risk. That expected bias might, of course, contribute to the EPA's estimates being higher than Doll and Peto's. Another factor also mitigates the effect of using the upper confidence level for toxicology-based risk estimates: the EPA uses best estimates for risks that are based on data from human studies; these include risks from indoor radon and sunlight.

Smoking and diet are associated with a far greater percentage of total cancer deaths than is environmental pollution.

The agreement between the Doll-Peto and EPA estimates can be viewed as buttressing the conclusion that environmental exposures contribute a small percentage to total cancer risk. It is difficult to imagine a still different analysis—one not dependent on epidemiologic data or risk assessment—that could be brought to bear on the question of how much cancer is associated with environmental exposures. Until and unless such an analysis appears, we are left with two independent estimates that suggest that environmental pollution is associated with about 2 to 3 percent of cancer and geophysical factors with about 3 to 6 percent.

Implications for policymaking

While both analyses lead to the conclusion that little aggregate impact on overall cancer rates can be expected from attention to environmental exposures, this does *not* mean that pollution should go unchecked. Two to three percent of cancer is a small proportion of the total cancer risk, but it represents 9,000 to 13,000 deaths annually. Both the percentage of the total cancer risk and the estimated number of cases should be considered in making decisions about where to invest resources to combat cancer.

Pollution is involved in other significant health impairments beside cancer. Eye irritation from pollution, for example, is quite painful and can cause damage if prolonged. A far more serious problem is exposure to lead, which poses significant risk of injury to the nervous system. And quite apart from health effects, the ecological and aesthetic damages that accompany pollution must be considered.

More important, even with regard to cancer, cost-effective controls that use current technology may be available. For instance, the modification of homes on radon-contaminated soil could reduce the most significant current cancer risk in the EPA's catalog. The phasing in of chlorofluorocarbon substitutes, scheduled for the next dozen years, may help to check the expected increase in deaths from skin cancer resulting from continued depletion of stratospheric ozone.

Public perception of the importance of cancer risks associated with environmental exposures differs from the EPA's assessment of those risks.

Nevertheless, the Doll-Peto and EPA estimates underscore the limitations on cancer control through regulation of chemicals in the environment. None of the three largest risks quantified by the EPA—sidestream tobacco smoke, current cancers from sunlight, or indoor radon—is a product of industrial or agricultural activity. Therefore, neither the EPA's nor any other agency's current regulatory program can have any impact on those risks.

The EPA's *Unfinished Business* acknowledges that public perception of the magnitude and importance of cancer risks associated with environmental exposures differs from the agency's assessment of those risks. Opinion polls often show that chemical waste disposal is at the top of public concerns. Yet risks from chemical waste disposal activities at inactive and active waste sites rank 8 and 13 on the EPA's list of 31 cancer risks. Thus even if additional research supports the conclusion that waste sites are not serious health hazards, the EPA must move cautiously to reorder its priorities if it is to maintain public support.

The Environmental Protection Agency may be at a crossroads. On the one hand, it can begin to educate the public about the risks to be faced and redirect public concern toward the more serious risks. Alternatively, the agency can continue to reflect public concerns and regulate in areas that are likely to have little impact on cancer rates but that are popularly supported. In practice, both activities will probably go along together for some time to come, but larger health gains will follow only from actions that are based on attention to larger risks.

Michael Gough is a senior fellow in the Center for Risk Management at RFF. *This article is adapted with permission from an article in the August 1989 issue of* Environmental Science & Technology, *copyright 1989, American Chemical Society.*

Economic incentives to resolve urban crises

Winston Harrington

Traffic congestion, siting of locally undesirable facilities, and air pollution are among many problems of urban environmental quality that appear more unmanageable today than twenty years ago. Their persistence suggests that the solutions of the past are not working; the use of economic incentives may prove more fruitful if the public bias against market-based approaches can be overcome.

