

RESOURCES®

Economics clarifies choices about managing risk

A. Myrick Freeman III and Paul R. Portney

Like it or not, environmental risks cannot be completely eradicated. Difficult choices must be made about how best to control particular risks using the limited resources available. These choices invariably involve tradeoffs. Economics can help with these decisions by providing information on the pros and cons of particular courses of action.

ward. In fact, it might even appear that engineers rather than economists are better able to make such determinations, especially when the options under consideration involve primarily structures and equipment.

But appearances are deceiving. One of the real, albeit subtle, virtues of economics is its focus on what are called opportunity costs—that is, what society must give up in the form of other desirable things in order to pursue a desired goal such as reduced environmental risk. Under some circumstances, expenditures for pollution control equipment, cleaner fuels, or the like will closely approximate true opportunity costs. However, often this correspondence between money expenditures and opportunity cost is lacking. For example, rules on private behavior such as mandatory recycling of household wastes or limits on eating fish caught by sports fishermen involve no direct money outlays, but they impose costs in the form of time or reduced satisfaction. An economic perspective on costs provides valuable insights about the nature and magnitude of these forgone opportunities.

Government officials making decisions about such issues as allowable pesticide residues in foods, nuclear reactor safety standards, and air quality standards face a difficult problem. On the one hand there is the evident desire of the public to reduce the risks inherent in modern life. On the other hand reducing these risks is costly. So choices about risk policy involve tradeoffs. Risk management refers to the process through which a variety of considerations—scientific, legal, political, economic (benefits and costs), and even philosophical—are taken into account and a decision is reached concerning an environmental regulatory problem.

Economics can contribute in a number of ways to managing risks to health and the environment. At a basic level, economics can help to inform decision makers about how much various regulatory approaches or pollution control options will cost society. Upon first blush, this might seem pedestrian and straightfor-

An important criterion for the rational management of risk is that any reduction in risk be accomplished at the lowest possible economic cost. Economic analysis can help to identify the least costly way to accomplish a particular reduction in environmental risk. Used in this way—how we can accomplish X for as little as

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Benefit-cost analysis and risk

Benefit-cost analysis is based on the twin premises that (1) the purpose of economic activity is to increase the well-being of the individuals who make up the society, and (2) each individual is the best judge of how well off he or she is in any given situation. These premises provide the foundation for the widespread application of benefit-cost analysis in such areas as investments in water resources, transportation projects, and human resource development. They are applicable, as well, to the analysis of public policies toward risk.

If society is to make the most of its endowment of scarce resources, it should compare what it gains from a risk management policy (that is, the benefits) with what it gives up by taking resources from other uses (the costs). The benefits and costs should be valued in terms of their effects on individuals' well-being. Society should undertake risk management activities only if the results are worth more in this sense than what society would forgo by diverting resources from other uses.

possible—the application of economics goes by the name of cost-effectiveness analysis.

Besides helping to identify and properly measure costs, economics can help us to understand how these costs (as well as benefits) are distributed among the population. For instance, we might be interested in knowing whether residents of rural areas would bear a disproportionate share of the costs of an acid rain control program. Or, we might wish to know whether financing Superfund cleanups via direct budgetary outlays is more or less regressive in its impacts than financing those same cleanups through taxes on manufacturing firms. Again, we might want to determine whether the favorable effects of a policy are distributed equally among current and future generations.

Economics can help us answer these questions.

Normative guidance

Using economics merely to supply information about the costs of different options is one of its less controversial applications in risk management. The challenge comes when economics is used to answer questions like: What should we do about the problem of pesticide residues in foodstuffs? Which cleanup strategy is best at the XYZ site? Here economics is being asked to go beyond the purely informational—beyond describing what would happen here or there—and instead is being asked to provide normative guidance to decision making—that is, to help us answer the question, What *ought* we do?

To answer normative questions like these, economists generally rely on a branch of economics known as benefit-cost analysis. Economists view benefit-cost analysis as akin to common sense. This is because after peeling away the analytical veneer, formal benefit-cost analysis essentially asks: If we pursue a particular policy option, what good will come of it and what will we have to sacrifice to get it? It is a simple extension to ask whether the former is worth the latter.

Although benefit-cost analysis can clarify the pros and cons of taking particular actions, its application to the problems of environmental risk management has not gone smoothly. It is not embraced in any major environmental statutes except the Toxic Substances Control Act of 1976 and the Federal Insecticide, Fungicide, and Rodenticide Act of 1972. Nor is it the rule in other regulatory statutes protective of public health (for example, those having to do with occupational safety and health, or consumer products. In fact, the balancing of benefits and costs appears to be *prohibited* when the Environmental Protection Agency sets most standards for air and water pollution and the regulation of active or abandoned hazardous waste disposal sites. Similarly, the well-known Delaney clause in the Federal Food, Drug, and Cosmetic Act of 1938

explicitly prohibits the head of the Food and Drug Administration from considering the health benefits associated with certain food additives if these additives are known or suspected of causing cancers in humans. Moreover, although the last three presidents have issued executive orders mandating that benefit-cost analyses accompany any new proposed or final regulations, federal regulatory agencies have often resisted, and Congress has battled to have these presidential orders weakened.

In addition to the political unease over benefit-cost analysis, there is also more than a little public concern about its use in environmental decision making. This concern is harder to document, but it shows up often in public meetings, opinion polls, and everyday discussions.

Political unease

Political reservations about using benefit-cost analysis to help make risk management decisions are based on several concerns.

Distributional issues. Benefit-cost analysis is in one sense distributionally neutral. That is, a dollar's worth of benefits (or costs) count the same regardless of the economic position, geographic location, or other characteristics of the individuals to whom they accrue. This can spell trouble in political circles.

Consider, for instance, the case of acid rain. Emissions of sulfur and nitrogen oxides from coal-fired utility and industrial boilers, as well as from mobile sources, are believed to be responsible for damages to aquatic ecosystems, forests, agricultural products, materials, and even human health. A variety of control measures are available and reasonably well understood. If risk managers decide to use the "polluter pays" principle, there would be very uneven geographic distributional effects. Because states in the Ohio River valley are emitters of large amounts of sulfur dioxide, they would bear a heavy share of the total costs of controlling emissions. Application of the polluter pays principle could cause electricity bills in those states to increase by as much as 15 to 20 percent. Such geographic concern-

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tration of costs has been one of the stum-
bling blocks to amending the Clean Air
Act of 1970 to deal with acid rain.

Imprecise information. Politicians
view benefit-cost analyses of risk man-
agement options with suspicion for an-
other reason. Estimates of benefits and
costs must rest on a foundation of knowl-
edge of the physical, biological, and engi-
neering systems involved as well as the
economic factors determining monetary
values. For example, it must be possible
to answer such questions as: How much
will indoor radon concentrations be re-
duced by air filtration equipment? How
many fewer cases of lung cancer will
there be if radon levels are reduced? How
much will emissions be reduced by vapor
recovery devices on gasoline pumps?
What effect will this have on atmospheric
ozone levels? What will be the impact on
agricultural productivity of reduced
ozone concentrations?

None of these question is easy to an-
swer. We sometimes have no more than
well-educated guesses about the answers
to these technological, physical, and bio-
logical questions. Some critics therefore
believe that benefit-cost analysis can be
rigged; that it will more often than not be
used to justify a risk management deci-
sion that is taken not for analytical but
rather for political or other reasons.

Myth of abundance. One of the uses
of benefit-cost analysis is to help ration
scarce resources among competing ends.
This use is a reflection of the fact that
there are more things worth doing than
there are resources with which to do them.
While this sounds innocuous enough,
politicians generally prefer to avoid
making explicit such declarations. No
politician is likely to gain much support
for telling a group that, although they are
bearing some environmental risk from
problem X, the risk is relatively small and
the money necessary to reduce it could be
better spent elsewhere. *Even when it
knows better*, the public likes to be told
that its government is working to elimi-
nate all environmentally transmitted
risks. Sensing this, politicians shy away
from analytical approaches based on the
premise that resources are finite and pri-
orities have to be set.

Public unease

Politicians aside, the public has
additional concerns about applying bene-
fit-cost techniques to risk management
problems.

Uncompensated risk. Benefit-cost
analysis is silent on the question of
whether the losers from any risk manage-
ment policy should be compensated. In
practice, therefore, even policies that re-
sult in aggregate benefits in excess of
costs could still leave some people worse
off. It would be natural for the losers to
oppose the policies. And this opposition
could be quite vocal if the losses were
concentrated among a relatively small
group of people.

Nowhere is the issue of uncompensated
risk more clearly visible than in the prob-
lem of proposed siting of LULUs (locally
undesirable land uses) such as hazardous
waste incinerators and low-level nuclear
waste disposal facilities. Those around
any proposed site will reject the argument
that it is in the best interest of society for
them to accept the increased risks that
these facilities pose. And very often their
opposition will prove successful. In an
effort to deal with this impasse, analysts
have begun to propose mechanisms for
compensating the losers.

The "right" to be risk-free. Many

citizens feel that they have a basic and in-
alienable "right" to be free from contami-
nants in the water they drink, the air they
breathe, and the food they eat. They resent
these rights being weighed against eco-
nomic dislocations, balance-of-trade
concerns, and other seemingly imper-
sonal factors.

There is a ready response to such objec-
tions. First, even those rights guaranteed
in the Bill of Rights are not absolute. For
instance, one's freedom of speech is re-
stricted when it comes to standing up in a
crowded theater and shouting "Fire!"
While no formal benefit-cost analysis
supported these relatively mild restric-
tions on our basic rights, they are prem-
ised implicitly on the notion that com-
pletely unfettered speech or assembly
may sometimes do more harm than good.
In other words, the benefits of some re-
straints may be worth the costs.

