

# RESOURCES®

## Launch vouchers offer new space research opportunities

Molly K. Macauley

*Queuing up to launch a space science research payload can involve a wait of at least six years and up to \$100 million per year in storage and maintenance costs. Issuing launch vouchers may provide a means of streamlining the system and saving money in the process.*

served to make the problem worse. Now, in what one expert calls an ongoing game of musical space shuttles, the scramble to launch Magellan (which finally lifted off, four days late) has left in limbo the takeoff of another long-overdue mission, the Hubble Space Telescope. In turn the retrieval of a carrier called the Long-Duration Exposure Facility (LDEF) has also been delayed. That facility, containing automated experiments in materials science, has been in space since 1984. If not retrieved soon, LDEF is in danger of falling back to earth.

**O**n April 28, 1989, with just 31 seconds left to go, the nation's first major planetary space mission in ten years was put on hold. An electrical problem in the space shuttle's main fuel pump had delayed yet again the Magellan mission to Venus. While another delay in a mission that was already six years late was disappointing—particularly to some of the country's most renowned planetary scientists, who were among the tens of thousands gathered for the liftoff—even more disturbing was the narrow window of opportunity for launching Magellan. Venus and the earth would be properly aligned for only 29 days; otherwise, the \$300 million Magellan project would have to go back into storage until at least January 1991.

These large science missions, together with thirty others, are not the only players in the musical shuttle game. Also scrambling for launch are over 100 smaller space science research payloads. All told, the delays for large and small payloads currently extend to six years or more.

These delays bring huge costs. Storing payloads and maintaining their flight readiness can total up to \$100 million a year for each large payload and \$5 million or so for smaller ones. Indirect costs are more difficult to measure but potentially are as important. They are likely to include attrition among space scientists in universities and industry, as well as declining enrollments of new students in space science. To be sure, the field of space science requires patience—even on-time missions can take eight years or more before a planetary destination is reached—but an additional four years or

Such are the onerous demands of space science and a temperamental shuttle program. These demands had led to a backlog of unlaunched missions even before the three-year delay in space transportation following the accident of the shuttle *Challenger* in January 1986, and the accident

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more of delay in getting off the ground is bound to discourage space research.

### Vouchers to the rescue?

How to increase opportunities to get to space was addressed in national space policy announced in February 1988. The policy called for consideration of a radically new approach to space access, "space transportation vouchers." As envisioned by the policy, vouchers would permit research missions currently queued up for launch on the space shuttle to purchase alternative, commercial U.S. launch services. These services are represented by a variety of conventional unmanned rockets that, in years past, have routinely launched communications satellites and other payloads for private industry and government.

Although the policy does not detail how vouchers might work, they presumably would operate much like vouchers that have been used in U.S. federal housing programs. Certificates issued and financially backed by government would be given to researchers for redemption on any mode of space transportation—the shuttle as well as unmanned launchers. Researchers in private industry, government, and universities could be eligible, and voucher-supported research topics could run the gamut from materials, life, and earth sciences to engineering research and plasma physics. Vouchers thus support the tradition that space research should be publicly funded at least in part, but bring the possible advantages of a marketlike mechanism to the process of allocating these federal research funds.

The voucher proposal contrasts markedly with the present system. Payloads now fly in an order determined by centralized administrative decisions. A shuttle flight is first scheduled around a government-sponsored large payload (like Magellan) that takes up much of the shuttle's carrying capacity (about 48,000 pounds), and smaller payloads (ranging from 60 to 10,000 pounds) are then added on a first come, first served space-available basis. Examples of smaller payloads range from an experiment to evaluate the interaction of oxygen with various mate-

rials, to so-called Get-Away-Special canisters ("GAS cans," ranging from 60 to 200 pounds; see figure 1) and "Hitchhikers" (750 to 1,200 pound canisters), which might contain anything from an ant farm to sensors for studying ultraviolet emission. These self-contained payloads are predominantly designed by researchers in industry, although some (such as the ant farm) are projects sponsored by industry and designed by post-secondary and even elementary and secondary school students.

Smaller payloads such as these, then, are scheduled jointly with large payloads. Shuttle delays thus ripple throughout the space science community. And further delays seem inevitable given constantly moving shuttle schedules and cutbacks in future shuttle flight rates.

Vouchers might alleviate these problems for several reasons. First, by allowing researchers to make use of conventional rockets rather than requiring them to use the shuttle, vouchers could increase the supply of space transportation. This flexibility would relieve schedule pressure on the shuttle—whose managers could then focus on launching payloads that require human interaction—and reduce the backlog of missions sooner than exclusive reliance on the shuttle might permit. Second, vouchers might allow the realization of the benefits from space research earlier than is likely to be possible by way of the shuttle. In turn, by demonstrating demand for space access, vouchers might stimulate the supply and diversity of commercial launchers, and, in the future, of payload return vehicles.

Other potential benefits of vouchers include two by-products of expanding near-term flight opportunities for space research. One would be a gain in experience to better inform the highly contentious debate over funding U.S. space science in general and the proposed space station in particular.

An additional by-product might be greater participation in space activity by industry and non-NASA government agencies. By offering more certain and timely access to space, vouchers might alleviate the financial and technical uncertainty that presently inhibits funding

of space science by industry—investors generally saying "no buy if it won't fly soon." In addition to increasing industry participation, voucher-facilitated access to space might spur space research by others in government. A 1988 National Research Council report, "Industrial Applications of the Microgravity Environment," notes that government offices possibly interested in space science research include the National Oceanic and Atmospheric Administration, the National Institute of Standards and Technology, the Department of Energy, and the National Institutes of Health.

### Possible cost savings

Even if these by-products did not materialize, a good case can be made for vouchers on the basis of their cost savings in comparison with the current system. Consider first the cost of vouchers. A full-scale voucher program that issues vouchers to all payloads requesting flight dates between now and 1995 could cost about \$4 billion. This estimate would be significantly less if some payloads could be modified so as not to require return to earth. By comparison, space transportation services provided solely by the shuttle are estimated to cost on the order of \$3 to \$6 billion. It should be emphasized that these estimates measure the cost of the shuttle program at *real resource costs*. The reported cost of a shuttle flight typically includes only the cost of fuel and other expendable items. Yet depreciation of fixed facilities (such as launch pads and reusable orbiters) and other capital costs, in addition to the cost of expendable items, constitute a truer measure of resource costs. These costs must be taken into account in order to see the full social cost of the shuttle.

Thus there is a good chance that vouchers could save up to \$2 billion if the costs of the shuttle program are at the high end of this estimate. Even if shuttle costs are on the order of \$3 billion, however, vouchers could bring cost savings if some payloads do not need to be returned to earth. Moreover, when delay costs are taken into account, a one-year delay just in the larger planetary and astronomy

missions could readily justify any cost difference between the voucher program and the cost of shuttle launches. The indirect costs of delay, such as declining interest in space research careers, would further support the cost-advantages of vouchers.

### Promising institutional change

Aside from potential cost savings, vouchers would also bring a crucial change in approach to managing two areas: space transportation and space research. The present administrative approach sharply separates these activities; they are managed and budgeted in different NASA offices. Such a division of responsibilities leads to a host of problems: NASA task forces note that these include inefficient use of resources, wasteful competition for resources, and ambiguous and conflicting goals. For example, consider the transportation-related questions a space research experimenter faces in designing a payload: Should the payload be automated, or make use of human interaction? What should be the on-orbit duration of the experiment? Should the payload be returned to earth or should data be collected by computer and relayed home electronically? These transportation concerns represent expensive engineering tradeoffs leading ultimately to choice between use of the shuttle and conventional rockets. Such decisions are now made without full information about the relative cost of these tradeoffs.

By allowing researchers a choice between transportation modes, vouchers could force a closer coupling of the budgetary and cost impacts of payloads and space transportation. Just how this coupling would take place would depend on the design of the voucher.

### Possible disadvantages

Vouchers, however, may not be without their own pitfalls. For instance, how quickly can payloads now configured for shuttle launch be refitted for alternative vehicles? Is there a sufficient supply of alternative vehicles to meet voucher

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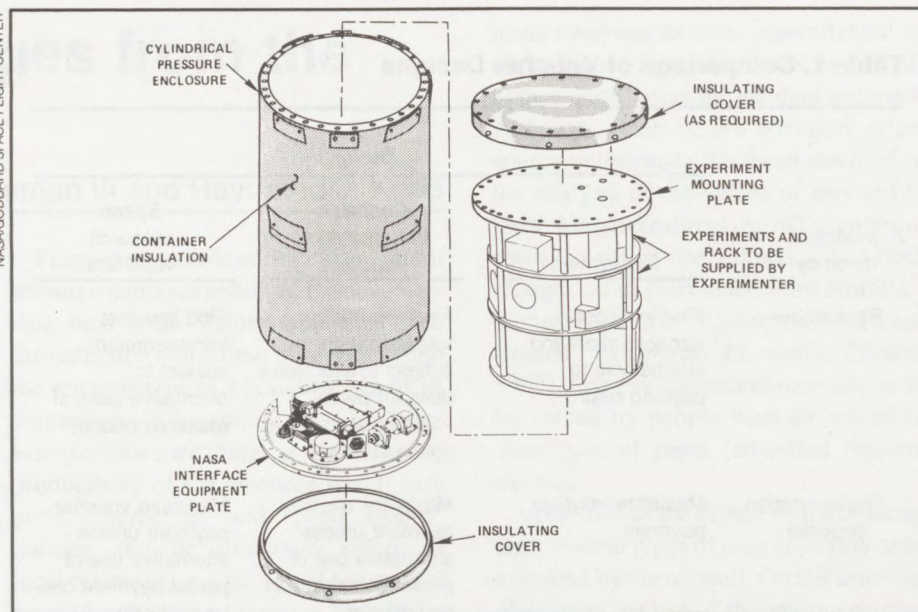


Figure 1. Small self-contained payloads called Get-away-Specials.

demand? Would a one-time voucher program, as envisioned by the national space policy, be adequate to spur demand and supply? Are the high reentry forces for return vehicles other than the shuttle an insurmountable technical difficulty?

