# RESOURCES

2-9

A Blueprint for Public Participation

# From the President



# RESOURCES

RESOURCES FOR THE FUTURE 1616 P Street, NW Washington, DC 20036–1400 202-328-5000

Fax: 202-939-3460 Editorial: day@rff.org Address changes: hase@rff.or Internet: www.rff.org

#### OFFICERS

President, Philip R. Sharp /ice President-External Aflairs, Lesli A. Creedon /ice President-Finance & Administration, Edward F. Hand

#### BOARD OF DIRECTORS

Frank E. Loy, Chair Lawrence H. Linden, Vice-Chair Catherine G. Abbott, Vicky A. Bailey, Michael J. Bean, Preston S. Chiaro, Norman L. Christensen, Jr., Maureen L. Cropper, W. Bowman Cutter, John M. Deutch, E. Linn Draper, Jr., Mohamed T. El-Ashry, J. Andres Espinosa, Daniel C. Esty, Dod A. Fraser, Kathryn S. Fuller, Mary A. Gade, James C. Greenwood, David G. Hawkins, Michael A. Mantell, James F. O'Grady, Jr., Steven W. Percy Matthew R. Simmons, Robert N. Stavins, Joseph E. Stiglitz

#### RESOURCES

Stanley N. Wellborn, Director of Communications Felicia Day, Managing Editor Sarah Beam, Assistant Editor Marc Alain Meadows, Art Director

Published quarterly since 1959, *Resources* (ISSN 0048-7376) contains news of research and policy analysis regard ing natural resources and the environment. The views offered are those of the contributors and should not be attributed to Resources for the Future, its directors, or its officers.

2006 Resources for the Future. All rights reserved. No part of this publication may be reproduced by any means, either electronic or mechanical, without permission rom the publisher. Contact Felicia Day at RFF (email: day@rff.org).

Resources is sent to individuals and institutions at no cost. To subscribe, contact Scott Hase at RFF (hase@rff.org) or 202-328-5006. The publication is also available on the RFF website, www.rff.org.

Cover illustration by Randy Lyhus

Design and production: Meadows Design Office, Inc

3 3 2 Printed with soy-based inks on 50% recycled and recyclable) paper containing 15% post-consumer iber; processed chlorine free.

# A Not-So Innocent Abroad

Nothing really prepares you for your first trip to China. I flew into Beijing on a Sunday afternoon, and that night, 300,000 tons of the Gobi Desert descended on the city streets. Although sandstorms occur every spring, this one was unusually intense, with more than a quarter of an inch of brown dust covering everything.

The storm dramatically brought home for me both the power of nature and the difficulty we have in coping when the resulting problems grow exponentially in scale. While thousands of people wielding push brooms and driving water trucks that sprayed the streets cleaned up Beijing the next day, the plume from that sandstorm blew into Korea and Japan, and most likely reached the West Coast of the United States. Without question, international and cross-boundary environmental problems are going to become all the more important in years ahead.

I went to China at the request of Bo Cutter, an RFF Board member, to confer with Chinese officials and industry representatives on energy policy. Having read many reports and watched plenty of documentaries, I was well aware that China was undergoing rapid economic growth and that environmental problems were mounting. But what struck me was the incredible consumerism that has taken hold there. In the streets, you see thousands and thousands of cars where once bicycles dominated.

I was just as struck by how open officials were about the problems they see in the country, in terms of both the environment as well as the economic inequalities that are exacerbated by rapid growth. While I was there, the government announced very publicly its own failure to meet its environmental goals. It certainly would be nice to see more U.S. leaders willing to be honest about the status of things in our own country! Make no mistake—our system is radically more open than theirs. But we should acknowledge that the Chinese can have frank, serious, and broad-based discussions about policy. However, their candor only goes so far: I got a taste of the government's power when a CNN International broadcast on protests in America over Chinese President Hu Jintao's visit was censored.

It is readily apparent that the United States—and indeed, the world—has much at stake in the extraordinary changes going on in China and elsewhere in the developing world as the pressure on global resources intensifies.