To those who would argue that we have
a right to be free from all environmental
risks, the counterargument would run as
follows. First, in a fundamental physical
sense, we can never be free of such risks.
Primitive woodburning puts harmful par-
ticulate matter in the air, and the human
digestive system ensures that some
wastes will always be with us. Thus, a no-
risk world is simply impossible. Even if it
were not, some risks would surely be



WATER SKI INDUSTRY ASSOCIATION

*Risks associated with sports are voluntarily borne, while one has little choice about risks
from the air one breathes outside.*

judged to be so small in comparison to the costs of alleviating them that it would be best to accept them.

Expert versus lay opinion. Public opinion polls show a steady erosion of public faith in experts. For a variety of reasons—some having to do with erroneous predictions in the past (for example, that nuclear power would become too cheap to meter), some having to do with generally increasing skepticism—the public seems less willing to be reassured that a particular risk, while real, is nonetheless quite small. This means that benefit-cost analyses, which depend critically on expert opinion or findings, will also have its detractors among the populace. This becomes all the more likely when the experts themselves represent business concerns, or, if university-based, derive part of their funding from corporations or trade associations. In cases where such suspicions are rampant, it becomes difficult to quell fears that experts feel are unwarranted. This divergence between expert and lay opinion cuts the other way, too. The public is often very slow to warm to concerns that experts may place near the top of their list of environmental risks.

Qualitative dimensions of risk. Risk analysts are sometimes puzzled when people react strongly to what may seem to be relatively small risks, yet appear to accept, or even seek out, risks such as skydiving and motorcycle racing. Such behavior is understandable. The risks associated with such sports are voluntarily borne, while one has little choice about the air one breathes while outside. Research over the last twenty years or so has demonstrated over and over again that such characteristics as voluntariness, familiarity, and dread influence the way individuals perceive and react to risks.

Facing facts

Economics is the science of scarcity, and society is surely limited in the resources it can allocate to the control of environmental risks. Thus, it is important to think analytically about which risks we want to address first and how much control we wish to pursue. Like it or not, tradeoffs will be made when these risks

are addressed. This follows directly from the observation above that society's resources are limited. Because this is so, we simply cannot eradicate any and all risks.

At some point decision makers will have to say to themselves that additional risk reductions will be so expensive that they are probably not worth additional effort. The virtue of economics is that it makes these decisions explicit. In other words, it forces decision makers to say openly, for example, that society cannot afford to spend \$1 billion to save an additional life through more stringent regulation of substance X. While such acknowledgements are often painful, they do enable the public to see the tradeoffs that their elected officials are making and object if they disagree with them. Pretending that such tradeoffs do not have to be made only means that they will be made implicitly and out of the public eye.

One conclusion, then, is that the public and its political leaders would be well served if the public better understood economic methods and their application to problems of environmental risk management. The fact that this is a familiar refrain does not detract from its importance.

Sauce for the goose, however, is sauce for the gander. Just as it would behoove the public and its political leaders to better understand the economic approach to risk management, so too must economists understand why their message is so often ignored. While benefit-cost and cost-effectiveness analyses have their strengths, they also have weaknesses, some of which are nearly fatal in the political realm. Until economists do more than pay lip service to the importance of distributional concerns in real policymaking, for instance, they will remain peripherally involved in policy formulation at best.

Economists must also understand that the public cares about more than simply the statistical magnitude of risks. It is also concerned about the mechanisms through which these risks are transmitted, the degree to which the risks are voluntary, the benefits that accompany the risks, and other dimensions that are often disregarded in standard economic analyses.

Compensating the losers

No one likes having a hazardous waste disposal facility in his or her neighborhood, even though that location may be the best choice from society's perspective. What about compensating these "losers" for having the site nearby? The benefit-cost criterion for risk management policies only identifies those cases where the gains are large enough so that there is a *potential* to fully compensate the losers. It is silent on the question of whether compensation should be paid or not.

Robert Cameron Mitchell and Richard T. Carson, in their article "Property Rights, Protection, and the Siting of Hazardous Waste Facilities" in the *American Economic Review* (May 1986), have proposed that communities as political entities be granted what is, in effect, a property right—that is, a right to refuse to accept proposed LULUs (locally undesirable land uses). Along with this right would be an obligation for the community to hold a referendum on any proposal to locate a LULU within its boundaries. Any corporation or larger government entity wishing to place a LULU within the community's boundaries would have to offer compensation to the community if it expected to gain approval through the referendum.

Until these concerns are acknowledged and incorporated in our economic models, economists may dismiss as irrational responses that make very real sense. ■

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Will climate change complicate African famine?

Charles F. Hutchinson

No one knows exactly how global greenhouse warming will affect harvests in the semiarid African Sahel. But a strategy of sound agricultural development could help to fend off the effects of drought and famine that might follow.

The African Sahel, that region immediately south of the Sahara, has been gripped by recurring droughts for the past twenty years. Too often, famine has followed on the heels of drought and world headlines have chronicled the human suffering that resulted. In recent years this attention has sparked large-scale mobilization of relief by the European and North American communities and also a growing apprehension of the potential for such disasters in the future.

During 1988 news from the Sahel was distressing. Rains came and harvests were generally good, but famine persisted within and nearby the region, most notably in the Sudan. Equally troubling for the longer term, debate among climate researchers continued over likely changes resulting from global greenhouse warming. Though the specifics of these changes remain unclear, there is one point of general agreement: the earth will be getting warmer and Africa will be affected.

Problems of the recent past in the Sahel, combined with the uncertainty raised by the potential of climate change, raise three fundamental questions: What is the relationship between drought and famine? How might changes in global climate affect the Sahel region? What can be done to prevent future famines that could accompany global climate change?

African drought

A hallmark of semiarid regions in general, including the Sahel, is the great vari-

ability in precipitation both within and between years. Thus, neither the failure of Sahelian rains in 1984 nor their late arrival in 1987 are uncommon events. Either circumstance contributes to drought and ultimately to decreases in crop yields.

Because the climate is semiarid, the seemingly unusual recent run of dry years in the Sahel is not without precedent (see figure 1, page 7). Comparable drought sequences likely occurred in the late seventeenth and early eighteenth centuries and again in the 1820s and 1830s. Two factors, however, set the recent series of droughts apart from those of the past. First, the run of wet years in the 1950s encouraged the extension of agriculture into increasingly marginal areas, creating a situation from which problems would most certainly arise when drought again prevailed. Second, the granting of political independence to many Sahelian countries in 1960—and the consequent disruption of economic and political continuity—coincided with a pronounced decline in precipitation and the onset of the recent series of droughts.

Does drought mean famine?

Particularly today, it is easy to find drought with no famine, and conversely, famine without drought. The past year brought examples of both. In the United States, thanks to a broad, well-subsidized agricultural base, diverse climatic resources, and a strong highly integrated economy, a significant drought beset the heart of the major agricultural region, yet did not result in famine, food shortages, or even highly inflated food prices. In stark contrast, parts of Sudan experienced no drought, but were subject to severe famine. Both sides in the ongoing Sudanese civil war used famine as a weapon by denying farmers access to their fields and intercepting food assistance—a situation that is unfortunately common.



Famine—Detail from "The Four Horsemen of the Apocalypse," by Albrecht Dürer.

As a result of such experiences, it has become clear that the relationship between drought and famine is more complex than generally believed. Conditions that lead to famine are created by any one or a combination of economic, social, or political factors. Political instability, weak or poorly integrated economies, and social (that is, ethnic) friction can combine to make systems of food production and distribution highly vulnerable to disruption. The vulnerability created by internal conditions may make it difficult or impossible for indigenous institutions to deal decisively with external shocks such as drought.

Drought alone is usually incapable of creating famine. However, it can, and often does, play an important role in hurrying the famine process along. Ultimately, therefore, drought must be given particular attention to better determine and deal with its root causes.

Climate change scenarios

Regional implications of a change in global climate are extremely conjectural. A number of global circulation models have been under development at research institutions for some time, but results indicated by the models show little agreement. In fact, the magnitude and spatial distribution of the changes they portray for temperature and precipitation across the African continent are fundamentally

different. However, there is concurrence on two points for the Sahel: temperatures are likely to remain constant or increase, and precipitation is likely to remain constant or decrease. In short, the best case suggests a continuation of current semiarid conditions, and the worst case points toward increasing aridity. Under either scenario, periodic drought will remain a feature of the Sahelian landscape.

Preventive measures

The dramatic famine relief efforts mounted by western powers during the 1970s and 1980s have come to dominate much of popular thought regarding the Sahelian condition. Although there is no question that these efforts are warranted when emergencies arise, they should be seen for what they are: short-term remedies for the symptoms of larger ills.

Solutions to famine in the Sahel are no different than they have been in other countries. They revolve around the development of a vital agricultural sector within the national economy. China and India are notable examples of countries that, within the past two generations, have moved from the list of those countries classed earlier as "famine prone" to those that are approaching "famine resistant." This evolution has been achieved in both cases through sustained programs of agricultural development.

Ironically, agricultural development has been a priority for the Sahel since independence. It has been the focus of vast quantities of aid from a host of international donor agencies.

Over time, a number of assistance programs that rely on the basics of agricultural development have been implemented. These basics have been broadly defined as the four "I's" by the Food and Agriculture Organization (FAO) of the United Nations, and include: (1) incentives to grow more than what is needed to subsist; (2) inputs, such as seeds, fertilizers, and credit; (3) institutions that provide indigenous support for agricultural development; and (4) infrastructure for production, distribution, and marketing. Despite these efforts, however, the Sahel

has not succeeded in following the examples of China and India.