Experts suggest that such problems are not unsolvable. They offer evidence to indicate that payloads can be fairly readily reconfigured. Estimates of supply suggest that by 1991, if not before, production lines will be well-oiled and operating to provide an ample supply of conventional launchers to meet demand (as projected by the current queue of space science missions that are voucher candidates). A survey of experiments also indicates that reentry forces are likely to be accommodated by most payloads.

Other possible shortcomings of vouchers pertain to the administrative design issue. In thinking about how to spell out a voucher program, two problems in particular need to be faced. One is the difficulty of assigning face values to vouchers. The need to amass sufficient data to ascribe values to vouchers imposes a significant information-gathering burden on government. Unlike housing vouchers, for example, where the large supply of housing generally provides marketplace measures of rents, there are not large numbers of space transportation suppliers for all sizes of payloads to permit com-

petitively determined measures of vehicle costs. Overvalued vouchers could result in windfall profits for the unmanned launch industry.

The second design difficulty is how to determine the appropriate size of the program—essentially a judgment about the appropriate amount of public support for space research. This difficulty reflects the broader problem of allocating public support to research in general and space research in particular. It also reflects the problem of dividing responsibility for research funding among public and private sectors.

These difficulties are not unique to a voucher program, since issues of rationing shuttle capacity and determining space research budgets must be tackled in current policy for space transportation and science. Moreover, even an overvalued voucher—provided it was less expensive than the shuttle—could reduce the total U.S. space transportation bill. Accordingly, vouchers may perform at least as well as the current policy and may do so at lower cost.

### Voucher options

With these problems in mind, there are at least three alternative voucher programs worth considering (summarized in table 1). Under one program, vouchers

**Table 1. Comparison of Voucher Designs**

A. Incentive faced by:	Design		
	Copayments	Cashable transportation vouchers	Space research vouchers
Researcher	Find low cost transportation and alternatives to payload return	Find low-cost transportation, subject to alternative uses for partial voucher payment for space science	Find low-cost transportation, subject to alternative uses of research budget
Transportation provider	Maximize voucher payment	Maximize voucher payment unless alternative use of partial payment can be split with researcher	Maximize voucher payment unless alternative use of partial payment can be split with researcher
B. Government role: Determine scope of vouchers (size of program funding) and administer program			

would be issued for a standard face value that was less than projected total transportation costs. The difference would be made up by copayments from payload sponsors. Copayments would ensure against incentives for researchers to overstate transportation and payload return requirements if there were no penalty for so doing (the penalty is analogous to copayment in medical insurance). Copayments could, for instance, be required for the return vehicle, thus forcing payload owners to better assess experiment design alternatives (such as automating their payload).

A second design alternative would be "cashable" transportation vouchers. Cashable vouchers would be valued at the estimated cost of unmanned transportation, but would include a provision under which recipients could keep the difference between estimated and actual costs if the latter were lower, provided that difference is allocated to space research. The advantages of cashable vouchers are that researchers would be encouraged to search for low-cost transportation, and that the burden on government to guess transportation costs precisely would be reduced. In addition, if the transportation

cost savings were divided between the researcher and the transportation supplier, suppliers as well as researchers would have incentives to lower costs.

A third alternative would be to issue vouchers for an entire *space research project* rather than for its transportation component only. Such space research vouchers could be funded from space research budgets augmented to include transportation. They would provide space scientists with the greatest degree of choice in all aspects of the research effort: in searching for low-cost transportation, in designing payloads with transportation requirements and costs in mind, and in allocating the budget among transportation, payload design, ancillary ground-based lab facilities, and even professional staffing.

Of these alternatives, research vouchers would best reduce the sharp discontinuity now existing between research and transportation. Research vouchers would also align space research (and the management of the project budget) more closely with the process of research in other, non-space fields, where grants are awarded to a project as a whole. Thus space science might be better able to

compete for talent with other research fields, and maybe the long line of space access would shorten.

Any of these design alternatives should allocate the burden of space transportation and research risk between the government (as the funder of space transportation) and the commercial supplier of the transportation. The economics of risk-sharing offers some guidance. It suggests that the burden should rest with the supplier, given the greater information the supplier has about actual costs and risk and the difficulty of monitoring them.

### A pilot program

As a step toward designing a voucher system, a pilot program could be undertaken to test and evaluate different designs on a small scale. By analogy with the evolution of housing vouchers, Congress could direct NASA to establish an experimental space transportation allowance program. It could specify voucher payment formulas, target dates for completion, and conditions for eligibility. The program could be undertaken at existing Centers for the Commercial Development of Space—collaborative university and industry programs set up by NASA to promote space science research.

Like housing vouchers, space vouchers would require a multiyear budgetary commitment. The government might also need to finance part of the costs of any major investment in unmanned launch facilities or return vehicles necessary to accommodate space science demand. Based on the estimated costs of vouchers, however, even this investment would be likely to provide space transportation at lower cost than is presently incurred by the shuttle program. Thus all signs suggest "go" in launching a pilot voucher program. ■

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# Assessing damages from the Valdez oil spill

A. Myrick Freeman III and Raymond J. Kopp

*People who have never been to Prince William Sound and never plan to visit nevertheless may feel a keen sense of loss over the damages it has sustained from ten million gallons of spilled oil. Many economists contend that this loss must be reflected in court damage awards. Moreover, they say, there are methods available for attempting to put a dollar value on it.*

**W**hen the Exxon Valdez hit Bligh Reef in Prince William Sound, Alaska, on March 24, the massive spill of crude oil triggered several important efforts. The first, of course, has been the attempt to recover as much oil as possible, clean up oiled beaches and shoreline, rescue threatened sea mammals and birds, and restore as much as possible of the affected area to its pre-spill condition. At this writing, the effort is employing more than 4,000 workers and costs may run to the hundreds of millions of dollars. It appears that the Exxon Corporation will be financially liable for cleanup and restoration costs.

The second initiative set into motion is a set of scientific studies of the dispersion, breakdown, and persistence of the spilled oil in the environment and its impacts on the terrestrial and marine ecologies of the region. Shortly after the accident, Exxon agreed to contribute \$15 million toward scientific studies of the spill's impact.

And third, economists have taken on the thorny task of quantifying and assigning monetary values to the damages to the natural resources of the impacted region. Under provisions of the Clean Water Act of 1972 and Alaska State law, both the federal and state governments can sue "potentially responsible parties" to recover the economic damages sustained by the publicly owned natural resources of the affected region.

From an economic perspective, natural resource damages resulting from an accident such as the Valdez spill stem from the reduction in the flow of services from the environment as a consequence of its contamination by spilled oil. These services include such things as the biological productivity of the resource which supports commercial and sports fishing, hunting, and the subsistence efforts of local residents, and the visual beauty and amenities that attract tourists. Estimation of the damages involves identifying which valued services are provided by the publicly owned portions of the affected resources, measuring how much these services have been reduced or impaired as a consequence of the spill, and determining how much these lost services were worth to the people who formerly benefited from them.

## What are damages?

The economic concept of damage is based on the idea of compensation—finding out how much money it would take to

make everyone who has been affected by the reduction in service flows as well off as they were before the incident occurred. Although much of the attention of resource economists has been devoted to the analysis of the values of services to those who make direct use of the environment (so-called use values), it has been recognized at least since John Krutilla's pioneering article, "Conservation Reconsidered" (*American Economic Review*, 1967), that environmental services could be valued by people who do not make direct use of them (so-called non-use values).

In the case of the Prince William Sound area, several types of uses are likely to be impaired by the oil spill. One of the more obvious is the use of the marine ecosystem as a source of fish for the commercial fisheries of Alaska. Prince William Sound houses some of the most productive fisheries in the world and supplies both domestic and international markets. If scientific studies are able to establish a relationship between the spilled oil and the harvest rates of commercial species of fish, quantifying the dollar loss to these fisheries will be relatively easy. This is because market prices—which reflect the value society places on the fishery—can be observed. These prices can provide a basis for measuring this component of the damage caused by the spill. Consumers

ROBERT RESSLER, U.S. COAST GUARD



Damage ensues in part from society's knowledge that a natural asset has been injured.

as well as fishermen and processors are likely to suffer these losses. Consumers' losses may come in the form of higher prices for fish products. Fishermen and processors may suffer because of reduced revenues and higher costs.

