

RESOURCES



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INSIDE:

Water Management Lessons from China

Market-Based Tools—the Right Choice?

Discounting Benefits of Climate Policies

RESOURCES



RESOURCES FOR THE FUTURE • WINTER 2002 • ISSUE 146

FEATURES

5 GLOBAL WATER MANAGEMENT DILEMMAS: LESSONS FROM CHINA

Policies governing water quality and availability can be a powerful lens for looking at environmental protection as a whole. As China modernizes its water infrastructure, with some assistance from international development agencies, the opportunity arises to evaluate western approaches to water management in the context of China's much more integrated and detailed approach.

Baruch Boxer

10 ARE MARKET-BASED INSTRUMENTS THE RIGHT FIRST CHOICE FOR COUNTRIES IN TRANSITION?

In recent years, international assistance and lending organizations have strongly pressed central and eastern European countries to adopt market-based approaches to solve their environmental problems. However, few of the institutions necessary to carry out such changes existed or were strong enough to allow economic instruments to work.

Ruth Greenspan Bell

15 DISCOUNTING THE BENEFITS OF CLIMATE CHANGE POLICIES USING UNCERTAIN RATES

Evaluating environmental policies, such as the mitigation of greenhouse gases, frequently requires balancing near-term mitigation costs against long-term environmental benefits. Conventional approaches to valuing such investments holds interest rates constant, but the authors contend that there is a real degree of uncertainty in future interest rates.

Richard Newell and William Pizer



QUARTERLY

1 FROM THE PRESIDENT

2 GOINGS ON

Carbon Mitigation Policies
Debated at RFF Seminar

Methods for Reforming
Permitting Process
Explored in New RFF
Report

New RFF Report Assesses
EPA's On-Line Workshop
on Public Participation

21 INSIDE RFF

23 DEVELOPMENT

RESOURCES

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Paul R. Portney

Ensuring RFF's Independence

Resources for the Future has just begun its 50th year. Our research is on the cutting edge, and RFF researchers are increasingly visible as trusted sources of information for all participants in important policy debates. It is difficult to think of a better way to begin our second half-century.

With visibility sometimes comes controversy, however. In the torrent of publicity surrounding the collapse of the energy giant, Enron, attention has been directed at the company's contributions not only to politicians but also to think tanks and other nonprofit organizations. Resources for the Future is one of those organizations. Such scrutiny is appropriate and we welcome it.

Between 1990 and 2001, Enron contributed periodically to RFF, with annual gifts ranging from \$10,000 to \$45,000; during this time, Enron's combined contributions amounted to a fraction of 1% of RFF's operating budget. Overall corporate support accounts for about 14% of the revenues RFF has available for its operations each year (see p. 29 for a "pie chart" showing the other sources). The corporate contributions we receive must be unrestricted—that is, they cannot be earmarked for particular projects or even general program areas. In addition, former Enron Chairman and CEO Kenneth Lay was a member of RFF's Board of Directors from April 2000 until February 2002, when he resigned. The Linda and Ken Lay Family Foundation has supported RFF periodically since 1992; in 2000, the foundation contributed \$15,000 to RFF. As has been reported in the press, and in an RFF press release in May 2001, the foundation pledged \$2 million to endow an unrestricted research chair at RFF. Finally, between April 1999 and April 2001, I attended five meetings as a paid member of an advisory council to the Enron Corp. and shared my views with Enron officials about a range of environmental and public policy questions, as I have done in many other public and private settings over the years. Robert Grady, vice-chair of the RFF Board of Directors, also participated in several of these meetings.

All of this is germane to the challenges that face RFF as it begins its 50th year. If asked to identify RFF's most significant accomplishment over its first half-century, it is tempting to point to its path-breaking, independent research. After all, RFF researchers have demonstrated that the United States is not likely to run out of critical natural resources and shown also that the preservation of wilderness areas often makes better economic sense than developing them. We have shown that marketable pollution permits or effluent taxes often make it possible to meet environmental goals more quickly and less expensively than other types of regulation. And we have argued convincingly that environmental risks must be carefully prioritized and addressed in order of importance. This work has profoundly influenced real-world policy.

Even more important than its research record, though, is the reputation that RFF has built since 1952—indeed, it is the coin of our realm. RFF researchers are seen as analytically keen, politically nonpartisan, and serving the public interest rather than private concerns. This is no mean feat in Washington, and preserving this reputation requires constant vigilance. As in the past, we recruit to the research staff only those whose commitments are to do scholarly and independent research, then let the chips fall where they may. We recruit to the RFF Board of Directors representatives of diverse interests and backgrounds, including environmental and business leaders, Nobel Prize-winning scholars, and government policymakers. We maintain a diverse base of financial support that makes us not dependent on any one source of support. And we rigorously hew to our policies regarding the types of contributions RFF will accept and the kinds of consulting activities in which its officers and staff can engage.

What you'll get from us is what you have every right to expect—50 more years of path-breaking research in the public interest.

Paul Portney



GOINGS ON

Carbon Mitigation Policies Debated at RFF Seminar

As the debate over how to develop an effective and viable carbon mitigation policy continues, experts on the subject gathered at RFF in December to discuss the financial and political costs of carbon dioxide and other greenhouse gas emissions reduction programs. While great progress has been made in understanding the aggregate costs of such policies, not enough attention has been paid to the distribution of those costs and the political ramifications thereof. To this end, four papers were presented in an effort to determine who is likely to bear the costs of various reduction policies under discussion and, as a result, the feasibility of those policies.

The Cost of Political Feasibility

The first presentation was from Stanford University Professor and RFF University Fellow Larry Goulder. His research considers the distributional effects of future carbon mitigation policies. "Standard CO₂ policies are cost effective but politically unrealistic," he explained. "The lion's share

of the economywide costs falls on a few highly [politically] mobilized industries, [and] these industries seem to wield effective veto power." This political power, said Goulder, is responsible, at least in part, for the failure of some cost-effective and efficient policies.

Goulder's research suggests that efforts to preserve fossil-fuel industry profits would have a very small impact on the efficiency of carbon mitigation programs. If 13% of permits were given rather than sold to industry, then after-tax profits would be protected and the increase in the overall cost to industry would be negligible.

Keeping the Constituents Happy

Where Goulder examined options for compensating the fossil-fuel sector for the burdens imposed by mitigation policies, RFF researchers William Pizer, James Sanchirico, and Michael Batz looked at the effects of those policies on households in different parts of the country.

According to Pizer, the question driving

their research was, "If you take the same household and plop it down somewhere else, what happens?" The answer could help carbon-mitigation decisionmakers evaluate the effects various plans might have on their constituents.

Using information based largely on the Census Bureau's Consumers Expenditure Survey—specifically, the results from 1984 to 2000—Pizer, Sanchirico, and Batz discovered large discrepancies in energy use in the different regions of the United States. Because of these discrepancies, the costs of carbon mitigation, households in some sections of the country, notably the Midwest and Texas, would face heavier burdens than those in other regions dramatically so when compared to those in the Pacific Northwest.

Eye on the Bottom Line

The second session focused on the study of carbon policy impacts on industry. RFF's Richard Morgenstern presented a paper he wrote with colleagues Mun Ho, Jhih-Shyang Shih, and Xuehua Zhang, which poses the question, "If we put a charge on all the carbon in use now, how would it affect individual industries in the manufacturing sector?" The researchers studied the effect of two different policies: an economywide carbon mitigation policy (such as a carbon tax) and a downstream policy focused exclusively on the electric-utility industry. The results varied dramatically, said Morgenstern. (See Table 1 for an overview of their results.)

The petroleum-refining industry, the industry that would be hardest hit under an economywide plan, ranks 145th under the electricity policy. The eight industries that would suffer most under an economywide policy bear more than 50% of the total cost to manufacturing. Under the electricity policy, these rankings differ, in many cases,

Editor's Note

We hope you like the new look of *Resources*. This issue marks the first phase of the redesign process, with more changes to come in subsequent issues. We're adding bibliographies to feature stories so that you can find out more about a given topic. There's also a new section — "Reaching Out" — that highlights the work RFF researchers are doing to share their ideas with a broader audience, such as giving testimony before Congress, appearing on television and radio, and writing opinion pieces for major newspapers.

We welcome your comments and suggestions. You can contact the editorial staff at editor@rff.org. To learn more about all that's going on at Resources for the Future, visit our website, www.rff.org.

Felicia Day
Editor



Table 1. Comparison of Economywide and Electricity-Only Policies

Ranked by Economywide Policy			Ranked by Electricity-Only Policy		
Industry Name	Economywide Carbon Charge	Electricity-Only Carbon Charge	Industry Name	Economywide Carbon Charge	Electricity-Only Carbon Charge
Petroleum refining	1	145	Primary aluminum	13	1
Products of petroleum and coal	2	191	Electrometallurgical products, except steel	18	2
Lubricating oils and greases	3	154	Cement, hydraulic	9	3
Carbon black	4	36	Aluminum rolling and drawing	49	4
Asphalt paving mixtures and blocks	5	76	Primary smelting and refining of copper	52	5
Lime	6	6	Lime	6	6
Nitrogenous and phosphatic fertilizers	7	25	Primary nonferrous metals	64	7
Asphalt felts and coatings	8	196	Blast furnaces and steel mills	10	8
Cement, hydraulic	9	3	Metal cans	48	9
Blast furnaces and steel mills	10	8	Aluminum castings	95	10

Source: Morgenstern et al. 2001

dramatically. The presentation concluded with the notion that the two policies have very different effects on the different industries.

Level Playing Field

RFF's Dallas Burtraw discussed the effect of allowance allocation approaches on the cost of carbon emissions trading, research that he conducted with colleagues Karen Palmer, Ranjit Bhavirkar, and Anthony Paul. Burtraw told the audience he was concerned that "efficiency and equity head in opposite directions," pointing out that the electricity industry is responsible for one-third of carbon emissions but would be responsible for two-thirds of reduction targets under a cost-effective economywide policy.