Yield risk or price risk

In the past, most agricultural development plans for arid or semiarid areas generally did not consider drought as a recurring feature of the climate. Average precipitation values were taken as the norm, and plans were assembled accordingly. This thinking still is common, even in countries such as the United States where semiarid lands have seemingly been successfully developed. As a result of this failure to recognize constraints imposed by climate in semiarid areas, the objectives employed by donor agencies in the Sahel appear to follow the same lines used in other climatic zones. Generally, agricultural research and development in more humid climates seek to maximize profit through increasing yields while reducing inputs. This is eminently sensible in those places where yield risk—the risk of losing a crop—is smaller than price risk, the risk of a poor market at harvest.

In developing countries, especially those that are arid or semiarid, the objectives may be quite different. Yield risk assumes considerable importance in agriculture geared toward subsistence. Thus, the primary objective of traditional agricultural systems has been to minimize risk—yield risk—often at the expense of yields or profit, by dividing land, labor, and capital resources among several different and independent activities. This clearly represents a fundamentally different strategy. It is translated into agricultural diversity, or an approach in which "several eggs are put in many baskets." However, as traditional agricultural systems have incorporated larger and larger cash cropping components, they have become increasingly subject to price risk as well. Thus, agricultural systems that have both subsistence and market components are exposed to significant elements of both price risk and yield risk.

That part of the Senegal River valley shared by the West African countries of Senegal and Mauritania offers examples of the strategies that are used to deal with price risk and yield risk. The Senegal

River, which rises in the Guinea highlands to the south, floods during the dry season (late fall). As the floodwaters recede, local farmers plant sorghum in the low-lying lands flanking the river. During the summer rainy season, millet is planted in the lighter upland soils. In this way local farmers meet a large part of their subsistence needs and minimize yield risk by exploiting all the agricultural opportunities presented to them throughout the year.

Other yield-risk minimization tactics are also pursued, some of which seem almost nonsensical in other environments. For example, farm families commonly work several widely separated fields in the two major production areas (lowlands and uplands). This fragmentation spreads their risk and improves their chances of having one or more fields that produce a crop during the year. They also grow different complementary crops within the same field (by intercropping sorghum and cow peas, for example) and encourage selected native plants in areas adjacent to their fields that supplement the food supply, particularly in times of drought. Beyond agricultural pursuits, many members of farm families regularly seek off-farm employment to provide yet another source of income.

Irrigation has been employed in virtually every arid or semiarid climate in the world, both to improve yields and to insulate farmers from yield risk. Not surprisingly, small and large irrigation development projects have been initiated along the Senegal River, including a major dam at Manantali for controlling the flow of the river and producing electric power. The rationale was that, by regulating the flow of the river, three high-value rice crops could be grown for market during the year, and farmers' reliance on riskier recession and rainfed cropping systems would be reduced or eliminated.

Irrigation development has, so far, had mixed results. Rice production in the region—and hence income—has risen considerably as the irrigated area has expanded. However, recent development has been carried out by businesses rather than local farmers—businesses whose

primary interest is in crops that meet market demands rather than local subsistence needs. These new irrigated plots have been developed on lands near the river that in the past were incorporated in traditional local patterns of field rotation. Moreover, farmers who previously worked the land are often excluded from the irrigation development. Thus, in some places, irrigation has destabilized existing subsistence agricultural systems.

Even subsistence-oriented farmers who have had access to irrigated land have not behaved as planned. Rather than putting all their eggs in one basket and concentrating solely on irrigation, they have incorporated irrigation as a new element in their traditional yield-risk minimization strategy. Such farmers have grown only one irrigated crop a year and continued their recession and dryland farming as dictated by the season. This approach has proved to be prudent because, aside from its benefits, irrigation has also brought another set of risks. Spare parts and fuel are not always available for irrigation pumps, often making it impossible to produce any crop in irrigated fields.

The mixed success of irrigation, combined with the poor local market for electric power and delays in the construction of a generating plant, have brought about evolutionary changes in the development strategy of the Senegal River valley. For the foreseeable future, the Manantali dam will be managed to yield an optimal flood for recession sorghum, probably at the expense of power production. Meanwhile, current agricultural research along the valley mirrors this change in development orientation with programs that address problems associated with the major crops (sorghum, rice, and millet) produced by each cropping system (recession, irrigation, and dryland farming) and which are consistent with traditional strategies of yield-risk minimization through diversification.

Solutions to Sahelian famine

Representative of the Sahel at large, the situation in the Senegal River valley suggests how to address the conditions that

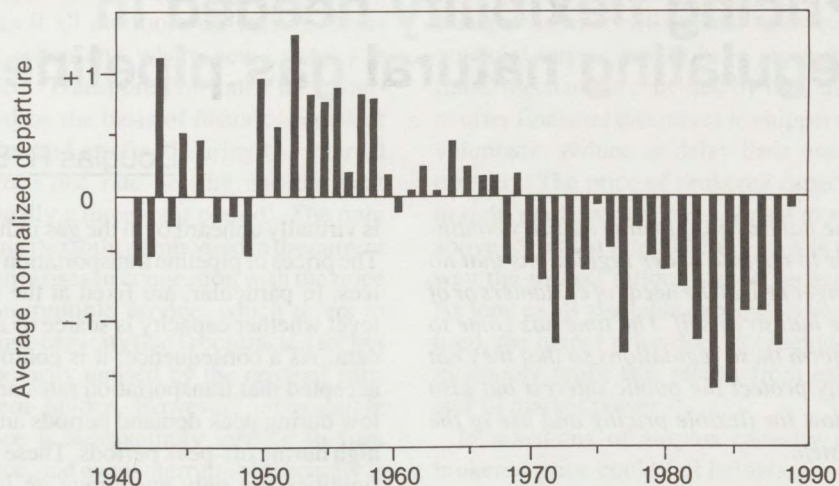


Figure 1. Rainfall index for 20 sub-Saharan stations in West Africa. Source: Peter J. Lamb, *Illinois State Water Survey* (1989).

lead to current famine and to famine that might accompany global climate change.

Solutions to famine in semiarid regions are built on sound agricultural development—but development that recognizes and accommodates the risks associated with drought. It can be and has been argued by researchers in developing countries that their ability to deal with drought is probably the key to meeting the challenges of global climate change.

The agricultural strategies that have evolved in arid and semiarid lands, such as the Senegal River valley, rely on a “diversified portfolio” that minimizes the yield risk that accompanies drought. Ultimately, irrigation will be part of the answer. But if the Senegal River is representative, irrigation will not come quickly or soon, and it is likely to be only part of the answer. A program to develop and support diverse cropping systems that are consistent with traditional practices is both appropriate and efficient in meeting the very real risks of today while preparing for those that will undoubtedly accompany global climate change.

These objectives, however, will be extremely difficult to meet. First, an emphasis on diversity also requires a division of human and capital resources that are scarce to begin with. Local governments have found it difficult, if not impossible, to manage and support a sus-

tained program of research and development in diversified cropping. Second, in addition to the economic burden, agricultural development presents its own set of risks—most of them relating to economic and political hazards. Urban populations in the Sahel have grown alarmingly as a result of the disruption of agricultural production due to drought. Thus the incentives to farmers—good prices—that are required to further development also threaten political stability in most countries, since they must be reflected in higher food prices in the cities. The balance that must be struck between the competing needs of urban and rural populations will be difficult to define and much harder to achieve. In the end, these economic and political issues will likely contribute more to the threat of future famine in the Sahel than will global climate change. ■

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Pricing flexibility needed in regulating natural gas pipelines

Douglas R. Bohi

The natural gas pipeline industry continues to operate under regulations that no longer reflect the needs of customers or of the industry itself. The time has come to reform these regulations so that they not only protect the public interest but also allow for flexible pricing and use of the system.

Like all energy industries, the natural gas industry is affected by volatility in world oil markets. Fluctuations in the price of oil impose enormous pressure on the gas industry to adjust to changes in competition from other fuels. The resulting fluctuations in gas demand lead to increased risks in contracting for gas supplies and in investing in natural gas reserves, pipeline capacity, and storage facilities. However, because of regulation, the gas industry does not have the flexibility to respond quickly and efficiently to changes in market conditions. The regulations involve rigid pricing formulas and ponderous entry and exit conditions that prevent the industry from meeting the competition, from balancing demand and supply, and from increasing capacity where it is needed. These regulatory constraints can work perfectly well under stable market conditions where demand, costs, and prices are either constant or growing at a smooth pace. But in a volatile environment, the rigidities created by price and entry regulations prevent the kinds of adjustments that are necessary to maintain economic efficiency.

Many of the same problems arise in all regulated industries, but the pipeline industry stands out among its regulated cousins when it comes to pricing the use of fixed capital assets. While it is not uncommon in the electricity, telecommunications, or public transportation industries to vary prices according to peak and off-peak demand periods, such a practice

is virtually unheard of in the gas industry. The prices of pipeline transportation services, in particular, are fixed at the same level whether capacity is scarce or abundant. As a consequence, it is commonly accepted that transportation rates are too low during peak demand periods and too high during off-peak periods. These price rigidities not only encourage an inefficient pattern of use of the existing pipeline system, they also create the perception of a need for additions to the pipeline system when they may be unnecessary, and they distort the incentives to invest in storage capacity.

It is easy enough to devise new rate designs that would allocate the use of the pipeline system more efficiently, including methods for establishing peak and off-peak prices. However, the problem is not simply one of finding a pricing formula that works better in today's market. Tinkering with rate design formulas means simply substituting one set of rigid pricing rules for another. The efficiency problem has to do with pricing rigidity, not just the pricing formula.

The problem of pricing rigidity

Since there is reason to believe that energy markets will continue to exhibit substantial price volatility in the foreseeable future, the efficiency problems created by regulatory rigidities will not go away. The challenge for regulators is to reform the regulations in ways that will allow for flexibility in pricing and reduced barriers to entry and exit while still protecting the public interest from the potential abuses of market power.