Phil Sharp

# CONTENTS



### DEPARTMENTS

## **Contributors**

About the scholars featured in this issue 2

## Goings On

CAFE Reforms Could Address Long-Term Oil Consumption, RFF Scholars Testify Before House, Senate 3

How Do International Crises Affect Trade in Oil? *Robert J. Weiner* 4

Adding a Public Voice to Investing the "Hot Air" Windfall *Ruth Greenspan Bell and Elena Safirova* 5

# Inside RFF

Former Spofford Interns Continue to Work on Chinese Environmental Issues *Ruth Greenspan Bell* 23

Mining Executive and New RFF Board Member Calls for Action on Global Warming 24

#### FEATURES

The Nonmarket Benefits of Nature: What Should Be Counted in Green GDP? 6 James W. Boyd

Swimming Upstream: The Challenges of Managing the World's Fisheries 10

An interview with James N. Sanchirico

"Ground Truthing" Policy: Using Participatory Map-Making to Connect Citizens and Decision Makers 14

Shalini P. Vajjhala

# The Role of Forest Sinks in a Post-Kyoto World 19

Roger A. Sedjo and Masahiro Amano

### RESOURCE LINKS

Learn more about the feature stories in this issue. The following links will take you to special pages on the RFF website:

The Nonmarket Benefits of Nature: www.rff.org/greengdp

Swimming Upstream: www.rff.org/swimmingupstream

"Ground Truthing" Policy: www.rff.org/participatorymapmaking

The Role of Forest Sinks in a Post-Kyoto World: www.rff.org/roleofforestsinks

# **Contributors**





MASAHIRO AMANO





JAMES W. BOYD



JAMES N. SANCHIRICO



SHALINI P. VAIJHALA



Roger A. Sedjo



ROBERT J. WEINER

**Masahiro Amano** is a professor of forestry at Waseda University, Japan, and chairman of the Japanese Ministry of the Environment's Committee on Carbon Sinks for the Kyoto Protocol. Previously, he was director of the Forest Management Division at the Forestry and Forest Products Research Institute.

RFF Resident Scholar **Ruth Greenspan Bell's** interests focus on how to develop a more robust culture of compliance in countries in economic and political transition and in the developing world. She directs the International Institutional Development and Environmental Assistance Initiative, a program designed to help countries build more effective systems of environmental protection.

James W. Boyd is a senior fellow and division director of RFF's Energy and Natural Resources Division. He works in the fields of environmental regulation and environmental law and economics, focusing on the analysis of environmental institutions and policy. Current research focuses on the development of environmental benefit indicators for use in both environmental management and national welfare accounting.

**Elena Safirova**, an RFF fellow, conducts economic modeling and policy analysis related to transportation and urban land use. She is currently modeling long-term projections of air quality based on policy, population, land use, and transportation changes.

RFF Fellow James N. Sanchirico is an expert on the economics of managing living biological resources, such as fisheries, biodiversity, and invasive species, with an emphasis on marine issues. An overarching theme of his ocean research is understanding the potential benefits and costs of zoning the oceans, an approach akin to zoning land.

**Roger A. Sedjo**, an RFF senior fellow, has directed RFF's Forest Economics and Policy Program for more than 25 years. He is an expert on forest economics and policy and helped write a number of major International Panel on Climate Changes reports addressing climate and forests. He has also examined sequestration incentives and trading mechanisms.

RFF Fellow **Shalini P. Vajjhala** studies the social impacts of large-scale physical and economic phenomena. Her work has taken her all over the globe, from Lesotho, where she mapped mobility and access patterns of isolated villages, to India, where she studied resettlement issues, to Pittsburgh, where she engaged in community planning in low-income neighborhoods.

**Robert J. Weiner** is RFF's 2005–06 Gilbert F. White Fellow. His work at RFF focuses on understanding why oil prices are so high and so volatile, examining in particular the role of speculators and speculation in oil trading. He comes to RFF from George Washington University, where he is professor of international business and international affairs.

# Goings On

# CAFE Reforms Could Address Long-Term Oil Consumption, RFF Scholars Testify Before House, Senate

s oil prices climbed throughout the spring and the public looked for relief at the pump as the summer travel season approached, RFF President Phil Sharp and Senior Fellow Billy Pizer were called before a May 3 House Energy and Commerce Committee hearing to testify on how reforming the Corporate Average Fuel Economy (CAFE) standards might affect the issue. The following week, Sharp appeared before the Senate Committee on Commerce, Science, and Transportation's Subcommittee on Surface Transportation and Merchant Marine to discuss the same subject.

"CAFE has been a very imperfect, but important, policy in dealing with fuel consumption," Sharp testified. "The [National Academy of Science's CAFE review panel] concluded, in 2002, that our oil imports would have been 2.8 million barrels a day higher had the policy not existed. That said, the academy report outlines possible reforms that could improve the standards."

Sharp was careful to note that while reforming CAFE standards could have many benefits, reducing gasoline prices is not among them.

"Action now by Congress on fuel economy standards obviously will have no immediate impact on gasoline prices. Indeed, it will take some years for changes in the policy to have any



impact at all," he said. "But action now on fuel economy standards can help the United States address important concerns over the longer term."