Twenty years ago the United States experienced what was commonly called an urban crisis, characterized by riots in the inner cities, blighted neighborhoods, an increase in crime, congested freeways, deteriorating facilities, and worsening air and water quality. In response to these problems, the War on Poverty was initiated. The Kerner Commission and the Department of Housing and Urban Development were established, mass transit and municipal waste treatment subsidies were implemented, freeway construction was begun in earnest, and the Clean Air and Clean Water acts were passed. After a while the urban crisis seemed to fade from public consciousness.

Yet today distinctively urban predicaments are again in the news, and there is widespread belief that they are becoming increasingly unmanageable. The issue of manageability applies with particular force to urban environmental crises where attempts to improve the quality of life have had unforeseen, if not always unforeseeable, results. Such is the case with regard to traffic congestion, the siting of locally unwanted facilities, and air pollution—three problems that have defied the somewhat simplistic solutions applied a generation ago. These solutions, at best, have only partially mitigated the problems at hand and, at worst, have exacerbated them.

Traffic congestion

Since the nineteen-fifties, the construction of an extensive network of expressways in every major urban area has enabled Americans to travel broadly in their own country and to live the suburban life-style that most seem to prefer. Less desirably, however, the new freeways and interstate highways have increased our dependence on the automobile and allowed other forms of transportation to atrophy. While effecting a decrease in travel time and congestion over the short term, over the long term they have permitted the spread of low-density development—a phenomenon that has led to increasing congestion as commuters travel farther distances between their homes and workplaces. Many urban areas now support satellite employment centers that are almost impossible to service with mass transit.

In spite of massive roadway construction, the journey to work is steadily becoming more onerous. Average travel times are on the increase, and the duration of the rush hour is lengthening. Today about 65 percent of rush-hour traffic on U.S. freeways is considered congested, which compares to about 40 percent in 1975.

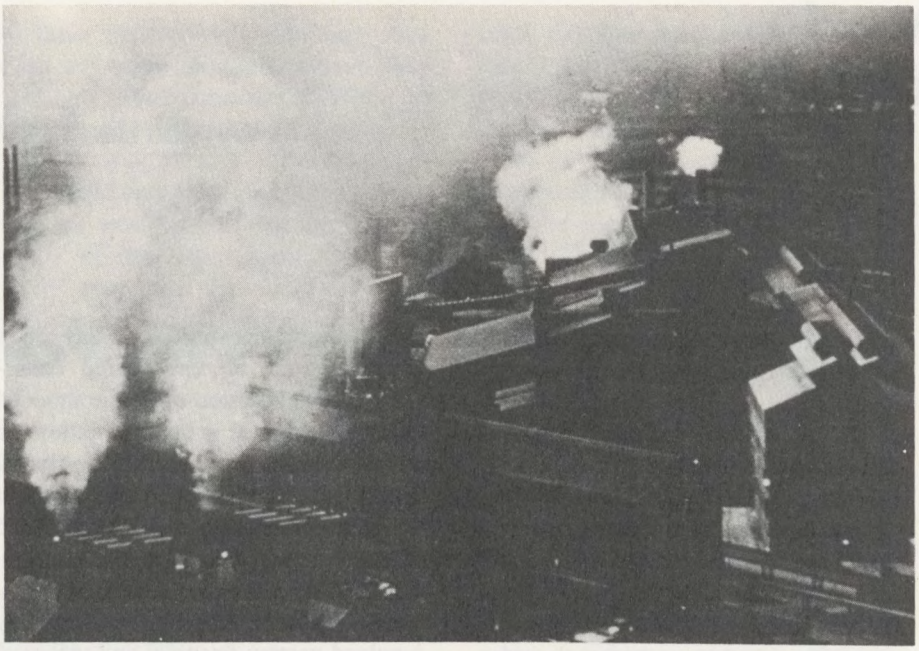
Facility siting

Delivering basic urban services such as water supply and trash disposal is becoming increasingly difficult and expensive due to facility-siting problems. In particular, it has become nearly impossible to site socially useful but locally undesirable structures such as landfills and major highways. The facility-siting difficulties of today are to a large extent an unexpected consequence of legislation on environmental protection enacted in the late sixties and early seventies and, more recently, of laws designed to safeguard the rights of parties that might be adversely affected by siting decisions.