Natural gas regulation has a long way to go—perhaps further than most other regulated industries. Still embodied in the regulations is a philosophy that comes from the days when the primary role of regulation was to stimulate the development of the gas industry by protecting



Pipeline additions have diverse and interdependent implications.

investments and guaranteeing rates of return. Limiting competition became the primary means by which the regulator protected existing investments. Consequently, an elaborate system developed in which gas reserves were dedicated to specific customers, and competition among pipelines was carefully avoided. In the process, pipelines were placed at the center of planning for the entire industry: producers had to look to the pipelines to market their gas, while distribution companies had to depend on pipelines to assure themselves of adequate supplies. Financial risks, however, were shifted downstream to ultimate consumers.

There was also an economic efficiency rationale for limiting competition, namely, the natural monopoly argument. By this reasoning, fixed costs are relatively invariant to the number of customers that are served over a wide range of a total volume (throughput). Competition merely divides the market into smaller segments, so that fixed costs are spread over fewer units of throughput and fewer customers. Limiting competition therefore provides an efficiency gain that can be passed on to customers in lower prices. Of course, price controls are necessary to ensure that the gains from natural

monopolies are in fact passed along to customers.

Unfortunately, the accepted system of price controls established prices on the basis of embedded costs of service. This approach shifts the focus of attention of the regulator from pricing issues to judgments about the prudence of costs incurred, a responsibility that the regulator is not well equipped to fulfill even in the best of circumstances. The best of circumstances, as pointed out before, prevail when costs are constant and demand is stable. Volatility in costs and demand makes the regulator's job impossible to perform well and raises the question of whether the gains achieved from regulation are worth the cost—that is, whether imperfect competition would be a better protector of the public's interest than imperfect regulation.

Rigid controls on the entry of new pipelines made more sense when the industry was in its infancy. Now that the pipeline system has matured to the point where many consumers and producers in different regions are directly or indirectly connected, pipeline additions have diverse and interdependent implications. As a consequence, legal proceedings conducted for the purpose of issuing a "certificate of public convenience and necessity" soon degenerate into complex, global cost-benefit analyses of a proposed new pipeline. In these proceedings it is not surprising that objective standards of economic efficiency play a minor role compared to individual perceptions of fairness.

The extensive development of the interstate pipeline system also undermines the natural monopoly rationale for limiting entry of new pipelines. It is now possible to increase competition among interstate pipelines for end-use markets at very small additions to fixed costs. This may be achieved through the construction of short spur lines that link end-use markets with alternative interstate pipelines.

Brokering pipeline capacity

The current system of pricing transportation services does not ensure that the existing pipeline system is used effi-

ciently, and the resulting inefficiency makes it all the more difficult to determine when and where new capacity is needed. Transportation rates are determined on the basis of historical costs of service and are fixed during the interval between one rate hearing and the next (normally a three-year period). The only pricing flexibility embodied in the current system arises in connection with the price of interruptible service, which refers to pipeline capacity that is contracted for but temporarily unused by the original entitlement holder. However, interruptible service is substantially inferior to firm service, and even interruptible capacity is allocated on a first-come-first-serve basis and, hence, is only coincidentally consistent with economic efficiency.

While the current system needs to be improved, it is also recognized that it is not feasible to allow transportation rates to fluctuate according to what the market will bear. The existence of market power would soon lead to excessive prices, underutilization of existing capacity, and underinvestment in new capacity.

The proposal recently issued by the Federal Energy Regulatory Commission (FERC) to allow brokering of pipeline capacity attempts to insert market-based incentives in the use of pipeline capacity

Pipeline transportation prices are the same whether capacity is scarce or abundant.

while at the same time limiting the exercise of market power. Contract prices paid to the pipeline for the initial allocation of transportation entitlements would continue to be regulated on a cost-of-service basis, as they are now. However, pricing flexibility would be allowed in the resale of transportation rights held by shippers.

In many markets, shippers do not possess any market power. In these cases, maximum pricing flexibility could be allowed to allocate capacity from lower-valued uses to higher-valued uses. In a tight-capacity situation, no shippers

would be forced to give up their existing transportation entitlements. However, potential buyers would have an institutional mechanism provided by brokering to offer financial incentives to shippers to voluntarily reduce or delay their use of capacity. The price of brokered capacity in tight markets may be expected to rise above regulated rates, because this is the way the market rations scarce capacity. As long as all available capacity is being used, the higher price does not include a monopoly profit that results from exercise of market power.

In situations of surplus capacity the brokered price could fall below existing interruptible transportation rates. This would still be acceptable to shippers who sell unused capacity because they would benefit from any resale that earns a positive price.

However, buyers would be more attracted to short-term firm service than to interruptible service, and may be expected to absorb more of the available capacity. If enough new buyers are attracted by the availability of firm service, it is possible that they could in some circumstances bid up the price above the previous interruptible rates.

To make the incentive system work, it must be possible to transfer revenues from buyers of brokered capacity to sellers of brokered capacity. Local distribution companies (LDCs) and other holders of entitlements to capacity must be able to offer financial incentives to their customers to encourage them to alter the volume and timing of their demands. Also, LDCs must be allowed to retain some of the profits earned from brokering to make it worthwhile to reallocate transportation rights. Finally, pipelines must be allowed to restructure rates to recoup fixed costs now assigned to interruptible service, for these costs otherwise would not be recovered if the surplus capacity were brokered.

Brokering not only promises to improve utilization of the existing transportation system, it should also provide information to pipelines that would help them restructure their rates in subsequent rate hearings. This information should also help to justify proposals for new

construction to relieve critical bottlenecks.

Easing entry barriers

The FERC controls entry of new pipelines to prevent unnecessary duplication of facilities that would raise capital costs paid by consumers. The problem is that FERC is not in a position to effectively control pipeline costs, so that consumers end up paying more for pipeline services than necessary. While regulations should not be expected to be perfect, one should periodically reconsider whether there are better ways to achieve the objectives of regulation, including the possibility of less regulation. Competition might limit pipeline costs more effectively than regulation, even allowing for higher capital costs that would result from building duplicate facilities. The challenge is to find a way to balance the gains from additional competition against the additional capital costs of allowing competitive entry into the market.

This balance is likely to favor more competition in situations where there is currently little competition and where the additional pipeline facilities are not extensive. Using the Department of Justice standard for measuring the degree of market concentration, for example, we might expect little or no gain from additional competition in end-use markets already served by four or more independent interstate pipelines. Conversely, the fewer the number of independent pipelines serving a given metropolitan area, the greater the gains from additional competition. At the same time, the cost of adding new pipelines declines with the length of the line, among other things, so that lines shorter than (say) 100 miles might be accorded lighter regulatory scrutiny in a certificate proceeding than pipelines longer than 100 miles.

That a great deal of potential competition could enter the market at low cost is suggested by the findings of a recent (but still unreleased) study done at the Federal Trade Commission. Of the 208 standard metropolitan statistical areas (SMSAs) currently served by interstate pipelines, none could be said to be competitive

according to the Department of Justice definition (that is, no SMSA is currently served by four or more independent pipelines). Of these 208 markets, 134 are conservatively estimated to be sufficiently large that they could undertake to build a spur line to an independent pipeline, less than 100 miles away, at an addition to fixed costs of no more than 5 percent. That is, the cost burden of the duplicate facility would be small.

The potential competitive effect of allowing free entry of spur lines of less than 100 miles in length is startling. Of the 134 larger markets, all but 15 could be served by four or more independent pipelines with spur lines no longer than 100 miles (and of these 15 markets, 6 are located in Florida, which of course has a natural geographical barrier to potential hook-ups). It is emphasized that all four spur lines need not be built to obtain the benefits of competition. Merely the threat of new entry that could occur when the differential in prices between existing service and potential new service exceeds 5 percent can provide competitive pressure on existing suppliers. In these circumstances existing suppliers would be conscious of the need to control costs in order to reduce the prospect that competitors would encroach on their markets. The key to achieving this competitive pressure is the speed with which a potential entrant can receive a certificate of public convenience and necessity and begin construction. The longer the delay, the less the pressure on incumbent pipelines to worry about the threat of new competition.

While such an approach may be conceptually desirable, the question is whether it could be implemented in practice. The FERC has attempted to move in this direction (through what is known as the Optional Certificate Program), but that program is not yet well defined and is not aimed at the specific objective of speeding the processing of applications for spur lines in highly concentrated markets.

An additional institutional barrier in the certification process is the requirement to conform to National Environmental Policy Act (NEPA) guidelines. Environmental impact statements are

time-consuming, and they impose much the same analytical requirements as traditional certificate applications. In many cases, the FERC decision-making process will be slowed more by environmental than economic regulatory issues.

If the Optional Certificate Program cannot be successfully modified and the NEPA procedure cannot be streamlined, it is worth exploring whether the statutes that establish FERC's authority to regulate pipeline entry should be modified. The class of spur lines described above could be deleted from FERC's jurisdiction—if not FERC's entire certification jurisdiction—and left to state and local authorities to determine whether applications meet the public interest. There is precedent for such an action, since oil pipelines and electric transmission lines do not require federal certification. Moreover, this option eliminates the need to conform to NEPA guidelines, since new gas pipeline construction would no longer entail a significant federal action.

Continued volatility in energy markets means that regulation of the natural gas industry must be reformed to allow the industry to adapt to changing market conditions. Wellhead price decontrol and open-access transportation would be important steps in that direction. In addition, transportation rates must become more responsive to prevailing market forces and barriers to entry of new pipelines should be relaxed. FERC's proposed rulemaking on brokering pipeline capacity goes a long way toward fixing transportation rate problems, while an optional certificate program that differentiates spur lines in concentrated markets would be an effective way to ease entry barriers. Only time will tell whether the regulatory and political processes can generate such desirable outcomes. ■

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Incinerator ash quandary hinges on toxicity question

Elaine M. Koerner

Incineration can greatly reduce waste volume and thus help to solve a nationwide dilemma—shrinking landfill space to accommodate burgeoning levels of municipal solid waste. But critics are worried about its health effects, especially possible risks from the ash it produces. How risky is ash?

