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Research Front and Center— and on the Horizon

This is an interesting and exciting time at RFF. For one thing, our budget is growing—to \$8.6 million for the fiscal year that just began, from \$7 million just a couple of years ago. This larger budget is due to no single benefactor but rather is the result of steadily growing support from all sources—our endowment, government, foundations, corporations, and individuals. These sources include many of you, the readers of *Resources*, for which we are most grateful.

Second, the issues on which RFF's researchers are hard at work are increasingly visible. Nowhere is this visibility more evident than on climate change policy, the subject of our two feature articles in this issue of *Resources*, as international negotiations proceed in the wake of the Kyoto protocol. RFF will continue to be an original source of careful and independent analysis of the major issues in the climate policy debate, and will also continue to help those interested to understand the various positions staked out by advocates.

Climate is not the only issue where RFF's work lines up well with important policy debates. For instance, we continue to pay close attention to the ongoing changes in the electricity industry in the United States. Are you aware, fair readers, that we will all be "shopping for good deals" on electricity before too long? RFF Director Linda Taliaferro, the subject of an interview in this issue, believes that the interests of traditionally disadvantaged parties must be well represented if retail competition in this industry is to succeed.

Also, RFF continues to devote a lot of attention to the environmental consequences of the transportation sector—at a time when newspapers are replete with stories about the emissions standards to which the ubiquitous "sport utility vehicles" ought to be held in future years, and about the consequences of alternative fuels and fuel additives for cars, trucks, and buses.

Throw into this mix our ongoing work on forestry, waste management in both the public and private sectors, biodiversity policy, risk management and regulatory reform, and corporate social responsibility and we are right in the center of important debates.

RFF's reach is expanding in other areas as well. To take but one example, a steadily growing share of our work deals with environmental and resource problems in newly emerging democracies and developing countries. Recent or ongoing projects involve collaborators in China, Thailand, Mexico, Taiwan, Ukraine, Lithuania, and Romania. RFF is just now embarking on what may be a very ambitious collaboration with the new government of Colombia. Future issues of *Resources* will bring you news of these and other projects with a distinctively international flavor.

So, stay tuned, readers, and—if you can—please contribute to RFF so that we can continue to expand in this exciting era. Thanks!



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GOINGS ON

Council considers emissions trading

Members of the RFF Council met in Washington in October to preview some of the issues recently aired at the Fourth Conference of Parties in Buenos Aires. The focus was on the role that greenhouse gas emissions trading can—or should—play in devising a global policy to thwart climate change. **Todd Stern**, who directs the White

program. The World Bank's Chief Economist (and RFF board member) **Joseph E. Stiglitz** capped the meeting off with a dinner speech.

The Council met in conjunction with the annual meeting of the RFF Board. The Board created the Council in 1991 to recognize RFF donors and their interest in natural resource and environmental policy. 

cates of trading concede, however, that no workable trading system is poised and ready to go. Expanding on the current capacity to analyze the various alternatives quantitatively is what RFF researchers are now doing.

So far, quantitative analysis has focused primarily on carbon taxes, using economy-wide models that leave out important details about trading in individual business sectors and thus limit study of policy options. The goal of RFF's three-year project is to supplement the analytical framework with sectoral models and then integrate them with an economy-wide model. The sectors under study include electricity production; automotive transportation; and commercial and residential energy use.

The discussion was fruitful, according to workshop organizers Michael Toman, who directs RFF's climate economics and policy program, and **Jean-Charles Hourcade**, who directs the Centre International de Recherche sur l'Environnement et le Developpement in Paris. While differences of opinion were not reconciled, some hints of what might lead the way to their resolution were identified, the organizers reported.

International emissions trading was a prime focus of discussion, since Europeans and Americans diverge on the merits of buying and selling permits to emit the greenhouse gases that are the byproducts of industry, energy production, and transportation. However, workshop participants suggested some ways that each side could begin to build up mutual confidence. The United States, for example, might consider ways to demonstrate concrete changes in domestic energy use and investment without quantitative limits on international trading. European governments could increase confidence by strengthening their legal commitments to the targets.

PATRICK DEASON PHOTOGRAPHY



Todd Stern

House Climate Change Task Force, and **Anders C. Jessen**, who is the first secretary, Delegation of the European Commission, described their respective governments' relatively more and less enthusiastic embrace of trading to meet their emissions reduction commitments.

Joining them in a panel discussion were **Richard L. Sandor**, the CEO of Environmental Financial Products, **Jennifer L. Morgan**, a climate policy specialist with the World Wildlife Fund, and **Michael A. Toman**, the director of RFF's Energy and Natural Resources Division and RFF's climate economics and policy




Joseph Stiglitz

DOE funds RFF analysis


The U.S. Department of Energy awarded a \$450,000 grant to a group of RFF researchers recently to advance the sophistication with which greenhouse gas trading approaches are analyzed. The DOE award reflects growing interest in tradable permit systems to control emissions of gases that trap heat in the atmosphere and that are associated with climate change. What motivates this interest is the belief that trading will lower the costs of complying with any emissions reduction targets that the U.S. government agrees to hit.

Even the staunchest advo-

 For more information, contact RFF Public Affairs Manager Michael Tebo at 202-328-5019; tebo@rff.org.

RFF hosts climate conclave

A week after international climate negotiations in Bonn this past summer, RFF hosted a follow-on workshop in Washington. The idea was to create a hospitable climate in which some thirty academics and government officials could talk "off the record" and clarify points of disagreement about the climate policymaking process. Participants from Canada, Europe, the United States, and Japan attended.

 To download the workshop organizer's related report "International Workshop Addresses Emissions Trading Among Annex B Countries" go to http://www.weathervane.rff.org/netable/annexB_tradeconf.html.

For more information, contact Michael Toman, toman@rff.org.



GOINGS ON

Service sector scrutinized

RFF's Center for Risk Management is taking a closer look at the service sector of the U.S. economy to see how well current laws and regulations fit the firms in that sector. The service industries comprise the largest sector of the economy and account for almost three-quarters of employment and gross domestic product. Yet relatively little is known about their impact on air and water quality as well as on other aspects of the environment. To learn more, RFF is conducting the assessment in collaboration with EPA's Policy Office, which is also funding the project.

Health care; food services; leisure activities; and whole-sale/retail sales are the four industries undergoing examination for their direct impacts, their upstream and downstream effects, and any indirect effects they may have on individual behavior or on other sectors of the economy. The intensity of any impact is being gauged as well.

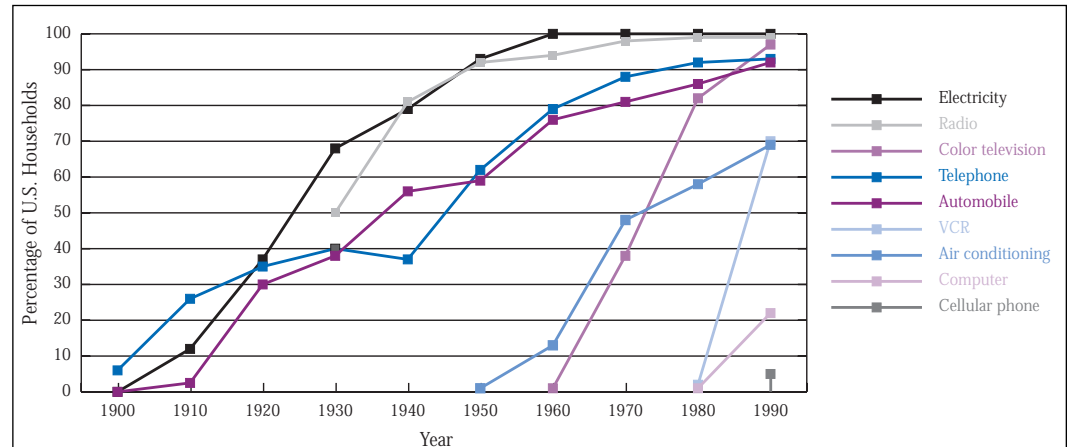
RFF and EPA will convene a workshop to review the preliminary results and suggest next steps. The workshop, which will involve around thirty invited attendees, is tentatively scheduled for January. Once the initial analysis is complete, RFF will circulate a draft report of the results.