By contrast, accurately estimating the damages to some of the other types of uses will be much more difficult. Many of the services provided by the region's resources cannot be purchased in markets. For example, the scenic beauty of the Sound enjoyed by local residents and visitors will be diminished by the presence of the oil on the beaches and the absence of wildlife killed or driven away by the oil pollution. Resident and nonresident sports fishermen may find the region less attractive because of the reduced chance of catching fish or fear of catching contaminated fish. No one is asked to pay a price for the pleasure of enjoying the scenic beauty or the right to fish on the open waters. How then can we place a value on these losses?

Economists have developed techniques for estimating the values of such unpriced resource services. They include drawing inferences from behavior such as willingness to incur travel costs to experience natural environments first hand and asking people directly about the values they place on these environments through what has become known as contingent valuation surveys. Although the absolute accuracy of such estimates cannot be guaranteed, economists do possess a widely accepted framework for measuring these values. The framework applies not only to those services traded in markets but also to those types of individuals' values that are unpriced and therefore not revealed through market transactions.

### **Non-use values**

A third category of damage ensues not from the diminution of the quality or quantity of services provided by the Sound, but rather from society's knowledge that a unique natural environment has been injured. Economists refer to these damages as lost non-use or intrinsic values. The parties suffering lost non-use values may be the same parties who have

experienced lost use values but may also include the generally larger group of individuals that had no direct involvement in the area of the spill but nevertheless feel a loss. Generally, economists would argue that non-use values have been reduced if individuals enjoying none of the Sound's use values would have been willing to pay some dollar amount to ensure that a spill of this magnitude would not have taken place or that the probability and/or magnitude of such an occurrence in the future could be reduced.

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## **H**ow can we place a value on the pleasure of enjoying scenic beauty?

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It would be misleading to suggest that all economists agree about the measurement of non-use values or even agree whether non-use values can be measured at all. However, they do tend to agree that there are features of natural environments like Prince William Sound (such as unusual concentrations of wildlife, including rare and endangered species; unique scenic beauty; and pristine wilderness) that are valued by people who have never been to the Sound or never plan to visit. The origin of these values may lie in a desire to preserve the natural environments for the enjoyment of future generations or from a simple expression of stewardship. Economists generally place diminished non-use values on an equal footing with diminished use values and argue that failure to account for lost non-use values will understate the damage suffered by society. The case of the Valdez spill is no exception.

A substantial body of accumulated research dating back to the middle 1960s has led to the development of methods and empirical techniques for quantifying non-use values. Termed contingent valuation, the methodology combines knowledge from several disciplines in a consistent conceptual framework to measure non-use values. Contingent valuation is based on surveys used to gather data to help determine society's willingness to

pay for public goods. This information about people's willingness to pay can be used as an indication of the existence of non-use values and as a tool for non-use value quantification. The contingent valuation method has been applied in the field on several occasions. It can be used to place dollar values on such things as enhanced visibility due to decreased power plant emissions and the diminished non-use values associated with contaminated drinking water.

Measuring non-use values is an admittedly difficult task. By necessity the measurement techniques involve not only economic theory but knowledge of psychology, statistical science, and the techniques of survey research. Moreover, the introduction of these measurement techniques into courts of law and natural resource damage cases can hinge on the courts' interpretation of the rules of evidence as applied to survey results.

In addition, the surveys themselves and the questions they contain may be poorly designed, executed, and analyzed and thus produce results that misleadingly purport to quantify non-use values. Yet a growing body of research shows that well-designed, executed, and analyzed contingent valuation studies lead to valuation estimates that accord nicely with the results from other techniques. Thus there is confidence that contingent valuation can be reliably applied to the estimation of lost non-use values.

### **Who should pay?**

Since the Valdez spill, it has been widely held that Exxon has behaved irresponsibly and the public should not have to pay for the mistakes of the corporation or its employees. Meanwhile, the prices of crude oil and gasoline have increased in the wake of the spill, prompting outrage and the suspicion of gouging. This suspicion is difficult to substantiate, since other factors such as the loss of some North Sea oil production and lack of refinery capacity in the face of new regulations governing gasoline volatility appear to have contributed to the price rise.

To the extent that negligence or criminal behavior might have been a factor in

the spill, the economic concept of deterrence and simple notions of justice suggest that those with individual or corporate responsibility should bear the costs associated with their actions. But the idea that consumers of petroleum products should bear at least some portion of the costs of environmental risk and damage associated with bringing fuel to the pumps has validity from an economic perspective. Those who use petroleum products do bear some responsibility for the environmental risks and damages that are an inevitable part of the oil exploration, production, and delivery system that serves their demands. An efficient allocation of resources requires that they accept the financial burden that goes along with that responsibility.

### Economic role in assessment

If the economic damages from the Valdez oil spill can be accurately assessed

and monetary damages can be collected from the responsible parties, we can expect several economically beneficial consequences in addition to the potential for compensating those who experienced the most serious losses. First, since the damages will become part of the cost of doing business, prices of petroleum products will rise, thus more accurately reflecting the environmental costs associated with their extraction and transportation. Higher prices, in turn, should mean less consumption of petroleum. At the same time, the potential liability for damages due to future spills is also likely to reduce the expected returns to the oil companies from exploration and development in more risky environments. And third, the prospect of liability for large natural resource damage claims should provide the oil industry with incentives to take further actions to increase the safety of their operations and to reduce the risks of future accidents.

On the other hand, if the economic damages are not accurately assessed, or if court-awarded damages are not based on sound economic analysis, we can expect undesirable consequences. An award that is excessive and exceeds the appropriate social compensation will lead to an economically inefficient underutilization of the nation's oil resources, while understating the damages would lead to excessive oil extraction and consumption. Whatever the economic damages are, it is important to do our best to get the numbers right. ■

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## Hazardous waste management: a West German approach

Joanne Linnerooth and Allen V. Kneese

*Using both the carrot of economic incentives and the stick of regulatory control, Bavarian industry and government are working together to effectively manage their hazardous wastes. Some of these approaches may provide a blueprint for U.S. practices.*

**H**azardous waste management in the United States is one of the most heavily regulated and costly areas of environmental protection. The cradle-to-grave regulatory system features detailed record-keeping requirements, a complex permit process, strict financial liability for generators and transporters of hazardous wastes, and a large clean-up fund drawn

from private sources. In addition, the 1984 amendments to the Solid Waste Act place restrictions on disposal of many wastes on land and greatly emphasize source reduction and recycling. Still, many toxic wastes continue to be disposed of on land, and few contaminated sites have actually been cleaned up. The public continues to resist new waste treatment and disposal facilities, government regulators are hampered by cumbersome reviews of their actions, and generators often have little choice but to continue environmentally inferior disposal practices, as well as illegal disposal of their wastes.

The United States is not alone in its hazardous waste crisis. Most industrialized countries face similar dilemmas. In the midst of confusion, however, some countries or regions stand out as having

hazardous waste management systems that appear to be more effective than those of the United States. Denmark and the Scandinavian countries are well known for their progressive systems. Perhaps the most notable system is that in Bavaria, the largest state in the Federal Republic of Germany (FRG).

Nearly twenty years ago, Bavarian officials became concerned with the problem of hazardous wastes and joined together with industry to create a comprehensive infrastructure for their management. The present-day results of this joint initiative are impressive. Increasing emphasis is being placed on waste reduction strategies—clearly the preferred longer-term goal. A number of noteworthy waste treatment technologies have been implemented, alleviating many of the environmental problems caused by land disposal of wastes. Only pretreated wastes are disposed of on land, almost no wastes are exported from the state, and few wastes are handled on site. Nearly all hazardous wastes in Bavaria are sent to two main, integrated facilities where they are tested



Figure 1. State of Bavaria, West Germany, special waste management system.

for composition and then channeled into treatment processes and/or final disposal. These processes, for the most part, even now meet the future intent of current U.S. waste disposal legislation.

Sources that generate small amounts of hazardous wastes in Bavaria are not exempt from regulations, and a comprehensive collection service exists. Bavarian taxpayers have contributed to the financing of this system, with the remarkable result that there is almost no illegal dumping or black-market disposal. (Illegal disposal is thought to be a problem in the United States.)

These same Bavarian public subsidies, however, have discouraged industries from engaging in as much waste reduction as they might have had they been burdened with the full cost of disposal. Moreover, subsidies distribute some of the cost burden away from industry and to the public. Limited waste reduction and inequity in cost sharing might even be considered the Achilles' heels of an otherwise successful system. But even on these matters the Bavarians may be taking corrective measures. The subsidies are being phased out, and a recent federal law—the Waste Avoidance and Manage-

ment Act—is aggressively addressing the problem of waste reduction.

