



RESOURCES

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Reauthorizing Environmental Legislation: Issues and Impact

Several of this nation's environmental laws are now or soon will be up for reauthorization; not coincidentally, as the reauthorization debates heat up, researchers at RFF have been closely studying the laws and their impacts.

Superfund is currently getting the lion's share of public attention. In this issue, Kate Probst and Paul Portney explain in direct, unencumbered style the basic features of the statute as it now stands, as well as the sorts of changes that various groups are seeking to make. To provide this overview, they draw on four years' worth of research and policy analysis at RFF regarding Superfund, including a major report in 1992 on the liability standards in the statute and the pros and cons of changing them, as well as a book now in press on the economic impacts associated with the law.

Jim Boyd and Molly Macauley look at one specific issue regarding Superfund—the possible effects of Superfund liability on the redevelopment of older, often abandoned downtown industrial sites. Recognizing that many factors (including crime, high tax burdens, and the growth of exurban markets) militate against inner city redevelopment, they identify a number of measures that can be taken to blunt any possible Superfund disincentives.

The nation's basic pesticide law, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), is also up for reauthorization. A major issue in this debate concerns the law's requirement that the U.S. Environmental Protection Agency (EPA) balance the possible health

risks associated with pesticide use against their economic benefits. John Antle and Prabhu Pingali describe the health risks and productivity benefits arising from the use of pesticides in rice production in the Philippines.

Encouragements or prohibitions on balancing aside, what do regulators really do when setting standards? Using data they collected on EPA's regulatory decisions concerning asbestos, pesticides, and hazardous air pollutants, Maureen Cropper and George Van Houtven attempt to determine statistically whether EPA *appeared* to balance benefits and costs in these three areas of regulation. In addition, they seek to determine what value EPA was implicitly placing on avoiding a given cancer case. Their findings on both counts are surprising.

Make no mistake about it: RFF research is often technical. But, as these articles show, this research is, more often than not, of direct relevance to important policy problems. In "Inside RFF," we describe some of our outreach activities, where RFF researchers help others make better policy decisions, both domestically and internationally. In this issue, Mike Toman reflects on a recent trip he and other RFF researchers made to Ukraine and Russia, a trip supported in part by a grant from the Trust for Mutual Understanding.

We are grateful to the growing number of individuals and organizations whose financial contributions help make RFF's research, policy analysis, and outreach activities possible.

Robert W. Fri, President

Cleaning Up Superfund

Paul R. Portney and Katherine N. Probst

Controversy over Superfund has come to the fore as the statute comes up for congressional review. Critics of the law express concern about the amount of money being spent for Superfund cleanups, question whether such spending is directed toward cleanups of sites that pose serious health and ecological risks, and bristle at the apparent unfairness of Superfund liability provisions. Defenders of the law point to the increased care with which hazardous materials are now handled and to the large number of privately funded cleanups under way. Although no changes were made the last time Superfund was reauthorized, significant reforms in the law may be enacted in this or the next session of Congress. These reforms hinge on two questions central to all disagreements over Superfund: What is the appropriate extent of cleanup at Superfund sites? And how shall the costs of these cleanups be apportioned?

Over the last twenty-two years, Congress has enacted seven major laws under which the U.S. Environmental Protection Agency (EPA) has been delegated regulatory responsibility. Six of these laws—the Clean Air Act, the Clean Water Act, the Safe Drinking Water Act, the Toxic Substances Control Act, the Resource Conservation and Recovery Act, and the Federal Insecticide, Fungicide, and Rodenticide Act—could be called “forward looking.” That is, under these statutes EPA writes regulations that prescribe the current and future generation, transportation, use, and disposal of a variety of products or pollutants that might endanger human health or the environment.

In contrast with these laws, the seventh major environmental law takes a largely retrospective view. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, better known as Superfund) was enacted to deal with the legacy of sites contaminated by hazardous materials as a result of mining, petroleum refining, manufacturing, waste disposal, and a variety of other economic activities dating back, in a few extreme cases, to the nineteenth century. Superfund has been reauthorized twice since its passage in 1980 and is up for renewal again; as is generally the case, reauthorization provides Congress the opportunity to think about what changes, if any, it wants to make in the law.

There is no shortage of suggestions. Virtually everyone affected by Superfund—from the businesses that feel its economic sting to the citizens who fear nearby contamination—has complaints about the way the waste remediation program established under Superfund has worked during the past thirteen years. This makes it very difficult for anyone—in Congress, in the Clinton administration, or in the business or environmental communities—to craft a set of reforms that would be pleasing to all. And despite criticisms, most experts would agree that Superfund has created powerful incentives to reduce the generation and improve the management of hazardous substances. The desire to preserve the most beneficial effects of the law further complicates discussions of reform.

It is our purpose here to provide a brief sketch of the Superfund program as it has evolved to this point, indicate the reforms that various groups have proposed, and offer our views as to the likely outcome of the congressional debate over reauthorization.

Overview of the program

At the risk of oversimplifying a very complicated statute, we may say the Superfund law has tried to accomplish several things. First, it has provided a mechanism through which contaminated sites that pose serious threats to human health and the environment are identified and ranked. The most troublesome sites are placed on the National Priorities List (NPL)—that group of sites for which federal moneys can be used for cleanup. There are currently 1,286 such sites on the NPL.

Second, the law has established a process for determining which possible remedies (cleanup approaches) are feasible and appropriate for each site on the NPL and for selecting the desired remedy.

Third, it has created several new federal taxes—one falling on petroleum and on chemical feedstocks used in manufacturing, the other a more general corporate income tax—that help stock a trust fund. This fund is used on an emergency basis to finance cleanups of sites posing immediate risks to health and the environment and on a nonemergency basis to finance long-term cleanups at sites where no “responsible parties” can be found and made to clean up the site(s) in question.

Last, but by no means least, the Superfund law has created a mechanism through which EPA can identify these responsible parties, apportion liability among them, and require them to pay for the remedy that has been selected.

Although controversy surrounds each of these provisions, we believe two questions lie at the heart of virtually all serious disagreements over Superfund. First, what is the appropriate extent of cleanup at each of the sites on the NPL? Second, how shall the costs of these cleanups be apportioned? Before we turn to these questions, it is useful to put Superfund in perspective with other federal environmental regulatory programs.

Superfund costs and controversies

According to EPA, individuals, government agencies, and businesses had to spend about \$130 billion in 1993 to comply with all federal regulations written under the seven environmental laws listed above. Given the attention it has received lately, one would think the Superfund program was responsible for a significant share of these expenditures. In point of fact, however, this is not the case.

In 1993, total spending to meet Superfund requirements was about \$6 billion. Of this, \$3 billion was spent by the U.S. Departments of Energy and Defense and about \$1.5 billion by EPA. Thus, under Superfund, all private firms, state and local governments, and individuals spent less than \$2 billion on waste remediation.

As best we can determine, total annual spending pursuant to Superfund requirements in 1993 is likely to be on the order of \$6 billion. This figure includes \$3 billion in combined expenditures by the U.S. Department of Energy for cleanups at its nuclear weapons plants and by the U.S. Department of Defense for cleanups at its military bases. Of the remaining \$3 billion, about \$1.5 billion was spent by EPA. This implies that all private firms, state and local governments, and individuals spent less than \$2 billion last year on waste remediation under Superfund. Since private parties are not required to report their annual cleanup expenditures, there is great uncertainty about this last figure.

If Superfund currently accounts for a relatively small fraction of total annual expenditures on environmental compliance, why has it become so controversial? Three explanations are likely. First, although current spending for Superfund cleanups may not yet be significant, this amount will change with time. If all 1,286 sites on the NPL are cleaned up at the current average per-site cost of \$30 million, for instance, total expenditures will eventually grow to nearly \$40 billion. And if EPA continues to add sites to the NPL at the current rate of 50 per year for the next decade, total expenditures will increase by \$15 billion. These are sums worthy of serious attention.

Second, there is great concern—particularly among those in the business community—that the moneys being expended on site remediation are not being directed toward very serious risks. These critics allege that EPA systematically overestimates the health and ecological risks arising from site contamination, often by making unreasonable assumptions about the likely human exposures to contaminants. Many of those helping to pay for site cleanups say they are willing to pay to address serious risks, but resent squandering scarce resources on what they regard as often trivial problems. On the other hand, environmentalists contend that serious contamination at some sites is going unaddressed.

Third, controversy surrounds the allocation of cleanup costs. When Superfund was passed in 1980, Congress, having no appetite for increasing federal spending to pay for site cleanups, created a liability system to make it relatively easy for the government to link private parties to sites and make them pay for remediation.

Under Superfund, liability is referred to as retroactive, strict, and joint-and-several. It is retroactive in the sense that it applies to activities that took place before—occasionally long before—Superfund was enacted. Strict liability is that which is unrelated to the care or

the negligence responsible parties may have exhibited in the past. Joint-and-several liability implies that any one party at a site can be required by the government to pay for the entire cleanup, regardless of the share of wastes it contributed. (That party can then in turn sue other contributors, but it must incur the legal costs associated with bringing these suits.)

Each of these liability provisions has been exceptionally controversial. For instance, it is galling for one responsible party at a site to be told that it must shoulder a disproportionately large share of cleanup costs because none of the other contributors can be found, or because they are insolvent or otherwise incapable of paying for cleanup. Similarly, firms that took pains to manage hazardous substances in a responsible way in the past bristle at the fact that their efforts are no defense against Superfund liability.

These controversies lead back to the two questions raised above: What is the appropriate extent of cleanup at Superfund sites? How shall cleanup costs be apportioned? We turn now to these two fundamental issues.

How clean is clean?

Section 121 of Superfund spells out the criteria governing site cleanups. Importantly, the law calls for a cleanup that “utilizes permanent solutions and alternative treatment technologies . . . to the maximum extent practicable” at each site. This seemingly innocuous wording is the source of much of the controversy over the Superfund statute.

Consider a site located in or near a residential area. There are houses nearby, but the site—once an industrial dump, say—is fenced off and currently vacant. The soil at the site is contaminated but is not contributing to the contamination of an underground aquifer. Some might find it appropriate in these circumstances to cap the site in order to contain the contamination and to build

a more secure fence around it, but then to do little more than continue to monitor it carefully. In view of the risk posed by the site, some might deem this a reasonable response. In fact, they would argue, it would be wrong to go much beyond the measures described here, as doing so would eat up scarce resources that might better be deployed elsewhere.

Some argue that scarce resources necessitate the ranking of cleanup priorities; others argue that a precise balancing of risks against cleanup costs is a practical impossibility.

But would this be a "permanent" remedy? To many in the environmental community and in Congress, the answer is no. Critics of such a risk-based approach—in which the extent of the remedial action depends upon the seriousness of the current health risks a site poses—believe that a permanent remedy is one that goes well beyond containment, extending perhaps to the excavation and incineration of contaminated soils or the pumping and treatment of contaminated groundwater. They would balk at a remedy that would reduce exposure to contamination without removing the contamination itself.