Burtraw and his colleagues compared three allocation approaches—auction,

grandfathering, and generation performance standards (by which emissions allowances are determined by the amount a firm generates)—as they pertain to the electricity sector. They concluded that allocation of permits by auction was the most efficient reduction method, saying such a program would cost society half as much as a grandfathering or generation performance standard.

Looking back at the workshop, Morgenstern, who organized the conference, said, "We engaged the policy community in discussing these issues and developed the information base." He described the workshops as a "critical step in designing potential policies so as to minimize the adverse burdens" to industries, thereby creating a climate in which appropriate and effective policies can be enacted.

Correction

In the Summer 2001 issue of *Resources*, an article about an ongoing project in Shanxi Province in China did not mention all of the members of the research team. They included: Robert Anderson, Resource Consulting Associates, Inc.; Steinar Larsen, Norwegian Institute for Air Research; Wang Jinnan, Yang Jintian, and Cao Dong of the Chinese Research Academy of Environmental Science; and Stephanie Benkovic, Melanie Dean, Joseph Kruger, and Jeremy Schreifels of the U.S. Environmental Protection Agency.



GOINGS ON



Methods for Reforming Permitting Process Explored in New RFF Report

In *Reforming Permitting*, a new RFF report, Senior Fellow Terry Davies paints a realistic picture of the U.S. pollution control permitting process, assesses current permitting reforms, and offers policy recommendations "to improve a system that is suffering from major defects and weaknesses."



Terry Davies

"Permits are the pivot on which much of the pollution control system turns," Davies says. "If the permitting process is cumbersome,

costly, and not effective in controlling pollution, then pollution control also will be inefficient and ineffective. This is, arguably, the situation in the United States today."

The permitting system is so fragmented and complex that even specialists cannot tell what the rules are, Davies says. A large portion of permits are outdated, leaving facilities with time-consuming permit requirements that may have little relationship to current operations or government regulations. Environmental groups and the public are also handicapped by the complexity of the regulations and the opaqueness of the permits, he says.

Davies offers detailed recommendations for Congress, the U.S. Environmental Protection Agency, the states, industry, and environmental groups. The opportunities for constructive change are many and run the gamut from minor corrections to revolutionary changes, he says. Small permitting reforms can have a significant impact but the bigger challenge "will be to use permitting as a lever to change the overall pollution control system."

RFF's Robert Hersh, Aracely Alicea, and Ruth Greenspan Bell also contributed the report.

Reforming Permitting can be found on the RFF website at www.rff.org/reports/PDF_files/reformingpermitting.pdf.

New RFF Report Assesses EPA's On-Line Workshop on Public Participation

In his new report, *Democracy On-Line*, RFF Fellow Thomas Beierle evaluates the U.S. Environmental Protection Agency's (EPA) on-line experimental workshop on public participation—the National Dialogue on Public Involvement in EPA Decisions. The Dialogue, which was held last year, gave more than 1,000 people an opportunity to discuss public participation in EPA policies, from rulemaking and permitting to the drafting of its draft Public Information Policy (PIP).

Beierle, with funding from the William and Flora Hewlett Foundation, investigated participant satisfaction, whether new voices were introduced into the policy process, the quality of communication, and what participants and EPA gained from the process.

"In undertaking the Dialogue, EPA

broke new ground," writes Beierle. "It was the first time that the agency had sponsored an on-line public dialogue in conjunction with a formal public comment process."

According to Beierle, the Dialogue was a great success. He found most participants were pleased with the results, and the number and diversity of participants was far greater than could otherwise be achieved with an in-person event; reaching such a diverse group was EPA's goal. For its part, EPA had more staff participants in the Dialogue than have been represented at an



Thomas Beierle

in-person meeting.

More than half of participants thought their participation would have some impact on EPA's PIP and its implementation; lead agency staff members already have begun incorporating comments from the Dialogue into the PIP implementation plan. More than three-quarters of participants claimed they learned a great deal about the views of other participants on public participation. None of this is to say the process was flawless, but most problems related to the Dialogue—such as software issues and concerns regarding participant access to computers—can be overcome, says Beierle.

Democracy On-Line can be found on the RFF website, at www.rff.org/reports/PDF_files/democracyonline.pdf.



Global Water Management Dilemmas

Lessons from China

Baruch Boxer

Policies governing water quality and availability can be a powerful lens for looking at environmental protection as a whole. As China modernizes its water infrastructure, with some assistance from international development agencies, the opportunity arises to evaluate western approaches to water management in the context of China's much more integrated and detailed approach, which has evolved over the past two millennia.

What is "water management"? Can we measure its success or failure? And in whose terms and to what ends? What are the appropriate scales for evaluating management options and their effects in diverse settings around the world? China is a good example of a country seeking to apply international water management strategies and standards in the face of difficult demographic, economic, and physical circumstances. Much can be learned from a close look at China's experience in recent years, because that experience reflects policy adjustment processes and challenges in many developing countries.

Concern is growing worldwide over the social, ecological, and security implications of water shortages, along with a widespread decline in water quality. In recent years, several major global strategic planning efforts have been conducted by multilateral agencies, the United Nations (UN), nongovernmental organizations, and international scientific bodies to shape a global water policy agenda. Several of these initiatives over the past decade culminated in a December 2001 International Conference on Freshwater in Bonn, Germany, which sought to defin-

itively clarify water issues and suggest solutions. The conference was convened specifically to help prepare an agenda for the August 2002 World Summit on Sustainable Development (Rio+10) to be held in Johannesburg.

Relating Global Experiences to Local Conditions

However, there is little evidence from all of these efforts that national and international bodies are in a position to effectively address water problems in an integrated manner at local, regional, national, and global levels. One problem is that it is difficult to develop commonly understood and generally applicable management policies, practices, and interventions at regional or global scale.

Responses to water problems in most countries mainly involve place-specific application of scientific, engineering, and institutional knowledge with limited transferability. A major challenge in achieving sustainable water resource development and management is relating global experience and understanding to the specific requirements of diverse countries and regions with

unique cultural and historical traditions, varied levels of social and economic development, and distinctive institutions.

China has embarked upon a vigorous campaign over the past decade to drastically reshape its water development and management policies in the context of ambitious market reforms and a major reassessment of the legal and ideological foundations of its water economy. The magnitude and complexity of this task are daunting. It represents a concerted effort to integrate long-standing policies defining government responsibility for judicious water development, protection, and use with newer perspectives on modern economic and legal strategies for realizing the long-term benefits of water sustainability.

China's water policy initiatives are of universal interest for several reasons. Most important, they test assumptions as to the efficacy of modern policy remedies for water conservation, hazard mitigation, and environmental protection in a society where assurance of adequate water supply and protection from flood and drought have been the hallmark of successful governance for over two millennia. Water mythology, water engineering, and water knowledge have been critical in shaping the distinctive forms, patterns, values, and cultural ecology of China's unique civilization. China's water policy experiments also provide insight into the potential benefits and limitations of foreign models for combining engineering interventions, economic incentives, and management strategies to achieve interrelated water quality, water supply, and water conservation goals.

Given the magnitude of China's water problems and its long experience in dealing with them, these new ways of thinking and acting are being closely watched. The issue at stake is whether the rhetoric of water sustainability can be effectively translated into workable programs and policies under increasingly stressful conditions of imbalance in water supply, sharp variations in water surplus and water shortage over time and geographic distance, and the rapid deterioration of surface and groundwater quality.

Here I consider four dimensions of this transformation process, each of which illustrates some of the unique challenges and contradictions that Chinese water policymakers are addressing as they confront the task of developing and managing water resources in support of the country's economic and technological modernization. They are:

- building upon a 1988 Water Law to accommodate new water resource management concepts and challenges;
- implementing a dramatic policy shift in early 1999 from pri-

mary emphasis on planned structural engineering interventions to address water supply and control problems, to recognition of the need for a more comprehensive and diffuse notion of water as a resource (*ziyuanshuili*) to be developed and managed in response to changing market criteria;

- accommodating cultural/historical perspectives on water-state-society interactions, along with more recent and still-prominent Marxist theoretical frameworks, while simultaneously trying to adopt western market-oriented water policy instruments to improve the efficiency of water engineering, use, and control; and
- meeting the challenges of modifying indigenous water science and engineering theory and practice to facilitate the absorption of foreign technical and institutional approaches to water policy development.

Legal Issues

Key underlying assumptions of China's water program are that the landmark 1988 Water Law must: serve as the regulatory framework for a system that rationalizes and substantiates water and the water infrastructure as public economic goods in the transition to a market economy; and support a redefined, but still preeminent role for the Ministry of Water Resources (MWR) as the leading government body responsible for overall water planning, monitoring, research, and development. MWR also oversees national-level policymaking and interprovincial policy coordination, and flood and drought protection and control.

From its preliminary drafting stage in the early 1980s, the Water Law was assumed to be empowered through ancillary statutes drafted to address planning and regulatory issues associated with specific problem areas like water quality, soil erosion control, inland navigation, and groundwater protection. To this end, complementary laws have been promulgated. Currently, to facilitate basinwide water quality regulation and to improve coordination of water protection and development initiatives across administrative boundaries, there are strong appeals for a water basin law, to be implemented in the seven major river basin systems.

Since the late 1980s, however, efforts to establish a legal foundation and Water Law-based program to effectively address technical, institutional, regulatory, and environmental dimensions of the water economy in the context of socialist modernization have not come to fruition. There are several reasons for this which illustrate some of the fundamental challenges

China faces in trying to modify its supply-driven water system, a legacy of the earlier planned economy, to create a law-based, economically efficient, and ecologically sound water management regime.

A major difficulty is that economic, administrative, and social support dimensions of the Water Law still reflect a pervasive Ministry-promoted culture of active state and party social guidance and definition of responsibility for water management. The powerful authority of the Ministry on water protection and infrastructure development was seldom challenged prior to the late 1970s, and capital and labor support for key projects was usually made readily available.