### The legal framework

Bavaria, along with the neighboring state of Hesse, has been a forerunner of hazardous waste management practices in the FRG and has inspired much of the federal legislation. Under federal law each state enjoys a great deal of autonomy in implementing its own environmental programs. This autonomy is reflected in the Waste Disposal Act (WDA) of 1972, a federal framework law prompting each West German state to create its own more detailed legislation. Much like the U.S. Resource Conservation and Recovery Act (RCRA), this law sets out a minimum mandatory list of wastes to be considered hazardous, delineates lines of authority and responsibility, requires that all hazardous waste facilities have permits, and lays out a cradle-to-grave control system with mandatory trip-ticket procedures and record-keeping. Indeed, the system of manifests in the United States was modeled on Waste Disposal Act procedures. Going further than RCRA, however, the West German law requires that all generators of hazardous wastes and operators of disposal facilities appoint a waste supervisor responsible for the firm's waste management program. In addition, it requires that each state submit a waste management plan similar to that currently requested by the U.S. Environmental Protection Agency.

In 1986, the West German Waste Disposal Act was replaced by the Waste Avoidance and Waste Management Act, known as the Waste Law. As its name suggests, emphasis in the new law has been shifted from waste disposal to waste reduction and recycling for both hazardous and household wastes. Besides increasing the control powers of state authorities and harmonizing the disparate German standards, the 1986 Waste Law aggressively promotes source reduction and recycling. It strengthens the licensing power of state authorities by requiring that all newly planned industrial facilities incorporate state-of-the-art technology for reducing or recycling wastes as a

condition for licensing. Moreover, priority is given to consumer products that eventually become hazardous wastes; the idea is to force responsibility for product disposal upstream onto the manufacturers and retailers.

Instruments now available to the federal government under the Waste Law to encourage source reduction and recycling include requiring product labels to specify toxicity and how the product should be disposed of; separate collection of certain wastes, such as paper and glass; outright bans on some products, such as certain types of packaging; and direct intervention in production processes. In addition, manufacturers and retailers can be required to accept returned recyclable products and to introduce deposit systems.

Though West German industry largely continues to operate under the 1972 law, changes are beginning to occur as the 1986 law is gradually implemented. The new Waste Law was motivated by a waste management crisis in West Germany at large. With the exception of Bavaria, the FRG lacks sufficient capacity for land disposal and incineration of hazardous wastes, and the public, as in the United States, vehemently opposes building new facilities. Authorities hope that when fully implemented the new law will address this crisis and reestablish public confidence by increasing state controls over the movement of waste, setting out uniform nationwide standards governing all aspects of waste management, and promoting radically new programs to reduce wastes.

### Bavarian practices

Small and medium-sized firms dominate the industrial sector in Bavaria, where there are around 6,000 hazardous waste generators and around 120,000 shipments of such wastes each year. (Bavaria has approximately the same population as Pennsylvania, but is slightly smaller.) As early as 1966, the district of Mittelfranken in Bavaria founded a fully public, municipal cooperative (the Mittelfranken Cooperative for Special Waste Management) responsible for the disposal of special wastes—



what we call hazardous wastes. In 1970 a semi-public organization, the Association for the Management of Special Wastes in Bavaria, was created to handle special wastes for the rest of Bavaria.

In both instances, integrated, all-purpose facilities were built for treating, depositing, and incinerating hazardous wastes. In addition, the association operates a system of satellite treatment and collection centers in the state (see figure 1). The association was financed originally by hazardous waste generators (30 percent), by the Bavarian government (40 percent), and by member communities (30 percent). Waste generators pay disposal fees geared to the difficulty of handling their wastes.

Only pretreated wastes may be land-disposed in Bavaria. There is no deep-well injection (a common practice in the United States, especially among industries that dispose of their wastes on-site). Extensive use is made of physical/chemical treatment plants for many waste streams, including waste water. Solvent recycling plants are also part of the regional system.

All organic wastes are incinerated in high-temperature, rotary kilns equipped with state-of-the-art filters (see photo). Air emissions are continuously monitored. The bottom ash from the kilns, as well as the fly ash from the stack and residues from the filter scrubbing water, is placed in hazardous waste landfills.

Under the new federal waste law, Bavarians will still be able to deposit bottom ash in hazardous waste landfills. However, in a radical departure from past procedures, fly ash and filter water sludge must now be stored in salt mines presently used only for disposal of especially toxic wastes.

Bavaria has already been successful in shifting a large portion of its hazardous wastes away from land disposal toward more expensive treatment and incineration technologies that are considered safer. This success has hinged on a combination of economic incentives (including subsidies) and regulatory control. Out-of-state exports of hazardous wastes to take advantage of lower-cost alternatives are prohibited without special per-

mission. Moreover, generators must obtain permission to manage their wastes on-site; only about 10 percent have done so, given that the central facilities have generally been less costly than do-it-yourself alternatives. (By contrast, most industry-generated hazardous wastes in the United States are disposed of on-site.)

In effect, the Bavarian controls have created a statutory monopoly whereby generators are required to make exclusive use of regional facilities. Another key Bavarian feature is that the generator's and transporter's liability ends once the wastes are delivered to the facilities—a major difference from U.S. practice. This circumstance may change, however, with the recent introduction in Bavaria of legislation on environmental liability that would include generators and transporters of hazardous waste.

Compliance is good mainly as a result of the public subsidies. Public absorption of liability and the nature of the government/industry cooperative partnership also have played important roles in encouraging compliance. In a sense, industry has been lured into the waste management systems, with the result that state authorities now have a nearly complete picture of waste generation in Bavaria. Authorities can easily identify noncompliance, so subsidies can be, and will likely be, phased out with little concern that wastes will be diverted to illicit disposal routes.

In sum, the key organizational characteristics of the Bavarian hazardous waste management system are integrated, all-purpose facilities; statutory monopolies through restrictions on exports and on-site disposal; mixed public/private ownership and control; and public subsidies and public liability.

### Organizational options

The fully integrated hazardous waste management system in Bavaria is only one of a wide range of possible organizational paths, each with its pros and cons. Integrated facilities, which serve all generators under one management and whose operations are in close proximity, offer authorities clear oversight and control

and have inherent cost advantages where wastes require more than one type of treatment. Also, they permit taking advantage of economies of scale and development of competent laboratory facilities. Centralization simplifies the otherwise complex waste-handling system made up of thousands of autonomous generators and transporters who sometimes have limited knowledge of their wastes and no clear directive about what to do with them. With a centralized facility, the only rule is that the waste must be delivered to the facility or an associated regional collection center. These advantages must be weighed against the additional costs and risks of transporting wastes over longer distances to regional facilities.

Monopoly markets for hazardous waste treatment facilities, also a feature of the Bavarian system, may be essential for the financial viability of the facilities, especially if legal but environmentally inferior and lower-cost alternatives are available in other states or countries. As regulations become more uniform in the FRG—and if they are successfully enforced, thus eliminating environmentally inferior alternatives—arguments for policies ensuring a stable waste stream to a facility may not be so persuasive.

Whether a waste disposal facility operates as a regulated private enterprise, a public enterprise, or a combination as in Bavaria, depends ultimately on the political culture of the country. The public enterprise component has worked well in Bavaria where the civil servants responsible are strongly committed to good environmental management. The environmental record of public institutions in the United States is less convincing.

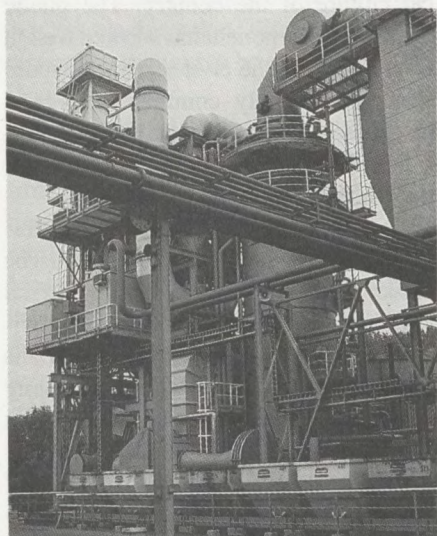
One overriding message from the Bavarian experience is that tradeoffs must be made. Perhaps the most controversial option pursued by Bavaria is the provision of public subsidies. The Bavarians have chosen to place priority on creating a workable hazardous waste management infrastructure and protecting the public against midnight dumping. The costs of meeting these goals have included departure from the polluter-pays principle, with the financial burden being partly shifted

to the taxpayers, and disincentives for waste reduction. And while the subsidies will now be phased out, a second force militates against further source reduction. Waste reduction—positive from an environmental perspective—could spell eventual bankruptcy for the capital-intensive waste facilities, to which investments were initially attracted because of the subsidies.

Wastes have been reduced in Bavaria, but the reductions have not met the current goals of the federal government. Implementation of the 1986 Waste Law will present the challenge of combining a workable infrastructure with incentives for waste reduction.

### Cultural transplant?

In some respects, the Bavarian waste management system already meets many objectives of the 1984 amendments to the U.S. Solid Waste Act, and it will meet more of them if the West German government is successful in imposing waste reduction measures through the Waste Law. Moreover, Bavaria has over ten years of operating experience. During this time the authorities have successfully combined economic incentives with command-and-control policies, clearly recognizing the tradeoffs involved. But a full transplant of the Bavarian experience to the United States would inevitably clash with U.S. political culture.