For more information, contact Terry Davies, RFF fellow and CRM director at 202-328-5080; Davies@rff.org.

Facts for Thought

An occasional presentation of data about energy, natural resources, the economy, and the environment



Penetration rates of major consumer products in U.S. households

Source: Federal Reserve Bank of Dallas; adapted from *Fortune*, June 8, 1998

One important issue in environmental policy debates concerns the possible rates of adoption of environmentally benign technologies. In that vein, it is interesting to see how quickly familiar household products and services have found their way into our homes. It took more than fifty years to electrify 95 percent of U.S. households, but only twenty years before 95 percent had color televisions. More households had color TVs than telephones in 1995! How long before computers have a penetration rate of 90 percent?—**Paul R. Portney**

RFF to train Asian bank staff

The Asian Development Bank has chosen RFF to design and conduct a training program to help ensure that environmental considerations are better integrated into its operations. The training program will familiarize bank staff with emerging policy instruments for environmental management and show how they can help promote economic and environmental progress within developing member countries in the Asian and Pacific Region.

"RFF appreciates that this is

a unique time to be providing training," Visiting Scholar **Ruth Greenspan Bell**, who is leading the project, says. Asia's recent economic difficulties make devising efficient ways to protect natural resources and the environment all the more important. Even before the advent of these economic problems, Bell notes, the ADB has been gradually increasing its emphasis on loans designed to influence public sector reforms, in the areas, for example, of energy, agriculture, transport, industry, and urban development.

In taking on the project,

Bell adds, she has been impressed by the bank's desire for practical training that its staff can use in their day-to-day interactions with key policy-makers in developing member countries.

"We hope to provide training that will help bank personnel do their day-to-day jobs better," Bell says.

In designing and delivering the training, Bell will be joined by Senior Fellow **Alan Krupnick** and **David McCauley** of the International Resources Group.



American Opinion on Global Warming

The Impact of the Fall 1997 Debate

by Jon A. Krosnick, Penny S. Visser, and Allyson L. Holbrook

Extensive media attention to global warming and the surrounding debate during the fall of 1997 focused public attention on the issue. Both before and afterward, most Americans believed that global warming exists, is bad for people, and should be combated. But beneath the surface, dramatic changes were taking place: public opinion on global warming became more politicized.

During the fall of 1997, the American media focused a great deal of news coverage on global climate change and the debate being waged over whether the phenomenon poses serious problems or even exists. Kicked off in early October by the White House Conference on Global Climate Change, the media barrage included hundreds of stories on global warming on television and radio and in newspapers and magazines. The surrounding debate about the issue and its implications received further amplification in advertisements, paid for by business and other advocacy groups, as well as radio talk shows and numerous web sites. Coverage and debate continued until the United States and other nations met in Kyoto, Japan, in early December to sign a climate treaty. Afterward, the media turned away from global warming and attended to other issues.

Media focus on the environment at such a pitch has occurred rarely during the last thirty years. In only a few other instances has the concentration of coverage been comparable: in 1969, when both a blowout at an offshore oil drilling platform in Santa Barbara and the first Earth Day heightened environmental consciousness, and then again in 1990, when the *Exxon Valdez* spilled millions of gallons of oil into Prince William Sound.

Did the 1997 media deluge and public debate have any impact on Americans' opinions on global

warming? The traditional approach to answering this sort of question has been to measure the percentage of citizens who hold various views before and after exposure to information on a certain subject. If those percentages stay the same, most analysts conclude that opinions did not change, because (1) people failed to notice the media coverage, (2) the information offered to people lacked either credibility or novelty, and/or (3) people's opinions were so strongly crystallized that they were nearly impossible to budge.

Remarkably, though, this traditional approach to studying public opinion change would lead to exactly the *wrong* conclusion about the impact of the fall 1997 media coverage and debate on global warming. Beneath the surface of seemingly stable public opinion distributions there can be dramatic, interesting shifts in the views of different subgroups of the electorate. But to see those dynamics, one must bring to bear the conceptual and methodological tools of political psychology.

We are political psychologists, and in this article, we outline the findings of our recent survey research studying the impact of the fall 1997 media coverage of the issue of global climate and the debate that surrounded it.

We commissioned the Ohio State University Survey Research Unit (SRU) to conduct telephone interviews with a representative cross-section of 688

American adults between September 1 and October 5, 1997, that is, before the White House held its conference on global climate change. The SRU also interviewed another representative national cross-section of 725 adults between December 20, 1997, and February 13, 1998, that is, after the United States signed the climate treaty in Kyoto.

During the thirty-minute interviews, respondents were asked an extensive range of questions relevant to global warming. This allowed us to understand the contours of public beliefs and attitudes and to see how they changed.

Opinions in September–October 1997

Existence of global warming. Prior to the White House conference, substantial proportions of Americans said that they believed in the existence of global warming. A large majority of people (77 percent) said they thought the world's temperature probably had been rising during the last one hundred years, and 74 percent said the world's temperature will probably go up in the future if nothing is done to stop it.

Consequences of global warming. A majority of Americans (61 percent) believed that global warming would be bad; 15 percent thought it would be good; and 22 percent thought it would be neither good nor bad. When asked about a series of specific possible consequences of global warming, most respondents said it would cause undesirable outcomes: more storms (69 percent), reduced food supplies (57 percent), more water shortages (54 percent), rising sea levels (52 percent), and extinction of some animal (52 percent) and plant species (50 percent). When deciding how good or bad global warming would be overall, people placed the most weight on its impact on sea levels, food supplies, and animal species extinction.

Effort to combat global warming. When asked how much should be done to combat global warming, majorities of Americans advocated significant effort. Fifty-nine percent said the U.S. government should do "a great deal" or "quite a bit." Fifty-eight percent said the same about other countries' governments, 59 percent said so about U.S. businesses, and 44 percent said so about average people. However, only very small proportions of respondents believed these various groups were in fact doing "a great deal" or "quite a bit": 11 percent regarding the U.S. government, 4 percent regarding foreign governments, 7 percent regarding U.S. busi-

nesses, and 5 percent regarding average people.

Actions needed. A large majority of Americans (80 percent) believed that reducing air pollution will reduce future global warming. And 88 percent of people said the U.S. government should limit the amount of air pollution that U.S. businesses can produce. Likewise, a substantial proportion of people (71 percent) thought the United States should require countries receiving foreign aid to reduce their air pollution.

Willingness to pay to reduce air pollution. When asked whether they would be willing to pay any more money each month in higher utility bills in order to reduce the amount of air pollution resulting from some electricity generation, 77 percent of people said they would.

Summary. In sum, the American public largely shared the views put forward by President Clinton before the concentrated media coverage and related debate began in the fall of 1997. Majorities of people believed in the existence of global warming, believed it would be undesirable, felt efforts should be made to combat it, and supported federal legislation and personal sacrifice as mechanisms for doing so.

Did the Media and Debate Attract the Public's Attention?

More exposure to news stories. In September–October, 48 percent of respondents said they had seen either a newspaper or television news story about global warming during the prior four months, and this figure rose significantly to 56 percent among people interviewed in December–February. These figures suggest that media focus on global warming did indeed catch the attention of readers, viewers, and listeners.

More thinking about global warming. When asked in September–October how much thinking they had done about global warming, 54 percent of respondents said either "a lot" or a "moderate amount." When asked this question in December–February, 65 percent of people gave one of these two answers, again a statistically significant increase.