Since then, however, modernization efforts have drawn attention to many previously neglected problems like nonpoint source pollution, hazardous waste management, wetland loss, biodiversity preservation, and adequate and safe urban water supply. The current practice of drafting supplementary water-related laws to address pressing issues is not well-suited in a situation where there is an urgent need to coordinate scientific and engineering research, and regulatory enforcement and adjudication, in the face of the overwhelming challenges of urban and rural water supply, pollution control, and environmental preservation.

Finally, China, along with many other countries and international bodies, gives lip service to the notion of sustainable water use as a key policy goal. The assumption is that the Water Law, with its complementary statutes, will help translate and integrate western management models and experience to accommodate alien concepts like demand management, market-responsive economic optimization, rational pricing, and institutional power-sharing.

The Engineering-to-Resource Transition

A dramatic shift in water policy thinking occurred in early 1999 with the introduction by the MWR of the resource water conservancy or *ziyuanshuili* concept as a major theoretical and methodological departure. This represents a distinctive Chinese perspective on water management. It aims to formally recast longstanding social and economic criteria for justifying and measuring the economic and social value of hydropower resources, as well as the infrastructure for water supply, treatment, control, protection, and distribution. More broadly, the focus shifted to the concept of "water resources" as it applies to the China of today.

Key Chinese Terms

Several key Chinese water policy terms are defined below. Evolving modern Chinese water policy concepts and methods can be understood only in the context of the specific technical associations of Chinese water-related terms that linguistically may have diverse meanings and connotations that reflect their long historical evolution. For a copy of the article with all of the Chinese water policy terms spelled out in either *pinyin* romanization or Chinese characters, contact the author at boxer@rff.org.

baohu—protect, safeguard

jietyue—economize (water use)

maodun—contradiction (a fundamental concept in Marxist dialectical philosophy)

peizhi—deployment (of water resources)

shuili—traditional water engineering knowledge, practice, and cultural values (literally, water benefits)

shuiziyuankaifaliyong—development and use of water resources

zhili—control, harness (river)

ziyuanshuili—resource policy-defined water management (in contrast to traditional engineering-focused *shuili*)

Wider focus on water as resource, moreover, clearly anticipates the need for new institutional mechanisms and policy instruments. Presumably these will ease the transition from long-standing reliance on plan-driven guidelines for meeting goals and evaluating performance to greater provincial and local autonomy in choosing appropriate market instruments.

This fundamental policy shift is an essential adjustment that demands new, non-Marxist theoretical perspectives on the historical benefits of traditional water engineering knowledge, practice, and cultural values (*shuili*). It also requires the reshaping of public attitudes and responsibilities toward water as a resource, thereby promoting new ethical values of protection, conservation, and improved scientific management to reform the *shuili* enterprise in support of the modern socialist market economy. Furthermore, new technical vocabulary and scientific rationales must extend definitions of *shuili* engineering benefits to include newly specified nonmaterial benefits, like ecological support, improved public health, and recreation, which are implicit in the *ziyuanshuili* agenda.

Three main theoretical areas must first be developed to facilitate and guide a smooth transition from engineering-dominated water management thinking to the new *ziyuanshuili* program. These include: first, systems thinking to probe the interrelated roles of water, as a distinct natural, human, and ecological resource; second, how to delimit and measure the connections between sustainable use ideas and the real-world physical, economic, and social processes that can formally substantiate the *ziyuanshuili* program through effective policies; and, finally, the need to recalculate the physical and social asset values of engineering facilities while incorporating new, largely intangible health, environmental, and welfare values implicit in the *ziyuanshuili* concept.

History, Dialectics, and Markets

China's ambitious efforts to confront water problems through the introduction of new laws and policies that seek to wean the water economy from its familiar planned orientation is a Herculean task that requires revolutionary policy measures. Given China's size, its variable and uncertain physical endowments, and the speed with which the economy is being modernized, it is not surprising that progress is slow.

The main 21st century water challenges and contradictions result from population growth, the expansion of industry and agriculture, growing disparity between water supply and demand in the north, rampant pollution, and fragmented administrative jurisdictions. Attempts to overcome them must acknowledge the historical legacy and cultural imprint of two millennia of traditional water engineering knowledge, practice, and values, as well as recognizing a still-present Marxist ideological framework.

This broad dialectical framework contributes in two important ways in China to the development of a "socialist market economy" that can support modern water management policies. There are contradictions that need to be addressed in undertaking the transition from a planned to a more realistic resource perspective on balancing water engineering and policy needs and priorities. Areas of contradiction (*maodun*) are clear and salient in the Chinese context, and include water resource development and use (*shuiziyuankaifalियong*), governance (*zhili*), deployment (*peizhi*), economizing (*jieyue*), and protection (*baohu*).

Of these contradictions, deployment is the most crucial because it forces consideration of how governance can serve as a key policy link for resolving inherent contradictions in water

development, use, and conservation alternatives while setting priorities for water projects primarily as sources of social and economic benefits (such as wastewater treatment plants, irrigation works, and reservoirs) or as protection against hazards (including sea walls, flood diversion and drainage works, and dikes).

The fundamental challenge of redefining the *shuili* enterprise in market terms is a second, more elusive task. Here, the main issues are: how to resolve contradictions in thinking about *shuili* primarily as a productive commodity in itself where value can be enhanced through private investment and the auctioning of land and facilities; or whether the *shuili* enterprise should primarily become a mechanism and vehicle for the spreading of benefits throughout the wider socialist market economy through public health improvement, increased energy generation capacity, cleaner water, and better ecological support.

Science, Technology, and Policy

Since the inception of China's environmental program in the early 1970s, indigenous environmental science research has supported the development of water-related environmental laws, policies, and regulations. Studies in marine and aquatic ecology, environmental chemistry, pollution biology, estuarine studies, soil science, epidemiology, and other fields contributed effectively to early monitoring, standard setting, and enforcement work that supported China's incipient environmental mission.

Prior to the flood of foreign contacts that began in the early 1980s, self-reliant Chinese investigators studied diverse aspects of water and other pollution. Their purpose was twofold: first, to describe, analyze, and recommend solutions for local and regional air, water, and solid waste pollution problems; and second, to use empirical work to explore, refine, and show the relevance of Marxist thinking about human-environment relations to policy development and problemsolving in specific problem areas. This kind of work was especially noteworthy in areas like fluvial (stream) dynamics and sediment transport, marine ecology and aquaculture, phytoremediation, and microbial degradation of pollutants in textile, petroleum, and other industries.

Self-reliant scientists had to develop their own theoretical perspectives and methodologies in response to local conditions, problems, and ideological directions. This resulted, in some problem areas, in creative insights, imaginative methodologies, and beneficial results for the environment and public health at local levels despite increasing pollution and environmental degradation on a national scale.

RESOURCES FOR THE FUTURE

For example, to evaluate water quality and the distribution, movement, and effects of toxic elements in aquatic organisms and reservoir sediments, environmental chemists, aquatic biologists, and "chemical geographers" carried out extensive studies in the 1960s in the Yang and Sanggan watersheds of northern Shanxi and Hebei provinces. These studies were designed to support environmental standard setting and regulation in anticipation of intensified industrial and agricultural development.

The question now is whether Chinese environmental scientists and engineers will still be able to contribute to policy development imperatives that reflect distinctive Chinese social and environmental circumstances while employing state-of-the-art standardized foreign technologies and methodologies. One emerging problem is that Chinese scientific talent can't be most effectively used because many Chinese firms and municipalities cannot afford the technologies necessary for their application. Also, foreign investors in industrial plants and other enterprises introduce pollution control technologies that conform mainly to their own profit-making agendas. They are thus sometimes insensitive to the need to spend more to adapt the best modern technologies and processes to provide the most effective benefits in face of unusual environmental challenges in specific Chinese locales.

Conclusion

The challenges of water policy reform in China today can be thought of in two primary ways. On the one hand, there is the problem of assimilating a torrent of recent environmental economic theories and methods for achieving the greatest benefits, at least cost, in developing, using, conserving, and maintaining the quality of surface and groundwater resources. These ideas are being widely propagated by a new generation of economists and engineers, many foreign trained, who avidly seek to address China's water problems by applying internationally accepted strategies and methods.

On the other hand, these externally generated policy initiatives must make sense in Chinese terms. This means that they must be made workable in the context of an ongoing, self-directed, and spirited effort by the Chinese water engineering and science community to redefine conceptual, technological, and social rationales for environmentally significant water policies spawned by the economic, political, and ideological conflicts of the last half-century.

Baruch Boxer is professor emeritus of geography at Rutgers, the State University of New Jersey, and a visiting scholar at Resources for the Future.

For more information

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Are Market-Based Instruments the Right First Choice for Countries in Transition?

Ruth Greenspan Bell

In recent years, international assistance and lending organizations have strongly pressed central and eastern European countries to adopt market-based approaches to solve their environmental problems. However, few of the institutions necessary to carry out such changes existed or were strong enough to allow economic instruments to work. A better approach might have been to emphasize incremental improvements that could have been attained with the existing institutions.

It has now been more than 10 years since the fall of the Iron Curtain. Those of us who closely watched the transition can vividly recall the excitement and sense of possibility of those early days.

Environmental activism appeared to be an integral part of the systemic changes occurring throughout Central and Eastern Europe. Severe environmental degradation throughout the region had been an early rallying point for the democratic opposition, which used it to demonstrate the failures of state socialism. It seemed logical that these concerns would translate into a commitment by the new governments to strengthening environmental protection and cleaning up the mess left behind. In 1989, President George H.W. Bush gave a famous speech (at least in the environmental community) in Budapest that

pledged U.S. help for efforts at environmental rebuilding.