This very brief discussion suggests the basic nature of the debate. On the one side are those who argue that scarce resources necessitate the ranking of cleanup priorities, an activity that implies some sites should receive much less extensive remedies than others. To these individuals, chain-link fences and "Keep Out" signs will constitute appropriate remedies for at least some low-risk sites.

On the other side are those who argue that while a precise balancing of risks against cleanup costs may be a nice conceptual approach to remedy selection, it is a practical impossibility

in light of the almost total lack of reliable data on the actual health and environmental risks at sites, as well as the great uncertainties about the costs of various possible remedies. In the view of these people, site-by-site balancing of risks and cleanup costs would drag the cleanup program into the next millennium. In addition, they point to the congressional preference for permanence in remedy selection.

Are there hybrid approaches that might placate both camps? Perhaps. One change that has been suggested would be the establishment by EPA of maximum permissible concentrations of contaminants in soils and groundwater at Superfund sites. Any remedy would be required to meet these standards, but with one important twist: different standards would be established for different sites, depending upon the intended future use of a site. Thus, for instance, a Superfund site that would be redeveloped as an industrial park would have to meet less stringent cleanup standards than a Superfund site on which a housing development or a school would be built. In this way, a crude form of balancing would take place; this hierarchical approach would reflect the fact that humans' exposure to remaining contaminants would be much less likely at the industrial park than at the school playground.

Whether or not such a change is politically feasible remains to be seen. Perhaps surprisingly, tailoring cleanup to intended land use may make less difference than one might suspect from a strict reading of the law. We say this because if one looks closely at the cleanup remedies EPA has selected at Superfund sites all around the United States, it is hard to see any uniform pattern suggesting strict adherence to the concept of permanence. Rather, remedy selection seems to depend at least in part upon which EPA regional office is in charge of a given site, the amount of press attention devoted to the site, and the extent of public involvement there. Interestingly, remedy selection also

seems to depend upon the seriousness of the health and environmental risks the site poses. Thus, although the Superfund statute seems to discourage risk-based cleanups, these considerations do seem to be part of the decision-making calculus. (See "Cleanup Decisions Under Superfund: Do Benefits and Costs Matter?" by Shreekanth Gupta, George Van Houtven, and Maureen L. Cropper in the Spring 1993 issue of *Resources*, as well as "When Is a Life Too Costly to Save? The Evidence from Environmental Regulations" by Cropper and Van Houtven in this issue.)

Who pays for cleanups?

As noted above, Superfund contains expansive liability standards. Not surprisingly, these standards have been the source of tremendous controversy. Equally unsurprising, a number of groups have sought changes in Superfund that would relax these standards in one way or another.

Banks and other lending institutions fear being held liable for cleanup costs under Superfund because they lent money to, and sometimes foreclosed upon, firms that were found to be responsible parties at Superfund sites. Claiming that Congress never intended for "nonpolluters" such as themselves to be caught up in the liability net, these institutions have pressed for elimination of what has come to be known as lender liability.

Also unhappy are municipal officials. A fair number of Superfund sites are landfills that municipalities either operated or contributed wastes to at one time. Like industrial contributors to these sites, they have been named as responsible parties by EPA or have been sued in "contribution actions" by one or more firms that have been stuck by EPA with the cleanup bill. They, too, are claiming that the Superfund law was never meant to impose significant economic costs on them; they generally argue that municipal waste (or garbage, as it used to be

called) is much less likely to be among the risky contaminants at municipal landfills. (We should point out, though, that the paint thinners, used motor oils, car batteries, and other liquid and solid wastes that households once casually discarded with their trash can be every bit as toxic as some industrial wastes.)

Private firms, both large and small, are also unhappy with Superfund. They have argued forcefully that they should be neither held liable retroactively nor held liable for contamination caused by others. While there is now no doubt about their legality, retroactive and joint-and-several liability provisions do strike many observers (including some with no financial stake in the matter) as being somewhat unfair. Several recent proposals put forward by coalitions of responsible parties would change the liability provisions of Superfund to address these perceived inequities. For instance, one proposed change would require EPA to pay for any "orphan" shares at Superfund sites; these are the cleanup costs that would be assigned to firms or other responsible parties that either cannot be located or are financially insolvent.

By far the most unhappy bearers of Superfund liability are insurance companies. Although they are never held to be responsible parties by EPA, they, too, have been ensnared in the recovery of cleanup costs. This is because many of the industrial and other private firms that are responsible parties have sued their insurance companies under the comprehensive general liability policies they have taken out for many years. The responsible parties have contended that these policies do cover the costs they incur to clean up Superfund sites.

For their part, the insurance companies point to the standard language in these policies, language to the effect that coverage pertains to "sudden and accidental" damages. The insurers then argue that the gradual leakage of contaminants at a site is not at all sudden and maintain for this reason that they are not liable. Because insurance is regulated

almost exclusively at the state level in the United States, suits brought against insurance companies by responsible parties have been played out in many different state courts; these courts have sided in about equal measure with each of the parties—a confusing situation, to say the least.

Two types of relief for insurers have been suggested. Under one proposal, retroactive liability would be eliminated—that is, no one would be liable for cleaning up wastes disposed of before 1981. This would benefit both responsible parties and their insurers. Under another proposal, Congress would absolve insurers from having to reimburse the cleanup costs of the firms they insured. In either case, the "quid" for this "quo" would be the creation of a separate fund—financed in part or in toto by a tax on insurance companies—to help pay for cleanup costs at those sites where liability is removed.

Responsible parties often recover cleanup costs by suing their insurance companies; under one proposal, Congress would absolve insurers from reimbursing the cleanup costs of the firms they insured.

Nearly two years ago we completed a report (*Assigning Liability for Superfund Cleanups: An Analysis of Policy Options*, Resources for the Future, 1992) that looked carefully at several ways in which the liability standards in Superfund could be changed, including some possible approaches that resemble proposals currently being put forward. At that time we concluded that, while the current liability standards in Superfund are unfair in several respects and result in a lot of litigation, any changes in them will create some new inequities

even as they ameliorate others and thus will provide new incentives to sue. We also concluded that EPA has the power under the current Superfund statute to address many of the criticisms being raised, though doing so would not be easy.

Guessing on changes

It is very difficult to predict what will happen to the Superfund law. The Clinton administration appears to be inching its way steadily toward a set of changes that it will propose to Congress. Although the administration's proposed changes will start the debate in earnest, Congress may well elect to reauthorize the law in its present form for another five years or so, thus putting off—as it did in the prior reauthorization—debate over significant changes. One never goes broke betting on the status quo.

Nevertheless, we hazard the guess that Superfund will be changed in several important ways in this or the next session of Congress. First, it seems likely that Congress will modify Section 121 of Superfund—wherein the standards for cleanups are spelled out—to allow for different degrees of cleanup of Superfund sites depending upon their intended future use. In addition, Congress may restrict "treatment" at NPL sites to highly contaminated hot spots. It also appears likely that Congress will require EPA to pay for orphan shares at NPL sites using an enhanced Superfund trust fund. If so, responsible parties who have complained about joint-and-several liability should be appeased.

Regardless of what happens to Superfund in this or coming years, the United States will be dealing with contaminated sites for decades to come. We will be surprised if the controversy does not outlive the cleanup program.

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When Is a Life Too Costly To Save? The Evidence from Environmental Regulations

George L. Van Houtven and Maureen L. Cropper

Some environmental statutes require the U.S. Environmental Protection Agency (EPA) to balance benefits and costs when issuing regulations, while other statutes prohibit such balancing. But do these requirements or prohibitions make a big difference in the regulations that are written? According to a recent study conducted at Resources for the Future, the answer is "no." The study reveals that both benefits and costs appear to have influenced the regulations issued by EPA, regardless of the statutory mandate under which the agency was operating. The study also suggests that the value that EPA implicitly attaches to the prevention of one case of cancer is very high—from \$15 million to \$45 million. This is much more than individuals appear to be willing to spend to reduce their own risks of death.

Under the various environmental statutes the U.S. Environmental Protection Agency (EPA) administers, the agency is responsible for issuing regulations to protect the public from exposure to pollution. These regulations can include outright bans of certain products—for instance, pesticides and products containing asbestos. They more commonly include limitations on the amount of pollution a factory or vehicle can emit.

Most economists would argue that these regulations should be made, at least in part, on the basis of benefit-cost analyses. That is, they believe that an

environmental standard should be set just at that point where the marginal cost of setting a slightly more stringent standard would begin to outweigh the marginal benefit of increased stringency. Congress, however, sometimes limits EPA's ability to engage in such balancing when the agency issues regulations.

For example, under the provisions of the Clean Air Act that pertain to the establishment of maximum permissible air pollution concentrations, EPA cannot take costs into account. When establishing effluent standards under the Clean Water Act, the agency is allowed to consider costs but not benefits. Only two environmental statutes—the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA)—actually require that EPA balance the benefits and costs of regulation in setting environmental standards.

Recently, we conducted an after-the-fact analysis of regulatory decisions that EPA has made over the last two decades. Our purpose was to see whether EPA *appears* to have balanced costs and benefits in issuing its regulations, regardless of whether the law under which the agency is operating directs or prohibits this balancing. In our study, "balancing" is determined by the following question: If we look back at a class of regulations EPA has put in place—for example, emissions standards for toxic air pollutants—do variations in the costs and benefits of all the regulatory options the agency considered at the time help explain the stan-

dards selected? If the answer is "yes," we argue that balancing has taken place.

We conclude that EPA *has* acted as if both costs and benefits influence its selection of regulatory standards; specifically, other factors being equal, a more costly standard is less likely to have been selected than a less costly one, and a standard that saves a greater number of lives is more likely to have been selected than one that saves a smaller number of lives.

Intuitively, however, balancing requires more than just paying some attention to costs and benefits. It also requires that the cost EPA is willing to impose on society to save an additional life be regarded as "reasonable." One way to determine what EPA considers reasonable is to see if there is some threshold value for the cost-per-life saved above which the agency has been reluctant to issue regulations. (For lack of a better term, we call this threshold value the "value of a life" implied by the regulations.) For each class of regulations that we examined, we calculated the value of a life that was implicit in the regulations.

We conclude that EPA has acted as if both costs and benefits influence its selection of regulatory standards.

We were especially interested in two issues. The first and most important of these is how the value of a life implicit in environmental regulations compares with society's apparent willingness to pay to save lives: Is this value acceptable to American society? The second issue concerns the way in which the implicit value of a life seems to vary across EPA programs and across population groups: for instance, do environmental regulations pertaining to pesticides place a higher value on a life saved than regula-

tions pertaining to hazardous air pollutants? Also, does EPA implicitly attach more weight to saving the life of a worker exposed to pesticides or asbestos on the job than to the life of a consumer exposed to these pollutants?