Faster reaction time. Psychologists gauge how crystallized a person's opinion is on an issue partly by how long it takes him or her to report that opinion when asked. The longer it takes to retrieve the opinion from memory and/or to build the opinion from miscellaneous considerations that come to mind, the less

crystallized the opinion is considered to be. People were significantly quicker at reporting their attitudes toward global warming during the December–February interviews (2.9 seconds on average) than they had been during the September–October interviews (3.3 seconds on average). These figures suggest that the thinking people did about the issue during the fall led them to crystallize their opinions on it.

Higher certainty. In line with this conclusion, 28 percent of respondents said they were extremely or very sure of their opinions on global warming in September–October, and this figure rose significantly to 34 percent in December–February.

Summary. From all these indicators, it appears the barrage of news coverage of global warming and the accompanying discussions did indeed reach people. But did they change opinions?

Opinion Change?

When examined on the surface, American public opinion seems to have remained largely unaltered. In December–February, 79 percent of people said global warming had been occurring; 75 percent said they thought it would occur in the future if nothing was done to stop it; 58 percent said it would be bad for people; 57 percent said the U.S. government should do a great deal or quite a bit to combat global warming; and 79 percent said they believed reducing air pollution would reduce global warming. These figures are not appreciably different than the comparable measurements made in September–October.

Statistically significant movement did appear on some dimensions, though, suggesting more public support for legislative solutions and *less* support for personal sacrifices to combat global warming. For example, 91 percent of people in December–February said the U.S. government should limit air pollution by U.S. businesses, up somewhat from 88 percent in September–October. Likewise, 80 percent of people in December–February said the United States should require air pollution reductions from countries to which it gives foreign aid, up from 71 percent in September–October. Yet *fewer* people were willing to pay higher utility bills to reduce air pollution: 72 percent in December–February, as compared with 77 percent in September–October.

These changes in opinion distributions are not huge, leaving unchallenged the general conclusion

that public opinion was largely stable. But political psychologists are always suspect of conclusions reached by such means, for a couple of reasons. First, when contentious debates between politicians and policy experts unfold as occurred on the issue of global warming, the public often takes its cues from the few political leaders they trust most. If different groups of citizens look to different leaders for cues, many people’s opinions can move, but in opposite directions. These changes are masked when the public as a whole is examined. Second, all citizens are not equally likely to be moved by public debates of this sort. People with strong attitudes and beliefs will remain steadfast, while those with weak preferences and perceptions are most likely to look to trusted leaders for cues as to what to believe. So we must examine the attitudes of these latter citizens if we are to detect any changes.

As the media widely reported during the fall of 1997, President Clinton and Vice President Gore championed the notion that global warming was a potential problem that Americans need to address, while many prominent Republicans and conservatives expressed skepticism. Thus, Democratic/liberal citizens might be expected to have moved toward the administration’s point of view at the same time that Republican/conservative citizens moved away. And indeed, this is exactly what occurred. In September–October, the gap between self-identified strong Democrats and strong Republicans was relatively small, and it grew substantially by December–February.

For example, in September–October, 72 percent of

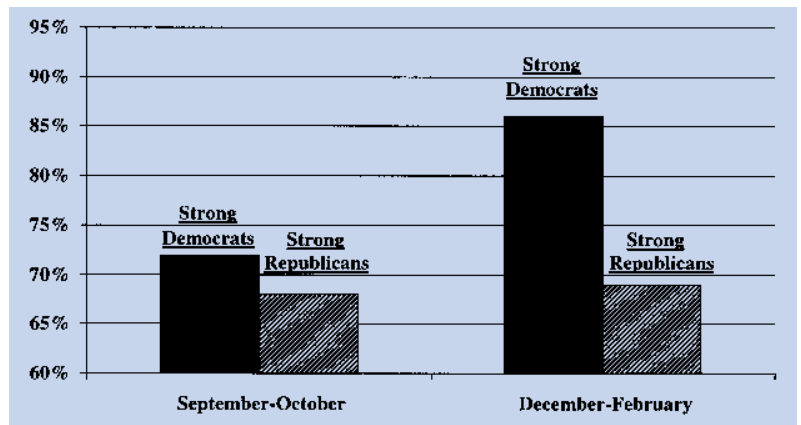


Figure 1. Polarization of opinions about whether global warming has probably been happening.

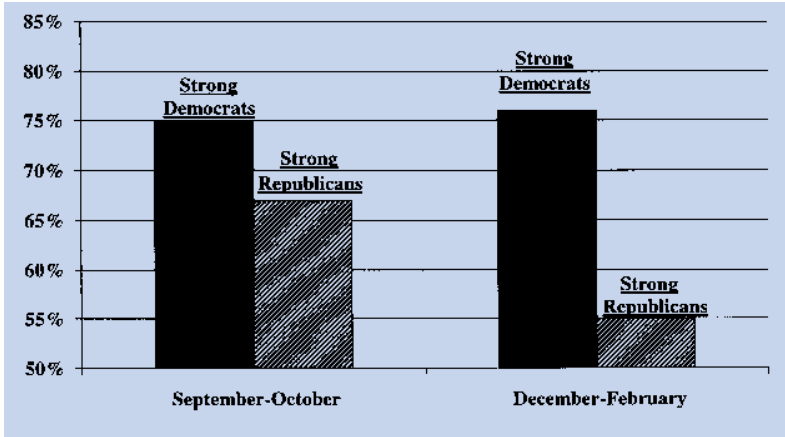


Figure 2. Polarization of opinions about whether global warming will happen in the future.

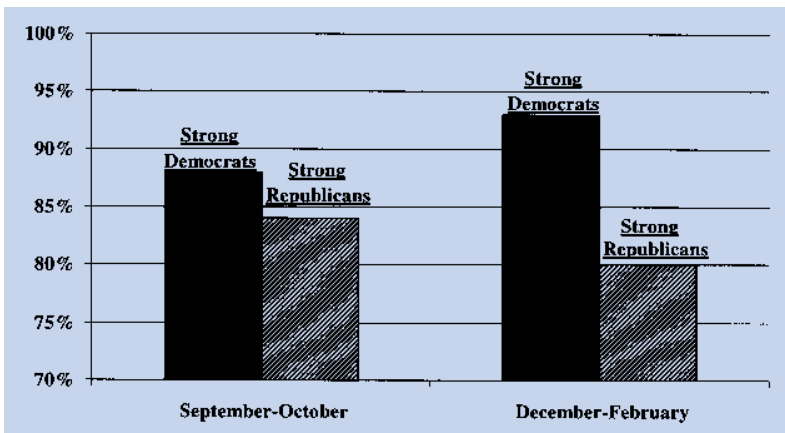


Figure 3. Polarization of opinions about whether the U.S. government should limit air pollution by U.S. businesses.

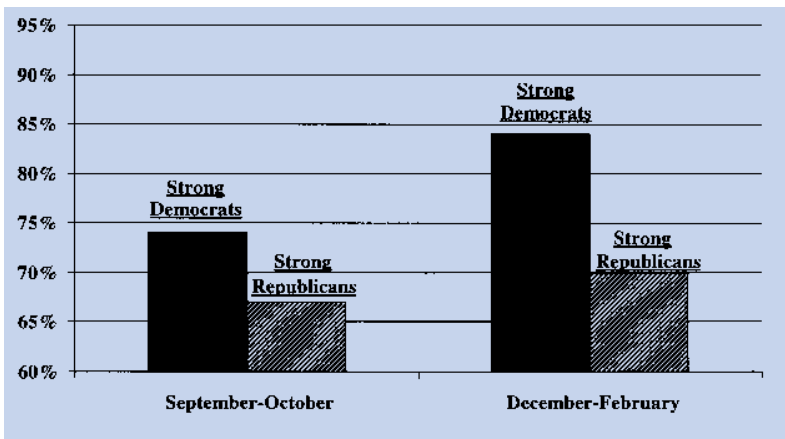


Figure 4. Polarization of opinions about whether the U.S. government should require recipients of foreign aid to reduce air pollution.

those who identified themselves as strong Democrats thought global warming had been occurring, compared with 68 percent of self-identified strong Republicans, a gap of 4 percent. In December–February, these figures were 86 and 69 percent, revealing an increased gap of 17 percent (see Figure 1).