**Bavarian state-of-the-art incineration filters.**

First of all, there is a difference in approach between the United States and the FRG. The preferred German approach to environmental policy has been to develop a coalition around a consensus of interests. In the early 1970s, the then West German secretary of state for environmental policy stated that environmental problems had to be solved with industry, not without it or against it. This consultative style still dominates, although some environmental interests—especially the Green party—would welcome more government confrontation with industry.

Beyond that, historical conditions in Bavaria, which allowed for expedient siting of hazardous waste facilities, do not now exist in the United States, or for that matter in West Germany outside of Bavaria. Moreover, any attempt to create a public monopoly in the United States would likely meet strong resistance from the increasingly powerful private waste management sector. Restricting waste exports to other states or regions within the United States might be deemed inconsistent with the Commerce Clause protecting interstate commerce and thus unconstitutional. Further, U.S. industry has traditionally been held responsible for environmental costs associated with its production, which means that subsidization of waste facilities with public funds might meet strong political resistance.

Despite these obstacles, more public involvement in creating and financing hazardous waste facilities (especially integrated facilities) might be desirable in the United States. Limiting this option is strong public opposition to the siting of hazardous waste facilities, even though they are badly needed. This opposition has been positive in the sense that it has forced more consideration of the safety of waste facilities and initiated a serious dialogue on waste minimization.

But before abandoning the pursuit of an environmentally sound waste management infrastructure in favor of total reliance on waste reduction, consideration must be given to the possible costs of such a strategy. Paradoxically, incentives for waste reduction also inspire midnight dumping and the transport of wastes out of the country—options hard to control in

the U.S. context. To avoid these shifts in risk, a balanced approach with the goal of reducing risks in an equitable and cost-efficient manner should be pursued.

Integrated hazardous waste management facilities have been considered in the United States. As early as 1974, the Environmental Protection Agency prepared a report to Congress that advocated regionally centralized processing facilities. However, attempts at creating integrated treatment facilities in the United States have largely failed—among them a \$100 million facility proposed for Louisiana by the IT Corporation and a publicly owned facility planned by the Gulf Coast Waste Disposal Authority in Texas. On the other hand, in Alberta, Canada, an integrated system modeled after Bavaria's has been successfully sited.

Time is running out. As the amendments to the U.S. Solid Waste Act force more wastes off the land, alternatives must be available. The reduction of wastes at their source and the recycling of wastes should receive high priority. There are limits, however, to the extent to which hazardous wastes can be reduced. To deal with the remaining wastes in an environmentally acceptable way, an infrastructure must be created that goes hand in hand with efforts at waste reduction.

The technologies are available. The challenge is to find an infrastructure that encourages the use of available and proven technologies in the short term, and at the same time encourages source reduction rather than reliance on these technologies in the longer term. Bavaria provides an example: a state that has a working and accepted infrastructure for managing currently generated hazardous wastes, a pricing system that encourages compliance, and a longer-term strategy for reducing wastes. Clearly it is an example to which the United States should pay close attention. ■

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# Has risk assessment become too "conservative"?

Adam M. Finkel

*Momentum is gathering to support the view that risk assessment, especially of carcinogens, tends to be skewed toward overestimating risks. Perhaps influenced by these arguments against overcaution, the Environmental Protection Agency has begun to reevaluate some of its procedures and lower some risk estimates. Adam Finkel of the Center for Risk Management cautions against hasty changes and calls for preserving the virtues of both good science and prudence.*

**Q**uantitative risk assessment (QRA) is a science and an industry, and "risk numbers" are both its language and its currency. These numerical predictions of how many persons will suffer disease or death because of environmental exposure, or of the probability that an average person or a particular individual will succumb, now lie at the heart of environmental health regulation, particularly when it involves carcinogenic substances.

The recent controversy over dieldrin (Alar) in apples, for example, centered around estimates generated by the Natural Resources Defense Council (NRDC) that as many as 5,300 of the current group of 22 million preschool children in the United States may contract cancer during their lifetime as a result of childhood exposure to Alar. This represents an estimated increase of 1 chance in 4,200 (above the background probability we all have of getting cancer) that Alar will cause cancer in a typical child. The NRDC also estimates that about 5 percent of preschool children ingest substantially more food containing Alar than the average child, and that these children face excess cancer risks approaching 1 in 1,000.

Experts and laypeople alike tend to ask two very different kinds of questions

when confronted with numbers like these. One set of questions involves ethical judgments about the acceptability of the stated risks; the debate over whether a risk of (say) 1 in 4,200 is too high will depend on personal and group judgments. These judgments concern the voluntariness of the risk, the magnitude of the probability (perhaps in relation to other environmental, occupational, or lifestyle risks we are more familiar with), the costs of eliminating or reducing the risk, and the real or perceived benefits of the risky product or activity. This acceptable-risk issue pits those who argue that no involuntary risk is acceptable if it can readily be reduced further against those who believe our society has become preoccupied with trivially small dangers. This is a vigorous debate, with divergent views expressed both within the expert community and the general public as well as between these two groups.

The other set of questions has to do with the believability of the estimates themselves. In contrast to the controversy over acceptable risk, the debate over whether risk numbers are credible has begun to resolve itself, at least among practitioners and expert observers of QRA. The general reader may be surprised that this group tentatively has concluded that risk numbers generally are *not* credible. The conventional wisdom of the experts is that these numbers are systematically skewed in the direction of overestimating risk, because the process used is in danger of being so "conservative"—so overly cautious—as to be a caricature of itself.

The intellectual and regulatory momentum is clearly on the side of the "revisionist" position, which seeks to replace conservative procedures because the status quo is allegedly causing alarmist and counterproductive reactions. The lack of resistance to some of these changes reflects the compelling evidence supporting some revisions, the fact that

the public may not be aware that subtle but accelerating changes are under way in QRA, and perhaps simply the natural swing of the pendulum in such matters. In my view, however, the rush to eschew conservatism is fueled in part by an uncritical acceptance of a set of flawed assumptions about QRA, so the pendulum swing may itself be counterproductive. I wish to offer a note of caution against hasty or piecemeal changes, and to suggest a new approach that may preserve the virtues of both good science and prudence.

## The case against conservatism

The fundamental logical flaw of conservatism is that it can compromise our ability to make clear choices and set rational priorities. The strongest critics of conservatism view this distortion in the broadest possible terms; conservatism, they say, artificially inflates the relative importance of all proposed measures to reduce health and environmental risks. Some revisionists simply do not believe that the hazards of industrial pollution are as dire as the standard QRA procedures imply. But arguments that focus on the need to reduce existing risk numbers and redress the balance between risk and cost probably exacerbate the tension between the experts and the public, and may backfire. After all, a "realistic" toll of 530 extra deaths from Alar (if revision caused a lowering of this risk number by a factor of 10) might be no more acceptable to the public than a cautious estimate of 5,300 fatalities.

Therefore, a more reasoned and perhaps ultimately more successful argument against conservatism is that it creates imperceptible distortions among different risks, which we cannot redress simply by paying less attention to cancer risk reduction (or by agreeing that we are spending about the right amount even though we have exaggerated the size of the risks). The insidious aspect of consistently analyzing the "worst case" is that some cases are simply "worse" than others, in the sense of being less plausible or less likely to occur. For instance, one typical conservative shortcut is to assume

**Table 1. Some Potentially "Conservative" Assumptions and Alternatives Commonly Used in QRA**

Assumption	Possible alternative
Dose-response function is linear, so slope at low doses equals that at high doses	Fit "sublinear" or threshold function to observed data
Response of most sensitive rodent species/sex tested predicts human risk	Pool the responses of all rodent groups tested
All rodent tumors are predictive of human cancer risk	Discard data involving tumor sites and/or mechanisms that do not exist in humans
"Maximally exposed individual" (MEI) lives at plant or site boundary	Obtain case-specific data on MEI
MEI's exposure is determined by upper-bound values of human uptake parameters (for example, breathing rate, water ingestion)	Use uptake parameters that represent the "average" human
Concentration for all "not detected" samples is set as if it were just below the limit of detection	Assume these represent instances of zero concentration

that the most highly exposed individual near a chemical plant or a hazardous waste site lives at the property boundary, and that he or she is downwind of the pollutant source 24 hours a day. In some cases, the resulting risk estimate will be quite conservative, if no one actually lives near the boundary or in the direction of the prevailing winds. In other instances, the estimate may be nearly correct. If the cancer risk estimate cited for the former situation was 1 in 10,000, and the estimate for the latter was 1 in 100,000, the former would seem more risky even though (unknown to the investigator) this estimate was less credible than its counterpart.

### Steps toward revisionism

Perhaps influenced by these arguments against conservatism, the U.S. Environmental Protection Agency (EPA) has recently begun to reconsider some of the official risk estimates it developed in earlier years. To date, all of the proposed reevaluations have resulted in lowered risk numbers, generally by about a factor of 10. The most noteworthy of these cases involve methylene chloride (a solvent

used, among other things, to decaffeinate coffee), arsenic, and TCDD, also known as dioxin.

Potentially more far-reaching than these ad hoc changes in specific risk assessments is EPA's September 1988 decision to rewrite its influential series of guidelines for quantitative risk assessment, which had been published in 1986. These guidelines determine which assumptions should be used under various circumstances, and indicate in general terms when professional judgment should supplant formulaic procedures. Although it is too early to tell specifically how the new guidelines will reflect what has been called the new era of post-conservative risk assessments, they may encourage the use of alternatives (see table 1).