To answer these questions, we gathered data on EPA-estimated costs and benefits associated with three categories of pollutants that EPA regulates:

1. asbestos, sources of which are regulated under the Toxic Substances Control Act;
2. all cancer-causing pesticides used on food crops that underwent EPA's Special Review process between 1975 and 1989; and
3. all carcinogenic air pollutants for which EPA set National Emissions Standards for Hazardous Air Pollutants between 1975 and 1990.

When we gathered data for each source of these pollutants (each crop in the case of pesticides), we arrived at a total of 39 asbestos regulations, 245 pesticide regulations, and 40 regulations pertaining to four hazardous air pollutants—benzene, inorganic arsenic, radionuclides, and vinyl chloride.

We limited our study to the regulation of carcinogens because quantitative risk data—that is, estimates of the number of lives at risk as a result of exposure to a particular pollutant or product—are available more often for carcinogens than for other substances. The availability of such data for carcinogens implies that the number of lives saved by each of the regulations we examined can be quantified. We also purposely selected some regulations issued under the two statutes (TSCA and FIFRA) that require EPA to balance costs and benefits, as well as those regulations that set emissions standards for hazardous air pollutants under the Clean Air Act, which prohibits such balancing. We included these regulations in our study in order to determine whether the directives given EPA in the enabling legislation made any difference in the way in which the agency appeared to weigh benefits and costs.

It is important to be clear about one thing. We were not privy to EPA's decision-making process for any of the regulations discussed here. What we have done is to look back at the information

on benefits and costs that the agency had when it formulated the regulations, to examine the pattern of regulatory decisions, and then—using statistical analysis—to ascertain whether these decisions were consistent with the hypothesis that benefits and costs influence the regulatory outcome, regardless of the statutory mandate.

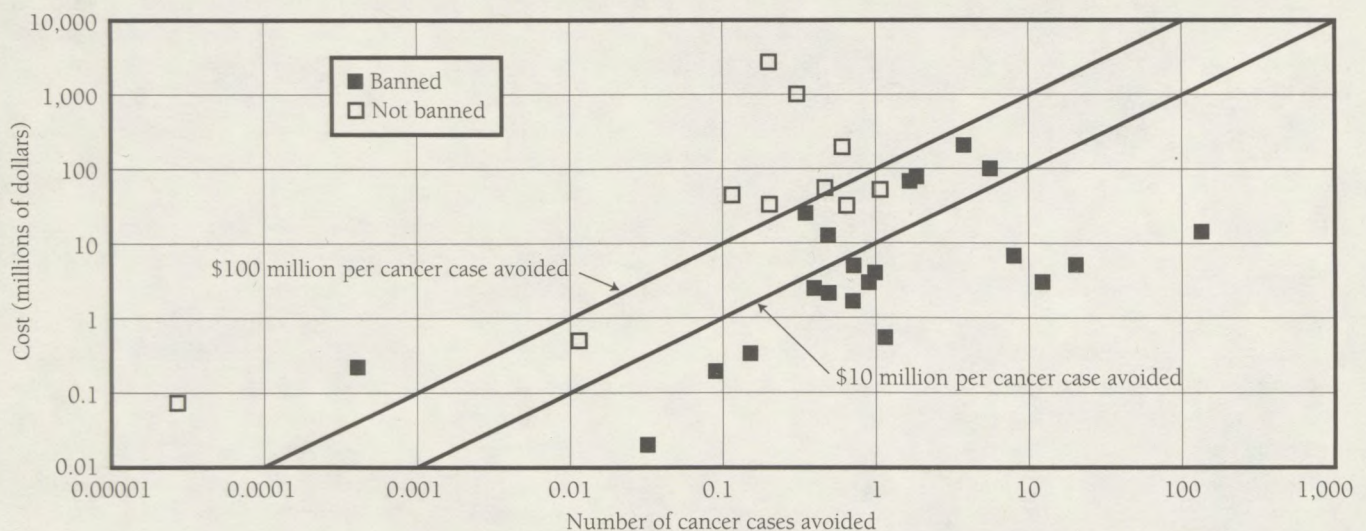
We turn now to a discussion of the specific regulations.

Asbestos regulations under TSCA

In 1985 EPA announced its intent, under the authority of the Toxic Substances Control Act, to ban the use of asbestos in 39 products. Because TSCA requires EPA to balance benefits and costs, the agency's Notice of Intent to Regulate was followed by a detailed assessment of the health risks associated with exposure to asbestos fibers, as well as the costs that would result from the proposed bans.

Well-documented epidemiological evidence indicates that some forms of

Cost-effectiveness of asbestos ban



Note: Each of the 31 squares represents a decision by EPA to ban or not to ban the use of asbestos in one particular product. The lower diagonal line illustrates the rule "ban only those products for which the cost-per-life-saved is less than \$10 million." The higher diagonal line illustrates the rule "ban only those products for which the cost-per-life-saved is less than \$100 million."

asbestos are human carcinogens. This evidence is particularly strong for lung cancer, gastrointestinal cancer, and mesothelioma, a cancer of the lung or abdominal lining. Estimating the number of cancer cases associated with a particular asbestos-containing product (for example, brakes lined with asbestos) requires estimates of the potency of asbestos—that is, of the likelihood that an individual will develop cancer as a function of exposure—as well as of the number of people who are exposed to various levels of asbestos.

In the analysis accompanying its final rule, EPA presented estimates of consumers' and various groups of workers' exposure to each product to be regulated, as well as an estimate of the number of cancer cases then-currently associated with each of these sources of asbestos. It also calculated the number of cancer cases that would be avoided if each product were banned. EPA was able to estimate this number, as well as the cost of the ban, for 31 of the 39 products considered for regulation.

EPA's asbestos regulations imply that the value of a cancer case avoided is \$49 million; this value seems high considering that the value of life implicit in workers' occupational choices is about \$5 million.

A plotting of the regulatory costs and the number of cancer cases avoided for each of the 31 products for which complete data are available (see figure, p. 7) is consistent with the hypothesis that EPA considered benefits and costs in issuing its asbestos decision. Products for which the cost of the ban was low and the number of lives saved was high (tending toward the lower right-hand

corner of figure) were almost always banned, while products for which the cost of the ban was high and the number of lives saved was low (tending toward the upper left-hand corner of figure) were for the most part not banned.

Since avoiding cancer cases is the only benefit of the asbestos ban mentioned by EPA (ecological risks, for example, not being mentioned), it is tempting to infer from the plot that there is a threshold value for a cancer case avoided below which all products were banned. For instance, the rule "ban only those products for which the cost-per-life-saved is less than \$10 million" (a rule illustrated by the lower of the two diagonal lines in the figure) would explain many of the bans, but it would yield incorrect predictions for some products. Similarly, the rule "do not ban any product for which the cost-per-life-saved is greater than \$100 million" (a rule illustrated by the higher of the two diagonal lines in the figure) would be correct almost all the time, but it would yield incorrect predictions for some asbestos-containing products.

To compute the threshold value of a cancer case avoided that is implied by the asbestos regulations, we estimated statistically the line that maximized the number of regulations correctly predicted by the above-noted rule. We found that the implied threshold value of a cancer case avoided is \$49 million (measured in 1989 dollars). (This value would have fallen between the two diagonal lines in the figure.) This value seems high—especially in contrast to estimates of the value of life that are based on individuals' willingness to pay for risk reductions.

Consider, for example, the added compensation that workers require to accept jobs that pose increasingly greater health risks, compensation that provides useful information about individuals' risk-reward trade-offs. Based on dozens of studies, the value of life that seems to be implicit in workers' occupational choices is about \$5 million, an

amount much lower than the value of life implicit in EPA's regulation of asbestos. While labor market compensation is for risks that are voluntarily borne, it is hard to imagine that the additional premium associated with involuntary risks is \$44 million. Not coincidentally, perhaps, EPA's failure to give sufficient weight to the costs of regulation in issuing its asbestos bans was cited by the Fifth Circuit Court of Appeals in the *Corrosion Proof Fittings* case, which overturned the ban.

Pesticide regulations under FIFRA

Under the Federal Insecticide, Fungicide, and Rodenticide Act, EPA is responsible for ensuring that all pesticides used in the United States have no unreasonable adverse effects on the environment. If EPA suspects that a pesticide poses risks to human health or to ecosystems, the pesticide—or, more accurately, the active ingredients used in the pesticide—is subject to what is known as a Special Review.

A Special Review entails a formal risk-benefit analysis of the pesticide, after which EPA can either ban the pesticide for use on specific crops, restrict the manner in which the pesticide is applied, or allow its continued use without modification. Between 1975, when EPA initiated its first Special Review, and December 1989, Special Reviews of 37 active ingredients were completed. We restricted our analysis to those active ingredients that are suspected human carcinogens.

In considering whether or not to ban a pesticide, EPA examines risks of cancer to consumers of food containing pesticide residues and to persons exposed to the pesticide in the workplace—these are the people who mix the pesticides (mixers) and load them into the dispensing equipment (loaders), as well as those who apply the pesticides (applicators). The agency also examines noncancer health risks, such

as risks of miscarriages or of fetal damage. In addition, it considers the adverse effects of the exposure of fish, birds, and mammals to pesticides.

The implicit value of a cancer case avoided among pesticide applicators was \$52 million. Risks to mixers and loaders of pesticides and to consumers seemed not to influence EPA's decisions to ban uses of active pesticide ingredients.

Against these risks, EPA balances the benefits of pesticide use—that is, the gains to both farmers and consumers as a result of the increase in agricultural output brought about by pest control. Depending on the relative weight given to these and other factors, EPA might decide that a particular ingredient can no longer be used on a particular crop.

It is tempting to plot the cost of bans against the number of cancer cases avoided for pesticide regulations, as we did for asbestos regulations; however, the resulting diagram would be misleading. Because the avoidance of cancer cases is only one of the benefits of banning a particular use of a pesticide, our inferred threshold value of a cancer case avoided would overstate the value that EPA implicitly attaches to reducing cancer risks. Instead, we estimated a statistical model designed to predict EPA's decisions to cancel (or not cancel) the use of each of the active ingredients in pesticides on each of the food crops for which the ingredients were registered.

Our model, which correctly predicted 87 percent of the 245 decisions EPA made between 1975 and 1989, suggests that EPA considered both the risks and benefits of pesticide use in issuing its pesticide regulations. The benefits of pesticide use were statistically signifi-

cant and of the expected sign: the higher the benefits of pesticide use, the less likely it was that a pesticide was banned for use on a particular crop. The risks associated with the pesticide were also important in explaining which uses of a pesticide were banned and which were not. Other factors being equal, the higher the risks of cancer to applicators (the group with the highest average exposure to pesticides), the greater the probability that a pesticide was banned. The implicit value of a cancer case avoided among applicators was about \$52 million (1989 dollars)—a value remarkably close to the value we found to be implicit in asbestos regulations.