Likewise, in September–October, only 75 percent of strong Democrats thought global warming would occur in the future, compared with 67 percent of strong Republicans, an 8-percent gap. In December–February, these figures were 86 and 55 percent, respectively, representing a 21-percent gap (see Figure 2).

Politicization was also apparent in opinions about whether the U.S. government should limit the amount of air pollution that U.S. businesses discharge. Eighty-eight percent of strong Democrats and 84 percent of strong Republicans said the government should so limit air pollution by businesses in September–October (a 4-percent gap), whereas 93 percent of strong Democrats and 80 percent of strong Republicans said so in December–February (a 13-percent gap; see Figure 3). And when asked whether the United States should require recipients of foreign aid to reduce pollution, 74 percent of strong Democrats and 67 percent of strong Republicans agreed that they should in September–October, a 7-percent gap. In December–February, 84 percent of strong Democrats and 70 percent of strong Republicans expressed this view, a gap of 14 percent (see Figure 4).

Although this growth of the partisan gap is clearly sizable, it appears even more dramatically when we focus only on those citizens most likely to take cues from partisan leaders: people who say they knew little about global warming in the fall of 1997. In terms of beliefs about whether global warming had been occurring, the difference between strong Democrats and strong Republicans grew from 1 percent in September–October to 20 percent in December–February among people who said they knew “little” or “nothing” about global warming, a change of 19 percent (see Table 1).

But among people who said they knew “a lot” or “a moderate amount” about global warming, the difference between strong Democrats and strong Republicans increased only very slightly, from 9 to 11 percent, a change of only 2 percent. For beliefs about whether global warming will happen in the future, the

Table 1. Growth in the Difference Between Democrats and Republicans Was Greatest Among the Least Knowledgeable Citizens

Belief	Respondents Who Knew "A Little" or "Nothing"	Respondents Who Knew "A Moderate Amount" or "A Lot"
Global warming has been happening	19%	2%
Global warming will happen in the future	29%	12%
U.S. government should limit air pollution by U.S. businesses	12%	2%
U.S. government should require recipients of foreign aid to reduce air pollution	25%	-20%

Note: The cell entries are the change in the gap between strong Republicans and strong Democrats. Positive numbers indicate that the gap grew between September–October and December–February, and negative numbers indicate that the gap shrank.

partisan gap grew by 29 percent among people who said they knew little or nothing about global warming, and shrank by 12 percent among people who said they knew "a lot" or a moderate amount.


Similarly, for beliefs about whether the United States should limit pollution by U.S. businesses, the gap grew by 12 percent among people who said they knew little or nothing about global warming, and only 2 percent among people who said they knew a lot or a moderate amount. Finally, for beliefs about whether the United States should require recipients of foreign aid to reduce pollution, the gap grew by 25 percent among people who said they knew little or nothing about global warming, and shrank by 20 percent among people who said they knew a lot or a moderate amount.

Conclusion

The extensive media coverage that occurred in the fall of 1997 and the debate surrounding it did focus public attention on the issue of global warming. Modest changes in the distributions of opinions occurred for the nation as a whole. But underlying these modest shifts were more sizable, crosscutting

changes that reflected polarization of strong Democrats and Republicans, especially among that segment of the electorate least knowledgeable about the issue. Despite this polarization, however, large majorities of Americans continued to believe that global warming had been happening, would occur in the future if nothing was done to stop it, would be bad for people, and that the U.S. government, American businesses, and foreign governments should take significant steps to combat the problem.

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 To download a copy of the authors' related report "The Impact of the Fall 1997 Debate About Global Warming on American Public Opinion" access <http://www.rff.org>. Copies may also be ordered by mail; see page 18.



Harvesting the Benefits of Carbon “Sinks”

by Roger A. Sedjo

Human effort to sequester more carbon—say, by growing more trees—is one way that countries can hold down the level of greenhouse gas buildup in the Earth’s atmosphere. Climate policymakers recognized this fact at Kyoto, but more work is needed to make the most of this strategy.

When industrial countries agreed to cut down on their greenhouse gas emissions last December in Kyoto, Japan, they were also signing on to the staggering task of figuring out how. Although the Kyoto Protocol is historic, it is no detailed blueprint for getting the job done. The treaty affirmed the worthiness of some tools, but left much to the imagination on how to use them.

One of these tools is carbon sequestration, the accumulation (or “soaking up”) of carbon in terrestrial as opposed to atmospheric forms. Carbon is stored in “sinks” that range from the world’s oceans and forests to agricultural soils. How humans deal with these storage sites can affect global temperatures. The Kyoto Protocol recognizes the hand that humans have in sequestration, providing for nations to receive either credit or blame, depending on whether they act to expand or contract sinks.

But climate policy experts will have to spend more time at the negotiating table before sequestration is likely to be an effective national strategy. Too many policy questions still need answers, and the Protocol recognizes only one aspect of the sequestration that may be possible.

In the meantime, policymakers and analysts in the nations that signed the Kyoto Protocol are getting better acquainted with the basic concept of carbon sequestration and assessing its merits as a climate change tool. What is clear already is that creating new forests as carbon sinks on low-cost lands is among the

least expensive ways to lower greenhouse gas buildup, especially in the short run.

What Is A Carbon Sink?

Carbon is stored in a variety of places. Natural stocks include oceans, fossil fuel deposits, the atmosphere, and the Earth itself where the element is present in rocks and sediments; in swamps, wetlands, and forests; and in the soils of forests, grasslands, and farmland. Human-created carbon stocks, which are expanding, include long-lived wood products and waste dumps.

A stock that is taking up carbon is a sink. A stock that is releasing carbon is a source of emissions.

Oceans, soils, and forests all have some potential for carbon sequestration. But, for now, forests offer the greatest immediate promise. Unlike many plants and most crops, forests accumulate carbon over decades and centuries. Their potential for accumulation is large enough that significant amounts of carbon may be sequestered in a matter of decades. Fortuitously, forests that people manage for timber, wildlife, and recreation sequester carbon as a matter of course. Forests may also be managed strictly as sinks. In any case, forest sinks are the only ones that the Kyoto Protocol explicitly recognizes as eligible for emissions reduction credits.

Of course, a forest can become a source as well as a sink. Carbon can be released quickly, for example, if a forest burns. Tree decomposition and logging reduce

forest biomass, also. If enough carbon is released, the forest will become a net source. If enough regrowth occurs, however, the forest will become a sink once again.

In many forests, natural disturbances such as fires create a cyclical pattern of growth (sequestration), disturbance (emission) and regrowth (sequestration) over periods of many hundreds of years. Even when a change in land use is deliberate, however, monitoring exactly what is happening to the carbon as the forest changes is necessary before a sink/source contribution can be determined—or before credits or debits can be assigned under a legal commitment like the Kyoto Protocol.

Measuring Activity in Forest Sinks

How helpful carbon sequestration will be in meeting emissions reduction targets will depend on how broadly the eligible activities—new forest creation (afforestation), re-establishment (reforestation), and destruction (deforestation) are ultimately defined. For now, it is clear that developed countries can take credit for sink accumulations that occur during the years 2008–2012 from forests established *after* 1990 on lands that, *prior* to 1990, were not forested.