In the past, siting decisions were relatively easy to make as they mainly involved narrow financial and technical considerations. Homeowners living near a proposed site typically had little control over siting decisions or the subsequent details of construction and operation. While local landowners received compensation for land taken for a facility, adversely affected third parties were generally ignored. And where publicly owned facilities were to be built, even landowners had little choice in the matter inasmuch as the authority of eminent domain could be used to force transfers of property.

As a result of legislation that protects sensitive habitats against destruction by development and of several court rulings that acknowledge the rights of third parties, those opposed to major developments now have greater access to the courts as well as legal precedents with which to fight siting decisions. Now these decisions can be and usually are challenged by individuals and groups with diverse interests. In effect, the definition of property rights has changed with the placement of new limits on the use of property in order to protect environmental quality and the interests of third parties.

The fact that third parties now have a role in siting decisions is certainly a desirable change, for they do suffer losses in such situations. However, this democratization of decision-making has come at a cost. Because no mechanism



NATIONAL CLEAN AIR COALITION

The Clean Air Act helped to decrease some kinds of air pollution, but air quality problems still plague many U.S. cities.

has yet been developed to allow rapid adjudication of claims brought by third parties, facility siting has become a difficult and costly problem for public officials. At best, projects are subject to lengthy delays while issues are being resolved; at worst, worthy projects are abandoned after considerable expenditure and, often, much acrimony. As these facilities are generally regarded as socially beneficial, nearly everyone wants them to be built somewhere—but "not in my back yard." Today the NIMBY syndrome, as it is known, is making the cost of new facilities very high by delaying or defeating numerous siting projects.

Air pollution

Equally troublesome is the problem of maintaining urban air quality. The turning point in the regulation of air quality in the United States came in 1970 with the passage of the Clean Air Act, the federal government's first serious effort to reduce air pollution. Before 1970, air pollution control was largely within the province of local governments. Although successful in generally improving air quality, localities could do nothing to control automobile emissions, increasingly regarded as a major source of air pollution. In addition, because local air standards varied, advocates of federal legislation argued that nothing prevented polluting firms from shopping around to take advantage of less restrictive air quality regulations.

By establishing limits on emissions of those pollutants thought to pose the most significant threats to human health, the Clean Air Act was designed to do the job of cleaning the nation's air that local governments had been unable to accomplish. It appears that the act has indeed reduced emissions of some pollutants. In particular, ambient concentrations of particulates have fallen. Without the Clean Air Act, air quality would very likely be much worse. However, a number of cities still fail to meet air quality standards with regard to emissions of ozone and carbon monoxide. Furthermore, it now seems that some air pollution problems are not always directly traceable to the presence of high concentrations of pollutants in the air. An example is acid deposition, which results from the oxidation of the precursor pollutants sulfur dioxide and nitrogen dioxide. Although all regions of the country have complied with sulfur dioxide emission limits and nearly all with nitrogen dioxide limits, the United States still faces potentially serious acid rain problems.

Despite its undeniable achievements, the Clean Air Act has not improved air quality to the degree anticipated in 1970. Perhaps expectations were unrealistic. A more germane question is whether the act was predicated on an overly simplistic view of the air pollution problem, as it embodies what now appear to be two erroneous assumptions. The first is that there is a direct causal link between emissions and air quality; that is, we assume that by managing the one, we can manage the other. The second assumption is that we can determine the requisite amount of emissions reduction from the improvement we desire in the surrounding air quality.

Alas, the connections between emissions and air quality have proved to be much more complex than originally thought. Until recently, for example, air pollution chemists believed that general ozone formation was limited by volatile organic compounds (VOCs) emitted into the air. However, in Atlanta, where VOCs were substantially reduced between 1979 and 1987, ozone concentrations have hardly changed at all. Similarly complex is the relationship between ozone and acid compounds in acid rain.