By the turn of the century, say some experts, as much as 30 percent of municipal solid waste in the United States may be burned using large incinerators known as municipal waste combustors. Though other experts dispute this figure as too high—it is triple the current rate—they agree that incineration technology will be very much in the minds of local and regional decision makers during the next ten years.

Municipal waste combustors have had a very short history. Until recent decades, solid waste either was burned in back yards or transported to local garbage dumps. There it was buried or piled onto open heaps of other previously deposited solid waste. All this changed about twenty years ago when the amount of solid waste being generated, including paper, glass, plastic, metals, and food wastes, began to skyrocket.

Despite the hefty cost of these combustors (the price tag for one plant can be as much as \$135 million) and growing concern about the potential health effects of incineration, some municipalities and regional authorities have issued bonds and made the purchase. More are considering following suit. If the volume of incinerated waste does triple over the next ten years, the number of communities that choose incineration will have to be considerable. Why the appeal?

It seems mostly to come down to the issue of bulk. Incineration can reduce the volume of municipal waste by about 90

percent, a figure that is not lost upon local government officials confronted by rapidly diminishing landfill capacity and rapidly mounting heaps of community garbage. Moreover, incineration produces energy in the form of heat that can be harnessed to produce steam, which in turn can generate electricity. Most waste combustors in this country are currently being used in this dual-purpose capacity.

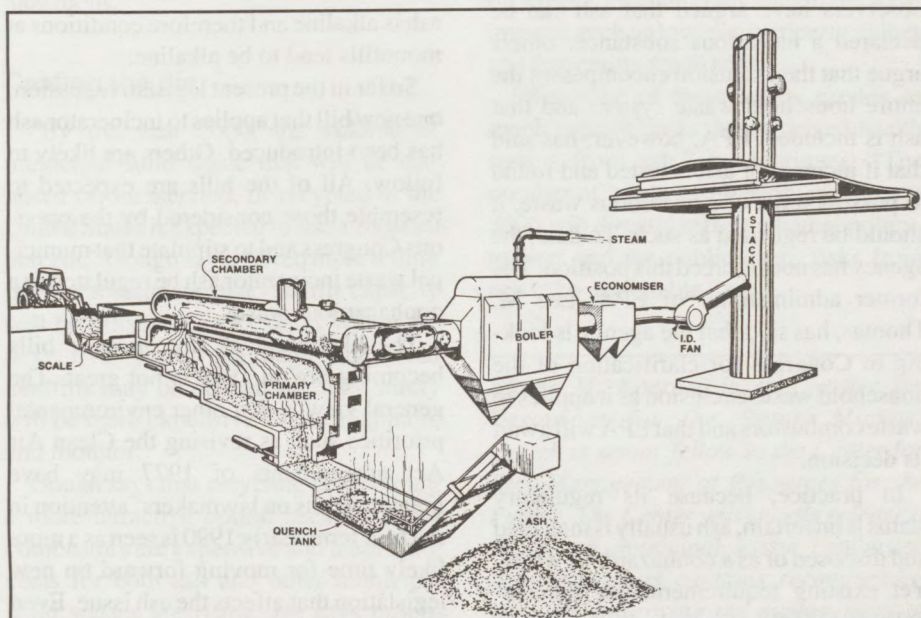
Concern over ash

Public opposition to municipal combustors has grown and become more vocal over the past several years. While criticism at first focused on airborne emissions of toxic substances produced during incineration, many experts have since come to believe that technologies now available can adequately control these emissions. Attention has now shifted from airborne emissions to ash. Municipal combustor ash consists of the residual material that is trapped in the stack—fly ash—and other combustion

products and noncombustible residues that remain behind in the combustion chamber: bottom ash. In most waste combustors, the two types of ash are combined for easier handling.

This combined ash may contain considerable quantities of toxic materials, including lead and cadmium. If present in sufficient concentrations and not properly disposed of, these materials may leach from the ash and contaminate ground or surface water supplies. Besides water contamination, the public also is concerned about human exposure to ash and ash dust at combustor plants and landfills. In addition, critics point to possible risks to area residents from ash dust blowing off solid waste trucks en route from incineration to disposal.

Yet clear guidance for appropriately managing incinerator ash remains elusive. The debate over ash persists because government, builders and vendors of incinerators, and the public cannot agree on what risks are presented by ash and whether or how these risks can best be managed. This failure to reach a consensus has caused cancellation of plans to install some combustor plants and has greatly prolonged the permit approval process and construction of others. It also has stymied needed improvements in the existing ash management system.



Process schematic of a municipal waste combustor.

Regulation

Current management practices are based on adhering to federal regulations directed at solid wastes in general, not at ash in particular. Ash and all other solid wastes are regulated by the U.S. Environmental Protection Agency (EPA) under the Resource Conservation and Recovery Act (RCRA) of 1976. Under the terms of RCRA, solid wastes are categorized as either hazardous or nonhazardous. Subtitle C of RCRA lays out strict requirements for managing the hazardous wastes. Subtitle D addresses the nonhazardous wastes.

Whether incinerator ash should be considered hazardous or not remains very much open to question. RCRA enumerates four traits that are characteristic of hazardous materials: corrosiveness, ignitability, reactivity, or toxicity. Toxicity is the only one of the four that could apply to ash. A toxicity test developed by EPA has been used on selected samples of ash with mixed results: some samples clearly indicate toxicity while others do not.

Categorizing ash as hazardous or nonhazardous is further complicated by a provision of RCRA known as the household waste exclusion. This provision states that household waste cannot be declared hazardous. Since the exclusion does not specifically include ash, some observers have argued that ash can be declared a hazardous substance; others argue that the exclusion encompasses the entire household waste system and that ash is included. EPA, however, has said that if incinerator ash is tested and found to possess traits of a hazardous waste, it should be regulated as such. To date, the agency has not enforced this position. The former administrator of EPA, Lee M. Thomas, has said that the agency is looking to Congress for clarification of the household waste exclusion as it applies to waste combustors and that EPA will await its decision.

In practice, because its regulatory status is uncertain, ash usually is managed and disposed of as a nonhazardous waste. Yet existing requirements for nonhazardous landfills are weak. In August of

1988, EPA proposed substantive revisions to these requirements that have generated substantial debate. It now seems unlikely that final revisions will become effective before at least 1992. Meanwhile, arguments about the appropriate disposal of ash continue.

Views from Congress, the courts

Congress has not yet acted to clear up the confusion, although the 100th Congress considered several bills that would have declared ash from waste combustors to be nonhazardous. Although they differed in detail, all of the bills would have required that most ash from incinerators be disposed of in lined—not unlined—landfills. (As many as 80 percent of existing landfills are believed to be unlined.) The bills also would have required less rigorous containment for ash monofills than for codisposal sites. Ash in monofills is believed to be relatively less risky because leaching of toxic substances is encouraged by acidic conditions, while

“But none of these issues excites so much opposition as the perceived health threats from ash.”

ash is alkaline and therefore conditions at monofills tend to be alkaline.

So far in the present legislative session, one new bill that applies to incinerator ash has been introduced. Others are likely to follow. All of the bills are expected to resemble those considered by the previous Congress and to stipulate that municipal waste incinerator ash be regulated as a nonhazardous waste.

The likelihood of any of these bills becoming law in 1989 is not great. The general view is that other environmental priorities such as revising the Clean Air Act amendments of 1977 may have greater claims on lawmakers' attention in the near term. Early 1990 is seen as a more likely time for moving forward on new legislation that affects the ash issue. Even if a bill were to be passed into law quickly,

it would be several more years before regulations could become final and EPA could begin to enforce them.

In the meantime, the Environmental Defense Fund (EDF) is suing two owners and operators of municipal waste incinerators. EDF charges that because ash from the two facilities failed EPA's toxicity test, it should be managed as hazardous waste and disposed of accordingly. Trial dates have not yet been set. An EDF victory may well spur Congress on to enact legislation that nullifies the court ruling and confirms its own view, which appears to be that ash should be considered a nonhazardous, albeit special, waste. An EDF loss might well help maintain the status quo.

Notwithstanding the hiatus in regulation, legislation, and the courts, local and regional authorities must continue to choose destinations for their municipal solid waste and make decisions about incineration. These decisions vary widely from locale to locale, but generally states in the Northeast with high population densities and little landfill capacity plan to use incineration to a greater extent than midwestern and western states with more landfill capacity (Connecticut already incinerates roughly one-third of its trash). Many states already have or are developing their own requirements for ash disposal. For instance, regulations in New York State echo many of the special handling requirements in the bills introduced during the 100th Congress.

Technology

Much of the debate over how incinerator ash should be regulated boils down to the issue of containment technology. Questions revolve around the rigorosity of engineering controls such as the number of liners that should be installed for different types of facilities, methods for collecting any leachate that escapes through the liners, and strategies for monitoring groundwater contamination.

One strategy being considered to ease concern over the adequacy of containment technology is to solidify or otherwise treat the ash before landfilling. Some companies offer chemical treatments

designed to reduce the leachability of toxic substances from ash. However, treatment is not being widely carried out because it is not currently a prerequisite for disposal at nonhazardous landfill sites. In essence, it adds a cost that can be avoided.

Though many critics focus on toxic components of ash such as lead and cadmium, concern is also being voiced about another component, salt. Incinerator ash contains extremely large concentrations of common table salt and other nontoxic salts that present problems of their own. Though they are unlikely to directly harm human health, they could adversely affect the environment by contaminating ground and surface water.