Resources were brought to bear on the environment from a number of sources, including the European Union's PHARE program (which assists the applicant countries of central Europe in their preparations for joining the European Union), western European countries, the international financial institutions, Japan, and the U.S. Agency for International Development (AID). William K. Reilly, then-U.S. Environmental Protection Agency administrator, was instrumental in writing a commitment to protect the environment into the charter of the European Bank for Reconstruction and Development. Bedrich Moldan, board chair of the Regional Environmental Center for Central and Eastern Europe (REC), an organization originally set up with AID funding to support nationwide

environmental reform, characterized these contributions as efforts to introduce the best environmental practices and ideas from the West.¹

One issue ripe for examination is the quality and impact of the environmental assistance that started flowing to the countries of the former Soviet bloc after 1989. Many western observers and some central European experts apparently envisioned a *tabula rasa* that would support leapfrogging over the mistakes committed in the name of environmental protection in the west. (Their aspirations were much like those who apparently thought that markets in all their aspects would magically appear once communism was removed.) This hope was expressed, in part, through a push for the development of new ways to control pollution.

Much attention focused on the development of efficient regulatory instruments and attempts to avoid the mistakes of environmental regulation in the west. Many donors and advisors—including the Organisation for Economic Co-operation and Development (OECD), AID, World Bank, and the European environment ministers themselves—pushed and continue to push for the development of economic instruments, such as pollution taxes, marketable permits, and the like. Whether deliberate or not, the language used to discuss these environmental tools frequently obscured complex issues. The most notable example is repeatedly characterizing traditional approaches as "command and control" and contrasting them with "markets," for an audience reacting to years of hated central planning. Some advisors flatly promised that economic instruments would have lower institutional and human resource requirements than command and control, a glittering and ultimately incorrect promise in countries with small and underfunded environment ministries.

Ten years offers time for reflection. With a few interesting exceptions, the principal environmental improvements in the former Soviet empire have been not the result of improved regulatory tools, but a consequence of the collapse of unproductive state-owned industries and decreased reliance on heavy industry. Meanwhile, overall environmental institutions remain weak and most of the new ideas proposed after 1989 have not been implemented. Poland's substantial domestic investment in environmental improvement and Hungary's gains in energy efficiency are illuminating exceptions of gains made without great social costs.

Despite donor enthusiasm, most countries in the region were not ready to take on the challenge of environmental reform, for two primary reasons. The environmental movement no longer played the catalytic role it had before 1989. When Communist

Party dominance ended, opposition leaders did not need environmental camouflage and could move into more direct roles in political life. The smaller number of people and organizations that continued to focus on environmental issues were pushed to the margin. The groups that remained tended to be top-heavy with technical experts and scientists, who were not very good at communicating with the broader audiences necessary to change policy.

The effort to move directly to market-based instruments...is a classic case in which optimism overtook good sense and little attention was given to institutional and social constraints.

Even more fundamentally, exhilaration was eclipsed by the enormity of the challenges on every possible front—depressed economies, badly frayed social safety nets, and widespread concerns about social unrest. The extraordinary difficulty of doing everything at once (including instituting environmental change) in a time of intense social and economic change was not the "most conducive...to furthering the huge constructive and cooperative effort of institution building that society [was] now challenged to perform."²

Introducing Market Mechanisms

Even as it became apparent that most countries in transition did not have the resources, motivation or public support to pursue environmental reform, donors continued, nevertheless, to push them toward the adoption of sophisticated tools. The effort to move directly to market-based instruments is worth examining as an illustration of the disconnect between hopes and expectations and on-the-ground conditions. It is a classic case in which optimism overtook good sense and little attention was given to institutional and social constraints.

What was overlooked was that markets do not act in a vacuum; institutions do matter for economic instruments, as they do for all tools of environmental protection. The example of emis-

¹ Europe After 10 Years of Transition, Speech at the REC on June 18, 2000. http://www.rec.org/REC/Programs/10th_anniversary/Speech.html

² Elster, Offe, and Preuss, *Institutional Design in Post-Communist Societies*.

sions trading, which was pursued in a number of countries and was the subject of several regionally based efforts, illustrates the gulf between advice and implementation.

One of the key motivations for industry to want emissions trading has been the economic pain firms have suffered from investing in compliance, which in turn is at least partly related

Government transparency was not a hallmark of the Soviet bloc governments, nor is it particularly a European tradition.

to a clear expectation of consistent and reliable enforcement. When firms have to grapple with the reality—rather than the theory—of environmental regulation, they develop a good grasp of what are the real costs to them of regulation, and of what it takes, at a practical level, to achieve compliance. There is little evidence of industries theoretically coming to the conclusion that emissions trading will be a cheaper way of achieving compliance than directed regulation. Why try to save money on regulation if you are not expending any to begin with and don't expect to in the future?

However, the environmental regulatory systems of the Soviet bloc countries were weak institutions. Laws were not the most important motivator of firm behavior and in any case were riddled with formal and informal exceptions. The state controlled everything and rewarded production over other values. Industry had not been hit on the head with the hard realities of environmental compliance. This is beginning to change in a few of the countries in transition. But even today in most of these countries, environmental enforcement is no more rigorous than it was during the Soviet period, and likely weaker because of the general confusion.

A second institutional requirement for emissions trading to work is very clear knowledge—not guesses—of what pollution each plant is discharging to the environment. Believable end-of-pipe monitoring assures that real, not imaginary, pollution reductions are being traded. But monitoring throughout the former Soviet bloc most often emphasized ambient measurements over end of pipe, and, in any case, was not consistent. In truth, no one could be sure what particular factories were emitting and whether they were meeting their discharge requirements. One could make estimations using the sulfur content of coal, but the

accuracy of the estimations would depend on a number of assumptions, including that the control equipment had been turned on and had been maintained—not a trivial issue in the countries in question. The environmental equivalent of "trust but verify" was missing.

Lack of Transparency

A whole series of measures and institutions are necessary to keep emissions trading honest. One of the most important in the United States is transparency. Permit requirements, emissions data, and the transactions themselves are all available for inspection by the public, including the firm's competitors. In the United States, where environmental regulation is a very contentious subject, this has helped to create a level of trust, a necessary predicate if government regulators, economic competitors, nongovernmental organizations, and the public interest community are going to go along with unconventional programs.

Government transparency was not a hallmark of the Soviet bloc governments, nor is it particularly a European tradition. Nine years into the transition, some of the countries in transition signed the Aarhus Convention in 1998, agreeing to increase their citizens' opportunities to obtain environmental information on demand. These countries are struggling with the nuts and bolts of implementation. It may be that emissions trading programs can work without as much transparency as the United States demands; in many countries, the public is more tolerant when industry and government sit down to negotiate. But it is clearly an issue that architects of any trading program must consider.

The connection between transparency and emissions trading is a particularly sensitive issue in the former Soviet bloc. Trading is, in some ways, a recognition that one party will be held to stricter standards than another similarly situated. When arrangements are made in the sunshine, there are fewer reasons to be concerned that these differentials will creep toward corruption. However, given their experience over the past 45 years, most citizens in the countries in transition are acutely aware how quickly this can happen.

In the mid-1990s, a project in Poland developed a legal basis for granting compliance schedules—essentially an alternative environmental compliance tool that involves grants of discretion. The Polish Ministry participants spent a considerable amount of time and energy devising safeguards to be sure that discretion would not be hijacked to serve the purposes of people in power, rather than the environment.

Need for Legal Systems and Institutions

No firm with any degree of sophistication is likely to participate in emissions trading programs if transactions are not backed up by disinterested mediating institutions available to act in a timely manner to protect a wronged party. Emissions rights are complex intangible property rights and sometimes involve future rights. Buying and selling them is not the same as buying and selling apples in a local market. Emissions trading and other complex market-based mechanisms need a viable, reliable legal system or some analogous set of institutions to ensure the integrity of trades and protect everyone involved.

These certainly did not exist in the early days of the transition. Some of the westernmost countries in transition were only beginning to reestablish a European legal system free of the political and economic "safety valves"—the legal means of last resort by which Party and state authorities could avoid their own rules—that existed throughout the period of Soviet dominance.³ Other countries, particularly Russia and the other parts of the Union of Soviet Socialist Republics had never really been subject to the reliable rule of law. While some countries have made progress in this regard, donor advice on emissions trading did not distinguish between countries with working legal systems and those without.

Trading systems are based on a real, rather than theoretical, understanding of how markets work and of how transactions are constructed, recorded, and policed—the very institutions of capitalism. Complex market transactions don't just happen; the actors must have considerable skills. Before 1989, scholars throughout the bloc studied non-Marxist economics, but the actual economy was structured under the rules of state socialism.

Industrial managers had been tutored in the old systems. They were not motivated by profit and loss, not held to western accounting principles, and not responsive to shareholders or the stock market. In general, they lacked the kinds of skills normally applied in complex emissions trading systems. The last 10 years have introduced masters of business administration programs and practical market experience, but not without a great deal of pain. A few countries retained a trading mentality that was reflected in small businesses, but, in general, industry has faced a steep learning curve and was not ready, certainly in the early part of the transition, to take on market-based environmental responsibilities.

³The phrase is Daniel H. Cole's in *Instituting Environmental Protection: From Red to Green in Poland*.

In sum, not only was there no *tabula rasa*, but there also were considerable although varied histories to overcome and institutions to build throughout the countries of the former Soviet bloc. The key elements—monitoring, transparency, a working legal system, and a realistic incentive to trade—were nowhere to be found. Scholars can debate whether the single-minded push of some donors to concentrate such intense efforts on developing sophisticated, market-based environmental regulation was a disservice, diverting energy from efforts that might have been more productive.

Industrial managers...were not motivated by profit and loss, not held to western accounting principles, and not responsive to shareholders or the stock market.

In any case, pushing inexperienced governments prematurely toward highly sophisticated environmental policy tools was not the only miscalculation by the donor community. Another was the emphasis placed on drafting new state-of-the-art environmental laws without apparently giving much thought to the existing laws and how they operated, much less to what the countries could actually manage in terms of the resources and experience they could bring to bear in implementing the new laws.

My purpose here is not to argue against the use of market-based instruments. I don't advocate throwing the baby out with the bath water. Rather, I am arguing that market-based instruments were done a disservice when the OECD, World Bank, and others pushed these tools too hard and too fast in countries that were institutionally unprepared to implement them. The power of these instruments may have been trivialized when the experts were less than candid about the total package.