The significance of the debate over the efficacy of the emissions reduction policy becomes apparent when potential human health effects are considered. Recent clinical evidence suggests that the health effects of ozone in the air may be more serious and may be felt at lower concentrations than once thought. Elevated ozone concentrations have already been directly linked with reduced lung function. Although epidemiologic studies cannot easily support a causal link, new evidence suggests that ozone at low concentrations may lead to long-term lung tissue damage that contributes to chronic lung disease.

Searching for solutions

What these urban problems—traffic congestion, siting of locally undesirable facilities, and air pollution—share is the

limited effectiveness of solutions applied to them in the past. The construction of more highways has only resulted in more traffic and is unlikely to be a remedy for overcrowding on the nation's freeways in the future. Measures that attempt to correct injustices and protect environmental quality in the siting of facilities have inadvertently made facility siting more difficult. The current emissions reduction policy, while effecting a decrease in some kinds of air pollution, may have improved urban air quality as much as is practicable; changes in land use and commuting patterns may be necessary to realize further improvement.

As a result of these disappointments, management strategies that rely heavily on economic incentives are being reconsidered. Such an approach is not new; economists have been suggesting the use of market mechanisms to deal with congestion and pollution issues for years. More recently, they have studied the possible benefits of using economic incentives to ease the facility-siting crisis.

Although economists have proposed the use of market mechanisms to resolve some urban problems in the past, their advice has often been disregarded. In the 1960s, for example, urban economists were suspicious of proposals to build more transportation facilities to solve urban congestion problems. They looked askance not only at increased investment in expressways but even more at large fixed-rail mass transit systems, and recommended instead user fees to ration access to roadways. Failure to impose such fees contributed to consequences that surprised few economists—too much congestion and, probably, too many freeways.

Environmental legislation and court rulings that protect the rights of third parties result in more challenges to facility-siting decisions.

Perhaps this outcome will increase the receptivity of urban authorities to practical pricing schemes that discourage highway use or ration freeway access. With such schemes there are practical problems too, such as the impossibility of pricing access to all urban streets—which is one reason why street construction is a function of government. In the face of this difficulty, tolls could be determined for only part of a transportation network, presumably the limited-access freeways that are main commuter routes. But if access is restricted on these routes, an increase in traffic on smaller thoroughfares would likely result.

Singapore provides an example of one large city that does use fees to limit use of roads. Since 1975, cars entering the center of the city during the rush hour must display a sticker that costs $5.00 (in Singapore currency) per day. When first instituted, this sticker fee cut the number of cars entering the city by 75 percent. Even today Singapore is much less congested than other cities of its size.

To overcome the difficulty of siting major facilities, the market approach would be to find those who oppose development and who have the power or a property right to stop it, and to compensate them as a way of mitigating opposition. At first glance compensation seems to be an attractive way of dealing with siting problems because it offers the potential for resolving disputes by mutually beneficial trade rather than by costly, prolonged, and often idiosyncratic litigation. However, a closer look suggests a number of difficult questions that must be answered.

First, who should be compensated? To be fair, compensation should be accorded those who would be injured by the development. Yet to facilitate siting, compensation should go to those with the legal and political power to delay or cancel the project. These two groups may not be the same.

Second, how much compensation would be necessary, and how would the amount be determined, given that potential beneficiaries have every incentive to conceal their true preferences? One way of overcoming this problem would be to auction off the undesirable facility to owners of competing sites to discover who would accept the least compensation for it.

Third, who would guarantee that compensation will facilitate siting, and how would such assurances be enforced? Compensation may do little good unless all groups and individuals with the ability to halt or delay development agree or are somehow required to honor the negotiated outcome.

Despite economists' recommendations, policymakers have not embraced market-based solutions to these urban crises.

And fourth, how should decisions be made? The developer might be required to negotiate with each affected individual, or entities such as local governments might have negotiating authority. The rights of nongovernmental bodies such as environmental groups must also be considered.