### Conservatism in perspective

A number of pervasive misperceptions about conservatism cloud the issue of whether risk numbers are credible and QRA procedures are reasonable. The following points refute three of the broad categories of misperceptions.

*Existing procedures are not so unscientific or unreasonable.* Critics tend to

malign different kinds of conservative assumptions with the same broad brush, failing to distinguish those that are gratuitous from those dictated by prudence or common sense. For instance, in contrast to the use of simplistic worst-case assumptions about exposure that could readily be refuted by reliable data, the commonly criticized use of the upper confidence limit when fitting a dose-response curve to animal data is a cautionary step of a quite different variety. This procedure recognizes that as we learn more about cancer potency, the truth may well fail to converge toward a lower result. To put it another way, suppose the owner of a baseball team approached one of his star players four days into the season and asked him to take a pay cut on the grounds that he was batting .050 at the time. The player would doubtless argue that he has always had about a 1 in 3 chance of getting a hit each time at bat, and that his current 1-for-20 string is too scanty a basis for claiming that that underlying probability has changed at all. By the same token, observing 5 tumors in a group of 50 rats does imply that each rat had about a 1 in 10 chance of getting cancer at that dose, but is only weak evidence against the more prudent assumption that the probability might be several times larger.

In addition, it is easy to carp about possible errors of commission in the QRA process without acknowledging that various errors of omission may make risk estimates more "nonconservative" for all or part of the human population. Of most significance, risk assessments commonly fail to account for the often-dominant indirect exposures (such as inhaling organic compounds that volatilize from hot tap water during showering and bathing) and for the likelihood that individual humans differ widely in their inherent susceptibility to carcinogenic stimuli (we currently assume that all humans are as homogeneous in their responses as are the inbred strains of rodents we test in controlled environments). Thus, the current mix of assumptions may contain certain margins of safety necessary to account for our inability to fully flesh out important considerations.

Beyond that, the common characterization of QRA as a "cascade" of conservative steps that yields progressively more unbelievable estimates may confuse issues of probability and magnitude. It is true that if one multiplies five estimates that each have only a 5 percent probability of being underestimates, the product will have much less than a 5 percent chance of being too low. However, many of the individual uncertainties in risk analysis are right-skewed; that is, the highest possible values in the "tail" are much greater in absolute terms than the more central values. The fact that extreme values are unlikely to occur becomes less and less important as the consequences of those values being true become greater. For example, the average indoor radon level in a sample of 5,000 homes in Pennsylvania was about 10 picocuries per liter (pCi/l) even though a randomly selected house had only about a 20 percent chance of containing more than 10 pCi/l. Decision makers and the public need to consider that while it is easy to ridicule a risk estimate for being exaggerated (in the sense of unlikely to be too low), such estimates may be more reasonable than less cautious ones.

*Data do exist to validate some existing numbers and procedures.* Critics of conservatism sometimes fail to acknowledge that evidence exists to support the "reality content" of risk assessment procedures or of the risk numbers themselves. For example, researchers at the Harvard School of Public Health recently concluded that on average, the linear dose-response function is not unduly conservative; for many chemicals, the best-fitting curve was in fact steeper at low doses than at higher ones. Similar challenges to the notion that the current estimates are systematically conservative come from recent studies of the dispersion models used to predict the movement of pollutants in air and water, which have shown that the models often underpredict actual concentrations, especially when the terrain or atmospheric environment is complicated.

The most direct "reality check" on QRA involves comparing the predictions of animal extrapolation to the actual can-

cer toll among humans exposed to known levels of a particular substance. Such a comparison can only be made for about two dozen substances (for example, cigarette smoke, vinyl chloride, and chromium) where both human and animal data on exposures and tumors are reasonably reliable. The basis for generalization is therefore limited, and the human potency estimates may be nonconservative (they generally come from data on small groups of relatively healthy workers). However, one research group recently found that, on average, conservative extrapolation procedures yield estimates of human cancer potency that agree fairly well with the actual potencies observed in epidemiologic studies.

*Alternative methods may substitute one set of flaws for another.* The prospect of replacing conservative assumptions with "best estimates" of actual risk may be no less problematic than the status quo. Although conservative estimates have been widely derided as "policy choices masquerading as scientific facts," central or average estimates themselves embody subtle value judgments regarding the implicit social costs of erring on the high or low sides. In this respect, best estimates are no better than conservative ones, which simply strike this balance more in favor of caution about underestimation, and may reflect a desire to minimize large absolute errors of underestimation. In addition, while it is desirable to reduce the ambiguity about how conservative estimates of different risks are, one can show that errors in ranking uncertain risks are also endemic even when best estimates are consistently used.

### Reframing the question

Many of the problems engendered by the use of conservative risk numbers (as well as their "real" counterparts) can be overcome by one deceptively simple step—abandoning the quest for single estimates of risk in favor of quantitative descriptions of the uncertainty surrounding these numbers. Such descriptions, which would take into account random and systematic sources of uncertainty in potency, exposure, and uptake, would

reveal all of the possible true values of risk and the likelihood associated with each.

If uncertainty analyses became routine, we could move beyond the narrow debate over whether the estimates were too high or too low and could instead choose the degree of conservatism explicitly and with appreciation of the scientific nuances and societal value judgments specific to each case. For example, researchers from the National Institute of Environmental Health Sciences recently conducted an uncertainty analysis showing that if the EPA wanted to retain an estimate of methylene chloride's potency that was a 95th-percentile conservative estimate, it might well have raised the official estimate by a factor of 1.5 (rather than lowering it by a factor of 9, as was done).

Quantitative uncertainty analyses can also facilitate dialogue between risk managers and the public concerning how much society is willing to pay to reduce the possibility of particular levels of harm, and can help regulators perceive which uncertainties are dominant and thereby set strategies for research. All of these benefits come at a price, however. Uncertainty analyses are expensive to conduct, sometimes difficult to explain, amenable to subtle manipulation by interested parties, and may be foreboding in that they reveal how little the experts actually know about the likelihood of different levels of harm. Nevertheless, the real challenge of QRA in the next decade will be to recognize that while acknowledging uncertainty may be as difficult as stepping out of one's own shadow, only through the attempt can we discern from what direction the shadows are cast and in which directions to move so that they might ebb. ■

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# The rural development dilemma

Louis E. Swanson

*Even while Congress considers major legislation to boost rural development, both policymakers and the public hold on to outmoded assumptions about farming and rural well-being. Real progress will remain elusive until everyone gains a clearer grasp of what truly constitutes the fabric of rural America and how each level of government can most effectively support the rural economy.*

**E**vidence that much of rural America is once again falling behind metropolitan areas socially and economically has mounted throughout the 1980s. As the evidence has emerged, a long-overdue discussion of policy issues and options for rural development has begun, advancing now from identification of the problems to questions about what has to be done. The principal stumbling blocks for a comprehensive rural development policy continue to be outmoded assumptions regarding rural America and its relationship to both farming and the rest of the U.S. economy and society. The identification of rural America's ills and development of a coherent public policy to correct them have proven to be much more difficult than anticipated.

Progress has been hampered by at least five factors: (1) an unrealistic, often romantic view of a bucolic rural economy and society; (2) serious limitations to existing social and economic data on sparsely populated areas; (3) the treatment of rural America as a geographical entity unconnected to the larger U.S. economy and society; (4) a perception that many rural areas do not have viable political solutions; and (5) the absence of a unified rural constituency and the presence of a formidable opposition to renovated and new rural development programs.

We will examine each of these factors in turn. The development of good public policy requires an accurate appraisal of problems and a clear understanding of program goals. Perhaps the first factor presents the most difficult hurdle, since it involves popular cultural perceptions.

## Flawed views of rural America

At least two false assumptions have guided rural public policy. The first is a pervasive tendency to associate rural economies and community well-being with farming. The second is that with the possible exception of farmers, rural people are faring relatively well.

Nationally, a half-century ago, farming was the dominant economic activity for many rural economies, and the family was the primary type of social organization of production. Hence it was reasonable to assume that the well-being of family farms directly influenced the well-being of rural communities. However, the intervening fifty years have witnessed a major transformation of rural society.

During this period rural America generally experienced a transition from dependence upon natural resource extraction (such as agriculture, mining, forestry, and fishing) to reliance on economic enterprises in secondary and tertiary activities, including the manufacture of nondurable goods, the provision of services, and government. In 1984 rural employment was distributed as follows: manufacturing, 40 percent; services and trade, 16.5 percent; government, 13 percent; farming, 9 percent; and mining, about 5.5 percent. Moreover, for the same year, farm families reported that more than 60 percent of their net family income came from off-farm jobs.

The 617 agriculturally dependent counties in the United States now account for less than 7 percent of the national rural population. By the late 1980s, then, the

old axiom that farm well-being, and by inference farm programs, determine rural well-being was no longer useful. Certainly some rural economies continue to depend on farming, but this is the exception rather than the rule.