Our analysis was quite surprising in one respect: neither risks to mixers or loaders of pesticides nor dietary risks to consumers seemed to influence EPA's decisions to ban uses of active ingredients in pesticides. One possible explanation for this is that risks to both mixers and loaders and to consumers are lower than risks to applicators, and therefore seen to be a less pressing problem. The median lifetime cancer risk associated with exposures to the pesticide ingredients we examined was 1 in 1,000 for applicators but only 1 in 100 million for consumers of food with pesticide residues.

National emissions standards for hazardous air pollutants

In contrast to regulations issued under TSCA and FIFRA, the National Emissions Standards for Hazardous Air Pollutants were, according to the Clean Air Act of 1970, to be set to protect human health without consideration of costs. As we shall see, however, during the mid-1980s EPA did attempt to consider costs in setting emissions standards for sources of hazardous air pollution. In 1987, the Natural Resources Defense Council successfully sued the agency for making costs a factor in the determination of those standards. As discussed below, the ruling in that case had a pro-

nounced effect on EPA's subsequent setting of standards for air pollution.

Section 112 of the Clean Air Act requires EPA to regulate the so-called toxic air pollutants, substances such as benzene, arsenic, asbestos, and mercury. These pollutants are not as ubiquitous as particulates, sulfur oxides, carbon monoxide, and other pollutants for which EPA is to set ambient air quality standards, but they are nonetheless harmful to human health. According to the Clean Air Act, EPA was required to establish a list of toxic air pollutants and then to set emissions limits for various sources of each pollutant. Between 1970 and 1990, only seven such substances were regulated. Five of these air pollutants are carcinogens, but quantitative risk data are available for only four—vinyl chloride, benzene, inorganic arsenic, and radionuclides. We examined the regulation of these substances.

After 1987, EPA always elected to regulate the source of a hazardous air pollutant if it posed a greater than 1 in 10,000 cancer risk to the maximally exposed individual. If this risk was less than 1 in 10,000, however, then the threshold value of a life saved was the same before and after 1987: \$15 million.

In seeking to regulate the various sources of these four pollutants, EPA considered at least one regulatory option that would reduce emissions of each pollutant, as well as the option of no regulation. For each option, it computed cost, the number of associated cancer cases, and the post-regulation risk to the "maximally exposed individual," the individual who receives the

greatest dose of a pollutant from a particular source. For most sources of hazardous air pollution, this individual is not exposed to the pollutant in the workplace, but rather lives near the source of the pollutant (for example, the person whose house is nearest to a copper or lead smelter).

To examine the possible trade-off between benefits and costs in the regulation of hazardous air pollution, we estimated a statistical model to explain which regulatory option was chosen for each of the 40 sources of vinyl chloride, benzene, inorganic arsenic, and radionuclides. Our results suggest that EPA's regulatory choices were consistent with the hypothesis that the agency was balancing the cancer risk reductions due to more stringent regulation against the costs this regulation would entail. In technical parlance, when we used all 40 sources of the four air toxics in our study to estimate our model, the coefficients of both the reduced cancer incidence and the regulatory cost were significant. The implicit value of a cancer case avoided—that is, the value that best enabled us to predict EPA's regulatory decisions—was very high—\$153 million, to be exact.

These results look somewhat different, however, if we distinguish regulations issued before 1987 from those issued after 1987, when the U.S. Court of Appeals for the District of Columbia ruled that EPA had improperly considered costs in setting emissions standards for toxic air pollutants. In the so-called *Vinyl Chloride* decision, EPA was directed to consider the costs as well as the technological feasibility of regulatory options only after an "acceptable risk" level had been achieved.

When we modified our analysis to take this decision into account, our results came out quite differently: they implied that a cancer case avoided was valued at approximately \$15 million before the 1987 court ruling and at the same amount after that ruling, so long as maximum individual risk was less than 1 in 10,000. After 1987, however,

EPA always elected to regulate the source of a hazardous air pollutant if it posed a greater than 1 in 10,000 cancer risk to the maximally exposed individual; in other words, the threshold value of a life was infinite. If this risk was less than 1 in 10,000, however, then the threshold value was the same for the post-1987 regulations as for the pre-1987 regulations: \$15 million (1989 dollars).

Surprises and questions

One of the striking findings of our analysis is that, in issuing the asbestos, pesticide, and toxic air pollutant regulations we examined, EPA has been willing to impose substantial costs on consumers and firms in order to save a life. Under each of the two statutes that allow the balancing of benefits and costs, the agency's implicit valuation of a cancer case avoided was in excess of \$45 million. Whether members of society would agree with this valuation, which is about ten times greater than individuals implicitly value the risk of death due to occupational hazards, is an important question.

Our findings suggest that EPA has, in the past, put in place more stringent regulations under statutes that require it to balance benefits and costs than it does under a statute that directs it to ignore costs and consider health risks only.

Nevertheless, compensation for risks faced in the workplace is generally for voluntary exposure to immediate risk of death. Exposure to asbestos and pesticides may not be voluntary (even for workers) if people are unaware of the risks they face; this fact may account for

the very high implicit value assigned to risk reductions in EPA regulations pertaining to these substances.

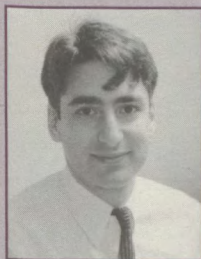
It is interesting to note that the value per cancer case avoided that is implicit in regulations pertaining to hazardous air pollutants was about one-third the value implicit in pesticide or asbestos regulations. In a sense, this is quite surprising. Our findings suggest that EPA has, in the past, put in place more stringent regulations under statutes that require it to balance benefits and costs than it does under a statute that directs it to ignore costs and consider health risks only. This does *not* "prove" that EPA balanced costs and benefits under the Clean Air Act, only that it made decisions that were consistent with the hypothesis that the agency behaved this way.

This in turn raises the question of whether statutes that prohibit consideration of costs in standard setting really make a difference in the regulations that are issued. Our analysis of the setting of the National Emission Standards for Hazardous Air Pollutants suggests that, short of recourse to the courts, prohibitions against consideration of costs may be difficult to enforce. Likewise, Congress may require that the costs of a regulation be balanced against its benefits; but as long as EPA has discretion in the weights it assigns to costs and benefits, the regulations it issues under statutes that allow balancing of benefits and costs may still be very costly.

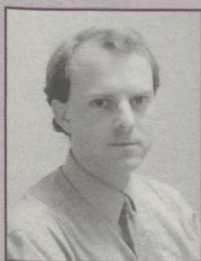
George L. Van Houtven is a member of the Department of Economics at East Carolina University. Maureen L. Cropper, a senior fellow in the Center for Risk Management at Resources for the Future and a professor of economics at the University of Maryland, is currently on leave as a principal economist at the World Bank. A detailed discussion of the issues in this article can be found in discussion paper CRM93-02, "When Is a Life Too Costly to Save? The Evidence from Environmental Regulations," by Van Houtven and Cropper.

INSIDE RFF NEWS AND PUBLICATIONS

New appointments



Resources for the Future recently appointed two new fellows to its Quality of the Environment Division. Allen Blackman, who joined the division on October 4, 1993, received his Ph.D. in economics from the University of Texas–Austin. He will be working on environment and development issues.



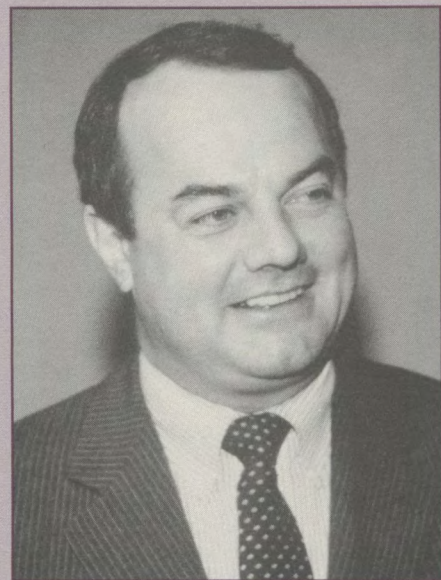
David Austin, who joined the division on November 1, 1993, received his Ph.D. in industrial organization from the University of California–Berkeley. He will be studying the value of patent protection and the strategic effects of key patent events on competing firms, as well as the economic costs of patent litigation. He will be conducting these studies in the area of biotechnology.

Gaskins elected chair of RFF's board of directors

Darius Gaskins, a senior partner with the Boston-based management and investment firm High Street Associates, has been elected chair of RFF's board of directors. Gaskins, who has served on the board for the past three years, brings a remarkably diverse set of perspectives to RFF, encompassing government, industry, and academia. Former president and chief executive of the Burlington Northern Railroad, Gaskins has also served as chairman of the Interstate Commerce Commission, deputy assistant secretary for policy analysis at the U.S. Department of Energy, and professor of economics at the University of California–Berkeley.

Upon being elected board chair, Gaskins said, "I believe we are at a very important point in the life of RFF, because the problems faced by our nation—indeed by the whole world—with regard to environmental issues cry out for the kind of independent economic analyses that RFF produces.

"The growing public concern about the federal budget deficit dictates that programs to improve the quality of the environment must be cost effective. The



recent public debate over NAFTA indicates that environmental policy is now thoroughly intertwined with international financial policy.

"I intend to work hard to ensure that there is a sufficient base of financial support to conduct research and to put this excellent research in the hands of decision makers who can use it to make better policy decisions."

RFF researchers have illuminating, sobering travel experiences in Russia and Ukraine

Michael Toman

The old woman, stooped and deeply lined, tottered precariously into the bread line that snaked out the door of the bakery off Independence Square in Kiev. Her hands shook as she fumbled with the small purse that held her money. "How much, how much?" she repeatedly asked others in the line as she withdrew some bills. She showed her funds to the man and woman next to her—200 Karbovanets and a few small bills. A year ago this would buy a jar of good caviar; now a loaf of bread costs over

1,700 Karbovanets. Reminded of this fact by other denizens of the bread line, the old woman turned slowly and went back out into the cold November afternoon.

During October 16–29, 1993, David Simpson and I traveled to Moscow and Volgograd (formerly Stalingrad) at the request of the U.S. Agency for International Development (AID) to help AID develop a joint initiative on air pollution control with the U.S. Environmental Protection Agency. James Boyd and I then spent the first week of November in

Kiev participating in a World Bank conference on the Bank's proposed environmental strategy for Ukraine.

While the conference provided information and analytical insights about the economic and environmental problems of these two countries, our personal experiences afforded us a deeper, intuitive understanding of the severe difficulties they must confront in overcoming these problems.