As a result of these and other practical difficulties, the use of compensation schemes in facility-siting has enjoyed mixed success in the United States. Certainly the 1980 Massachusetts Hazardous Waste Management Act, designed to facilitate siting decisions in part by encouraging the use of compensation, has not worked as anticipated. Because it denied a community's right to veto the siting of hazardous waste facilities under certain conditions, many communities regarded the act's preemption of local authority as coercive. By 1986, five attempts to site facilities using the law had all failed. However, compensation has expedited facility siting in France, which has managed to site enough new nuclear power plants to derive about 70 percent of its electrical generating capacity from nuclear energy. Until recently French national authorities made large contributions to local governments. Local residents have

enjoyed lower electric rates. The inducement was large enough that localities considered a nuclear plant to be a desirable neighbor. Japan and Italy have employed similar local government incentives to site nuclear plants.

By contrast, in the United States, local and state governments, as well as the federal government, often take measures that prevent compensatory actions from being adopted. At one time in New Jersey investments in nuclear plants were channeled into the local tax base of the rural communities in which a plant was located. Then the state passed a law that prevented local governments from benefiting from such investments, thereby removing any incentives for neighboring populations to accept these large, otherwise locally undesirable facilities.

With respect to protecting air quality, the use of economic incentives has been suggested as a way of curbing the formidable cost of pollution control efforts. Until about 1983, however, local, state, and federal authorities ignored the possibility of using incentives. When enacted, the Clean Air Act was viewed entirely as a command-and-control approach to air quality management in which the authorities directed polluters to adopt a particular pollutant-reducing technology or to meet some performance standard. No use of economic incentives was envisioned. Although such incentives were not ruled out in the preparation of implementation plans, no state made use of them.

Construction of more roads has only increased traffic congestion—an outcome that surprised few economists.

That view changed in the early eighties for several reasons. One was the perceived high cost of controls. Another was the change in administration; Republicans tend to be more comfortable with economic approaches than Democrats. Still another was the issue of nonattainment. By the late 1970s it was clear that many urban areas were not going to attain national air quality standards. Among other things, amendments to the Clean Air Act, enacted in 1977, made it difficult to add new sources of emissions in areas that failed to meet air quality standards without a compensating reduction in emissions from sources already located in those areas. This constraint evolved into policies that allowed some transfer of discharge permits—permits that allow holders the right to discharge certain amounts of pollutants into the air and water over a given period—and that gave promise of a more cost-effective approach to emission reductions.

Unfortunately, experiences with marketable discharge permits have so far been disappointing. Few trade gains have been realized, in part because very few trades have taken place. One analysis of marketable permit policy in southern California concludes that the policy was not effectively administrated. California's policy allowed some generators of pollution to discharge emissions without getting permits to do so. In addition, the mandatory review and approval of permit trades by local air pollution agencies inhibited trading and tended to eliminate the economic value of permits. The value of a marketable emission permit policy will always be limited if there is an uncertain connection between emissions and the desired policy outcomes.

Political questionability

One problem affecting the use of economic incentives is their apparent political unpalatability. Despite the recommendations of economists, policymakers have generally failed to embrace market-based approaches for dealing with traffic congestion, facility siting, and air pollution. The irony is, as has often been observed, that economists have the most influence over policy in those areas in which they disagree among themselves the most. For example, economists do not agree on macroeconomic issues such as the causes of inflation, unemployment, and economic growth. They are much more in agreement about microeconomic issues such as congestion tolls, compensation payments, effluent charges, and marketable permits; on these matters, however, they have almost no influence.

Despite its achievements, the Clean Air Act has not improved air quality to the degree expected.

What accounts for the apparent public bias against market-oriented approaches to some of our most pressing urban problems? Evidently the costs and disadvantages of such approaches are more obvious than the advantages. Persuading commuters that everyone will be better off with hefty tolls for road use is a tough sell. Marketable discharge permits are easy to ridicule as selling a right to pollute. Some local officials and citizens object to compensation as a form of bribery. Yet these policies, while not panaceas, clearly have a lot to offer, as two decades of research on their benefits reveals. Unfortunately, less attention has been paid to the question of how to design these policies to make them more palatable to public officials and the electorate at large. ■

Winston Harrington has been a fellow in the Quality of the Environment Division at RFF since 1980.