However, he noted that high gasoline prices and uncertainty about the future of the oil market have increased attention to fuel efficiency and alternative fuels. This presents Congress with a rare opportunity to act on a contentious issue. "After 20 years of stalemate on fuel economy issues," he said, "we finally have a moment where change is possible."

Pizer outlined for the committee opportunities to reform CAFE standards for passenger cars in light of recent reforms to the light truck standards.

"The light-truck rule provides a model for two improvements: differentiating manufacturers' standards based on their mix of large and small vehicles, and setting the overall level of the standards based on an explicit and careful cost-benefit analysis," he said.

"Further reforms include trading between the passenger-car and lighttruck fleets, trading among manufacturers, unrestricted banking of CAFE credits earned by exceeding the standard, and a cost-limiting safety valve."

The hearings came as the National Highway Transportation and Safety Administration (NHTSA) called on Congress to grant it the authority to make changes to passenger-vehicle standards. Bills that would allow NHTSA to do so are pending in both the House and the Senate, and Pizer and Sharp both remarked that delegating target setting and redesign to NHTSA made sense.

"I find the complexity of the standard-setting process, as well as the need to regularly revisit the level of the standard, to be more suitable for agency rulemaking than Congressional action," Pizer stated. "Congress can instead reform the structure of CAFE to increase efficiency, continue to give NHTSA clear guidance on the key costs and benefits it should consider, and perhaps require greater transparency with regard to the cost modeling."

Sharp also noted that policymakers might want to look beyond CAFE for ways to reduce fuel consumption.

"Many experts believe that a more effective approach to reducing fuel consumption-and a more cost-effective approach for the U.S. economywould be a stronger gasoline or oil tax, either as an alternative to CAFE or in conjunction with it," he said. "The impact would not only encourage consumers to purchase more efficient vehicles, but it would also encourage them to be more economical in their driving, a critical component that CAFE does nothing to address. Indeed, such a tax would have a more rapid impact on consumption than is possible through CAFE alone."

# How Do International Crises Affect Trade in Oil?

Robert J. Weiner

Recurring oil crises in recent decades have sparked much of the concern and debate regarding energy policy among government and industry officials, the media, and the public. From the energy instabilities and oil embargo of the early 1970s through today's high oil prices and conflict in the Middle East, oil shocks have been a dramatic feature of the international economic landscape.

These shocks have been followed by recessions in the United States and other industrialized nations, as well as oil-importing developing countries. In his 2006 State of the Union Address, President Bush pronounced America "addicted to oil" and conceded that oil as an energy source is prone to volatility and supply disruptions.

One of the most significant oil shocks occurred after Iraq invaded Kuwait in 1990. The invasion touched off an economic, financial, diplomatic, and military crisis, triggering a tremendous spike in oil prices and recession in Organisation for Economic Co-operation and Development and oil-importing developing countries. But was the Gulf Crisis really a market disruption? Did it tear the fabric of trade in the world oil market?

To answer this question, I decided to study the changing role of international trade intermediaries—often referred to as trading companies—in the oil market during the Gulf War. My research shows that the crisis diminished the role that intermediaries played in petroleum sales—both during the crisis and after.

Intermediaries work as middlemen, connecting buyers and sellers in international trade and serving as the glue that holds many commodity markets together. Along with national oil companies, these intermediaries have come to complement (and in some cases replace) the so-called Seven



Sisters—the corporate energy giants that dominated international oil trade from the 1920s until the early 1970s. But although they have attracted harsh scrutiny from policymakers for their role in the United Nations' Iraqi Oilfor-Food Program, intermediaries have received limited attention in the research literature.

My research takes advantage of a unique database of individual sales transactions in the Brent market. Produced in the U.K. North Sea, Brent Blend is by far the most widely traded crude oil in the international market. The database is unusual in that it identifies the terms of each crude oil transaction, as well as the buyer and seller of each cargo traded, whereas terms of individual transactions are not typically available to researchers, despite their enormous size.

This database is generated by a daily trade-press survey of oil traders. Participants in the Brent market are diverse, with the largest traders falling into two categories. The first comprises oil companies, including the majors (Exxon, BP, Shell, etc.), other integrated petroleum companies, producers, refiners, and national oil companies. The second category comprises financial houses and trading companies-Wall Street banks, commodity traders, and Japanese general trading companies. This diversity provides an opportunity to test hypotheses regarding behavioral differences across types of companies before, during, and after the crisis.