The second popular misperception—that rural America on the whole is doing relatively well—has been empirically grounded on reports of rural population growth. Between 1973 and 1983 the populations of nonmetropolitan counties grew at a faster rate than those of metropolitan counties. Social scientists proclaimed that this demographic turnaround signified a rural renaissance. The most common explanation was that the population had a desire to live in rural areas and that this demographic anomaly was a result of these people acting on their residential preferences by migrating to rural areas. Those rural areas having recreational and retirement amenities and/or the presence of universities experienced relatively rapid growth (and continue to do so). However, most of the population growth was due to a combination of residential mobility and natural population growth. The former was simply a part of the post-World War II process of suburbanization, and not migration.

The retention of population growth among nonmetropolitan counties was a result primarily of a lack of job opportunities in metropolitan areas during the 1970s, which counteracted the historical rural-to-urban migration pattern. We now know that during the period 1973-1983 nonmetropolitan counties dependent upon natural resource and manufacturing industries were hard hit by loss of jobs.

The year 1973 was also significant statistically, since it was at that time that the brief six-year period (1968-1973) of a narrowing of per-capita income differences between metropolitan and nonmetropolitan areas ended. Since 1973, and during the period of rural population growth, per-capita income differences have continued to expand.

The overly optimistic interpretation of rural well-being was important for contributing to a dismissal of concerns about the vitality and well-being of rural areas. After all, it was reasoned, if rural popula-

tions were growing, they must be prospering. The public-policy consequence was the justification of a minimalist rural development policy in the 1980s. During the 1980s, public programs for rural areas were cut dramatically, and the U.S. Department of Agriculture (USDA) and the land grant universities pulled back from research and extension efforts focused on community development. This withdrawal occurred simultaneously with the recession of the early 1980s; not surprisingly, the consequences were devastating for most rural economies.

It was the financial crisis in farming during the mid-1980s which, ironically, provided the need for a revised rural development policy. Since part of the problem was the assumption that farm well-being determines rural community well-being, the reintroduction of rural development in the context of a farm crisis had the effect of reaffirming this assumption.

A change in policy assumptions is a difficult process to effect. The public still appears to associate farming with rural well-being, and to believe that the farm programs of the past fifty years have helped farm families. In fact, the evidence is that these programs have facilitated the decline in the number of family farms.

Despite empirical evidence to the contrary, these out-moded assumptions about farming and rural areas are still resilient. Recent Senate discussions concerning rural development have been punctuated by comments from influential senators who view the drought relief effort of 1988 as a rural development effort. And a powerful farm organization testified before the Joint Economic Committee of Congress that an extra \$40 billion in farm programs would kick-start the rural economy. The continued use of this assumption by farm groups has been called a cynical effort to maintain their lucrative farm entitlements.

### Limited data base

The second factor inhibiting the development of rural policy is an inadequate data base. Professional rural social scientists repeatedly decry the inadequacy of

data on rural well-being. There is a considerable knowledge gap about both the specific conditions of rural people and the effectiveness of past government programs for rural areas.

The knowledge gap about rural community life has not significantly narrowed since the classic community case studies of the 1930–1950 period were conducted. It is paradoxical that during the 1980s—when federal policy was shifting toward decentralized planning and toward greater participation by state and local governments—research on the ability of local societies to act on their own behalf to promote economic development was virtually eliminated by the land grant colleges of agriculture.

The third factor preventing a broader policy dialogue on rural development is the narrow scope in which the problem is defined. Rural interest groups, academics, and policymakers continue to treat rural development as a territorial or sectoral phenomenon. This focus has tended to preclude placement of rural economic and social problems in the context of regional, national, or even international political economies. The interconnectedness of rural issues with policy issues in other arenas has thus been overlooked.

A quick examination of rural problems reveals a remarkable similarity with those of the inner cities. Both populations are being left behind in the economic expansion of the 1980s, and for many of the same reasons. Each of these geographic

areas has similar problems with education and health services and, increasingly, in areas of social pathologies—particularly violent crimes and crimes against property.

### Lack of viable solutions

The fourth hurdle is that it is often assumed that rural economic problems are not the result of failures of the markets—for both capital and information—but of a clear competitive disadvantage in most markets. Coupled with this is the notion that government, especially the federal government, is part of the problem and not part of the solution. From this perspective it is concluded that the primary way of fostering economic development is through the operation of free markets, and since such market mechanisms have not fostered the type of economic development necessary for a viable rural economic sector, and government is not able to induce such development, those areas that are left behind are simply the unfortunate by-products of national economic adjustment. To the extent that this ideological perspective directs rural development policy, we can expect only more of the minimalist policies of the past several decades.

### No powerful constituency

The development of a comprehensive rural development program lacks a uni-



*The heartier the local nonfarm economy, the less the local tax burden will fall on farmers.*

fied constituency while facing considerable organized opposition. There are no politically powerful interest groups promoting rural development, with the notable exception of the National Rural Electric Cooperative Association. Chief among the opponents are farm organizations and agricultural commodity groups who view rural development as a threat to their agricultural entitlements. However, rural development *should* be attractive to farm organizations, given the dependence of farm families on viable off-farm economic opportunities. Since local taxes are often raised from property taxes, further deterioration of the nonfarm sector will likely lead to an increase in those local property taxes. The more hearty the local nonfarm economy, the less the local tax burden will fall upon farmers.

Relatively passive opponents of rural development have been the Department of Agriculture and the land grant universities. Their opposition has taken the form of neglect. They define their mission as primarily to assist commercial agriculture, and in so doing believe they help all rural people. In other words, most key USDA administrators and deans of colleges of agriculture still accept the myth that farming determines rural well-being.

At this time, the USDA does not have a clear mission statement on rural development. However, this view of its mission may change over the next decade as the nonfarm public's concerns over food safety issues and pollution of the environment by agricultural chemicals, as well as the plight of rural people, press upon USDA the idea that its mission is much more than just farm production.

A possible source of support for rural development might be current concern with agricultural trade at the General Agreement on Tariffs and Trade (GATT) negotiations. It is increasingly apparent that concern for the negative consequences of reduced trade barriers for rural communities is a major obstacle to GATT agreements. It is reasonable to assume that national rural development programs that account for the possible high cost of transition to lower trade barriers will be a necessary part of any future broad-based agreement.

Rural development in the United States is possible. A wide range of public policy analysts have provided economic and social rationales for rural economic development. Each has argued that there is a role for all levels of government in the development and execution of a public policy.

### **Comprehensive rural policy?**

For a comprehensive rural development policy to emerge, each of the five hurdles discussed above will have to be addressed. In particular, the public and Congress will have to accept that while farming and other extractive industries primarily occur in rural areas, these are no longer the industries that dominate the rural economy nationally. While no single industry dominates that economy, many rural economies are dependent upon single industries. Furthermore, the public and policymakers should learn to view rural problems (as well as those of the inner cities) as structural rather than cyclical. The current restructuring of rural economies presents opportunities as well as difficulties. These changes could severely constrain the range of options, but they will not close out all options.

A new approach to rural policy seems to be emerging. The trend is to assign rural economic development to rural communities and the states, and social policy (especially for education and health care) to the federal and state governments. Such decentralization of the locus of policy initiative can have positive results. However, the decentralization of planning is less a consequence of truly believing that local societies can direct their own economic development than a realization that the shot-gun social programs of the past have been expensive and inefficient, and have often by-passed local political bases.

Many, if not most, rural communities lack the ability and the resources to foster their own economic development. This does not mean that there is not a great deal of potential for new rural economic activity. Rather, economic development will require a cooperative effort by all levels of government. Local governments must

initiate a broad-based review of existing human, natural, and capital resources. This review should be done in cooperation with development professionals available from the states and the land grant universities. Once a plan has been democratically agreed upon, it can be implemented and monitored, with the cooperation of state governments and the financial support of the federal government. Infrastructure development and maintenance should be the primary responsibility of state governments in cooperation with local governments.

While the economic development of local resources should occur at the local level, the provision of education and health care ought to be part of a national economic development policy. Neither rural America nor the inner cities have the capital and human resources to provide an adequate education or offer minimal health care. Given the considerable proportion of the U.S. population living in rural areas and the inner cities, it is detrimental to long-term economic development to neglect this generally ignored portion of the labor force.

To date, legislative activity to create a comprehensive rural development policy by renovating old policies, developing new missions for existing public institutions, and initiating new programs has fallen short. The Congress appears to be on the verge of considering a major rural development bill; but given the budget deficit and the lack of a clear strategy for an omnibus approach to rural education, employment, and health needs, it is unlikely that this initiative will immediately ameliorate the identified problems. Rural development should be seen as part of a long-term national strategy to greatly upgrade our human resources while providing employment opportunities and basic services. Unfortunately, neither Congress nor the general public appears to be willing to make such a long-term national commitment. ■

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*Louis E. Swanson has been a resident fellow in the National Center for Food and Agricultural Policy at RFF and is associate professor of sociology at the University of Kentucky.*



## Five resident fellowships awarded

Resources for the Future recently awarded five resident fellowships under two of its award programs.