RFF recycles

Resources for the Future, along with all the other tenants of the Resources and Conservation Center, has joined the mounting nationwide effort to recycle the waste paper and other waste materials it produces. Under an arrangement with Waste Management Company, RFF and its co-tenants separate and set aside all reusable paper stock, newspapers, computer paper, bottles, and aluminum cans, which are subsequently collected and recycled. The Resources and Conservation Center, of which RFF is co-owner with the National Wildlife Federation, has thus become one of the first office complexes in Washington, D.C., to undertake so extensive a recycling program.

As part of its effort to contribute to environmental quality, the center also makes use of advanced energy-saving technologies. At the time of the center's dedication in March 1989, it was the first commercial office complex in the nation's capital to employ an ice storage air conditioning system. The center also utilizes a special heat recovery process and energy-saving lighting.

Summer interns

Every summer Resources for the Future offers a number of paid internships to students. Interns assist RFF staff with a variety of projects ranging from technical studies to applied policy analyses. Applicants should have outstanding academic records in the undergraduate or graduate programs in which they are enrolled and have undertaken course work in one or more of the following fields: microeconomics; statistical and quantitative methods; agricultural, environmental, or natural resource management; or environmental sciences.

The deadline for applications is April 1, 1990. The internships begin on or about June 1, 1990 and last from two to three months. Stipends are commensurate with experience and length of stay. For further information about applying for internships, contact the Office of the Vice President, Resources for the Future, Box S, 1616 P Street, N.W., Washington, D.C. 20036. Telephone (202) 328-5022.

Krutilla honored

At its annual meeting in 1989, the Society of Conservation Biology presented former RFF senior fellow John V. Krutilla with a distinguished achievement award for his pioneering role in establishing the field of natural resource economics. The award also recognized Krutilla's work in developing ways of imputing values to biological species lacking traditional markets.

At various periods during his thirty-three-years at RFF, Krutilla served as associate director of the Water Resources Research Program and as director of the Natural Environments Program. Formerly senior fellow in the Quality of the Environment and Renewable Resources divisions, he retired in 1988.

New book

Energy Price Shocks and Macroeconomic Performance, by Douglas R. Bohi

Do sharp increases in energy prices lead to recessions? This new book challenges the common assumption that severe recessions in the United States and other industrial nations resulted from the oil price shocks of 1974 and 1979 and that governments must therefore take actions to prevent the recurrence of similar costly experiences.

Bohi examines several arguments that attempt to explain how higher energy prices might cause a rapid decline in output and employment. Drawing from existing research and examining data from manufacturing sectors in Germany, Japan, the United Kingdom, and the United States, he concludes that factors other than energy price shocks account for the widespread decreases in output and employment in these nations. From his review of monetary policies, Bohi finds that a recession occurred in those countries that pursued a deflationary monetary policy. Only Japan, which adopted a different course after 1979, avoided a recession.

The possibility that energy price shocks are not as damaging to the economy as is usually thought has important implications for energy policy. Bohi's study raises doubts about the wisdom of large expenditures for strategic petroleum reserves, weakens arguments for limiting oil imports, and calls into question standby plans for government intervention in energy markets in the event of another oil supply disruption.

January 1990. 103 pp.
$9.95 paper. ISBN 0-915707-51-9

NCFAP policy review

The Political Economy of U.S. Agriculture: Challenges for the 1990s, edited by Carol S. Kramer

More than twenty analysts, researchers, and other experts examine how U.S. agricultural policies respond or fail to respond to various pressures such as consumer concerns relating to the environment, food safety, and new technologies; financial instability and budget constraints on the domestic front; and trade policy disputes and the interdependencies of a global economy that challenge agriculture from abroad. They also identify the principal challenges facing U.S. agriculture in the 1990s.