The evidence makes it clear that the Gulf Crisis indeed affected patterns of oil trade. These patterns changed significantly during the crisis, with intermediaries playing a smaller role than before in serving as counterparties to the large oil companies that produce and refine the commodity. Moreover, although the crisis ended as abruptly as it had begun, and oil prices declined sharply to pre-crisis levels, the previous status quo was not restored. One possible explanation is that lightly capitalized trading companies were seen as less creditworthy after the crisis than before.

Intermediaries continue to be important in world oil trade, notwithstanding predictions of their demise as a result of improved information systems. Some intermediaries have entered upstream or downstream segments of the industry; the reason for others' survival is hard to pinpoint, given the paucity of data. The dominant role played by trading companies as purchasers of Iraq's oil exports during the UN Oil-for-Food Program suggests the usefulness of ongoing research into their role and behavior in international oil trade.

# Adding a Public Voice to Investing the "Hot Air" Windfall

Ruth Greenspan Bell and Elena Safirova

ne of the more controversial provisions of the Kyoto Protocol gives Russia, Ukraine, and countries in Central and Eastern Europe the right to sell or trade excess emissions credits, which were gained because the protocol set emissions targets at 1990 levels, after which many of these countries' economies (and emissions levels) collapsed.

These fortuitous credits, often referred to by critics as "hot air," are unlikely to have any salutary effect on greenhouse gas reductions because they are not associated with future reductions in emissions. They also represent an enormous windfall: the potential revenue from their sale could amount to billions of dollars.

This revenue presents a singular opportunity to bring about lasting change in Russia, Ukraine, and Central and Eastern European countries. Properly channeled, revenues from excess credits could provide direct support for projects such as curtailing energy consumption and switching to low- or non-carbon energy sources that reduce greenhouse gas emissions, as well as for other environmental efforts. Funding would also help build institutional and human capacity to administer such projects and assure their long-term success.

We are engaged in a joint effort to consider how two countries, Poland

and Ukraine, which are holding large quantities of credits, can invest the proceeds in ways that will build their capacity to better manage their greenhouse gas emissions. Our partners are Poland's Institute for Sustainable Development, which is headed by Andrzej Kassenberg, and the Institute for Industrial Ecology, Kiev, Ukraine, with the active participation of Olga Gassan-zade.

Together, we have planned a combination of joint research, formulation of policy alternatives, and dissemination of those options into the policy arena in each country. What is innovative about this plan is the effort to add a public voice and independent policy analysis to ongoing discussions on how the proceeds from these sales might be used to advance environmental protection.

We believe that a public voice is essential to the eventual success of such plans, for at least two reasons. The first is that local experts can provide valuable insight into the institutional capacity and readiness to act in each of their countries. Moreover, local knowledge should be a part of any analysis of investment goals and how these are carried out, and in many cases can help evaluate the credibility of potential investments.

The second reason is that a public voice has value in all situations where potentially huge amounts of money might change hands. Much of the thinking about green investment has taken place within a relatively small community of climate scholars, activists, and government, but the implications are important for a broader swatch of society. A public voice helps assure a more transparent process and open procedures.

### An "Expiring" Opportunity

Hot-air credits are technically slated to "expire" at the end of the first Kyoto commitment period, and various procedural issues have yet to be worked out before sales of credits can start. Today it is still unclear how high the demand will be. On the other hand, the credits are a temptation for countries having difficulty meeting their Kyoto targets, and many have expressed a preference for "greened" credits that would effectively link the purchase of credits with investments and activities that reduce greenhouse gas emissions.

Two other Kyoto Protocol flexible mechanisms, the Clean Development Mechanism (CDM) and Joint Implementation (JI), allow participating industrialized countries to invest in emissions-reducing projects in other countries in lieu of reducing their own emissions. However, CDM and JI projects are neither easy nor quick to develop; among other things, they must be certified by special commissions to allow the credits to be transferred.

Experts predict that sales of hot-air credits will pick up as 2012 nears and the pressure to meet Kyoto obligations escalates. If that happens, it will be critical that the countries in Eastern and Central Europe have effective green investment programs in place to make sure that their potential hot air does not vanish into thin air.

# THE NONMARKET BENEFITS OF NATURE

# WHAT SHOULD BE COUNTED IN GREEN GDP?

#### By James W. Boyd

To estimate the value of goods and services in an economy and track its growth, countries use various measures of national income and output. The most visible and influential of the national accounts is gross domestic product (GDP), a measure of the total value of final goods and services produced within a country in a given period. Although GDP captures only a part of what is important about an economy, it deserves a special status because it represents a significant bottom line: how much the market economy produces and what it is worth.