If environmental professionals in the countries in transition were led to believe that they could make this leap without at the same time constructing supporting institutions, the cause of environmental protection itself may have been dealt a blow by the disappointments that followed.

If the notion of a great environmental leap forward was not sensible, what approach might have worked better? Certainly, the old system could not be left in place. An emphasis on incremental improvements in pursuit of pragmatic goals might have

been smarter, particularly one that helped to build a transitional system that would have taken account of existing capabilities and institutions. This might have resulted in real, although small, initial environmental gains, and might have been accomplished without losing sight of the ultimate goal of developing the most efficient ways to manage the environment. Another constructive approach would have elevated the importance of institutional reform in the advice rendered on economic instruments.

The donor community also needs to rethink its way of doing business. Formulaic advice should be replaced with crafted responses that explicitly recognize the varied conditions in each country that would support reform. Donors need to do their homework, as well, which means getting to know each country in a very different way than they have in the past.

The importance of examining these issues today is not only

a question of historical review. Many of the same countries that were the subject of environmental assistance efforts are trying to enter the European Community. They will be required to incorporate into their environmental practices many highly sophisticated tools, layering them on to still-weak, thinly staffed domestic environmental institutions. Moreover, the same donors continue to urge countries with weak institutions in other parts of the world to adopt highly sophisticated tools for environmental protection. It would be wise to consider the lessons of environmental assistance in the countries in transition, as others embark on these new challenges.

Ruth Greenspan Bell is director of RFF's program for International Institutional Development and Environmental Assistance.

For more information

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RESOURCES FOR THE FUTURE

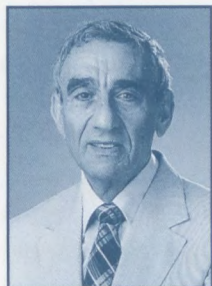
50 YEARS OF PATH-BREAKING RESEARCH

2002 marks our 50th anniversary. Throughout the year, we'll be taking a look at past achievements, hearing from special members of the RFF family, and keeping you up to date on upcoming anniversary events.

Reflections

As part of our anniversary celebration, we have asked members of the RFF family to reflect on their ties to the organization. Joel Darmstadter joined RFF in 1966. His principal research and writing has focused on various aspects of energy economics and policy. He continues to pursue these topics on a part-time basis as a senior fellow and resident consultant.

My son periodically asks, "Dad, why, at your age do you bother to go to work?" Along somewhat mischievous lines,



JOEL DARMSTADTER

I point out to him that the opportunity cost of chucking it all — that is, having to subscribe to the *New York Times* and the *Economist* and invest in a better home computer — is not to be viewed lightly. But I know this response does not convince.

The more reflective — and, I like to think, honest — answer to his question is difficult to render entirely cliché-free: it is hard to imagine being surrounded by a more collegial, bright, able, and friendly group of people. The work at RFF — whether I'm involved in it or not — is almost invariably interesting and often relevant to what I view as important policy issues, no matter that some of those policies emerge clearly only with the passage of time.

Looking back poses challenges — singling out particular milestones runs a risk similar to identifying your favorite piece of music or the best book of the year: you wonder if you have neglected something that deserved equal, if not, higher billing. Experiencing the presence and scholarship of seminal — for once, that overused adjective applies — researchers like Allen Kneese, John Krutilla, and Marian Clawson was an obvious reward to working here. Another major reward came in 1978, when RFF made a successful transition from depending

RFF's Reunion

As part of our anniversary celebrations, we are hosting a reunion for current and former Board members, staff, University Fellows, and dissertation and fellowship award winners.

When: Thursday and Friday, April 18 - 19

Where: RFF headquarters in Washington, DC

Events include a conference on public health and the environment (held in conjunction with the spring meeting of the RFF Council), a Washington, DC-area outing, and a reunion dinner in RFF's beautiful courtyard.

In conjunction with the reunion, we are compiling a directory of RFF alumni. Please visit www.rff.org/50 and complete the Alumni Contact Information Update Form, even if you are unable to attend the reunion. The directory will be distributed to everyone who responds.

For more information, visit www.rff.org/50 or contact RFF's Susan Johnson Doyle at 202-328-5038 or doyle@rff.org.

on the Ford Foundation for institutional support to functioning as a viable and independent research organization.

But, in this age of media-hype and sound bites, it's almost axiomatic that RFF's dispassionate research tends to produce nuanced findings rather than the black-and-white results that are the bread-and-butter of TV network news. At the same time, we can't ignore the necessity of news coverage and dissemination. We have to, and we are, finding effective media avenues that do justice to RFF scholarship, such as the *Washington Post*, C-SPAN, and NPR, to name just a few. I find myself pleased by the strides we're making in getting our message to those who ought to hear it.

The Best of RESOURCES

IN EACH ISSUE, WE'LL BE HIGHLIGHTING ARTICLES FROM RESOURCES THAT HAVE STOOD THE TEST OF TIME.

A DISPOSABLE FEAST

Hans H. Landsberg

More than 30 years ago, our esteemed colleague Hans Landsberg (who passed away in October 2001) shared, with his trademark eloquence, his perspective on environmental problems and the role of economic incentives in their alleviation. Since then, society has made some progress in implementing the reforms that Hans saw as necessary but his analysis remains apropos.

Like most of the problems confronting modern man, environmental pollution as a whole resists swift and simple solutions. There is no single cause lending itself to a single cure. Rather, each separate problem, such as air pollution, is a synthesis of several others, all springing from multiple causes. Much of the current discussion on the environment, however, reveals little or no understanding of those complexities.

The desire to ferret out causes and to swiftly apply remedies has led to speculation about several isolated factors as single determinants of environmental deterioration. Rapid population growth has been placed at the head of the list — an assignment that deflects attention from factors of more immediate bearing further down the list or absent from it altogether.

While population growth is likely to aggravate environmental problems in the long run, to consider the reduction of fertility as the sole response to present problems is to consider a woefully inadequate solution. Effective national measures for enhancing environmental quality must be based on knowledge of the complex and interacting processes that actually cause pollution.

These combined processes — the major determinants of environmental pollution in the United States today — can be stated simply: high per-capita consumption based

on high per-capita income, combined with sophisticated and powerful technologies. Some elements of this combination have been recognized and singled out as villains, but as a formula it is incompletely understood.

Electric power generation — a favorite contemporary villain — illustrates the point. Ninety percent of the growth in power generation in the last 30 years has been caused by higher per capita consumption and only 10% by population growth. Were we to consider anything above the 1940 level of electric power generation incompatible with sound environment, we would be unable to tolerate a U.S. population today of more than 20 million, assuming current per-capita consumption. Or, taking the present population for granted, we would have to slash per-capita consumption by 90%.

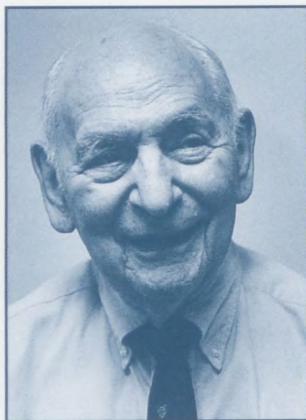
Technology-induced problems pose far more complex challenges. They form a spectrum, extending from nuisances, inconveniences, and insults to our aesthetic sensibilities all the way to potential threats to the life-supporting capacity of the earth. Similarly, the remedies range from fairly simple and cheap technological and institutional modifications to exceedingly costly ones involving a wholesale revamping of our way of life.

A given technology takes on "good" or "bad" characteristics according to its time, place, and purpose. The internal combustion engine, for example, did not come under indictment as a polluter of air until recently, but preoccupation with the motor vehicle as a safety hazard goes back to its very beginnings.

Our economic structure is based on a market system using costs, prices, and profits as guides to resource allocation. Few would contend that it is free of defects. But there has been no other system in history — nor is there one on the horizon — that has managed so well, at the least cost, to allocate resources among myriads of possible and competing end-uses.

THE CHALLENGE OF WASTE DISPOSAL

When it comes to disposing of wastes, however, we have no semi-automatic controls analogous to those regulating production and consumption. Indeed, here the system often works in reverse. Striving for the least cost for themselves, producer and consumer both tend to dispose of



HANS H. LANDSBERG

waste in ways that impose the greatest cost on society. In short, the market economy is a reasonably satisfactory organizing principle for allocating resources in production, but it does not help us and often hinders us in organizing the handling of wastes at the least cost to society.

Until recently this deficiency was of little significance. In earlier times, the capacity of the environment to assimilate waste was adequate for the then-prevailing levels of population, income, and technology. Consequently, the environment could legitimately be treated as a "free good," and limitations on its use were not necessary.

Any organizing principle of production — other than one that explicitly assigns a value to environmental factors — will tend to use these cost-free aids of production so intensively that eventually symptoms of excessive use appear — namely, pollution. Pollution will tend to occur sooner where incomes are high (and per-capita production and consumption are also high) and later where incomes are low. Any economic system, however, can be made to respond to environmental considerations, and that is the real challenge.

Economic growth need not consist of extras, frills, and planned obsolescence. It can also consist of public goods, including improved environmental quality. Economic growth should stand for increased options for everybody. In principle, therefore, it is something to embrace. It means moving from spending 70% of the household budget on food, as in much of Asia, to spending less than 20%, as in this country.

Then there is the corporation. Since it lives by the profit motive, it obviously exploits any cost-cutting opportunity, especially free use of the environment. But this opportunism is not unique to the private corporation. The Soviet Steel Trust behaves exactly as U.S. Steel does. In both instances, only the imposition of specific constraints on the producer brings about consideration for the environment.

The imposition of charges high enough to compensate for environmental damage would stimulate a search for a technology that would help the corporation reduce these charges or escape from them totally. But air, water, and land pollution are alternative ways of managing waste disposal; hence the charges must be structured to prevent the air polluter from turning around and becoming a water polluter, or vice versa.