Incineration techniques also enter into the debate over ash. In general, these techniques have been improved in recent years both to increase the efficiency of power generation and to better control emissions of toxic substances. Airborne emissions from waste combustors have been reduced to a level where many, but not all, observers say that the emissions are acceptable. To a lesser extent, environmentalists and some commercial firms are looking at ways to control the entry of toxic substances into the combustor. Even so, opponents of incineration argue that current provisions and practices are not sufficiently health-protective; such opponents often garner strong resistance to the installation of waste combustors in their communities.

Labels matter

What are the implications of regulating incinerator ash as a hazardous waste? Of singling it out for special handling and disposal? Of considering it nonhazardous?

Michael Gough, senior fellow in the Center for Risk Management at Resources for the Future and director of a research project on managing ash from municipal waste incinerators, says classification could have significant effects: "Clearly, labeling incinerator ash as a hazardous waste would impose higher costs on its disposal because the costs of constructing and maintaining a hazardous

facility are greater than those for nonhazardous facilities.

"In the more likely event that Congress declares ash to be a nonhazardous waste that requires special handling, disposal costs undoubtedly would be greater than for other nonhazardous wastes and proba-

Clear guidance for appropriately managing ash remains elusive.

bly less than those for hazardous wastes," Gough continues. "More important, however, labeling ash as a 'special waste' probably would make its management somewhat easier because it would avoid the stigma attached to 'hazardous waste.'"

According to Gough, a partial solution to ash disposal could be achieved by using ash in construction fill and roadbeds, as it is used in Europe. Furthermore, he explains, ash has been used to fabricate building blocks and concrete. Firms that have begun to investigate the possible reuse of incinerator ash in these materials say they pass the toxicity test after treatment. "But no matter what test results are available," he says, "they would be given little credence if ash is declared to be hazardous."

Casting the die

"By the year 2000, the volume of municipal solid waste that will be disposed of, incinerated, or recycled in the United States is expected to rise almost 20 percent," Gough says. "Even more telling is EPA's estimate that landfill capacity will be exhausted in 27 states within the next five years. Although additional landfills may be opened up, they surely will be more expensive to site, maintain, and monitor."

Gough says that recycling is becoming a more attractive option because waste combustors are expensive and landfilling costs for both ash and other municipal solid wastes are rising. He says proponents of recycling cite cases such as the

city of Seattle, Washington, which recycles about 30 percent of its waste, a rate comparable to that in Japan.

But in the near term, he says, states with relatively low-cost, bounteous land available at the right price could find themselves becoming multistate dumping grounds. Such a trend already has begun, with private interests buying up thousands of acres of land for future landfill sites. The New Mexico legislature already has passed a moratorium on new landfills as a result of such activities. On the other hand, at least one railway engineering firm is said to be designing cars to carry trash interstate.

According to a background document prepared for the EPA 1988 *Agenda for Action*, if current recycling and disposal methods are not stepped up and if the amount of garbage produced annually continues to grow at the current rate, the United States may have as much as 56 million tons of garbage "left over" with no provisions for disposal in the year 2000. Will local authorities turn to incineration to the degree some experts predict and use this technology to offset the excess garbage figure?

"The answer depends to a great extent on resolution of the ash controversy," Gough says. "Undoubtedly, disagreements will continue over whether or not to install waste combustors. First, they are expensive. Second, they may have local impacts such as lowering property values and increasing truck traffic.

"But none of these issues excites so much opposition as the perceived health threats from ash," he continues. "The number of waste combustors in the year 2000 will directly reflect whether policymakers and the public deem risks from ash to be acceptable." ■

Elaine M. Koerner is staff writer for Resources for the Future. Michael Gough is senior fellow in the Center for Risk Management at Resources for the Future. The Center will shortly release a report on municipal waste combustor ash; the report contains recommendations for improving the management of ash.

Farm support and environmental quality at odds?

Tim T. Phipps and Katherine Reichelderfer

Farm support programs designed to create and maintain a healthy agricultural economy are not necessarily good for the health of the environment. With care, these programs can be modified to reflect both environmental and support goals. Otherwise farmers may face new environmental legislation that embodies harsher restrictions and higher costs.

In many respects, a clean, safe natural environment is compatible with a vital, productive farm economy. But evidence shows that agriculture is the largest single contributor to several important environmental quality problems.

Seventy percent of the nutrients and 33 percent of the sediment reaching waterways originate on agricultural land. Approximately 75 percent of the pesticides sold in the United States are purchased by agricultural users. Most of the conversion of wetland and grassland to other uses over the past thirty years has been a result of agricultural expansion.

Public concern, especially about pesticide and fertilizer contamination of drinking water sources, has sparked accelerated state and federal environmental legislation. Early discussion of options for the next domestic farm bill suggest that this legislative action will carry over into the agricultural policy arena.

Environmental components

Environmentalists are relative newcomers to the farm policy process. In 1985 their views together with those of farm interests were incorporated into a new farm bill (the 1985 Food Security Act, or FSA). This bill combines environmental and resource conservation goals with support of farm income. Contained within FSA is a conservation section which includes "sodbuster" and "swampbuster" provisions. FSA also

includes conservation compliance provisions and establishes a cropland conversion program called the Conservation Reserve Program (CRP).

But these programs are no panacea for agriculturally related environmental problems. In its first two years, the CRP has concentrated enrollment of land in wind erosion areas rather than in areas where water quality is most vulnerable to pollution from sedimentation. Furthermore, CRP enrollment rates are declining, and rental rates sufficient to induce full enrollment of 40 million acres by 1990 may be higher than the agricultural budget can tolerate. Moreover, although the effectiveness of conservation compliance is determined in large part by the attractiveness of the farm program payments that would be forgone under non-compliance, the FSA authorizes annual decreases in those payment levels.

While environmentalists were effective in adding conservation and environmental components to the FSA, they have not so far directed their efforts to changing the farm support components of the bill, which constitute the heart of farm policy. Overlooking this strategy may be a mistake because these programs have links to many of the resource and environmental problems of agriculture. Current domestic commodity programs have helped to create agricultural production patterns that have led to environmental problems involving soil erosion, agricultural chemical use, and loss of wildlife habitat. Elimination, phase-out, or other modifications of current farm programs could reduce environmental problems enough to reduce the need for separate environmental legislation.

Farm support programs

Three major sets of programs are currently employed to achieve farm policy goals: programs for commodity price

support, farm income support, and supply control. While these programs are often employed in combination with one another, each has a distinct effect on environmental quality.

Commodity price support programs affect environmental quality in that they provide an incentive for farmers to grow more of the supported commodities and to bring more acreage into production. Price supports lead to unintentional, adverse environmental effects because supported commodities coincidentally are grown in ways that result in high levels of erosion and require large volumes of agricultural chemicals. In addition, commodity price support encourages even greater use of fertilizers and pesticides, since yield gains resulting from chemical application have greater value when prices are high.

Farm income support programs provide the means for crop production in regions where farmers must contend with high chemical and irrigation costs. These programs rely on a base acreage system that discourages the diversification of farm operations. Base acreage is used to determine a farmer's deficiency payment for each program crop and is equal to the average number of acres planted in each crop over the previous five years. Corn farmers, for example, are discouraged from planting other crops such as alfalfa because every acre of corn base planted in another crop would reduce the size of their corn deficiency payment for the next five years.

Diversification is important from an environmental perspective because a diverse landscape provides more productive wildlife habitat than monoculture and is also less susceptible to pest infestation. In fact, diversification is one of the most important techniques—as is crop rotation—for reducing the use of pesticides and chemical fertilizers in agriculture.

Supply control programs, the third type of farm support program, have varying effects on environmental quality depending upon the form of supply control. Those programs that rely on removing acreage from production to reduce surplus crop production relieve pressures on the land base, but encourage greater use of agricultural chemicals on land that re-

mains in production to compensate for the reduced amount of available land. Acreage control programs, then, increase the application rate of agricultural chemicals per acre, but may reduce soil erosion by limiting the amount of land in production.

By contrast, direct control of commodity supply, a less commonly used form of supply control, would not lead farmers to use more chemicals on land since land use is not restricted. But it might result in a higher level of soil erosion than acreage control since more land would remain in production.

Marketing orders, used mainly for fresh fruits and vegetables, are another form of supply control. Here, growers of certain commodities are allowed to control the amount of the product that is placed on the market in order to regulate price. Some marketing orders use cosmetic standards—such as color, or levels of visible surface insect or disease damage—to limit indirectly the amount of product that reaches the market. Cosmetic standards may cause individual growers to apply more pesticides than they would otherwise to increase the proportion of their crop that reaches the more profitable market.

Net effects

Each of these three sets of farm programs affects environmental quality in different, sometimes conflicting ways. The net effects of the current combination of farm program instruments are that (1) more acreage is retained in the agricultural sector than would be the case in the absence of farm programs, but (2) less acreage is cultivated, and (3) agricultural chemical use rates and crop yields per acre are higher.

There is considerable budgetary pressure to modify, reduce, or eliminate existing farm support programs. The abandonment of *all* programs, with retention of current conservation provisions, would increase the number of acres planted in crops but would result in the environmentally beneficial relocation and mix of production activities, with less intensive and less damaging use of agricultural chemicals on expanded acreage. How-

ever, abandoning all farm programs without providing some alternate means of support would also mean that farm income would decline, agricultural exports would fall, and rural communities and agribusiness interests would suffer. Clearly, new strategies are needed to reduce the conflicts between the goals of farm policy and environmental policy.

Policy choices

At this time, the government has two major alternatives for reducing agriculture's effect on the environment: modifying the provisions of current farm support programs in ways that reduce environmental problems, or implementing new environmental legislation aimed at counteracting the unintentional but adverse effects of current agricultural production patterns.