For years, both environmentalists and economists have called for a "green GDP" that measures what is valuable about nature, excluding goods and services that are already captured in GDP, such as nature's contributions to commercial harvests and other products. This approach has been advanced by the director of Sweden's Beijer Institute, Karl-Göran Mäler, and others in the early 1990s and has attracted the interest of governments around the world. More recently, RFF researcher Spencer Banzhaf and I have been using economic principles to define ecological units of account. These have a wide variety of applications, including strategic planning, government performance assessment, transfer of environmental benefit estimates, and green GDP accounting.

Why measure green GDP? For environmentalists, well-being provided by nature is as important as well-being provided by market consumption. Societies should be able to see how market consumption affects the consumption of public goods like beautiful views, clean air, and clean water. Another reason to measure green GDP is to track the provision of nature's benefits over time, either to hold governments accountable or to compare their environmental conditions with those of another country. Economists want society to articulate tradeoffs, measure performance, and maximize social well-being. These tasks are impossible to achieve when nature's contribution to human welfare is not measured.

However, measuring the benefits that arise from public goods provided by nature is no small task. Indeed, just this May, China announced that it was scrapping a two-year effort to develop a green GDP index, citing problems of calculation; instead, it will focus on a method of green accounting to be presented alongside gross domestic product. And as the United Nations notes in its 2003 publication, *Handbook of National Accounting*, "there is no consensus on how 'green GDP' can be calculated and, in fact, still less consensus on whether it should be attempted at all."

Despite its difficulties, I argue that the calculation of a green GDP can and should be attempted. The benefits of nature are too important and too large to be "left off the table" of national accounting. The real difficulties should not distract from the practical steps that can begin immediately. One reason that these steps have not been clarified is that economists have not previously integrated principles from accounting economics with those from environmental economics. I use both ecological and economic theory to describe what should and should not—be counted by green GDP.

# Making Green Accounting More Precise

GDP counts units in the market economy—cars, houses, legal services, loaves of bread, and so on. Unfortunately, nature does not come prepackaged in this way. So what should green GDP count?

GDP and its green counterpart must first count what is enjoyed or consumed. GDP measures two basic things: quantities of goods and services, and the prices of those goods and services. We need similar clues to the natural economy. When the beneficial aspects of nature are counted, nature's contributions to welfare can be much better described.

Nature offers plenty of features to count. Indeed, this abundance is part of the problem. To date, ecology, environmental economics, and the growing field of green accounting have failed to provide adequate guidance on what in nature should be counted as defensible measures of nature's services. This imprecision is a result of the failure to use ecological and economic theory to define services.

Terminology is a big part of the problem. Ecology and economics talk about ecosystem components, processes, functions, and services—and often in different ways. An important first step toward practical welfare accounting units is concrete guidance on what to count and why. To account for nature's benefits, the most important definition is that of ecosystem services. They are the appropriate units of account.

# What Are Ecosystem Services?

The term "services" originates in economics but has been adopted in ecology to signify the connection between ecosystems and human well-being. Ecosystem services arise from—and depend on—the broader sets of ecological components, processes, and functions but are different: they are the aspects of the ecosystem that society uses, consumes, or enjoys to experience those benefits. Five principles guide the definition.

First, services are nature's end products, not everything in nature. When GDP is measured, it counts cars, not tires, the factory, the workers, leather, paint, or steel (although those things are counted in other kinds of national accounts). Why is this? Because the value of the car *embodies the value of all its inputs*. If we counted and valued the individual inputs, we would be double-counting their value. Similarly, we needn't count everything in nature. We only have to count what matters directly to people.

The second principle, that ecosystem services are benefit-specific, flows from the first. For example, a given natural characteristic can simultaneously be an end product and an intermediate product. Accordingly, that characteristic can simultaneously be counted and not counted by green GDP. For example, wetlands should be counted as services associated with flood protection because they directly protect against floods and are substitutes for constructed flood control. However, wetlands should not be counted as services for the water quality benefits they provide. The water quality itself should be counted because that is what people directly value. To be clear: the wetland is valuable in both cases but only needs to be counted in one.

Similarly, units of tomatoes, onions, lettuce, and ground beef are counted by GDP if sold in stores as final products; they are not counted when combined and sold together on a bun as a restaurant hamburger. Wetlands should not be counted as services for the water quality benefits they provide—the water quality itself should be counted because that is what people directly value.

Similarly, tomatoes, onions, lettuce, and ground beef are counted as GDP if sold in stores as final products, but they are not counted when combined and sold together on a bun as a hamburger.