Some analysts contend that the omission of forest management, conservation, and protection from the lists of activities eligible for credit implies that they will not qualify toward emissions reductions. Others contend that management and conservation are encompassed in the process of creating and rebuilding forests. But that interpretation leaves the problem of verification. And it is not clear how much of what is considered conservation and protection would even produce positive changes in verifiable carbon stocks. These activities may simply protect stocks that already exist. Indeed much of conservation's contribution to carbon sequestration is reducing forest destruction—and avoiding new debits in national emissions inventories in the first place.

The question of how commercial timber harvests are to be treated is also unclear. One interpretation is that harvesting simply has not been included in the Protocol and should be ignored. Once again, the answer may turn on how forest activities are defined. Most commercial timber harvest operations are closed circles that involve logging followed by regeneration. It is possible to see these harvests as neutral for pur-

poses of the Protocol: the release and recapture of carbon cancel each other out.

Tapping Other Sinks

The Kyoto Protocol is silent on ways to earn carbon sink credits other than through forest creation and re-establishment. But the Protocol does leave open the possibility that other managed sinks may be recognized eventually.

Agricultural and grassland soils have substantial potential to sequester carbon, for instance. People may use these soils to manage carbon routinely, particularly as new approaches like conservation tillage are introduced. For the moment, however, the Protocol recognizes such soils only as carbon sources to be included in emissions inventories.

It is possible that emissions reduction projects that emerge under the Protocol's Clean Development Mechanism may not be as limited in what activities they may count toward credit; the potential categories are simply not clear.

A Glossary of Challenges

A number of practical issues need attention, too.

Baselines. These need to be established as points of reference for determining how much a given project contributes to the net carbon sink.

Additionality. Baselines are also needed to help substantiate that the carbon sequestration claimed is “real and additional,” and the result of some forestry-based activity over and above what would have occurred in the absence of an emissions reduction program.

Thus far, “business as usual” baseline measures of the total stock of carbon in a defined area have proved scientifically challenging, particularly in cases where heterogeneous forest ecosystems are being examined. Evidence indicates that the measurement of total carbon is a complex process, and is likely to be expensive because forest ecosystems are unique.

In addition, there is a risk of unintended consequences. Monoculture plantations of trees known to sequester carbon rapidly may be more straightforward to measure and at much lower costs. Such convenience could well lead to the almost exclusive establishment of single-species tree plantations (which may render them more susceptible to single-species blights, such as Dutch Elm disease). Monoculture crops could outstrip biodiverse, heterogeneous forest ecosystems.



To avoid such consequences, incentives could be put in place that reflect the entire set of social objectives to be met by a forest ecosystem, not just carbon emissions concerns.

It may turn out not to be necessary to evaluate the total terrestrial stock of carbon in a defined area. Assessors might focus instead on the carbon flows that result from land use changes in the area over a specified time. Changes that had long-term impacts on carbon sequestration would be included in a national inventory of carbon flows that could be compared with a national baseline.

Leakage. To receive credit for reducing greenhouse gas emissions, nations may protect some areas, but shift their emissions-creating activities to other locations so that no actual reduction occurs. Such circumvention of emissions targets is most likely to occur in cases where carbon sequestration is evaluated at the project level, rather than within the framework of a national carbon budget. Administered at the national level, a carbon budget program would monitor total additions and deletions to carbon stocks with reference to a defined baseline.

Verification. To verify forest-based carbon offsets, third-party audits are likely to be conducted, much like those now done to certify that timber is properly harvested from sustainably managed forests. If the scope of carbon sequestration develops to include agriculture and other land uses, verification methods will have to accommodate the potentially infinite number of land use portfolios that comprise the global carbon stock.

Opportunity Costs. Forest lands cost more to maintain or establish in some areas than they do in others. In the United States, losing an opportunity to use a piece of land other than as an undisturbed forest is often a high price to pay. Other parts of the world appear more promising as places to manage as carbon sinks. In certain regions forested land is located in remote and rugged terrain where logging would be an expensive proposition. Such land may be a prime candidate for conservation. As for afforestation, it tends to cost less to establish permanent tree cover in regions of low agricultural productivity—where the opportunity costs of land are low—than to carry out many other carbon offset projects. Indeed based on current knowledge, creating new forests on low-productivity agricultural lands is among the least expensive ways available to reduce greenhouse gas emissions, particularly in the near term.

In seeking to better identify the costs involved in using carbon sequestration as an emissions mitigation tool, researchers are also taking into account behavioral responses to alternative land-use values. The consequences of what may be an irreversible conversion, for example, may dampen a landowner's willingness to agree to a major land use change. Communities may be attached to traditional agricultural activities that may be hard to give up. When such factors are considered, the costs of carbon sequestration are higher.

Room to Grow

The Kyoto Protocol has provided an incentive to study carbon sinks and how humans might best make use of them to hold down the level of greenhouse gases in the atmosphere. However, the Protocol deals only with a small subset of the total carbon flow. Attention is limited to carbon fluxes caused by human activities involving the creation, re-establishment, and destruction of forests after 1990. The global climate treaty's

scope is further narrowed by its focus on changes in carbon stocks only in the commitment period of 2008–2012. In its current formulation then, the treaty is set up to ignore many changes, including positive ones that humans make to sequester carbon. Forest management, for instance, will generate far more carbon sequestration than credit received.

However, the Protocol does have provisions for enlarging its focus in time. Article 3.4 speaks to the possibility of adding other categories of land use changes and forestry activities in the future. Nations may eventually receive credit for sequestering carbon through a wider range of techniques, including the management of agricultural soils as sinks, which holds especial promise.

All things considered, carbon sequestration is likely to be one of several tools that countries add to their greenhouse gas emissions reduction kits. Once the ambiguities and limitations of its initial integration into the Kyoto Protocol are ironed out, care must be taken to recognize the true opportunity costs of alternative land uses. In many cases, social values other than carbon sequestration are also involved, and tradeoffs will be necessary.

Roger A. Sedjo is a senior fellow at RFF and director of its Forest Economics and Policy Program. His most recent book *Sustainability of Temperate Forests* is described on page 18.



To download a copy of the related report “Carbon Sinks in the Post-Kyoto World: Part 1,” (RFF Climate Issue Brief No. 12) access <http://www.weathervane.rff.org>. Hard copies may also be ordered by mail; see page 18.

Further Readings

General

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INTERVIEW

With Electricity and Justice for All

RFF board member Linda C. Taliaferro is a lawyer and founder of the Talin Group, a management training and development consulting firm. She has served as chairman of the Pennsylvania Public Utility Commission and is currently on the board of Orange & Rockland Utilities, Inc., serving New York, Pennsylvania, and New Jersey. At mid-career, she decided to attend divinity school and received an M.A. in religion. Recently, she spoke with J. W. Anderson, RFF's journalist in residence.

RFF: What is life like for the regulators these days? It's a very different world with the deregulation of the electric utilities.

Taliaferro: It's unfortunate, but the job for some hasn't really changed that much. The real models are the deregulation of the trucking and telecommunications industries. There's still some oversight for rate-of-returns issues, for example, in the water industry. But there's also more oversight for quality-of-service and consumer issues.

My tenure was the early eighties, during the fly-up in the oil prices and the Three Mile Island situation in Pennsylvania. But my experience also foreshadowed what would be coming in electric issues after the trucking, telecommunications, and gas industry changes. I tried to communicate to staff then that we had to spend time studying the environment in which the utility operates—the service territory, the industry mix in its territory. We were actually anticipating issues involving benefits offered industrial customers of electricity to stem the flow, at least in the Pennsylvania area, of their departure from the state. Some of it had to do with the high cost of the utility services.