Moscow is a startling study in contrasts. Much of the old decay is still evident—housing complexes and other

buildings are decrepit, and the infamous "ruble restaurants" still tell you what to eat (for only \$3)—but the streets are choked with late-model Western cars. Our hotel, a Radisson, was similar to hotels found in any large American city, right down to the chocolate on the pillow at night; yet at a nearby Metro entrance we saw people trying to supplement their regular incomes with sales of basic consumer goods to other equally poor Muscovites.

The burned-out Parliament building was a disturbing sight for Russians and foreigners alike, but enterprising citizens bid for the chance to sell tourists a customized postcard portrait with the building in the background. In Volgograd, much more of the old is still evident, to the point that it was difficult even to change dollars for rubles. Fortunately, our hotel there lacked hot water only one day.

We were warned repeatedly about crime against foreigners in Moscow, but we never seemed to have a brush with it. Thus it was especially ironic that, in Kiev, Jim's room was invaded by a team of plainclothes goons who spent ten minutes going through his things and scrutinizing his passport before deciding he was not their target.

Unlike Moscow, where there was a palpable pulse of progress, or even Volgograd, where some enterprise managers are struggling to convert to the new market system, Kiev exuded a feeling of despair and foreboding. Given pervasive energy shortages and imminent economic collapse, many Ukrainians seem to realize that their society may come apart at the seams this winter.

In Moscow, we encountered a few Russian experts who really understand the problems of economic and environmental management from a contemporary Western perspective. (There are many other modeling experts from the old central planning bureau who understand how the current economic system works, but not how to change it.) We had the sense that with time, a lot of

education, and some luck in the political area, Russians will develop the level of knowledge and experience necessary to address their country's economic and environmental problems.

We found it much harder to be sanguine about the situation in Ukraine. At the World Bank conference there was almost no common ground—the Western experts emphasized the need for structural reforms, while the Ukrainian experts emphasized the need for increased financial aid from foreign governments. As one close Ukrainian friend caustically put it, the current government "acts like the earth is flat." It believes that it can reinstitute central control.

From the standpoint of RFF's research and educational interests in the former Soviet Union, perhaps the most important lesson we have learned is that other fundamental changes must occur before much progress can be made on the region's serious environmental problems. The economic and legal systems of Russia and Ukraine provide neither credible incentives for reducing pollution emissions nor sanctions for violating discharge limits. Until these systems are changed, little can be expected from environmental policies.

Real progress in reforming the economic system, however, would not only soften the current trade-off between the environment and survival, but contribute on its own to environmental improvement through big increases in energy and materials efficiency and a restructuring of economic activity away from heavily polluting sectors. Unfortunately, any progress toward real reform will be slow even in Russia, and in Ukraine the most pressing question is how quickly reconstruction might occur after the collapse of the status quo.

Public and private organizations in the United States and other highly developed countries need to have a lot of patience when providing assistance to Russia and Ukraine. Specifically, they should avoid overly ambitious and misplaced efforts to solve the wrong prob-

lems first or to try to do everything at once. Ultimately, unless and until Russians and Ukrainians themselves are willing to reform their entire societies, our contributions from the outside will have little effect.

As the old woman left the bread line, a squabble broke out at the counter. One smartly dressed woman held up the line as the staff reluctantly brought her several additional loaves (each costing eight cents in U.S. money). "Speculator! Leech!" the cries rang out. After the woman concluded her purchase, the line slowly shuffled forward again...

Michael Toman is senior fellow in RFF's Energy and Natural Resources Division.

Summer interns sought

Every summer, Resources for the Future offers a number of paid internships to students. Interns assist RFF staff with a variety of projects ranging from technical studies to applied policy analyses. Interested students are invited to apply for RFF internships.

Applicants should have outstanding academic records in the undergraduate or graduate programs in which they are enrolled and have undertaken course work in one or more of the following fields: microeconomics; statistical and quantitative methods; agricultural, environmental, or natural resource management; or environmental sciences.

The deadline for applications is March 15, 1994. The internships begin on or about June 1, 1994 and last from two to three months. Stipends are commensurate with experience and length of stay. For further information about applying for internships, contact the Office of the Vice President, Resources for the Future, 1616 P Street, NW, Washington, DC 20036-1400. Telephone: 202-328-5067.

Seminars

David Gardiner, assistant administrator of the U.S. Environmental Protection Agency's Office of Policy, Planning, and Evaluation, and RFF's Vice President Paul R. Portney discussed the topic "Does Environmental Policy Conflict with Economic Growth? Two Views" at an RFF seminar on December 1, 1993. Articles based upon their presentations will appear in the Spring 1994 issue of *Resources*.



Vicki Been of the New York University School of Law discusses whether racial minorities and the poor are being exposed disproportionately to the risks associated with hazardous waste disposal sites. Been identifies flaws in existing research and reports on her work to remedy these flaws in an article that will appear in the Spring 1994 issue of *Resources*.

Bequests Provide Resources for the Future

Making a will commitment to RFF is a simple yet effective way of ensuring that RFF has resources for the future. To learn more about making a will commitment or other type of planned gift, please contact RFF Vice President-Finance and Administration Ted Hand at 202-328-5029 or check the appropriate box on the enclosed reply envelope.

Discussion papers

RFF discussion papers convey the preliminary findings of research projects for the purpose of critical comment and evaluation. Unedited and unreviewed, they are available at a cost of \$3.00 each to interested members of the research and policy communities. Price includes postage and handling. Prepayment is required.

The following papers have recently been released.

Center for Risk Management

- "Regulatory Review of Environmental Policy: The Potential Role of Health-Health Analysis," by Paul R. Portney and Robert N. Stavins. (CRM93-05)
- "Product Life Cycle Analysis: A Public Policy Perspective," by Paul R. Portney. (CRM93-06)

Energy and Natural Resources Division

- "A Perspective on Energy Security and Other Nonenvironmental Externalities in Electricity Generation," by Douglas R. Bohi. (ENR93-23)
- "The Distributional and Environmental Implications of an Increase in the Federal Gasoline Tax," by Alan J. Krupnick, Margaret A. Walls, and H. Carter Hood. (ENR93-24)

- "Estimating the Demand for Vehicle-Miles-Traveled Using Household Survey Data: Results from the 1990 Nationwide Personal Transportation Survey," by Margaret A. Walls, Alan J. Krupnick, and H. Carter Hood. (ENR93-25)

- "The Impact of Environmental Liability on Industrial and Greenfield Commercial Real Estate Development," by James Boyd, Winston Harrington, Molly K. Macauley, and Mary Elizabeth Calhoon. (94-03)

Quality of the Environment Division

- "'Easy Riding' in the Community Provision of Nonexcludable Local Public Goods," by Dallas Burtraw, Winston Harrington, and H. Carter Hood. (QE93-25)

- "Air and Water Quality Permitting in Lithuania," by Winston Harrington. (QE93-26)

- "Bias in Discrete Response Contingent Valuation," by Barbara J. Kanninen. (QE93-27)

- "The External Costs of Nuclear Power: Ex Ante Damages and Lay Risks," by Alan J. Krupnick, Anil Markandya, and Eric Nickell. (QE93-28)

- "Natural Resource Damage Liability: Lessons from Implementation and Impacts on Incentives," by V. Kerry Smith. (94-01)

- "Environmental Regulation and International Competitiveness: Thinking About the Porter Hypothesis," by Wallace E. Oates, Karen Palmer, and Paul R. Portney. (94-02)

Recent contributions

The following individuals have recently made gifts of \$100 or more in support of research and education programs at Resources for the Future:

Alvin L. Alm, Daniel G. Amstutz, Lynn Bergeson, Joan Z. Bernstein, Arnold T. Brooks, Marion Clawson, W. Kenneth Davis, Robert D. Day, Joseph M. Dukert, Merrill Eisenbud, Lee H. Endress, Bernard Charles Eydt, Antonio Ferreiro, Luther H. Foster, Lawrence E. Fouraker, Robert W. Fri, Charlotte Frola, Darius W. Gaskins, Jr., Donald L. Guertin, Patrick T. Hagan, Edward F. Hand, Reijiro Hashiyama, Robert H. Haveman, Robert L. Hirsch,

Robert C. Holland, H.M. Hubbard, Gerald D. Keim, Thomas J. Klutznick, Jan W. Mares, Vincente D. Mariano, Nobuhiko Masuda, Luc Michaud, Debra Montanino, Jerome C. Muys, Hidenori Niizawa, Jeffrey W. Nitta, Paul R. Portney, Clifford S. Russell, John and Jean Schanz, Theodore M. Schad, Glenn R. Schleede, Robert C. Seamans, Jr., Pauline and V. Kerry Smith, Flora Stetson, Calvin W. Stillmann, Carl H. Stoltenberg, Richard Stout, Linda G. Stuntz, William B. Sullivan, G. Neel Teague, Tom Tietenberg, Victoria J. Tschinkel, Henry J. Vaux, Hal and Marilyn Weiner, Patrick G. Welle, Nathaniel Wollman

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About contributions to RFF

Resources for the Future sustains its programs through its endowment and through income from foundations, government agencies, corporations, and individuals. RFF accepts grants on the condition that it is solely responsible for the conduct of its research and the dissemination of its work to the public. RFF does not perform proprietary research.

All contributions to RFF, a publicly funded organization under Section 501(c)(3) of the Internal Revenue Code, are tax deductible. If you would like more information about contributions to RFF, please contact Debra Montanino, Director of External Affairs, Resources for the Future, 1616 P Street, NW, Washington, DC 20036-1400. Telephone: 202-328-5016. Fax: 202-939-3460.

The following individuals have made gifts in memory of former RFF president Joseph L. Fisher, after whom RFF has established dissertation awards to support graduate students in the final year of their dissertation research on environmental and natural resource issues:

Hans A. Adler
James C. Corman and Nancy Malone
John E. Herbert
Ruth and Herschel Kanter
Neal and Marion Potter
Sam H. Schurr
Lauren Soth

RFF has received corporate contributions from the following corporations and corporate foundations:

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Arthur Andersen
ASARCO Incorporated
AT&T Foundation
Bechtel Group, Inc.
BLOCKBUSTER Entertainment Corporation
BP America, Inc.
The Dow Chemical Company
Electric Power Research Institute
ENRON Corp.

R.K. Mellon Foundation grant supports community risk project

The Richard King Mellon Foundation has provided the Center for Risk Management at Resources for the Future with a grant of \$100,000 for the development of a community risk profile of Pittsburgh and Allegheny County, Pennsylvania. The profile will integrate sociodemographic data at the community level with data on a variety of environmental hazards, such as air pollution and accidents involving the release of chemicals. Community risk profiles will be useful for local agencies and community groups seeking to set priorities for managing risks at the community level.