The third principle is a practical one. GDP's dirty little secret is that it counts what we can count, not what we should count. Consider again a car. GDP counts cars because they are things and therefore easy to count. Perhaps what we should count is "the satisfaction or utility of owning a car" or "sex appeal." But this is impractical. To place ecosystem services on an equal footing with market goods, we need to count things that can be practically measured and that have concrete meaning to people.

Fourth, ecosystem services should be ecological. This sounds obvious but reflects another terminology issue. Economists and others will often say, "Recreation is an ecosystem service." But recreation is more properly thought of as a benefit that arises when people combine inputs, including time, human resources (skill), capital (equipment such as boats, boots, and binoculars), and things in nature. Ecosystem services are the things in nature that make recreation possible or pleasurable, not the recreation itself. Once ecosystem services are combined with other inputs, such as human resources and capital, they cease to be identifiably ecological.

Finally, ecosystem services should be counted with the greatest possible spatial and temporal resolution. Individuals benefit from water quality and availability in particular places at particular times. To say that a trillion acre-feet of clean water are available nationally every year is meaningless. What matters is where and when the water is available. For example, the value of water for recreation depends largely on where that water is, in a scenic canyon or an irrigation canal. And clearly, the timing of water flows is crucial for irrigation, drinking water, and recreation.

# Standardizing What We Count

In late May, a workshop at RFF drew nearly three dozen experts from federal agencies, major environmental and conservation NGOs, and academia to discuss an idea vital to environmental progress: practical ways to count nature's

"All the environmental laws in the world won't matter if we can't measure what we've achievedor failed to achieve," said RFF Senior Fellow

James Boyd, who organized the workshop. "Nature presents us with an infinite number of things to count. Without principles to guide what should be counted, the result can be chaos, confusion, and paralysis. The public needs a clearer way to keep track of gains and losses in the benefits we receive from nature."

Participants debated alternatives and the desirability of standardizing environmental accounting practices. The workshop, funded by EPA's National Center for Environmental Economics, represents an outgrowth of Boyd's work on practical measurement of ecosystem services, which encompass the benefits of nature to households, communities, and economies. It was held off the record to encourage a free exchange of ideas and concerns about challenges at the participants' respective agencies and organizations.

"Our ultimate goal is to provide a standardized definition and measures of ecosystem services that facilitate performance assessment,"



Boyd said. Reporting anecdotes and success stories is no longer enough for donors who want to see evidence of a return on their investment, said one participant. The same holds true for government trustees of nature. Are their decisions improving our well-being or not?

Some participants felt that the demand for different kinds of information makes standardization impractical. Metrics need to emerge from where decisions are made: "who is at the negotiating table is what matters," said one participant.

Then-acting Interior Secretary Lynn Scarlett kicked off the workshop by reminding the participants to pay close attention to semantics and context as they deliberated.

Economists have been using all manner of tools, such as contingent valuation to find, check, and calculate environmental benefits, Scarlett said. "But I'm a little worried that value outside of the context of actual bidding in the marketplace is acutely subject to the assumptions used."

However, three things are certain, she said. First, the effects of environmental transformations are not always, or even perhaps often well considered in decisions. Second, the benefits from drawing upon nature's capital in investment and policy choices, and private decisions, are still frequently overlooked. And third, "the results of our environmental policy actions are too often neglected, as success is measured only by the processes we have in place rather than the actual outcomes achieved."

This perspective differs from that expressed in the *Handbook of National Accounting*, which states that "it is not generally the components of ecosystems that benefit humans, but the systems as a whole." Surely, the entire system is necessary, but so is the entire conventional market system. We only get at the value of the system, however, by counting its components. Aggregation can be meaningful only if it is "built up" from spatially and temporally distinct units.

# **Role of Ecology**

For decades, economists and ecologists have sought a consistent point of contact between their analytical realms. As defined above, ecosystem services provide this link. Economics has dominion over what should be counted if one wants to measure the benefits of nature. But ecology has dominion over the study of changes in services over time.

If one measures nature's value at only one point in time, then a great deal of ecological sophistication is not needed. One simply counts observable features, such as air, soil, water quality, land cover types, and species populations. As envisioned here, green GDP also allows period-to-period comparison of the quantity of ecosystem services over time (for example, has a particular government presided over an increase or decrease in ecosystem services?). Degradation or enhancement of services can be directly measured and reflected in the year's green GDP numbers.

However, green GDP can—and should—aspire to more than this. In particular, it can be, used to assess welfare losses arising from overconsumption—that is, borrowing from the future to consume today.