We had an early case—involving *Lukens Steel*—in which that firm wanted to switch utility companies and obtain out-of-state service. And at that time it created a very interesting legal problem, because it could have meant shifting approximately \$20 million in revenues from one utility to another. But the firm could not establish

that it was the high price it was paying for electricity alone that was causing their problems. So they weren't successful. But we then negotiated a way of offering incentives for them to stay in Pennsylvania and reduce their cost of electricity. I think some of those incentive pricing mechanisms foreshadowed today's goals.



Linda C. Taliaferro

RFF: Do utility commissions have the power, in your view, to oversee successfully the quality-of-service issues that are now going to arise?

Taliaferro: If you mean the legal authority, yes, they do, in my view. But the tricky part is bringing together the type of experience necessary in the economic analysis and the practical analysis and operating

experience—identification of problems and the ability to move fast toward solutions, the way the private sector is able to move. That's where the difficulties occur.

As a result of serving on the board of directors of a utility, I have seen it from the other side now. I and my colleagues have faced some of the decisions made by former regulatory colleagues on the commissions in imposing certain policies and operating standards. Take, for example, the whole issue of the divestiture of electricity generation—I am in a position to understand the desire for change. But at the same time I think the regulators have to understand the real motivating factors for all stakeholders—that is, the shareholders, rate payers, employees, and employers of the service territory. In time, we will know how successful we are, but experience with other industries does not provide for great optimism.

RFF: Do you think we're in for the same kind of turmoil in the electric utility industry that we have seen after deregulation in airlines and some of the other industries?

Taliaferro: Yes and it concerns me greatly. When I was doing some reading on the economic impact of deregulation and the whole philosophical debate, the thing that struck me was the availability of electric utility services throughout our society. According to EEI [Edison Electric Institute] it's around 98 percent of households—greater penetration than the phone system.

So there's a significant potential for disruption and confusion.

One problem area will be consumer fraud. Other issues will concern the nature of the services being offered and pricing of the alternative services. So there is room for a lot of mischief. Those at a disadvantage will be the economically and educationally and socially disenfranchised communities. I have very serious concerns about getting the information out to them. Those who would legislate on behalf of those communities need to understand that, as we know now, there is a void of information arising from the historic mistrust between utility management and the leadership in those communities.

RFF: Many people think of environmental justice as simply a matter of not putting the incinerator next to a neighborhood that isn't able to defend itself, but there's a lot more to it than that. Where do you see the issue of environmental justice going?

Taliaferro: I wish I could see where it was going, but I think that the first part of what you said is still a serious enough issue that has to be more widely recognized and dealt with in a balanced way. I think good science has to be brought to it, and good economics, and not answers driven by the political agenda of a few so that the ends are justifying the means. That's my concern.

In this issue as with the world climate issue, you hear it said that the less developed nations aren't involved. Well, let's go ask them why not. Until you get people who have the homegrown view of their own interest, speaking for themselves, then you won't really get the balanced decision making that you need.

RFF: Do you think that environmental justice is going to be a major concern in American politics? I have the sense that we were hearing more about this subject early

in the Clinton administration, and we've heard less about it recently.

Taliaferro: I think that as we evolve as a society we are going to hear it more. It has to be discussed not only as government policy and environmental approach but also discussed in terms of cultural issues. I think it is also going to be discussed from the spiritual side, if you will, but right now I can't think of a secular word for an ecumenical approach to this issue of sustainability. You have to recognize that you can't ensure your individual health or protect one small group or one narrow interest at the expense of everybody else. For example, I cannot, as someone with no children, simply ignore school reform and the training of young people. A failure to act may well come back and haunt me, whether in the level of my community's street crime, or in the lack of skilled workers to meet industry needs and foster economic growth. That's the circularity that has to be recognized—uniformly recognized.

RFF: Are the churches going to get more deeply into environmental issues?

Taliaferro: I think they are already deeply into them. At the seminary I discovered the level to which they are already involved. It's not covered in the media, but their involvement is there. Years ago the churches got involved with South African apartheid. Then they moved to issues of corporate investments and things like that. I am happy to see the churches' participation in environmental questions. At the same time, I am always concerned about the sources of the scientific and economic data.

RFF: Environmental justice is a pretty broad term. Within it, what interests you the most at this point?

Taliaferro: Right now it's the marginalized communities. The uneven application of

the standards is always one thing that concerns me. To take one example, it's the political and tax policy incentives that only the middle class takes advantage of because they're the only ones who can figure them out and see that they're eligible even if they aren't the ones who need it the most.

RFF: We all know what you do for RFF as a board member. What does being on the RFF board do for you?

Taliaferro: Actually, it's very exciting and keeps me in touch with some of the best economic analysis available. But more importantly it allows me to engage in discussions here from a different point of view, looking at the criteria and sometimes saying in small ways to people here: Wait a minute, how come I perceive it this way? I like staying in touch with the issues. I can capture the latest trends and analytical thinking in a comprehensible manner. Some information I file away, knowing that it's going to be useful. So it's not just me. It's also for people I interact with who, I think, also get the benefit of RFF.

RFF: Where would you like to see RFF go from here?

Taliaferro: I think I have been on the board long enough to remember when RFF was talking about public policy from mainly a domestic perspective. Now we see the new mission statement taking a world view. Where it goes from here is, I hope, to become an instrument of peace, through knowledge. That's about the only way I can put it. If you are fighting over the facts, you know, that's a potential for chaos. Hopefully, RFF will help us evaluate our interests to avoid problems, and in that way be an instrument for peace. Economic interests have led nations to war in the past, you know. ☺

Photo: Patrick Deason Photography



New Investment Abroad

Can it Reduce Chinese Greenhouse Gas Emissions?

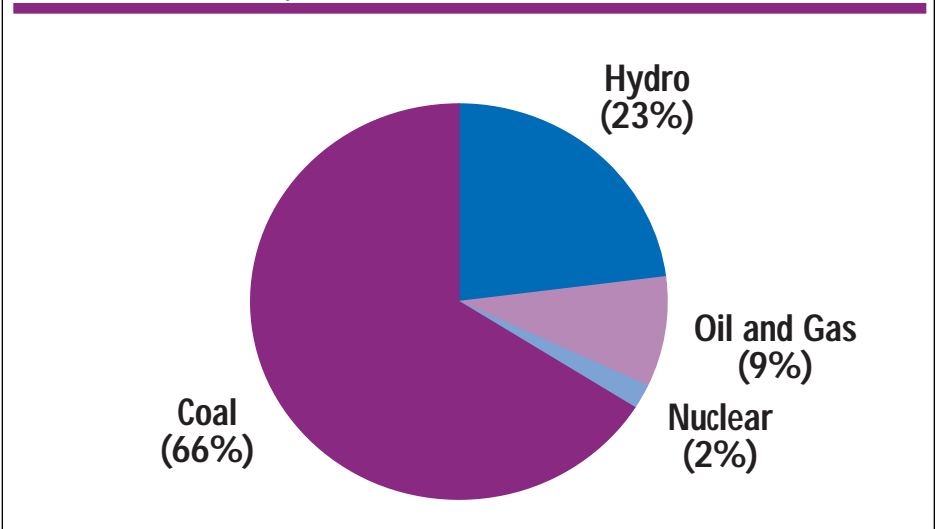
by Allen Blackman

In the next thirty years, developing countries will become the leading source of greenhouse gas emissions thought to cause global warming. Most of these emissions result from burning fossil fuels like coal and oil. Yet countries where weak public sectors and widespread poverty are pressing concerns are unlikely to be willing or able to undertake costly measures to lower emissions. Energy efficiency improvements may help resolve the dilemma. They not only reduce emissions of greenhouse gases but in some cases also significantly cut operating costs. Conceivably, firms in developing countries could be induced to invest in energy efficiency with minimal prodding. Foreign direct investment (FDI) by multinational corporations may be a principal means of transferring both the technology and the financial capital needed for such investments.