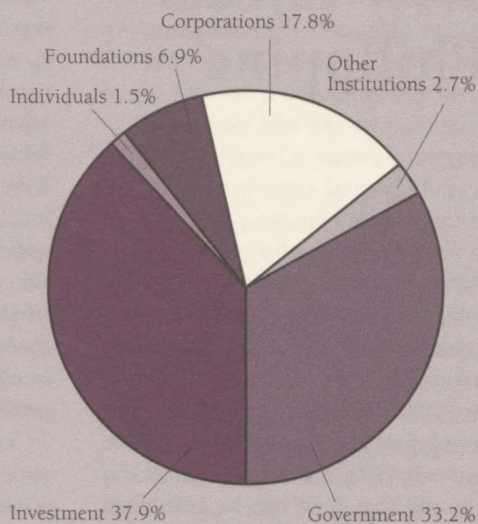
RFF meets first part of Hewlett Foundation challenge

Resources for the Future has received a \$60,000 grant from the William and Flora Hewlett Foundation for meeting the first part of a \$250,000 challenge to encourage support from individuals. The foundation is matching, on a one-for-one basis, gifts from new individual donors and new gifts from individual donors who have supported RFF in previous years. RFF thanks the more than 300 individuals whose financial support during the past fiscal year has made this matching grant possible.

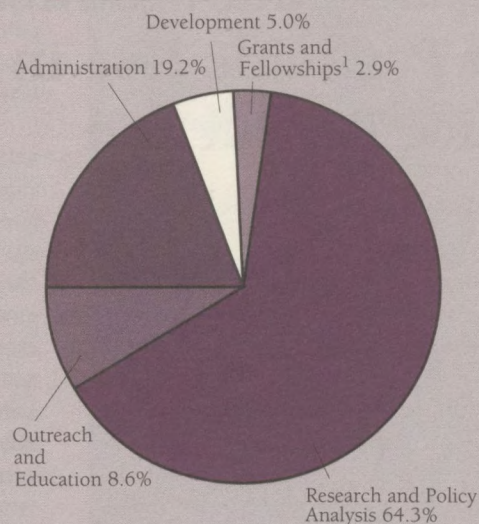
RESOURCES FOR THE FUTURE 1993 Revenues and Expenses

Friends and supporters of RFF frequently ask where the institution's support comes from and how the money is spent. These charts provide a graphic breakdown of revenues and expenses. (For more detailed financial information, consult RFF's annual report.)

Revenues



Expenses



¹External grants and fellowships awarded to university researchers

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NEW BOOKS FROM RFF . . .

The Measurement of Environmental and Resource Values: Theory and Methods

A. Myrick Freeman III

This thoroughly revised update of Freeman's classic *The Benefits of Environmental Improvement: Theory and Practice* examines in a clear and objective style the relationship between benefits and environmental decision making and the problems involved in measuring environmental effects. New topics include intertemporal welfare measures, the valuation of risk changes, hedonic wage models, nonuse values, and measurement of the cost of environmental policies. 516 pages

ISBN 0-915707-68-3 (cloth) \$65.00

ISBN 0-915707-69-1 (paper) \$24.95

Assessing Surprises and Nonlinearities in Greenhouse Warming

Edited by Joel Darmstadter and Michael A. Toman

Researchers examine the existing state of knowledge regarding surprises (effects that are not natural extensions of existing trends) and nonlinearities (responses disproportionate to changes in stimuli that may threaten adaptive capacities) in natural and socioeconomic systems confronted with human-induced climatic change. 158 pages

ISBN 0-915707-71-3 • \$25.00

Health and Productivity Effects of Pesticide Use in Philippine Rice Production

John M. Antle and Prabhu Pingali

Modern agricultural technologies have substantially increased crop production and farm productivity, but at what cost to society? The International Rice Research Institute's recent study of the health and productivity effects of pesticide use in two rice-producing regions of the Philippines reveals that rates of return to these technologies are overestimated because the adverse effects of pesticide use are not taken into account. In particular, the study shows that pesticide use can impair the health of farmers and consequently diminish farm productivity. Its statistical analysis confirms the theory that decreases in the health of farm workers are related to increases in the average cost of agricultural production. Thus it is in society's interest to reduce pesticide use. However, policies to reduce the use of all pesticides are not likely to generate as many social benefits as policies to reduce only the use of the most hazardous pesticides.

Green-revolution agricultural technologies—which make use of modern seed varieties and complementary inputs of fertilizer, pesticides, and mechanical power—have dramatically increased agricultural production and productivity. By conventional measures, investment in these technologies has yielded high rates of return.

But the estimates of these rates do not reflect the social costs of the technologies—in particular, the negative impact of insecticides and herbicides on

the health of farm workers. Anecdotal evidence suggests that this impact may be significant in developing countries, but a lack of data has made it impossible to document and quantify the health effects of pesticide use in any of these countries and to value these effects in such a way that they can be compared with the productivity benefits of pesticide use.

The International Rice Research Institute (IRRI) began remedying this situation in 1989, when it initiated a four-year program to assess the health and economic impacts of applying pesticides to rice fields in two of the Philippines' principal rice-producing regions, the Laguna region of southern Luzon and the Nueva Ecija region of central Luzon. To document the health effects of pesticide use, IRRI staff monitored the input and technology use practices, including safety practices used in handling pesticides, of a group of farmers whose rice production practices had been studied by IRRI throughout the 1970s and 1980s. Medical staff also conducted detailed medical examinations of each individual in the sample group to document general health status and symptoms of pesticide exposure.

Analysis of the collected data proceeded in three phases. First, researchers used the health data to construct an index of farmers' health impairment and developed a model to explain farmers' health in relation to their actual use of pesticides, controlling for other factors that affect health. Second, researchers used a model of rice production to estimate the impact of farmers' health on rice productivity. Third, researchers

simulated jointly the health model and the production model. This simulation allowed researchers to investigate the direct production benefits of pesticides as a production input and the indirect production losses that result from the adverse effects of pesticide exposure on farmers' health and productivity. In this way, researchers were able to obtain the health cost of pesticides in units of foregone production and thus to compare this cost with the production benefits of pesticide use. Using these data, researchers quantitatively assessed the health and productivity trade-offs of pesticide use.

We report here on the study's measurement of the health effects of pesticide exposure and on its relation of these effects to productivity. We then discuss the implications of the study's findings for agricultural research and the regulation of pesticide use. Although the study measured the environmental impacts of pesticide use in the Luzon and Nueva Ecija regions, these impacts are not included in the analysis below.

Health effects of pesticide exposure

A wide variety of pesticides is used in the production of rice in the Philippines. According to the hazard classification system of the World Health Organization, all the insecticides used by Philippine rice farmers are moderately or highly hazardous. (Many are either banned or unregistered for agricultural use in the United States.) By comparison, the herbicides used are relatively less hazardous.

To relate farmers' health to pesticide exposure, researchers constructed a general indicator of health impairment (the health impairment index). They measured the level of health impairment due to a particular illness in terms of treatment cost—the cost of returning the farmer to normal health—plus opportunity cost—the cost of the farmer's

lost work time during recuperation. The researchers based estimates of each cost on assessments of the type and severity of illnesses experienced by each farm worker in the sample group.

To identify the relationship between pesticide exposure and health impairment, the researchers related the health impairment index to several personal characteristics of each farm worker and to each worker's exposure to pesticides. Personal characteristics included age; alcohol consumption; tobacco consumption; and nutritional status, which was measured by the ratio of weight to height. Exposure levels, for which pesticide use was a proxy, were measured by the number of times each worker applied chemicals to rice fields in the crop season preceding the medical examination and by the types of chemicals he or she applied.

The researchers then tested the hypothesis that pesticide exposure explains observed variations in the health of farmers in the sample group. They formulated a statistical model to relate the health impairment index to each farm worker's age, tobacco and alcohol consumption, weight-height ratio, and use of pesticides. In doing so, the researchers divided pesticides into high and low hazard groups, according to the World Health Organization hazard classification system.

Statistical analyses showed that the number of times farm workers apply high-hazard pesticides was significantly related to the level of the workers' health impairment.

As expected, analysis of the data showed that the older individuals in the sample group had more health problems than younger individuals and that those with better nutrition had fewer such

problems than those with worse nutrition. The analysis also revealed that smoking and alcohol consumption were not statistically significant in explaining the level of the workers' health impairment, nor was the number of times farm workers apply low-hazard pesticides.

The analysis did show, however, that the number of times farm workers apply high-hazard pesticides was significantly and positively related to the level of the workers' health impairment. Researchers found that a 10-percent increase in the use of the highly hazardous pesticides raised the health impairment index from 3.7 percent to 7.5 percent.

This health assessment suggests that workers on rice farms in the Laguna and Nueva Ecija regions face chronic health effects as a consequence of prolonged exposure to pesticides. Specifically, IRRI's statistical analyses indicate that such exposure is significantly associated with eye, skin, lung, nervous system, and kidney problems.

Farmers' health and farm productivity

Economists regard health as an important component of the farmer's human capital, because it affects the ability to do physical labor and to manage farm operations. When a farmer's health decreases, reducing effective management and field labor, overall farm productivity also should decrease. Of course, decreases in a farmer's field labor may be partially offset by such substitutions as the hiring of additional farm workers.

Researchers estimated the effects of farmers' health on farm productivity by correlating the cost of production with input prices, farm output, and the health status of farmers. According to economic theory, the average cost of production should be inversely related to the level of productivity if input prices are held constant. Thus, economic theory predicts that as a farmer's health decreases, the average cost of production increases. IRRI's analysis



Photo courtesy of R. Cabrera, International Rice Research Institute

No protective clothing shields this Asian farmer from the effects of the insecticide he is applying to his rice crop. A recent study of the health effects of prolonged exposure to pesticides indicates that such exposure may cancel out the productivity gains from using them.

confirmed this theory at a high degree of statistical significance. It revealed that a 10-percent reduction in the health status of a farmer should result in a 1.4-percent to a 3.6-percent increase in the average cost of production.

To investigate the impact of reduced pesticide use on productivity and on farmers' health, researchers combined the estimated relationships between health and pesticide use and between health and productivity in a simulation analysis.

In the simulation, the researchers restricted pesticide use through the imposition of a tax on pesticides. This choice was made as a matter of convenience; it does not imply that a tax would have to be imposed if a country

implemented a policy restricting pesticide use. In fact, quantitative regulation of pesticide use is more common than taxation of pesticides in most countries. The study results hold true either way, however, because an equivalent quantitative restriction can be defined for each tax rate specified by the analysis.

Analysis confirmed that the average cost of production increases as farmers' health decreases; a 10-percent reduction in a farmer's health could result in a 3.6-percent increase in the average cost of production.