The Evolution of the **RFF LOGO**

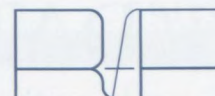
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**RESOURCES
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2002



With this qualification, there is no reason to believe that competition cannot become a help rather than an obstacle to environmental enhancement. In the search for new policies we have barely scratched the surface. The corporation, after all, has come to terms with industrial safety, with minimum wages, with the end of child labor, and with many other institutions that are not in its short-run interest but that society has imposed on it.

It is a perfectly valid contention that the corporation can be made responsive to policies designed to protect the natural environment. The real difficulty lies in translating concepts into a working system.

This article was condensed from the original, which ran in the June 1970 edition of *Resources*.

RFF in the news THEN *and* NOW

ON NATURAL RESOURCES ADEQUACY THE *NEW YORK TIMES* (4/8/63)

"The five-year study by Resources for the Future applies the most advanced tools of mathematics and economics to an evaluation of present trends and the modifying effects of new technology. ... The real value of the study and of the debate that it has aroused is that both sharpen public concern with the problems in this area."

ON CARBON MITIGATION POLICIES THE *ECONOMIST* (2/14/02)

"The RFF approach seems best; it forces politicians to say what prices society should be willing to pay to address global warming – and offers a pragmatic way to make that cost explicit."

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William Cronon, Professor, University of Wisconsin – Madison
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Paul M. Romer, Professor of Economics, Stanford University
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Discounting the Benefits of Climate Change Policies Using Uncertain Rates

Richard Newell and William Pizer

Evaluating environmental policies, such as the mitigation of greenhouse gases, frequently requires balancing near-term mitigation costs against long-term environmental benefits. Conventional approaches to valuing such investments hold interest rates constant, but the authors contend that there is a real degree of uncertainty in future interest rates. This leads to a higher valuation of future benefits relative to conventional methods that ignore interest rate uncertainty

Most environmental policies involve a trade-off between short-term costs and longer-term benefits. Investments in cleaner technologies, for example, require up-front expenditures that lead to future environmental improvements. Climate change presents a dramatic need for balancing costs and benefits over time because the benefits of mitigation measures are linked to the lifespan of greenhouse gases (GHGs), which may remain in the atmosphere for centuries.

How do we compare costs and benefits that are separated by many decades or even centuries? When an individual saves for retirement, or a business invests in new equipment, the market interest rate allows us to convert costs and benefits at different points in time into comparable costs and benefits at a single point in time. This procedure is known as discounting.

But few markets exist for assets with maturities exceeding 30 years, making the interest rate beyond that

horizon highly uncertain. This uncertainty has important consequences for the valuation of distant benefits from current policies, yet it has been virtually ignored.

We start by using one of several available models that estimate the time-profile of the benefits associated with reducing one ton of carbon emissions in the year 2000—see Figure 1. Regardless of any disagreement about the magnitude of climate consequences, the figure depicts a sensible pattern of mitigation benefits—a delayed, then an increasing, and finally a declining effect, as the climate adjusts first to the increase in carbon dioxide (CO₂) and then to its gradual decay. It turns out that only the overall shape of the path of benefits, not the magnitude, matters for our analysis of the effect of interest rate uncertainty.

The standard approach is to convert the model's path of benefits into equivalent discounted values in 2000, based on a single interest rate, and add them up. Applying

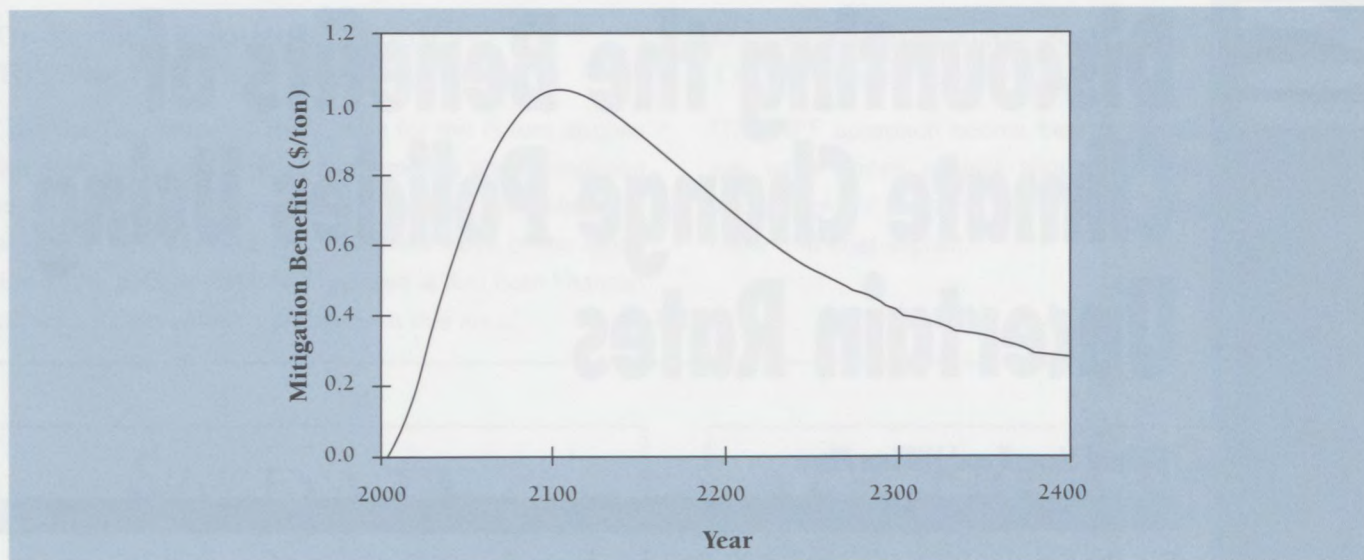


Figure 1: Time Profile of Benefits from Reducing 1 Ton of Carbon Emissions in 2000
 Note: Based on William Nordhaus' Dynamic Integrated Climate Economy (DICE) Model

an interest rate of 4%—the average rate of return to government bonds over the past 200 years—one obtains a discounted value of about \$6 per ton. This value can be balanced against marginal mitigation costs to determine optimal reductions or directly interpreted as the optimal tax on CO₂ emissions.

Despite the appealing simplicity of that approach, no one knows whether the interest rate will be 4% for the next 400 years. How, then, can we calculate the value of tomorrow's benefits in today's dollars?

Discount Rates

The term *discounting* arises because individuals typically value future consumption less than present consumption—they discount the future. Discounting is tied to the interest rate, which reflects the rate at which wealth can be traded across time. For example, investing \$100 at 7% yields \$107 at the end of the year. That \$100 today can be traded for \$107 next year indicates equivalence between these values. One would say that the future (next year) is discounted at 7%.

The investment criterion used in business provides another way of looking at the rationale behind discounting. Here's an example. Let's say private firms can borrow funds at 7% interest. If \$100 invested in research or equipment yields a net pay-off of more than \$7 every year, they can repay creditors and have something left over. Otherwise, they lose money. This is the net present value rule: if the net benefits from a project discounted

at 7% are greater than zero, the project is desirable.

Enter taxes. Because individuals pay up to 50% in federal, state, and local income taxes on their 7% pretax return, their actual return is closer to 4%. This consumption rate of interest is a measure of the rate at which people trade off their spending over time. Individuals can forgo consumption today, invest the money, and consume the after-tax proceeds from the investment at some future date.

The type of investment raises another complication, because riskier assets compensate investors by paying a higher rate of return. Thus, while equities have had an average return of about 7%, bonds have had an average return of only 4% before and 2% after taxes. To separate risk from discounting, we need to identify low-risk investments. Government bonds are considered very safe and a benchmark for the consumer interest rate absent any risk premium.

Applied 400 years into the future, however, the 2%–7% range of plausible discount rates has a corresponding difference in discounted values of 200 million-to-1. On top of this enormous variation depending on the choice of rate, we must consider how these rates may change in the future.

Consider the history of interest rates on long-term U.S. government bonds (Figure 2). Treasury bonds represent the highest-quality, lowest-risk market investment consistently available in the United States over the past 200 years. There have been persistent fluctuations in the real interest rate over the past

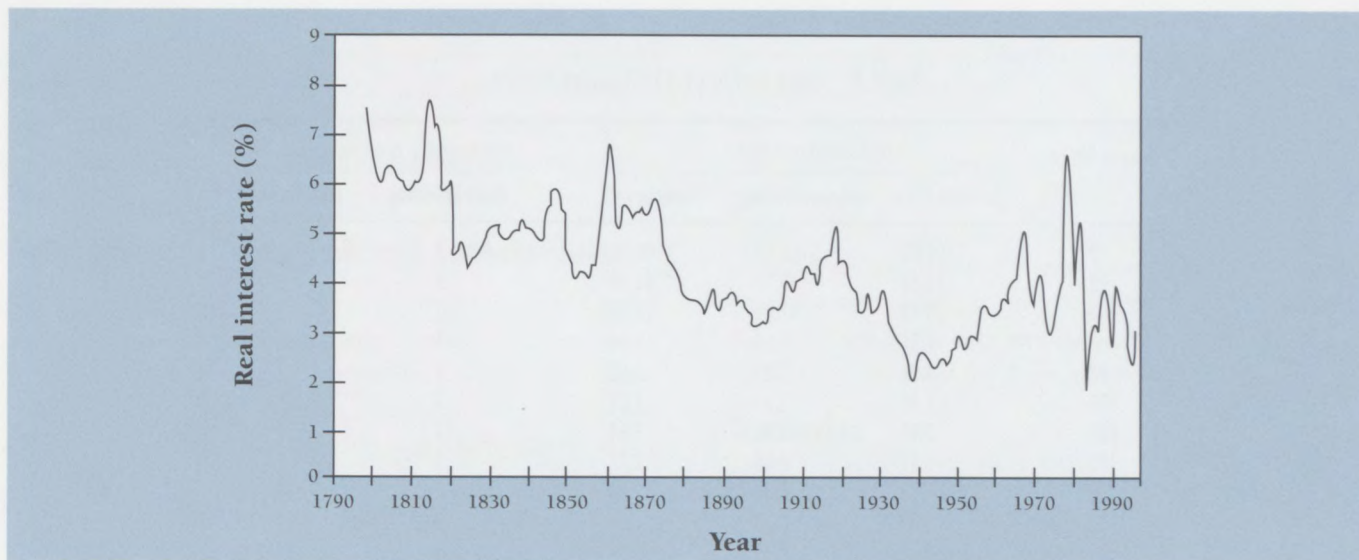


Figure 2: Market Interest Rate on U.S. Long-Term Government Bonds (1798–1999) (adjusted for inflation)

200 years, and it should not be surprising if interest rates continue to change by 3% or more—up or down. We need to evaluate the impact of this behavior on future valuations.