The Chinese electricity generating sector is an important test case for this hypothesis. China is already the world's third leading source of greenhouse gases and is likely to become the biggest contributor before the middle of the next century. China's fast-growing, almost exclusively coal-fired power sector is responsible for roughly a third of these emissions. In the early 1990s, China opened its doors to foreign direct investment in the power sector, a development that was met with a wave of enthusiasm by multinational corporations. What impacts has this recent opening had thus far?

Data from an original RFF survey of twenty American wholly-owned or joint-venture power plants in China suggest that FDI is indeed having a significant positive impact on energy efficiency. Average rates of coal consumption per kilowatt hour of electricity generated for the plants surveyed are considerably lower rates than rates for new Chinese plants of similar scale, and are even lower than rates for new American plants. The main reason is that almost a third of the twenty plants use

Sources of electric power in China



state-of-the-art generating technologies such as combined-cycle gas turbines (CCGTs) and circulating fluidized bed (CFB) boilers. These technologies have characteristics that make them especially attractive in China. Both CCGTs and CFBs accommodate the use of relatively cheap and plentiful low-grade fuels, a valuable feature given that the quantity and quality of fuel supply in China is uncertain.

In addition, unlike conventional steam turbines, CCGTs can be run efficiently even when started up and shut down on short notice as is often required in China. The plants in the RFF sample are even more efficient than rates of coal consumption indicate: a fifth of them use "waste" heat to generate heat or steam for industrial or residential facilities.

But not all the characteristics of FDI in China's power sector are encouraging from the standpoint of energy efficiency. To avoid the lengthy central government approval process for large plants and to minimize risk, early FDI tended to be in small-scale plants that are generally not as energy-efficient as large-scale plants. Perhaps more important, data from trade journals indicate that despite investors'

early enthusiasm, the volume of FDI in China's power sector will likely fall short of government targets for the year 2000 by a substantial margin. In large part, this shortfall is the result of persistent institutional barriers to FDI. Survey data suggest that the most important barriers are the uncertainties associated with the approval process for FDI projects, the regulation of the electricity sector, and the risk of default on power purchase contracts.

Allen Blackman is a Fellow in RFF's Quality of the Environment Division.

 To download the related report "Foreign Direct Investment in China's Power Sector: Trends, Benefits and Barriers" (RFF Discussion Paper 98-50) by Allen Blackman and Xun Wu, access http://www.rff.org/disc_papers/1998htm. Hard copies may also be ordered by mail; see page 18.



Cleaner Air, Cleaner Water

One Can Lead to the Other in the Chesapeake Bay

Save The Bay. For years, bumper stickers have carried the simple, urgent slogan on the back ends of cars in states that surround the Chesapeake. And for years governments in these jurisdictions have been responding to the call to do something about deteriorating water quality in the 200-mile-long arm of the Atlantic. Of course the task is far from simple. Tracking pollutants to their many sources and then finding ways to combat them is a major undertaking.

Merely identifying the sources of pollution has produced surprises. Agricultural runoff and municipal water treatment were fingered long ago as major culprits in the nitrogen buildup that chokes out aquatic life in the Bay. Only quite recently, however, did researchers discover that airborne nitrogen-oxide emissions—from utilities that generate electricity and from cars and trucks on the highways—can do the same kind of damage.

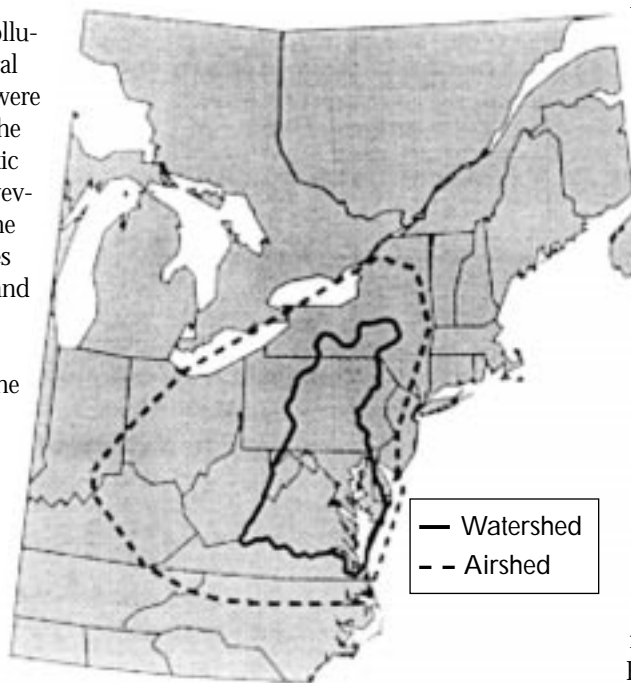
Now that researchers know about the connection between the Chesapeake region's air and water, however, they have begun to take a cross-media approach, which not only adds to the complications of analysis but improves the environmental outcome and reduces the price paid to achieve it. Analysts are thus on the lookout for "two-fers"—like a law that mandates cleaner air but whose implementation leads also to cleaner water.

RFF has completed a study this fall that substantiates just such an instance of ancillary benefits and the news is good for the Chesapeake Bay. RFF estimates that the huge body of water will benefit substantially from the large reduction in nitrogen-oxide emissions from utilities and other large sources that EPA has proposed for the Eastern United States under the Clean Air Act, plus expected reductions from mobile sources.

"The Bay obtains a bonus," Senior Fellow Alan J. Krupnick says of EPA's latest

effort to curb NOx emissions because they are a precursor to smog. EPA's more stringent emissions standards would reduce airborne nitrogen compounds (nitrates) that reach the Bay by at least 26 percent, the RFF study shows. But RFF projected even larger reductions if the EPA program were structured differently.

Program design matters, in other words, and is a "key message" of the analysis, Krupnick emphasizes. The Chesapeake



Chesapeake Bay Watershed and Airshed

Nitrates from the airshed enter the Bay mostly as deposits in the watershed that run off into the Bay.

Bay community and others with a stake in NOx emissions reductions should "not be indifferent," he says, to the features of a NOx trading program.

The RFF team estimated that the cost of complying with the new EPA program would be 40 percent cheaper than the cost all sources incur now to meet their obligations under the Clean Air Act. But RFF projected even larger savings if EPA extended the trading program to all the

different sources of NOx emissions—not just utilities. Savings could be achieved by shifting some of the burden of NOx abatement away from, say, electric utilities, and onto automobiles. At least as the RFF study turned out, the lower cost would be accompanied by fewer nitrate loadings to the Bay. The model showed a reduction in nitrates of more than 10 percent over what they would have been if only utilities could play the trading game.

Even greater cost savings (half the cost of command and control) could be had from an ozone exposure reduction program—one that targeted NOx emissions reductions geographically, concentrating cleanup in the Midwest and New York. But in that case the Bay would fare worse than under command and control. Thus not every tack that EPA might take to reduce ozone would benefit the Chesapeake as much as any other, nor do cost savings and NOx emissions reductions always go hand in hand. The crucial calculation for the Bay's health hinges on where the NOx is reduced.

These findings are gleaned from the first of a two-part analysis on which RFF researchers are working with colleagues Paul Guthrie and Brian Morton. The study is sponsored by EPA's Office of Policy, Planning, and Evaluation and the agency's Chesapeake Bay Program.



To download a copy of the report "The Chesapeake Bay and the Control of NOx Emissions: A Policy Analysis (RFF Discussion Paper 98-46) access http://www.rff.org/disc_papers/PDF_files/9846.pdf.

Copies may also be ordered by mail; see page 18.



ANNOUNCEMENTS


Applicants sought

RFF seeks applicants for its two academic award programs for the 1999–2000 academic year.