A pesticide tax should reduce pesticide use and thus improve farmers' health, but it may also reduce productivity. The trade-offs between health and productivity are not obvious, however, because a reduction in pesticide use also has a positive impact on productivity through improved health. The simulation analysis was designed to explore these trade-offs.

Once a pesticide tax has been selected as the instrument for reducing pesticide use, it can be applied in one of two ways: insecticides and herbicides can be taxed at the same rate or at different rates. Given that the insecticides used by Philippine rice farmers are more toxic than the herbicides they use, taxing the two types of pesticides at the same rate would not be efficient—that is, it would not mitigate health impacts at least cost. In order to assess the inefficiency of a uniform pesticide tax (equal tax rates for insecticides and herbicides), researchers compared the effects of this tax with those of a tax on insecticides only.

In the simulations, the uniform tax reduced insecticide use and herbicide use by about the same percentages. A

300-percent uniform tax decreased the quantity of each used by about 80 percent. The insecticide tax alone reduced the quantity of insecticides used by a somewhat smaller percentage but had almost no effect on the quantity of herbicides used. Thus both tax scenarios resulted in improvements in the health of farm workers; but because the insecticides are more toxic to humans than the herbicides, researchers concluded that the insecticide tax was about as effective as the uniform tax in reducing the adverse health effects of pesticide use.

The effects of reduced pesticide use on productivity depend not only on the indirect effect of pesticide use on farmers' health but also on the direct effect of pesticide use on crop yields. According to the statistical model of pesticide productivity, reductions in insecticide use would decrease rice yields less than reductions in herbicide use, presumably because inappropriate use of insecticides can disrupt the pest-predator balance in rice fields and lead to increased pest damage.

Of course the direct effect of reduced insecticide use is offset by improvements in farmers' health and thus in productivity. However, because the uniform tax both reduces productivity and improves health more than the insecticide tax, it is unclear which tax would have a greater overall impact on productivity. The results of the simulation analysis indicate that the insecticide tax alone has a much smaller effect on productivity than the uniform tax because it reduces insecticide use almost as much as the uniform tax and is therefore almost as effective as that tax in reducing the adverse health effects of pesticide exposure.

The advantage of the insecticide tax over the uniform tax is also demonstrated by combining the productivity effects and the health effects of reduced pesticide use. Productivity effects are measured as the change in the average cost of production; health effects are measured as the costs of treatment and

forgone labor per unit of rice produced. The sum of the average cost of production and the average health cost could be interpreted as a measure of the "average social cost" of production. It is important to note, however, that this measure does not include the potential environmental impacts of pesticide use.

Simulations of the combined productivity effects and health effects of reduced pesticide use show that the average social cost of production declines in the presence of the insecticide tax. In the presence of the uniform tax, this cost declines until the tax rate reaches 150 percent, and then it begins to increase. The difference in the effect each tax has on social cost is explained by the fact that the uniform tax has a larger opportunity cost in terms of forgone yield and only slightly greater health benefits than the insecticide tax. Thus, beyond a point, the yield losses outweigh the health benefits of the uniform tax. This finding again demonstrates the inefficiency of the uniform tax as compared to the insecticide tax, which is targeted at more toxic and less productive pesticides.

Implications for public policy

The IRRI study establishes that pesticide use has an adverse impact on the health of farmers and that a decline in farmers' health reduces the productivity of rice farms in two major regions of the Philippines. Therefore, policies that reduce insecticide use in Philippine rice production are likely to generate an improvement in social welfare through an improvement in farmers' health. Moreover, policies that reduce insecticide use in the rice production of other southeast Asian countries are also likely to generate an improvement in social welfare because rice production practices in these countries are similar to those in the Philippines.

The actual health benefits from a reduction in pesticide use are probably greater than those estimated in this

study. The study's measure of health impairment does not, for example, account for the full social cost of illness, as it likely understates the true opportunity cost of treatment and recuperation. It also does not account for impacts on family members who are not directly involved in rice production but who may suffer impaired health as a result of incidental exposure and accidental poisonings. Taking into account these possible additional effects, as well as the off-farm impacts of agricultural pesticides (such as food or water contamination), could strengthen the general conclusion that it is socially desirable to reduce pesticide use of the most hazardous pesticides, namely insecticides, used in rice production.

The simulation analysis of the uniform tax showed that the social benefits of restricting the use of all pesticides are less than those of targeting the most hazardous ones. Thus, it can be concluded that there could be substantial social benefits from tailoring pesticide policies to a pesticide's toxicity and productivity.

The results of the simulation analysis also have implications for the rates of return to agricultural research and for the allocation of research funds among programs at national and international research centers. The discovery of a significant adverse health impact due to insecticide use suggests that ex ante estimates of the rate of return to general rice research are likely to be overstated when they are based on conventional yield and production cost data. The analysis results also suggest that estimated rates of return on technologies that reduce insecticide use, such as varieties of rice that are resistant to pests and certain integrated pest management methods, are generally understated because they do not include the health and productivity benefits associated with reductions in pesticide use.

Given that many developing countries do not have or cannot effectively enforce regulations that protect individuals from the adverse health effects of pesticides, there appear to be two policy options to reduce these effects: restrict-

ing the availability of pesticides or finding alternative methods of pest control. In the long run, the best solution is likely to be the development of effective nonchemical control methods.

But in the short term, the only viable policy may be to restrict pesticide use by imposing, for example, pesticide taxes or restrictions on the importation, production, and distribution of pesticides. The study indicates that the health benefits of pesticide regulations may be obtainable at a low cost in terms of forgone production if the regulations target the most hazardous, least productive pesticides. In the case of Philippine rice production, that means restricting the use of insecticides.

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The Impact of Environmental Liability on Industrial Real Estate Development

James Boyd and Molly K. Macauley

Does potential environmental liability inhibit commercial development of properties in urban industrial areas (brownfield sites)? Researchers at Resources for the Future recently investigated whether uncertainty about aspects of liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and related law discourages the sale and redevelopment of brownfield sites. They find that such uncertainty—say, the difficulty of predicting the

allocation of liability in the event of a site cleanup—could interfere with sales of brownfield property, although to what extent remains unclear. Given high taxes, congestion, and other factors that hinder redevelopment in brownfield areas, CERCLA-related liability may contribute relatively little to inefficiencies in markets for industrial real estate. Even so, the RFF study suggests policy reforms that would minimize distortions due to such liability in these markets.

Under U.S. environmental statutes, someone buying a commercial property may acquire a substantial pollution cleanup liability. Experts familiar with environmental liability and commercial property markets widely presume that such liability will have a substantial and adverse effect on the purchase and redevelopment of property in old, urban industrial areas (brownfield sites). According to these experts, the threat of potential environmental liability makes it increasingly likely that commercial development will

occur in previously undeveloped areas in suburban or exurban locations (greenfield sites) where environmental contamination may be comparatively unlikely. The result of this shift from brownfield development to greenfield development, it is argued, is urban sprawl, which brings with it a host of environmental and other problems.

Absent uncertainty, pollution and liability associated with brownfield sites do not necessarily increase the relative desirability of greenfield sites: if a property is known to be polluted, land prices would fall to adjust for the costs of owning a contaminated site.

Anecdotal evidence suggests that potential environmental liability is affecting commercial development. In a recent survey conducted by the Independent Bankers Association of America, one out of five of the association's member banks reported a mortgage loss or default on commercial property as a result of the environmental contamination of a property. And seven out of ten banks revealed that they will not write certain classes of loans because of environmental liability concerns. Financial officers of industrial corporations and their managers of real estate report that such concerns have affected their corporations' decisions about where to locate and whether to expand their enterprises and also made it difficult to determine whether they can redevelop the property they already own. Similar concerns have prompted congressional proposals to legislate the redevelopment and reuse of contaminated urban land, as well as calls by lenders and borrowers to free property sales from onerous environmental liability provisions.

With support from the U.S. Environmental Protection Agency (EPA), we recently attempted to determine the effects on commercial development of environmental liability, such as that related to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund), its amendments, and related state and local provisions. Our first step was to describe conceptually the nature of uncertainty associated with environmental liability and how this uncertainty may encourage the underdevelopment or even the abandonment of formerly industrial properties in favor of greenfield sites.

Our concept of uncertainty extends and refines what is typically the focus of the environmental liability debate—namely, the uncertainty of estimating cleanup costs and of identifying parties responsible for paying these costs. We identified several additional sources of uncertainty in the legal and administrative treatment of polluted properties. These include the outcomes of (1) the environmental evaluation of a site, which is the first step in the process of determining whether a site is contaminated; (2) the scientific evaluation of the extent of the site's contamination; and (3) the decision concerning what amount of cleanup is necessary.

Our second step was to use our conceptual analysis as a framework to study the nature of uncertainty involved in actual (and then-ongoing) brownfield property sales. We developed case studies of twenty brownfield sites—some located in small cities and some in large cities—that taken together house a variety of industries and businesses.

We conclude from our analysis that uncertainty associated with environmental liability has the *potential* to interfere with sales of brownfield property. However, the *magnitude* of the effect of this uncertainty on decisions about where industrial sites are located or expanded remains unclear. Many industrial areas with potential environmental liability problems have been declining

economically for decades, a trend that significantly predates the enactment of CERCLA. Redevelopment in these areas is hindered by high taxes, low-quality government services, racial tensions, crime, and congestion.

Relative to these problems, potential environmental liability may have only a marginal negative impact on markets for industrial real estate. Given this, we cannot say that CERCLA-related liability is a significant cause of inefficiencies in real estate markets. Instead, we focus on changes within the existing context of Superfund policy—changes that can be expected to reduce any inefficiencies created by the current system.

Uncertainty about environmental liability may distort real estate markets, causing properties to be withheld from the market, making financing for commercial development projects unavailable, or biasing developers toward greenfield rather than brownfield development.

A common, but flawed, perception exists that development of greenfield sites enjoys a cost advantage over development of brownfield sites. On the contrary, commercial development of greenfield sites is itself costly, as zoning laws and community opposition can often impede such development. Moreover, nonurban lands may themselves be polluted due to past uses and may require costly risk assessments.

More generally, pollution and liability associated with brownfield sites do not necessarily increase the relative desirability of greenfield sites. The reasoning is as follows. If a property were known to be polluted, land prices

would fall to adjust for the costs of owning a contaminated site. If clean properties sell for \$100,000, a property with \$20,000 worth of contamination would sell for \$80,000. Because markets lead to discounted prices when property is polluted (or otherwise undesirable), prospective buyers should be indifferent to the choice between purchasing a clean property and purchasing a dirty, but cheaper property. This reasoning requires, of course, that the presence of contamination is common knowledge and that the assessment of the cleanup cost is relatively certain.