The Effect of Uncertainty on Future Valuations

Suppose we all agree that the current discount rate should be about 4%, based on the average market return to government bonds. Arguably, future rates might decline to as little as 1% over the next 100 years—or rise to 7%. If they fall to 1%, \$100 dollars in 2100 is worth \$20.28 today. But if they rise to 7%, \$100 in 2100 is worth only \$0.20 today. Placing equal weight on these two outcomes, the expected value of \$100 in 2100 would be \$10.24.

Now consider the same analysis for the present value of \$100 in 2101—just one year later. Based on a rate of 1% in 2100, the \$20.28 would be worth only \$20.08 ($20.28 \div 1.01 = 20.08$). Similarly, at 7% in 2100, the \$0.20 would decline to \$0.19 ($0.20 \div 1.07 = 0.19$). Averaging these results, the expected value of \$100 delivered in the year 2101 would be \$10.13. The expected value thus declines by 1% ($10.24 \div 10.13 = 1.01$).

That is, with equal probability on 1% and 7%, the effective discount rate is very close to the lower value, not the average of the two values. As it turns out, it is discount factors, not discount rates, that one should average—and this distinction makes a big difference for long time horizons. (Discount factors multiply future values to convert them into today's dollars.)

Why does one effectively use the low rate rather than the

average? Intuitively, discounting benefits 100 years hence depends only on the lower rate because the higher rate discounts future benefits to such an extent that they add very little to the expected value. The expected value of \$10.24 almost equals the value when the rate falls to 1%, \$20.28, multiplied by the probability of that outcome, 50%. In fact, the expected value would be virtually the same if the high-value interest rate were 10%—or 110%—instead of 7%. In this way, the change in value between periods comes to depend solely on the lower rate.

Next we need to model the fluctuations in interest rates. Do they take "random walks"? That is, just as when a drunk meanders down the street, his movement is random, and wherever he is now, that is the best guess about where he will be in the future. We might therefore assume that current rates represent the best estimate of future rates. Or do interest rates, whatever their short-term random movement, tend to revert to a long-run average or "mean"?

Unfortunately, the statistics neither confirm nor reject either model, and yet the choice makes an enormous difference. Under the mean-reverting model, which assumes that interest rates cannot remain high or low indefinitely, uncertainty about future interest rates has a much smaller effect on future valuation. Although the random walk model is more compelling to us, we report results for both models because subjective opinions could differ.

Based on statistical estimation of historical interest rates, we can simulate future interest rate paths. We repeat this process

Table 1. Value Today of \$100 in the Future

Years in future	Discounted rate model			Value relative to constant discounting	
	Constant 4%	Mean reverting	Random walk	Mean Reverting	Random walk
0	\$100.00	\$100.00	\$100.00	1	1
20	45.64	46.17	46.24	1	1
40	20.83	21.90	22.88	1	1
60	9.51	10.61	12.54	1	1
80	4.34	5.23	7.63	1	2
100	1.98	2.61	5.09	1	3
120	0.90	1.33	3.64	1	4
140	0.41	0.68	2.77	2	7
160	0.19	0.36	2.20	2	12
180	0.09	0.19	1.81	2	21
200	0.04	0.10	1.54	3	39
220	0.02	0.06	1.33	3	75
240	0.01	0.03	1.18	4	145
260	0.00	0.02	1.06	5	285
280	0.00	0.01	0.97	7	568
300	0.00	0.01	0.89	11	1,147
320	0.00	0.01	0.83	16	2,336
340	0.00	0.00	0.78	26	4,796
360	0.00	0.00	0.73	43	9,915
380	0.00	0.00	0.69	74	20,618
400	0.00	0.00	0.66	131	43,102

tens of thousands of times, each time drawing a different random path. Finally, we can make future benefits comparable with current costs by using a discount factor that translates future dollars into today's dollars. From the simulations, we have tens of thousands of equally plausible values for the discount factor at a particular point in the future. Common sense—and indeed economic theory—would tell us to average them to find an expected discount factor and, multiplied by the valuation in the future, an expected present value.

Table 1 presents our estimates, under both models, of discount factors over the next 400 years based on a 4% return in 2000 and using historical data on long-term government bonds to quantify interest rate uncertainty. For comparison, we present discount factors from a constant 4% rate. Discount factors are expressed in terms of the value today of \$100 provided at various points in the future—that is, the discount factor multiplied by 100.

After only 100 years, conventional discounting at a constant

4% undervalues the future by a factor of 3 compared with the random walk model of interest rate behavior. After 200 years, conventional discounting is off by a factor of about 40. After 400 years, it is off by a factor of more than 40,000. The mean-reverting model produces less dramatic yet still significant results, raising the discount factor by a factor of about 130 after 400 years.

We also run the numbers starting from initial interest rates of 2% and 7%—our upper and lower bounds—in the random walk model and find that the relative effect of interest rate uncertainty rises as the initial rate rises. For example, the effect after 400 years raises the valuation by a factor of 530 million based on an initial 7% rate, but the factor is a little over 100 based on an initial 2% rate. Intuitively, the effect must be smaller for low discount rates because the range of possible lower rates (0–2%) is narrower.

The difference between valuations using different initial rates is generally smaller when uncertainty about future rates is incor-

porated. The ratio of discount factors using a 2% versus a 7% initial rate (based on the random walk model) becomes about 40 after 400 years. Though still substantial, that compares favorably with a factor of 200 million based on constant discount rates. In other words, the effect of uncertainty renders the choice of discount rate less important.

Valuing Future Climate Change Consequences

We can now apply our uncertainty-adjusted discount factors to the consequences of climate change caused by CO₂ emissions. Take the estimated benefits every year in the future due to a one-ton reduction in CO₂ emissions in the year 2000, multiply by the discount factor for that year, and sum. The results are shown in Table 2.

Based on a random walk model and an initial rate of 4%, uncertainty about future interest rates raises the estimated present value of reducing carbon emissions from about \$6 per ton to \$10—an increase of more than 80%. Using the mean-reverting model, we find a more modest effect of about 14%. An initial rate of 7% yields a 95% increase, and an initial rate of 2% yields an increase of about 55%. This result—that the relative effect of uncertainty is larger when the initial rate is higher—reflects the greater opportunity for uncertainty to lower rates (versus a low initial rate that simply cannot go much lower).

Because we focus on a 400-year horizon, our results are con-

servative; extending the horizon further into the future introduces damages that are counted more heavily in the presence of uncertainty. Applying the uncertainty-adjusted discount factors to longer-lived GHGs (such as methane or sulfur hexafluoride) or including catastrophic or permanent events (including species loss) also generates larger increases in discounted climate damages because the consequences would be more heavily concentrated in the future. In general, the greater the proportion of benefit flows occurring in the distant future, the greater will be the error introduced through discounting that ignores uncertainty in the discount rate itself.

Conclusion

The evaluation of environmental policies frequently requires balancing near-term mitigation costs against long-term environmental benefits. To make these costs and benefits comparable, economic theory suggests discounting future consequences based on the market rate of return to investment. In this way, one gains assurance that environmental policies provide welfare improvements that are at least as good as other productive activities.

Here, we have considered the effect of uncertain future interest rates on the valuation of future benefits. Because unexpectedly low discount rates raise valuations by a much larger amount than unexpectedly high discount rates reduce them, uncertainty raises future valuations relative to analyses that assume a fixed discount rate.

Table 2. Expected Discounted Value of Climate Mitigation Benefits (per ton Carbon)

		Benefits from 1 ton of carbon mitigation	Relative to constant rate
Government bond rate (4%)	Constant 4% rate	\$5.74	—
	Random walk model	\$10.44	+82%
	Mean-reverting model	\$6.52	+14%
2% rate	Constant 2% rate	\$21.73	—
	Random walk model	\$33.84	+56%
	Mean-reverting model	\$23.32	+7%
7% rate	Constant 7% rate	\$1.48	—
	Random walk model	\$2.88	+95%
	Mean-reverting model	\$1.79	+21%

After studying past interest rate behavior, simulating uncertain rates in the future, and computing discount factors for various time horizons and alternative base rates, we have found that valuations rise and the effect of uncertainty is larger for higher base interest rates. Comparing the discount factors directly, we conclude that the valuation of future benefits is less sensitive to the choice of initial discount rate when uncertainty is taken into account.

Because today's environmental decisions affect future generations, many economists have argued that it is unethical to discount the well-being of future generations. Others have argued that the intergenerational discount rate need not equal the rate used by individuals within their own generation. These arguments have led to a tendency to simplify the problem by applying lower rates over longer horizons. Long horizons, however, eventually become short.

We find that using market rates between 2% and 7% and

accounting for uncertainty lowers the effective discount rate such that all generations are essentially treated the same after a certain horizon. In that sense, our findings can be viewed as an argument for intergenerational equity that originates from conventional economics.

Using conventional discounting techniques to value benefits over hundreds of years renders future benefits insignificant and, to many people, that somehow seems "wrong." Our results show that constant discount rates do in fact undervalue the benefits of GHG abatement measures. We can at least partially address that problem—without abandoning conventional economic theory—by viewing future interest rates as uncertain.

Richard Newell and William Pizer are fellows at Resources for the Future (RFF). Greater technical detail on the approach and results described in this paper are given in RFF Discussion Paper 00-45 and in a report published by the Pew Center on Global Climate Change (see "For more information").