Consider two human activities: commercial fishing and energy production. Both generate consumption (seafood and energy, respectively) that is reflected in GDP as a positive contribution to welfare. One reason to calculate green GDP is to reveal the effect of current consumption on future well-being. Unfortunately, economists have little ability to make such predictions in the ecological realm. If green GDP is to incorporate adjustments for resource depletion—and it should—then only biophysical science will be capable of substantiating those adjustments.

# **Conclusion: A Note about Prices**

What about prices, the other core aspect of a welfare index? By their very nature, environmental public goods lack the prices that are used to weight outputs in GDP. Indeed, the problem of missing prices spawned and continues to occupy an entire field of economics. It has also led many environmental accounting advocates to despair. To be sure, attaching weights (virtual prices) to environmental public goods is a significant challenge. But a more significant hurdle is deriving those weights without the benefit of consistently defined units of account. Defining units is a crucial step that environmental economists have largely neglected.

For several reasons, then, welfare-based accounting for environmental goods must begin with defensible definitions of the units to be counted. First, keeping track of these units (without prices) yields useful information. It is better to know how many cars and trucks are produced each year than to not know at all. The same is true for environmental public goods. Second, the missing price problem can be systematically addressed only if the units to which virtual prices are attached are consistently defined. Third, assigning prices to nature is controversial for philosophical and political reasons. Focusing on the quantities part of the problem avoids distraction by those debates and resistance to "putting price tags on nature." If green GDP is to be fully realized, then the price debates cannot be avoided forever. But they can be avoided for a while, as counting begins.

To say that a trillion acre-feet of clean water are available nationally every year is meaningless. What matters is where and when the water is available.

9

# Swimming

# THE CHALLENGES OF MANAGING THE WORLD'S FISHERIES

An interview with James N. Sanchirico

isheries—organized efforts to harvest fish and other aquatic species—make up one of the world's oldest enterprises and have played important roles in food production and cultural identity throughout history. Today, marine species and the people who derive their livelihoods from fishing are at a crossroads, as fisheries face threats from overharvesing, land-based pollution, aquaculture, and climate change. By some accounts, overfishing alone affects about one-third of the U.S. fish populations that scientists have assessed.

The United States is considering proposals to overhaul its fisheries policy under the Magnuson-Stevens Fishery Management and Conservation Act, which is more than six years overdue for reauthorization. Getting it wrong will maintain the status quo of stressed ecosystems and the depressed livelihoods of all those dependent on it. At this critical juncture, Resources sat down with RFF Senior Fellow James Sanchirico, an expert on the economics of fisheries, to glean insights into how fisheries are managed and what might be done to improve their future.

# *Resources:* As consumers, we're told every so often that another fish species is being overharvested and that we should avoid eating it. How is commercial fishing regulated in the United States?

It wasn't too long ago that we didn't manage fisheries at all. Instead, we thought of the seas as an inexhaustible resource. Then we started to realize that they're not, that humans affect fish populations adversely. So we began to think about managing fisheries—and began to realize that geography and species needed to be taken into account. Management of the grouper and snapper fisheries in the Gulf of Mexico would need to be very different from management of the cod fisheries off New England and the salmon fisheries in the Northwest, for example.

As a result, when fishery management was getting started in the United States around the mid-1970s, it was set up with a regional perspective. We now have eight regional fishery management councils that decide how many fish can be caught each year, who can catch them, and what particular gear can be used. Each council is comprised mainly of commercial and sportfishing members nominated by the state governors within a particular council area and selected by the secretary of commerce. Councils also include representatives from the fish and game offices, the National Marine Fisheries service, and, in the Pacific region, Native American tribes.

Once fisheries management plans are devised for particular species at the regional councils, they go to the Department of Commerce, where the commerce secretary evaluates them against a set of nine standards put forth in the Magnuson-Stevens Act.

*Resources:* Why has it been so hard to reauthorize Magnuson-Stevens? Unlike last year's Energy Bill, which also took many years to come to fruition, no multinational corporations are involved, and Americans certainly are not addicted to fish. Reauthorization of the act has been pending for more than six years now. There are four plausible explanations. First,

# stream

fishery management is just not at the forefront of our political debates, partially because a fair number of senators and congressmen are not from coastal states. It also hasn't risen yet at a national level as an issue of concern. Although people understand that we're overfishing, they go to the beach or recreationally fish from a charter boat, and everything looks fine, so it's hard to make that connection.

Second, we're trying to manage 256 major fish stocks in the United States, on top of three or four hundred others that aren't major in terms of their catch totals. And not only are fisheries diverse across ecology and biology but also across socioeconomic dimensions.