If markets function as they do in the preceding example, CERCLA's impact on development decisions would be expected to be minimal. Our concern is that markets may be functioning less well than they otherwise might be because of the uncertainty associated with many aspects of environmental laws and regulation. Such uncertainty could cause properties to be withheld from the market, make financing for commercial development projects costly, or bias developers toward greenfield rather than brownfield development.

Sources of uncertainty

Each of the sources of uncertainty that we studied can be traced to ambiguities and inconsistencies in current federal and state environmental statutes and their enforcement. The environmental evaluation, which determines whether a site is contaminated and ranks sites on the basis of the health and ecological risks they pose, is a key determinant of subsequent regulatory scrutiny and a signal of potential cleanup costs. The evaluation can employ either CERCLA's ranking system or state programs' hazard ranking systems. While the quantitative standards employed by these systems provide needed consistency in evaluation across sites, the criteria used by the federal and the state systems can differ. Moreover, many uncertainties are inherent in the data and risk analysis that

form the basis of these ranking systems. From the perspective of a current or potential property owner, the outcome of the preliminary site evaluation and listing process is highly unpredictable.

The cost of the site remediation that will be mandated once a site is slated for cleanup is also difficult to predict, as no consistent, objective standard exists for the level of cleanup that will be required. In general, individual cleanups are viewed as unique problems requiring unique solutions: there is bureaucratic latitude in selecting the remediation process, and cleanup goals and definitions can vary. There is also no method, even after a site remedy has been "completed," by which current or prospective developers or property owners can determine whether the cleanup is "permanent," because no statutory or administrative definition of a completed cleanup exists.

Perhaps the greatest source of uncertainty facing developers and property owners is how liability will be allocated in the event of a site cleanup. Common law historically has included concepts such as negligence, trespass, and nuisance in adjudicating environmental issues. CERCLA and its attendant case law have altered typical common law standards of liability and made cleanup liability strict, retroactive, and joint-and-several. This means, among other things, that both past and current property owners are liable for the cleanup of pollution created years ago and that a single producer who shipped waste to a site may be held liable for the costs of cleaning up waste shipped by other producers. The intent of these liability provisions is to obtain cleanup costs from potentially responsible parties.

The practical impact of this change is that it is difficult for former, current, or prospective property owners of an abandoned factory site, for example, to know whether they will be held liable for cleanup costs, irrespective of whether they caused the release of pollution. The current liability approach sends a strong signal to polluters and

those with whom they do business that they may eventually pay for the costs of environmental damage. In their current form, however, environmental liability rules can introduce a great amount of uncertainty into real estate markets.

CERCLA and its case law have altered traditional common law standards of liability, making it difficult for former, current, or prospective property owners of an abandoned factory site, for example, to know whether they will be held liable for cleanup costs, irrespective of whether they caused the release of pollution.

"Innocent landowner" provisions, which set forth the conditions under which a new property owner will not be held liable for contamination created by a previous owner, are an important legal approach that could reduce the uncertainties created by CERCLA-related liability. While these provisions now are defined more precisely than they were at CERCLA's inception, they do not remove uncertainties associated with ownership. For instance, a new landowner may not be found "innocent" if he or she bought a previously contaminated property at a particularly low price, since this could be a signal that the property was contaminated. However, courts may find it difficult to determine objectively how low a "low" price is.

Effects of uncertainty

We argued above that a developer should be indifferent to the choice between purchasing a contaminated property and purchasing a similar but

uncontaminated property if contamination costs are discounted from a property's price by the market. However, uncertainties created by CERCLA-related liability, along with the aversion of buyers and sellers to taking risks, could make contaminated properties less desirable than uncontaminated properties.

As an illustration, consider a transaction involving a former gas station site worth \$3 million to a potential buyer and \$2 million to the current owner. It is in both parties' interest to trade the property, since the gain from trade—or the difference in the value placed on the property by the buyer and by the seller—is \$1 million. Now if both parties knew that the property was contaminated and that the cost to clean it up was \$1 million, that knowledge would not reduce the gains from trade. Given the contamination, the property would have a net worth of \$1 million to the seller if he or she does not trade the property and a net worth of \$2 million to the buyer if he or she purchases the property.

The difficulty of predicting the outcome of a preliminary site evaluation, the cost of site remediation, and the allocation of liability in the event of a site cleanup can make contaminated properties less desirable than uncontaminated properties.

Now consider a case in which the buyer and seller are uncertain of the liability associated with the property. In such a situation the buyer and seller would face a gamble concerning the size of their liability if they owned the site. If they are averse to risk, then uncertainty about liability would reduce the value of the transaction—that is, the gains from trade. The reason is that risk-averse individuals or firms require a "premium" to

compensate them for taking risks. Concretely, this reduces the set of prices at which the buyer and seller are mutually willing to trade the property. Thus, the redevelopment of brownfield properties, all else equal, may be less attractive than the redevelopment of comparable but unpolluted sites.

Contractual limitations on liability

Liability can be contractually assigned to either real estate sellers or buyers through indemnity agreements. If the seller indemnifies the buyer, he or she in effect offers a warranty that absolves the buyer of liability attached to the property. Covenants-not-to-sue are a related arrangement in which a state government or the federal government will agree not to impose liability against a new owner of contaminated property.

By limiting liability or providing insurance against liability, both indemnity agreements and covenants-not-to-sue can reduce the negative impact of uncertainty and thus reduce distortions that lead to the greater relative desirability of unpolluted sites. However, such mechanisms are limited in scope relative to the many ways in which a property owner can be found liable under CERCLA and state environmental laws. They are also easily contestable by the government and other potentially responsible parties (PRPs).

The concept of contribution is central to indemnity. Under case law related to CERCLA, a PRP who pays to resolve his or her liability may in turn seek to have other PRPs "contribute" to that payment. An indemnity agreement thus prohibits one PRP—the party providing the indemnity—from seeking contribution from another PRP—the indemnified party.

Any single indemnification agreement, however, provides little insurance against liability given the many pathways by which liability can be imposed. Under joint-and-several liability, a prop-

erty owner can be sued directly—by the state or federal government or by neighboring property owners—or indirectly via contribution by PRPs that have not indemnified the owner. Similarly, a state

The existing liability system limits the effectiveness of contractual mechanisms—both indemnity agreements and covenants-not-to-sue—to assign liability and thus to reduce the negative impact of uncertainty on commercial development.

covenant-not-to-sue does not bar federal enforcement actions, and vice versa. Moreover, covenants-not-to-sue do not bar liability claims brought by other PRPs, public interest organizations, or injured neighbors.

While indemnity contracts and covenants-not-to-sue can reduce, in principle, the uncertainty associated with the cost of liability, overlapping jurisdictions and the joint-and-several standard of liability reduce their effectiveness. Such covenants provide meaningful assurance only when both state governments and the federal government agree not to sue a new property owner.

Lender liability and property financing

Property purchases are typically financed by a lender. As exposure to liability increases the lender's expected costs, the availability of finance for brownfield properties could be restricted, making greenfield development increasingly attractive. CERCLA exempts some lenders from liability under certain conditions; but if lenders are in a position to influence the borrowers' environmental

decisions, then lenders would be potentially liable. This potential liability on the part of the lender affects the cost of a loan, since the lender will require compensation for the risks incurred by financing a brownfield investment.

Lender liability serves a beneficial purpose, as well, in that it encourages lenders to assess the environmental risk posed by a site. In addition, it encourages them to take other steps to protect the value of their loans. For instance, lenders may choose to make state-of-the-art waste management by borrowers a condition for a loan.

Even in the absence of CERCLA, lenders would have an incentive to take such steps, because environmental liability can lead to the bankruptcy of the borrower and the foreclosure of his or her property. When this occurs, the collateral on which the loan is based is devalued and may even become worthless. Moreover, with the borrower in default, no further interest payments can be collected by the lender, independent of whether the lender is liable.

In other words, lending to a property owner whose site is contaminated is not likely to be profitable. All else being equal, finance costs arising from lenders' liability exposure will decrease the relative attractiveness of brownfield development.

Detection of contamination and the supply of brownfield sites

Given tight budgets for enforcing environmental laws and the difficulty of detecting environmental contamination, the government's ability to identify contaminated properties is limited. An effective way to avoid the discovery of contamination—and the costs of cleaning it up—is to keep property off the real estate market. Entering into property transactions greatly increases the likelihood of detection, because it is in the interests of both buyers and lenders to investigate environmental conditions.

It is easy to illustrate why a site would be withheld from the market if the current owner fears that contamination will be discovered. Suppose that the value of a property—absent liability—is \$4 million to the current owner and \$5 million to a buyer. In this case, the property would be purchased and redeveloped by the buyer.

Brownfield sites may be withheld from the market when their owners fear that contamination will be discovered during a sale. As a result, the supply of such sites shrinks, and buyers are encouraged to seek development on unpolluted properties.

Now suppose that the site has \$2 million worth of contamination but that this contamination would be revealed only if the property were sold. In this case the property would not be traded, as it would sell for at most \$3 million (the maximum value placed on it by the buyer minus the liability). This amount is less than the value of the property to the current owner if the property were withheld from the market (\$4 million).

When sites are withheld because of fears that contamination will be discovered, the supply of brownfield sites shrinks. This shrinking supply encourages buyers to seek development of unpolluted properties.

Recommendations

Our case studies of urban commercial property sales suggest that all the above-noted uncertainties associated with environmental liability can distort undesirably the market for brownfield and greenfield property. The studies

reveal that these uncertainties are to some extent discouraging brownfield redevelopment. In particular, they indicate significant practical limitations regarding the use of indemnity agreements and covenants-not-to-sue and instances in which it can be argued that property is being withheld from the market in order to avoid detection of contamination.

The case studies also suggest actions that would minimize distortions of the market for brownfield and greenfield properties. Policy changes aimed at reducing uncertainty for investors—such as consistent and quantifiable cleanup standards and enforceable indemnity agreements and covenants-not-to-sue—would reduce the impact of liability on choices of properties for redevelopment. For the same reason, clarifications of and limitations on lender liability would be desirable, particularly given that lenders already have incentives to conduct due diligence assessments. Finally, more timely and conclusive efforts to detect contamination would allow property sales to proceed, because current liability would be more definitively established than at present.

As long as the sale of property triggers regulatory scrutiny, the supply of available brownfield sites will be restricted while owners "wait out" their liabilities. With improved detection efforts, real estate markets would function better, as owners of brownfield properties with redevelopment potential are more likely to offer those properties to the market when their environmental liabilities are more precisely known and discounted.

James Boyd is a fellow in the Energy and Natural Resources Division at Resources for the Future. Molly K. Macauley is a senior fellow in the division. The issues in this article are detailed in discussion paper 94-03, "The Impact of Environmental Liability on Industrial and Greenfield Commercial Real Estate Development," by James Boyd, Winston Harrington, Molly Macauley, and Mary Elizabeth Calhoon.

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