For more information

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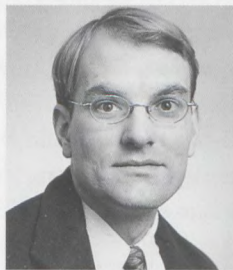
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RFF Welcomes Three New Members of the Research Staff: Spencer Banzhaf, Majid Ezzati, and Michael Margolis

Spencer Banzhaf comes to RFF with a Ph.D. and master's in economics, both from Duke University. He's worked as a consultant-in-residence and an economist for Triangle Economic Research.



Spencer Banzhaf

Banzhaf's work focuses on the economic valuation of environmental quality and the potential for introducing such values into economic accounts, such as the Consumer Price Index. "Over the

next year I plan to continue this work," says Banzhaf, "while also studying how the benefits from environmental improvements are distributed across society."

Majid Ezzati holds Ph.D. and M.A. degrees in science, technology, and environmental policy from Princeton University and a master's degree in electrical engineering and a bachelor's degree in electrical and computer engineering from McGill University.

Before joining RFF, he held a Global Health Leadership post-doctoral fellowship in the World Health Organization's Epidemiology and Burden of Disease Unit, where he conducted research on the contributions of socioeconomic, environmental, behavioral, and physiological risk factors to global and regional burden of disease.



Majid Ezzati

While at RFF, Ezzati will conduct research on the health effects of indoor air pollution from household energy use, the role of energy and other household level technologies in reducing disease burden, strategies for successful technology transfer, and quantifying the disease burden associated with different risk factors and the benefits of intervention programs.

Michael Margolis holds a Ph.D. in economics from the University of Wyoming. He also served as a post-doctoral research associate at the university. Before beginning his post-graduate studies, Margolis worked as a reporter for the *Del Rio News Herald*.

Of his work at RFF, Margolis says, "I'll be looking at several reasons people worry about the economic integration of the planet—food safety, invasive pests, and poor control of pollution and natural resource use. These and other factors give rise to real costs of trade, and we have only a very sketchy idea of how those costs compare to the benefits of trade."



Michael Margolis

All photos: Sylvia Johnson Photography

Correction

In the Fall 2001 issue of *Resources*, the bio for RFF board member Lawrence H. Linden incorrectly stated certain facts. He has been a managing director at Goldman Sachs and Co. since 1996, where he is co-chairman and chief operating officer of the firm's Global Compliance and Control Committee. He was a general partner of Goldman Sachs from 1992 to 1999. Linden worked at McKinsey & Co. from 1983 to 1992, rising to the rank of partner in 1988.

Summer Internships

RFF is now accepting applications for its 2002 summer internships. Approximately a dozen students will be selected to work directly with RFF researchers on a variety of ongoing projects or assist in developing new areas of research and policy analysis. A modest stipend will be offered for an average 10-week assignment.

RFF seeks candidates in the social or natural sciences with policy analysis experience, excellent writing skills, and an interest in complex policy problems that lend themselves to interdisciplinary analysis. Two of RFF's research divisions, Energy and Natural Resources (ENR) and Quality of the Environment (QE), additionally require a strong background and an interest in economics and quantitative methods. The Risk, Resource, and Environmental Management (RREM) division, RFF's third research division, seeks students with a strong interest in public policy.

Applicants may apply to one or more RFF division by submitting the following



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materials: cover letter describing interests, resume, photocopy of a recent transcript, and letter of recommendation sent directly to RFF by a faculty member. Applicants should specify which division they are applying to in the cover letter. Students applying to RREM should also send a brief writing sample.

Internships begin in June and run through mid-August. All materials can be faxed to 202-939-3460 or mailed to:

Resources for the Future, Summer Internship Program, 1616 P Street, NW, Washington, DC 20036. Applications to the ENR and QE divisions should be sent to the attention of John Mankin; applications to the RREM division should be sent to the attention of Marilyn Alano. All materials must be postmarked or faxed by 5:00 p.m. on March 15, 2002.

For more information, see our website:
http://www.rff.org/about_rff/internships.htm.

Reaching Out

RFF's researchers continue to bring their work to the world at large. The following is just a sampling of RFF outreach efforts over the last few months.

Molly Macauley attended meetings of the NASA Administrator's Space Science Advisory Committee and led discussions on measuring performance, public and private sector roles in technology development, and the role of the government in basic research. She was recently inducted into the International Academy of Astronautics.

Howard Gruenspecht talked about why the United States is unlikely to reduce its dependence on Saudi oil in interviews with ABC's Nightline and the *Weekly Standard*. He also was quoted in "Driven Mad by SUVs" in *Reason*.

The Christian Science Monitor published an op-ed by **Thomas Beierle** and **Ruth Greenspan Bell** on how environmental "right to know" programs have become a casualty of the war on terrorism. Bell also gave an invited presentation to the Environment Division of the InterAmerican Development Bank.

Kenneth Frederick testified on national water supply issues at a hearing before the Fisheries, Wildlife, and Water Subcommittee of the Senate Environment and Public Works Committee.

James Sanchirico gave a lecture on fishery economics and policy at the U.S. State Department's Foreign Service Institute.

Michael Taylor has written op-eds for *The Christian Science Monitor* and the *St. Louis Post-Dispatch* on the U.S. role in achieving global food security and the safety of our domestic food supply system, respectively.

Karen Palmer and **Dallas Burtraw** discussed their work on market solutions to climate change at a conference sponsored by Redefining Progress, a California think tank that focuses on environmental, social justice, and sustainability issues.

Margaret Walls attended an Organization for Economic Co-operation and Development conference in Paris and presented a paper on solid waste management.



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Through the generous support of corporations, individuals, and foundations, Resources for the Future is able to fulfill its mission to do scholarly research and policy analysis on the most important energy, environmental, and natural resource issues we as a society face. The unrestricted gifts and grants we receive help us maintain our ability to do scrupulously independent work, as well as our reputation as the only objective source for unbiased information on often difficult and divisive issues. We are grateful for the generous support of our 2001 benefactors and are honored to recognize them in this publication.

The RFF Council recognizes those corporations and individuals that provide significant annual financial support to the institution. Corporations give a minimum of \$25,000 annually and individuals, \$5,000 annually. In 2001, Council members provided more than \$2.5 million to RFF to help ensure that we continue to influence the development of sound public policies by injecting new knowledge and reason into the political debate. More importantly, Council members provided valuable intellectual leadership to RFF scholars—providing insight and "real-world" perspective on current and emerging research. We appreciate the support and involvement of all of our Council members.



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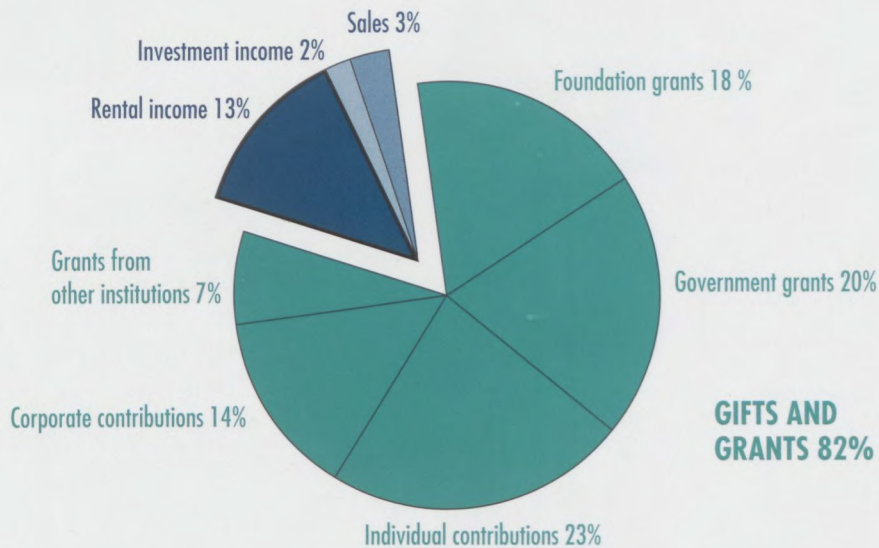
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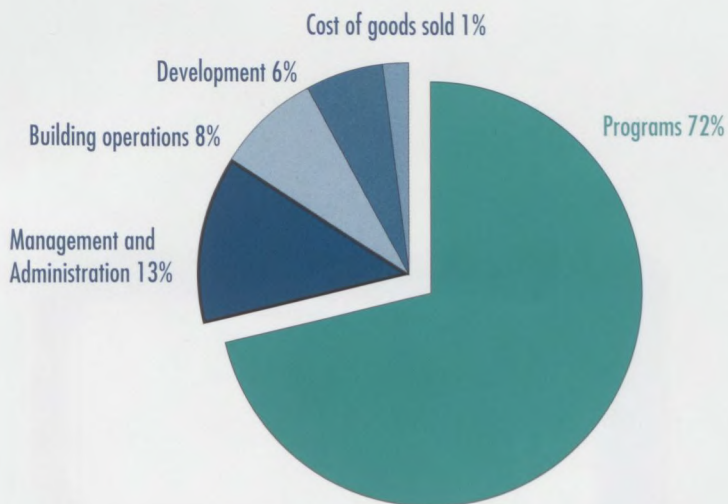


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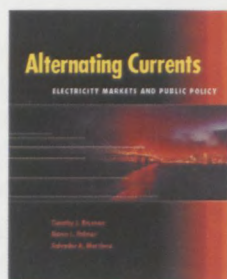
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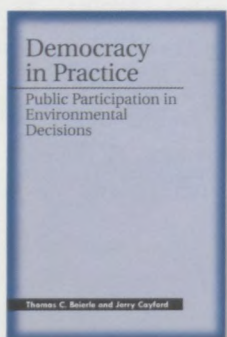


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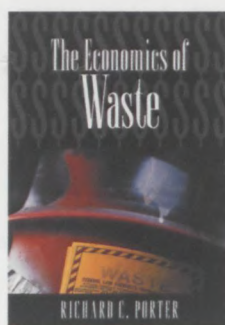


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