To honor the late **Joseph L. Fisher**, RFF president from 1959–74, RFF will award fellowships, each in the amount of \$12,000, in support of doctoral dissertation research. To be eligible, students must be writing dissertations in economics or policy sciences on issues related to the environment, natural resources, or energy, and have completed their preliminary examinations for a doctoral degree by February 1, 1999.

To honor the geographer and former RFF board chairman **Gilbert F. White**, RFF will award resident fellowships to two researchers, who have their Ph.Ds (or equivalent degrees) in hand. The fellows selected will each devote a year to scholarly work at RFF in social or policy science areas related to the environment, natural resources, or energy. The fellowships are open to all individuals who will have completed their doctoral requirements by the beginning of the 1999–2000 academic year, although some teaching and/or research experience is preferred. Gilbert F. White fellows are normally in residence at RFF for eleven months.

Applications for both award programs are **due February 26, 1999**. Awards will be announced in April.

 For more information, contact RFF's Coordinator for Academic Programs (202–328–5067); or access <http://www.rff.org>.



Economics and Policy Issues in Climate Change

Edited by William D. Nordhaus, *Yale University*

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Sustainability of Temperate Forests

Roger A. Sedjo, Alberto Goetzl, and Steverson A. Moffat

“Provides a good overview of sustainable forestry related to temperate zones. It also presents a good, practical discussion of the costs and benefits of moving towards application of sustainability practices. Would be a good supplemental text for courses on forest management and administration, and on forest policy.”

Hans M. Gregersen, *University of Minnesota*

Roger A. Sedjo is a senior fellow in the Energy and Natural Resources division of Resources for the Future. **Alberto Goetzl** is a forestry consultant with extensive experience in industrial forestry. **Steverson O. Moffat** is a Ph.D. student in forestry at North Carolina State University.



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for surface and US\$15 for air mail. Canadian and overseas payments must be in U.S. dollars payable through a U.S. bank.

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Had A Really Good Year? RFF Gift Fund for Tax Help

Individuals facing significant tax burdens in a particular year can take advantage of a unique opportunity that RFF provides—the establishment of an RFF Gift Fund. It is far simpler and less expensive than setting up a private foundation.

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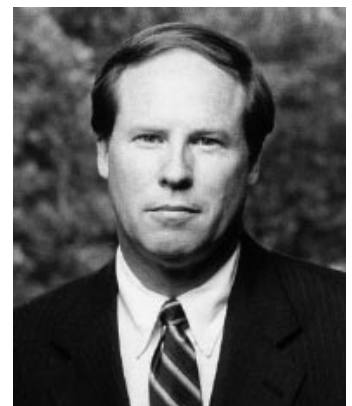
For more information about the RFF Gift Fund, gift annuities, gifts of appreciated securities, bequests, or other types of planned gifts, please contact RFF Vice President—Finance and Administration, Ted Hand at 202-328-5029.

Environmental outlook on RFF

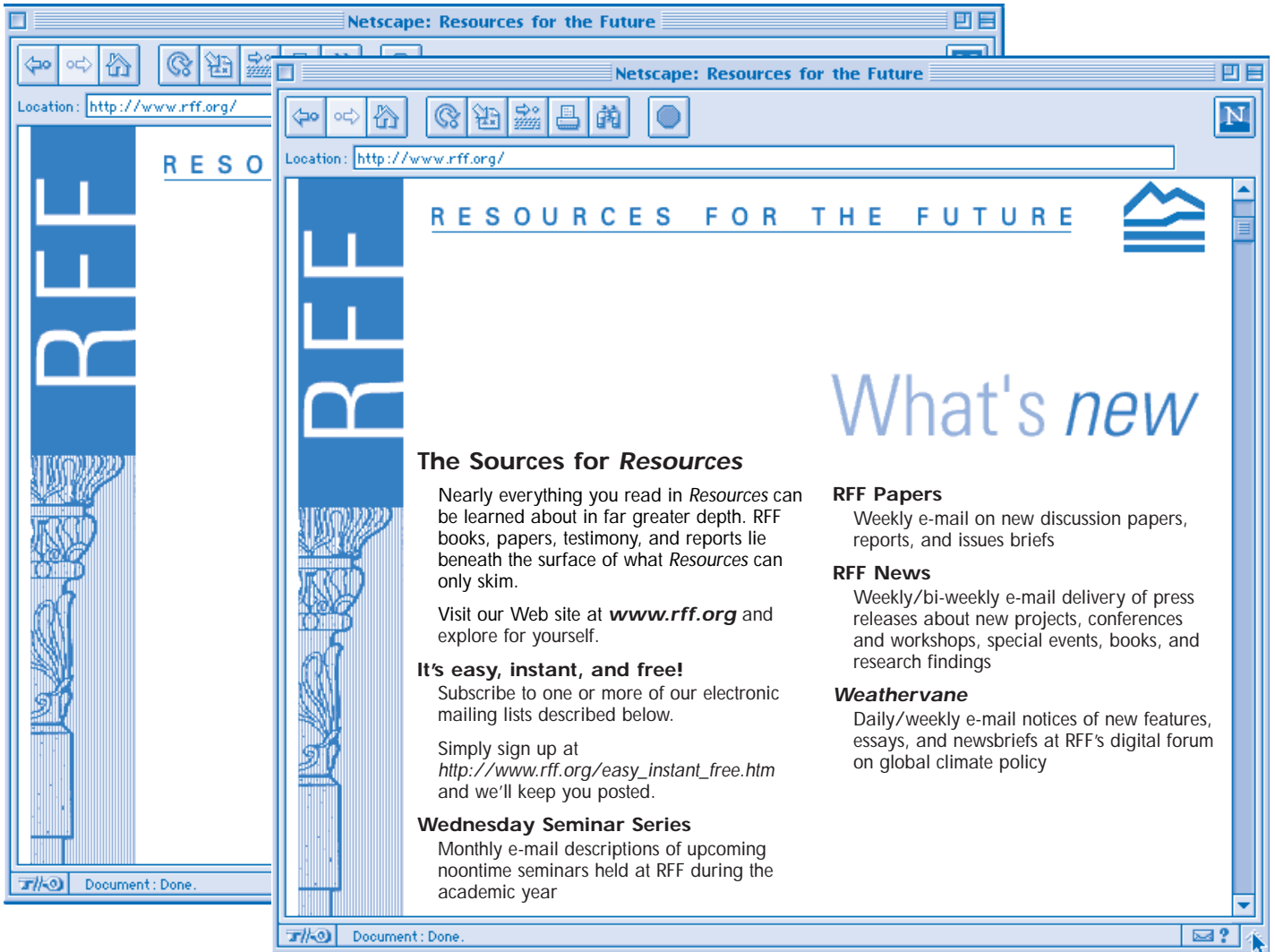
One very important group that RFF's analysis is intended to stimulate and inform is the environmental and conservation community. Recently, we asked two prominent members of that community what it is they value about RFF and its work.



There is a discouraging gap between quantitative analysts and “policy experts” in the environmental policy world. Although I certainly don't agree with all the conclusions that RFF reaches, there is no doubt that RFF's ability to “work with the numbers,” combined with its talents in zeroing in on timely issues, makes a valuable contribution to ongoing debates about environmental protection. I greatly respect the staff at RFF and call them frequently for their insight on many matters.—**Linda Greer, Senior Scientist, Public Health Program, Natural Resources Defense Council**



Resources for the Future is one of my favorite organizations. One of the most challenging problems facing those of us in the conservation community today is striking a balance between economic growth on the one hand, and the need to preserve and expand our rich natural and biological heritage on the other. This is exactly the kind of problem on which RFF researchers work. They listen carefully to all sides in policy debates and then enlighten everyone with their own careful analysis. RFF researchers are engaging more and more in the issues of the day, and no one can afford to ignore what they have to say.—**Patrick E. Noonan, Chairman of the Board, The Conservation Fund**



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