How could the indirect, adverse effects of current farm support programs on environmental quality be substantially reduced? First, legislative provisions should be introduced that would sever the link between direct farm income support payments and crop production levels. Second, long-term acreage retirement schemes could be targeted to those areas of the country having greatest environmental vulnerability.

Severing the link between income support payments and production levels could take many forms. One option might be the use of payments to purchase environmental services from farmers. In other words, farmers who adopt environmentally beneficial practices could be reimbursed by society for the resultant soil conservation, water quality, and wildlife habitat benefits. This option directly addresses the compatibility of agriculture and the environment and makes sense by offering to pay for services society values rather than for commodities for which there is a taxpayer-supported surplus.

Not only would separating income supports from production levels produce positive effects for the environment, it would also improve the general economy by leading to increased efficiency in the use of resources in agriculture. As with all policies, however, there would be win-

ners and losers. Producers of unsupported commodities such as beef cattle, dried beans, and sunflowers would face increased competition from former producers of supported commodities. Producers of highly protected commodities such as sugar and dairy products would face stiff competition from foreign producers whose costs are lower. Regions having high costs of production or poor-quality soils would experience a reduction in agricultural income. Taxpayers would gain from the targeting or elimination of price and income support programs.

Among other alternatives, two seek to modify the conservation reserve and cross-compliance provisions of the FSA. A widely discussed proposal would expand the Conservation Reserve Program. Under one scenario, land enrolled under the CRP would be expanded from 45 to 65 million acres. Improvement in water quality would be required as the main criterion for enrolling the additional acreage. Another scenario would expand the CRP to 70 million acres, require that 50 percent of the additional land be planted in trees, and encourage the use of vegetated stream borders to improve water quality and wildlife habitat.

The success of an expanded CRP in improving environmental quality would be contingent upon what type of land was enrolled. The current CRP has demonstrated that it is difficult to develop effective criteria for targeting the program toward improving water quality. An expanded CRP would face the same problem. Also, the CRP is an expensive program, and it might be difficult to expand that program given the size of the federal budget deficit and possible upward pressures on food prices.

A second alternative would be to generalize the cross-compliance restrictions in the FSA to cover environmental problems resulting from pesticide and fertilizer use. This "chemical compliance" approach could also be used in conjunction with other strategies. One proposal would deny all farm program benefits to anyone who clears land of trees to establish cropland or who contaminates well or surface water with agricultural chemicals.

Chemical compliance, however, does

have its limitations. It is very difficult to trace a specific water pollution incident to a specific use of a chemical on the land. Chemical compliance would therefore be expensive to monitor and difficult to enforce. In addition, it has the potential to influence landowner behavior only if the subsidies gained by participating in farm programs remain lucrative. A phase-out of target prices, then, would also be a phase-out of cross compliance.

Several additional farm policy alternatives offer promise for directly addressing the environmental problems linked to agriculture. These alternatives include taxes or user fees on agricultural chemical use, subsidies to encourage adoption of low-input sustainable agriculture or integrated pest management, and funding of research to develop alternatives to current chemical-intensive practices.

Much important environmental legislation already exists that affects agriculture but is not directly related to farm policy. If agricultural legislation does not independently recognize and address the environmental consequences of agricultural production and current farm policies, then the burden of legislative activity in this arena will fall to federal institutions and state-level agencies having direct responsibility for environmental quality. Such activity is already in process.

Because the costs of preventing pollution from agricultural sources are less than the costs of cleaning up contaminated water, especially groundwater, environmental legislation is increasingly directed at the source of environmental problems. The source of agriculturally related problems is the farmer. Thus, if voluntary actions are unsuccessful and agricultural programs are not modified, it is increasingly likely that restrictions on land use or farm management will be imposed on farmers.

Tradeoffs

Stricter environmental legislation affecting agriculture would produce tradeoffs. For instance, restricting land use to improve environmental quality would also reduce the incomes of some farmers.

Prohibiting pesticide or fertilizer use near vulnerable water systems could reduce crop yields. Although reducing crop yields might indirectly aid the farm sector by increasing commodity prices, individual farmers would pay the costs. In general, stricter environmental legislation would improve the environment but raise the cost of producing food and therefore its price.

The choice between a farm policy approach and an environmental legislation approach (or some combination of the two) depends upon whether and how the value of environmental quality benefits exceed farm sector adjustment costs. An evaluation of both the agricultural and environmental benefits and costs is needed to distinguish among alternative approaches. The environmental benefits of farm program modification need to be examined in concert with the implications for commodity prices, farm income, rural economies, agribusiness, and agricultural trade.

Modifying farm programs to allow for joint achievement of environmental and agricultural policy goals might be less traumatic for the agricultural sector than the alternative, and might be cheaper for society. The more we can modify farm support programs to reduce their negative environmental side effects, the fewer environmental problems will remain that require specific environmental legislation. Given the difficulty and expense of dealing directly with agricultural nonpoint pollution—whether it be the regulation of chemical use or enforcing surface and ground water standards—this is clearly a situation where an ounce of prevention is worth a pound of cure. ■

Tim T. Phipps is a fellow at the National Center for Food and Agricultural Policy at Resources for the Future. Katherine Reichelderfer is a visiting fellow at the National Center.

Corrections and additions

The following table referred to in the box on page 16 of the Winter 1989 issue of *Resources* was mistakenly omitted. It should have accompanied John F. Ahearn's article, "Will nuclear power recover in a greenhouse?"

In figure 1 on page 6 of the Winter 1989 issue, labels for world prices and U.S. prices were inadvertently reversed, in the article by Rehka Mehra entitled "Winners and losers in the U.S. sugar program."

Fossil Fuel Reserves and Consumption, 1987 (in percentages)

	Coal		Gas		Oil		Percentage of electricity from nuclear power
	own	use	own	use	own	use	
United States	26.0	19.0	5.0	28.0	4.0	26.0	17.7
USSR	24.0	16.0	38.0	33.0	7.0	15.0	11.2
China	17.0	23.0	1.0	1.0	2.0	4.0	—
Japan	—	3.0	—	2.0	—	7.0	29.1
France	—	1.0	—	2.0	—	3.0	69.8
West Germany	6.0	3.0	—	3.0	—	4.0	31.3
United Kingdom	1.0	3.0	1.0	3.0	1.0	3.0	17.5

Sources: BP Statistical Review of World Energy, June 1988, pp.8, 23, 24, 27; and Nuclear Power Reactors in the World, IAEA Reference Data Series no.2 (Vienna, International Atomic Energy, April 1988), table 7.

Recent RFF grants, corporate contributions

RFF's National Center for Food and Agricultural Policy received grants from the Farm Credit System and the American Farm Bureau Federation and a challenge grant from the Northwest Area Foundation in support of a project that will examine the economic, social, and political implications of the major alternatives for the 1990 farm bill. The center also received a grant from the German Marshall Fund of the United States for a conference on agricultural protectionism in the industrialized world. RFF's Climate Resources Program received grants from the G. Unger Vetlesen Foundation; from the United National Environmental Programme (UNEP) to prepare a chapter on policy options for adaptation to climate change for a report to the UNEP governing council; from the U.S. Department of Energy's Carbon Dioxide Research Division for a one-year study of processes for identifying regional influences of aid responses to increasing atmospheric CO₂ and climate change; and from the U.S. Department of the Interior for research on areas related to climate change, water resources, and environmental pollution.

In addition, RFF recently received grants from the following corporations: Amoco Foundation, Inc.; ARCO Chemical Company; Central Soya Company, Inc.; Electric Power Research Institute; FMC Foundation; Georgia-Pacific Corporation; The Mead Corporation; Mitsubishi; Monsanto Company; Pioneer Hi-Bred; The Procter & Gamble Company; Stone & Webster Engineering Corporation; Stout & Teague Company; Sun Company, Inc.; Syntex Corporation; Unilever PLC; Unilever United States, Inc.; Westvaco Foundation; and Weyerhaeuser Company Foundation. ■

New RFF complex dedicated

The Resources and Conservation Center, of which RFF is joint owner-partner with the National Wildlife Federation (NWF), was formally dedicated on March 17, 1989. Composed of two buildings and a public garden open to the community and occupying most of a square block in downtown Washington, D.C., the center is home to its two sponsoring organizations as well as to other tenants with related interests.

In addition to housing conference facilities, an eatery, and an exercise room, the center embodies advanced energy-saving technologies. Utilizing state-of-

the-art construction, it is the first commercial office complex in Washington, D.C., to employ an ice storage air conditioning system. The center also utilizes a special heat recovery process and energy-saving lighting.

Officiating at the ceremony were officers of the NWF and Robert W. Fri and Charles E. Bishop, president and chairman of the board, respectively, of RFF. William K. Reilly, administrator of the U.S. Environmental Protection Agency, delivered the dedicatory address and passed along a message of greeting and congratulations from President Bush. ■

Abel Wolman, 1893-1989

A world-renowned figure in the water resources world, Abel Wolman, died on February 22 at the age of 96. History will remember him most for his leadership in developing methods for, and leading the effort to, chlorinate drinking water. While this method has recently been somewhat called into question because of the chemical by-products it produces, there can be no doubt that it has saved many millions of lives worldwide. There were many other achievements to his credit, among them the major role he played in the development of the water system in Israel.

When I joined RFF in 1960 to develop a water quality program, Abel Wolman was the first person I went to see for advice. I still recall him sitting in his office at his beloved Johns Hopkins University, already the leading figure in the field of sanitary engineering, while he patiently explained water quality issues to me, a neophyte. Ever

since—until his death after a career spanning an unbelievable seventy years—he had taken a lively interest in the work of RFF. During many seminars I presented at Johns Hopkins, organized by Abel's son M. Gordon ("Reds") Wolman (himself a distinguished scientist who from 1980 to 1988 was chairman of RFF's board of directors), Abel participated actively. Even when he was in his late eighties he paid as close attention as anyone in the room and usually had the most penetrating questions and comments. As recently as 1986 he reviewed a major RFF study of giardiasis (the water-borne disease) completed by several of my associates, happily pronouncing it to be the best study of an epidemic he had ever seen.