Two recipients will take up Gilbert F. White Fellowships for the 1989-90 academic year. One is Robert T. Deacon, professor of economics at the University of California, Santa Barbara. The other is Jeffrey A. Krautkraemer, associate professor of economics at Washington State University. Both guest scholars will be housed in the Energy and Natural Resources Division at RFF. The Gilbert F. White Fellowship Program was established in 1980 in honor of Gilbert F. White, retired chairman of the RFF board, distinguished geographer, and internationally known statesman of science.

The National Center for Food and Agricultural Policy (NCFAP) at RFF has awarded three resident fellowships. Nicole S. Ballenger, coordinator of the Trade Liberalization Project of the Economic Research Service of the U.S. Department of Agriculture, will assess the economics and politics of agricultural export programs. Susan M. Capalbo, assistant professor in the Department of Agricultural Economics and Economics at Montana State University and a former

NCFAP fellow, will research the measurement of agricultural pollution externalities. Also appointed a NCFAP Resident Fellow is David R. Orden, assistant professor in the Department of Agricultural Economics at Virginia Polytechnic Institute and State University, who will study macroeconomic environments under which the 1990 farm bill may be implemented. ■

## New fellows

Peter M. Morrisette of the Environmental and Societal Impacts Group in the National Center for Atmospheric Research, Boulder, Colorado, has been appointed an RFF fellow. He will join the research staff of the Climate Resources Program in the Energy and Natural Resources Division in the fall of 1989.

A. Clark Wiseman is at RFF as a visiting fellow in the Forest Economics and Policy Program. He teaches in the School of Business Administration at Gonzaga University, Spokane, Washington, and will be studying the changing U.S. timber situation while at RFF. ■

## RFF awards \$80,000 in grants

Resources for the Future has awarded \$80,000 in research grants to individuals at four universities and one college. The awards were made through the RFF Small Grants Program, which provides financial support to researchers at other non-profit institutions and universities in the United States and abroad to study issues related to the environment, natural resources, and energy.

This year's grants were awarded to the following individuals for research on the subjects indicated:

- Clark S. Binkley, professor, and John Perez-Garcia, both of the School of Forestry and Environmental Studies at Yale University: Deforestation and Agricultural Activity in Brazil.

- Otto C. Kopp, professor in the Department of Geological Sciences at the University of Tennessee: Hazardous Trace Elements in Coal: Can Man and Nature Cope?

- Associate professor Brian Lamb, professor Hal Westberg, and science assistant Eugene Allwine of the Laboratory for Atmospheric Research at Washington State University: Vegetative Effects Upon Climate Changes: Development of a Global Biogenic Emission Inventory.

- Mark G. Smith, assistant professor in the Economics Department at Colorado College: An Analysis of Price as an Indicator of Market Efficiency in Rural-Urban Water Transfer in the Upper South Platte River Basin.

- Roderick G. Eggert, associate professor in the Department of Mineral Economics at Colorado School of Mines: Advanced Materials and the Environment: An Economic Analysis of Automotive Plastics and Composites. ■

## A reminder— if you are on the current *Resources* mailing list

If you have not already done so, please fill out and return to RFF, with your *Resources* mailing label, the mailing list update form attached to the outside of the Spring 1989 issue. If we do not hear from you by October 1, 1989, you will not receive the Fall 1989 issue or subsequent issues.

## Discussion papers

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

### Energy and Natural Resources Division

- "Will Nuclear Power Recover in a Greenhouse?" by John F. Ahearne. ENR89-06 (\$5.00)

### Quality of the Environment Division

- "Uncertainties in Estimates of the Costs and Benefits of Groundwater Remediation: Results of a Cost-benefit Analysis," by Walter O. Spofford, Jr., Alan J. Krupnick, and Eric F. Wood. (QE89-15) \$2.25
- "The Social Costs of Chronic Heart and Lung Disease," by Maureen L. Cropper and Alan J. Krupnick. (QE89-16) \$2.25
- "Notes on Systems of Frontier Factor Demand Equations," by Raymond J. Kopp and John Mullahy. (QE89-18) \$2.25
- "Weighted Least Squares Estimation of the Linear Probability Model, Revisited," by John Mullahy. (QE89-19) \$2.25

### The National Center for Food and Agricultural Policy

- "A Market Alternative to Farm Price Support Programs: Full Participation Markets in Contracts for Future Delivery," by James D. Shaffer. (FAP89-02) \$3.00
- "Environmental Protection and Agricultural Support: Are Trade-Offs Necessary?" by Katherine Reichelderfer. (FAP89-03) \$3.00

- "The Consumer's Stake in Food Policy: The United States and the European Community," by Carol S. Kramer and Barbara J. Elliott. (FAP89-04) \$3.00

### Center for Risk Management

- "Flammable Liquid Transportation Risks: A Case Study of Tank Trucks on Urban Roads," by Theodore S. Glickman. (CRM89-06) Free

## Reprints

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

243. "The Economics of Natural Resources," by Allen V. Kneese.

## Primer

*Acid Rain: Science and Policy*  
*A Primer*  
Winston Harrington

This brief text provides an introduction to the principal scientific and policy questions created by the increasingly troublesome problem of acid deposition. The author explores both what is now known about acid rain and what scientific and economic uncertainties continue to complicate the coalition of sound public policy to reduce it. A clear and balanced survey, Harrington's account offers an essential guide to this important public issue.

22 pages • paper • free

## New book

*Multiple-Use Management: The Economics of Public Forestlands*  
Michael D. Bowes and John V. Krutilla

Since the 1970s U.S. law has mandated that management of the public forests take into account the multiple uses of the forests and the need for benefit-cost comparisons. Yet even though recreation has outstripped timber production as the dominant use of the forests, the theory behind public forest management continues to be based on a century-old model of the single timber stand.

In this book Michael D. Bowes and John V. Krutilla take a long methodological step forward by developing a larger theoretical framework that encompasses the multiple uses and biological dynamics of the forest and the institutional and economic realities of forest management. Their rigorous exposition of theory provides the foundation for analyzing case studies of timber and water yields, recreation valuation, and joint production—analyses that demonstrate the authors' great skill and imagination in developing practical methodologies to meet actual forest management problems. They examine the implications of their model for such contemporary issues as below-cost timber sales, and for the Forest Service planning procedures and congressional budgeting processes that translate policy into forest programs.

September 1989. 384 pp.  
\$35.00 cloth. ISBN 0-915707-41-1

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## Recent funding received by RFF

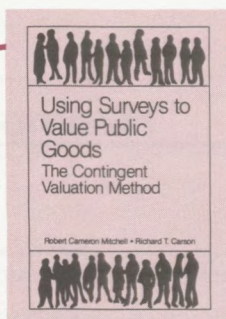
Resources for the Future recently received corporate contributions from the following sources: EG&G, Inc.; Ford Motor Company Fund; General Public Utilities Service Corporation (in support of the Center for Risk Management); Mobil Oil Corporation; Public Service Electric and Gas Company; and TRW Foundation.

In addition, RFF entered into several new government contracts. One is with the Bonneville Power Administration of

the Department of Energy for training and assistance in the use of models for evaluating the biological and economic impact of anadromous fish mitigation proposals. Under another contract, this one from the National Oceanic and Atmospheric Administration of the Department of Commerce, RFF researchers will carry out a study to determine the use of pesticides in coastal counties. The Environmental Protection Agency awarded a contract to the Center for Risk Manage-

ment to conduct research on how to best manage environmental risk.

The National Center for Food and Agricultural Policy at RFF received additional funds from the Department of Agriculture to explore aspects of agricultural trade policy and economic growth. The Environmental Protection Agency awarded additional funds for continuing work on the RFF national pesticide-use data base. ■



## Relevant To Today's Issues

### Using Surveys to Value Public Goods: The Contingent Valuation Method

Robert Cameron Mitchell and Richard T. Carson

The authors present the first systematic and comprehensive review of the theory and practice of the contingent valuation (CV) method of measuring the economic benefits of nonmarketed goods.

1989 • 482 pp. \$45.00 cloth

### Environmental regulation

#### Enforcing Pollution Control Laws

Clifford S. Russell, Winston Harrington, and William J. Vaughan

Economic models are used to show the extent of the difficulties involved in monitoring and enforcing pollution control laws on a continuous basis.

1986 • 244 pp. \$25.00 cloth

#### Rules in the Making: A Statistical Analysis of Regulatory Agency Behavior

Wesley A. Magat, Alan J. Krupnick, and Winston Harrington

The authors identify the factors that influence the stringency of rules issued by an agency such as the Environmental Protection Agency.

1986 • 195 pp. \$22.50 cloth

### The Mining Law: A Study in Perpetual Motion

John D. Lesly

The Mining Law of 1872 is presently under review in Congress. Lesly provides a detailed examination of the issues surrounding the law and suggests creative measures regarding the law's reform.

1987 • 537 pp. \$35.00 cloth

### Environmental quality

#### Measuring the Benefits of Clean Air and Water

Allen V. Kneese

Discusses methods for quantitatively estimating the benefits derived from the maintenance or improvement of air and water quality.

1984 • 171 pp. \$9.95 paper

#### The Benefits of Environmental Improvement: Theory and Practice

A. Myrick Freeman III

A unified theoretical treatment of the concepts of benefits and the empirical techniques appropriate for their measurement.

1979 • 286 pp. \$9.95 paper

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