The authors and commentators offer widely differing perspectives on the issues. In many cases they have agreed with each other's interpretation and analysis of the issues and events; in other cases they have disagreed, sometimes sharply. The result is a diverse set of themes and lessons that advances our understanding of the changing political economy of policies affecting the U.S. food and agricultural system. This fourth annual policy review is a companion volume to the 1989 review, *U.S. Agriculture in a Global Setting.*

January 1990. 298 pp.
$20.00 paper. ISBN 0-915707-49-7

RFF reports

Confronting Uncertainty in Risk Management: A Guide for Decision-Makers, by Adam M. Finkel

During the past decade, all of the major reviews of the U.S. national system for assessing and managing environmental health risks have bemoaned the fact that risk analysts and regulators do not understand or account for the uncertainties in estimates of risks, costs, or benefits. This report attacks the problem head-on by providing a sophisticated but relatively nontechnical blueprint for recognizing, quantifying, and responding to uncertainty in risk management.

In this study, Adam Finkel offers a set of guidelines for quantifying, depicting, and evaluating the ramifications of uncertainty in risk. He then presents a hypothetical case study wherein the use of a new type of risk assessment report enables decision-makers to more efficiently and defensibly control a particular toxic air problem and set a rational agenda for reducing the uncertainties that remain.

January 1990. 68 pp.
$15.00 paper.

Managing Ash from Municipal Waste Incinerators, by Alyce M. Ujihara and Michael Gough

Communities across the country face a solid waste crisis. With landfill capacity diminishing and recycling programs unable to take up the slack, many local governments are considering burning their garbage. But solid waste incineration has generated much public opposition, in large part because of the perceived health risks. In recent years attention has focused on the disposal of incinerator ash residues, which contain toxic substances. If not managed properly, these substances can leach from the ash and contaminate groundwater.

In this report, Ujihara and Gough examine what is known about incinerator ash in order to better understand the ash disposal problem. They review policy issues surrounding ash disposal, results of tests used to assess ash toxicity, field data from ash landfills, and technologies for treating and reusing incinerator ash. They make recommendations for improving federal requirements concerning ash management.

January 1990. 85 pp.
$15.00 paper.

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Discussion papers

RFF discussion papers convey the early results of research for the purpose of comment and evaluation. They are available at modest cost to interested members of the research and policy communities. Price includes postage and handling. The following discussion papers have recently been released:

Energy and Natural Resources Division

- "Agriculture in a Changing Environment," by Pierre R. Crosson and Norman J. Rosenberg. (ENR90-01) $5.00

Quality of the Environment Division

- "Valuing Amenity Resources Under Uncertainty: A Skeptical View of Recent Resolutions," by V. Kerry Smith. (QE90-01) $2.25
- "Estimating Recreation Demand Using the Properties of the Implied Consumer Surplus," by V. Kerry Smith. (QE90-02) $2.25
- "Trends in American Wildlife Resources," by Winston Harrington. (QE90-93) $2.25
- "Household Production Functions and Environmental Benefit Estimation," by V. Kerry Smith (QE90-04) $2.25

- "Are OSHA Health Inspections Effective? A Longitudinal Study in the Manufacturing Sector," by Wayne B. Gray and Carol Adaire Jones. (QE90-05) $2.25

- "Can We Measure the Economic Value of Environmental Amenities?" by V. Kerry Smith. (QE90-06) $2.25

- "Using an Upper Bound on Stand-Alone Cost in Tests of Cross Subsidy," by Karen Palmer. (QE90-07) $2.25

- "An Economic Appraisal of the D.C. Appeals Court Ruling on the DOI Regulations for Natural Resource Damage Assessments," by Raymond J. Kopp, Paul R. Portney, and V. Kerry Smith. (QE90-08) $2.25

National Center for Food and Agricultural Policy

- "Targeting Farm Programs," by Daniel A. Sumner. (FAP90-01) $3.00

- "The 1985 Food Security Act as a Basis for Future Farm Legislation," by Robert L. Thompson. (FAP90-02) $3.00

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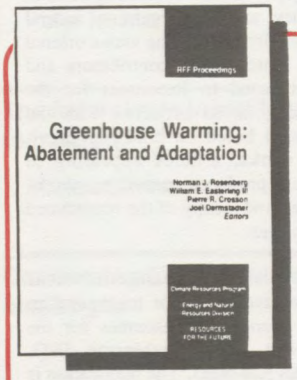

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