I am saddened by the death of an old friend. What a rich and full professional and personal life he had!

Allen V. Kneese

Discussion papers

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

Energy and Natural Resources Division

- "Water Resources: Status, Trends, and Policy Needs," by Kenneth D. Frederick. ENR88-02 (\$5.00)
- "Improving Performance of Wholesale Electric Generation Markets," by Michael A. Toman and Joel Darmstadter. ENR88-03 (\$5.00)
- "Analyzing U.S. Oil and Gas Exploration: A Joint-Products Rational Expectations Framework," by Margaret A. Walls. ENR88-04 (\$5.00)
- "Changes in Electricity Markets and Implications for Generation Technologies," by Hadi Dowlatabadi and Michael A. Toman. ENR89-01 (\$5.00)
- "Management of Watersheds for Augmented Water Yields—Plumas National Forest," by John V. Krutilla, Michael D. Bowes, and Thomas B. Stockton. ENR89-02 (\$5.00)
- "Temporal Aggregation in FORPLAN Linear Programs," by Michael D. Bowes. ENR89-03 (\$5.00)
- "Launch Vouchers for Space Science Research," by Molly K. Macauley. (ENR89-04) (\$5.00)
- "Policy Options for Adaptation to Climate Change," by Norman J. Rosenberg, Pierre R. Crosson, William E. Easterling III, Kenneth D. Frederick, and Roger A. Sedjo. ENR89-05 (\$5.00)

Quality of the Environment Division

- "Travel Cost Recreation Demand Meth-

ods: Theory and Implementation," by V. Kerry Smith. QE89-03 (\$2.25)

- "Valuing Environmental Resources Under Alternative Management Regimes," by A. Myrick Freeman III. QE89-04 (\$2.25)
- "Signals or Noise? Explaining the Variation in Recreation Benefit Estimates," by V. Kerry Smith and Yoshiaki Kaoru. QE89-05 (\$2.25)
- "Alcoholism and Human Capital," by John Mullahy and Jody L. Sindelar. QE89-06 (\$2.25)
- "Tradable Nutrient Permits and the Chesapeake Bay Compact," by Alan J. Krupnick. QE89-07 (\$2.25)
- "Valuing Individuals' Changes in Risk: A General Treatment," by A. Myrick Freeman III. QE89-08 (\$2.25)
- "Benefit Estimation Goes to Court: The Case of Natural Resource Damage Assessments," by Raymond J. Kopp and V. Kerry Smith. QE89-09 (\$2.25)
- "Moment-Based Estimation and Testing of Stochastic Frontier Models," by Raymond J. Kopp and John Mullahy. QE89-10 (\$2.25)
- "The Social Cost of Environmental Quality Regulations: A General Equilibrium Analysis," by Michael Hazilla and Raymond J. Kopp. QE89-11 (\$2.25)
- "Public Choices and Private Risks: The Role of Economic Analysis," by V. Kerry Smith. QE89-12 (\$2.25)
- "Benefit-Cost Analysis of Policies Toward Risk," by A. Myrick Freeman III. QE89-13 (\$2.25)
- "Measuring Welfare Values of Productivity Changes," by A. Myrick Freeman III and Winston Harrington. QE89-14 (\$2.25)

National Center for Food and Agricultural Policy

- "Reflections from the Past, Challenges for the Future: An Examination of U.S. Agricultural Policy Goals," by Kristen Allen. FAP89-01 (\$3.00)

Center for Risk Management

- "Urban Air Quality and Chronic Respiratory Disease," by Paul R. Portney and John Mullahy. CRM 89-02 (Free)
- "The Net Benefits of Incentive-Based Regulation: The Case of Environmental Standard-Setting in the Real World," by Wallace E. Oates, Paul R. Portney, and Albert M. McGartland. CRM 89-03 (Free)
- "Protective Action Decision-Making in Toxic Vapor Cloud Emergencies," by Theodore S. Glickman and Alyce M. Ujihara. CRM 89-04 (Free)
- "Economics and the Rational Management of Risk," by A. Myrick Freeman III and Paul R. Portney. CRM 89-05 (Free)

Reprints

RFF reprints present work that RFF staff members have contributed to journals, books, and other publications produced elsewhere. Selected among other criteria for their quality and the limited circulation of the original publication, they are offered at no charge for single copies, and at fifty cents prepaid for each additional copy. The following reprints have recently been released.

241. "Dioxin: Are We Safer Now Than Before?" by Adam M. Finkel.

242. "Property Rights and the Protection of Plant Genetic Resources," by Roger A. Sedjo.

New book

Greenhouse Warming: Abatement and Adaptation

A proceedings volume. Norman J. Rosenberg, William E. Easterling III, Pierre R. Crosson, and Joel Darmstadter, editors.

This proceedings volume contains the papers presented at an RFF workshop on greenhouse warming in June 1988. Chapters in the first section deal with the scientific basis of the greenhouse phenomenon, the climatic consequences of greenhouse warming, and the direct effects of enriching the air with carbon dioxide (CO₂), the most important of the greenhouse gases. Current emissions of all the greenhouse gases are documented, and likely emissions in the future are projected. The possibility of rising sea levels and their potential impacts are reviewed. One chapter deals with the question of how governments and the international community will determine how much

warming is too much and the obstacles to an international agreement to limit and enforce limits on emissions. In another chapter the greenhouse effect is contrasted to other kinds of environmental problems in the framework of risk assessment and risk management.

Chapters in the second section examine the possible impacts of greenhouse-induced climate change on natural resources—agriculture, forestry, water resources, and unmanaged ecosystems—and the possible responses and adjustments to these impacts.

The third group of papers examines the greenhouse warming issue from a number of special perspectives: How might climate change affect the developing countries? How does climate change relate to other environmental changes? What are the policy implications of greenhouse warming? What policies should be immediately implemented?

As these papers show, studying the sensitivity of various economic and ecologi-

cal sectors to a range of plausible futures is useful in attempting to estimate the potential benefits and costs of greenhouse warming and in evaluating the utility of abatement and adaptive measures for the renewable natural resources.

June 1989. 224 pp.

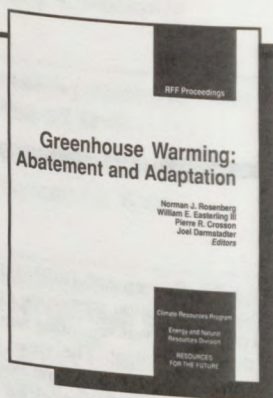
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(more news on next page)



Proceedings from RFF

Greenhouse Warming: Abatement and Adaptation

Norman J. Rosenberg,
William E. Easterling III,
Pierre R. Crosson, and
Joel Darmstadter, eds.

Papers from a workshop identifying alternative policy strategies for slowing greenhouse warming and coping with its consequences.

1989 • 224 pp. \$18.95 paper

Consumer Demands in the Marketplace: Public Policies Related to Food Safety, Quality, and Human Health

Katherine L. Clancy, ed.

Outlines research, education, and policy responses to the demand for safe and sufficient food.

1988 • 202 pp. \$10.00 paper

U.S.-Canadian Agricultural Trade Challenges: Developing Common Approaches

Kristen Allen and Katie Macmillan, eds.

Discusses issues related to the inclusion of agriculture in a bilateral free trade agreement.

1988 • 229 pp. \$10.00 paper

Economics and Technology in U.S. Space Policy

Molly K. Macauley, ed.

Papers from a symposium on the economics of space enterprise.

1987 • 270 pp. \$15.00 paper

Policy Aspects of Climate Forecasting

Richard Krasnow, ed.

Assesses the economic and policy value of long-range forecasts.

1986 • 176 pp. \$5.00 paper

RFF staff changes

Robert W. Fri, RFF president and senior fellow, recently announced that Michael A. Toman has been promoted to the rank of senior fellow in RFF's Energy and Natural Resources Division. Fri also announced that indefinite appointments have been extended to three RFF researchers: Winston Harrington and Alan J. Krupnick, both fellows in the Quality of the Environment Division, and Molly K. Macauley, a fellow in the Energy and Natural Resources Division.

In other RFF staff news, Nancy Bushwick Malloy has joined the National Center for Food and Agricultural Policy as its associate for leadership development. Tim T. Phipps has resigned as a fellow in the National Center for Food and Agricultural Policy to become associate professor in the Department of Agricultural and Resource Economics at West Virginia University. ■

Applicants sought for leadership program

The National Center for Food and Agricultural Policy at Resources for the Future is now accepting fellowship applications for its annual Leadership Development Program. Applicants must have at least a baccalaureate degree and have completed at least five years' work in a field related to food and agriculture. Particular attention is given to applicants who have records of increasing responsibility and strong leadership potential.

The program provides an opportunity for up to twenty-five midcareer professionals to obtain four-week public policy fellowships in Washington, D.C. Those selected participate in specially designed seminars, workshops, and discussions about food and agricultural policies. In addition, they under-

take independent policy projects dealing with a food or agricultural policy issue of their choice.

The 1990 program is divided into two two-week segments, separated by a two-week interval to enable fellows to return home. It will run from January 31 to February 15 and March 4 to 17, 1990. Tuition is \$1,900. Limited support is available from the National Center for fellows in special circumstances.

To obtain an application form for the program, write to: 1990 Leadership Development Program, National Center for Food and Agricultural Policy, Resources for the Future, 1616 P Street, N.W., Washington, D.C. 20036. Telephone (202) 328-5117.

The deadline for submitting applications is September 29, 1989.

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