Large commercial operations are vertically integrated. They have boats that catch the fish and sometimes do the processing on board, or they bring it to an onshore processor owned by their company. The company might own seven or eight vessels. Some of these operations are even part of large food conglomerates and have a bottom line to meet for shareholders.

In comparison, think of the opposite extreme: third- or fourth-generation Portuguese or Italian fishermen in New England and other parts of the country, where the culture of fishing is embedded in their identities. I'm sure you can find individuals who aren't interested in making a dime, or at least will say that they're not. To them what is important is that they can fish when they want, where they want; some of them don't want to be regulated at all. To try to come up with an overarching regulatory framework that can encompass that broad spectrum is not an easy task.

Third, other countries that have overhauled their fisheries management policies have had a strong impetus to do so. For example, New Zealand had a "perfect storm" in the early 1980s, and some very important fish stocks collapsed. This caused a crisis, around which a constituency formed. In Iceland, which also has rationalized its fishery management, fisheries at one point made up about 45 percent of its gross domestic product (GDP). So there, fisheries are a dominant issue. None of these catalysts exist in the United States, where fisheries make up far less than 1 percent of the GDP. Cllthough people understand that we're overfishing, they go to the beach or recreationally fish from a charter boat, and everything looks fine, so it's hard to make that connection.

Finally, reauthorization of the Magnuson-Stevens bill is getting hung up on several sticking points. For instance, how do we design rebuilding plans; what kind of standards should we put in place? Typically it's now legislated that unless certain exemptions are met-for instance, the fish population is very slow growing-fisheries have to rebuild collapsed fish stocks within a 10-year horizon. A bill put forth by Representative Richard Pombo (R-CA) would relax this 10-year requirement, a motion that has some environmental groups up in arms because they think that doing so allows more overfishing. Ongoing research at RFF, however, shows that it is not clear that more flexibility in the 10-year horizon will allow overfishing. What we are finding is that the time horizon for an economically efficient rebuilding plan depends on the catch rate, rebuilding target, initial fish population, and other important biological and economic factors. Where that falls relative to 10 years is not clear.

Another sticking point is the issue of whether and how to allow for rationalization of fisheries through individual fishing quotas (IFQs) and development of cooperatives. The current debate also focuses on whether we should give processors quotas, a very contentious issue that has held up the entire debate on rationalization. Under a quota system, processors would be given the right to the amount of fish that are caught to guarantee they will be supplied a certain amount of fish every year.

*Resources:* The marketplace for fish is global, just as it is for oil. Can you talk about the interplay between U.S. fishery policy and the actions of other nations competing for the same fish? While some fish stocks reside within the U.S. exclusive economic zone (the waters within 200 nautical miles of a state's coastline), some fisheries straddle countries. For example, the salmon in Alaska and Washington swim through Canadian waters. This raises issues of coordination. How do you determine the total catch and then allocate it? Which countries are going to catch what? And how do you monitor that within the country?

Then there are stocks that reside in international waters. These include very valuable bluefin tuna stocks, and other highly valuable pelagic fish that move across large expanses of the ocean. And they're very difficult to manage, because although commissions are set up that have representatives from many different governments, they often don't have much power behind them. Chilean sea bass—Patagonian toothfish—is an example of the difficulties of managing fisheries in international waters. The toothfish was overharvested very quickly because of a lack of coordinated management and enforcement. But it is not clear how to monitor and enforce out in the open ocean.

The global nature of the marketplace also gives rise to competition, sometimes to the benefit of the sea, and sometimes to its detriment. For example, Japan is a large consumer of fish, and many fishers compete for that market. But one of the nice things about competing in the Japanese market is that it's mainly based on quality. Typically, when you're fishing for quality, you're minimizing other impacts because you're not necessarily taking large nets through areas.

Other potentially competitive areas include particular species that are both raised by aquaculture and caught in the wild. Salmon is a good example. Because the market is being

The global nature of the marketplace gives rise to competition, sometimes to the benefit of the sea, and sometimes to its detriment. flooded with farm-raised salmon from countries such as Chile, Iceland, and Norway, the price of wild-caught salmon is generally lower than it would be in the absence of its farmraised competitor. Fishers in Alaska try to get around this by marketing their fish as more sustainable and "organic" than the farm-raised fish. But, in general, lower prices translate into less fishing pressure.

### Resources: What is the biggest threat to fish stocks?

That's a very hard question to answer because a lot of things

affect them, including destruction of habitat and issues of runoff and pollution. However, possibly the largest threat to fish stocks is that so many fisheries are still operating as if they are unmanaged. What I mean is that management focuses too much on treating the symptoms and not enough on the causes of overfishing, which are the perverse incentives that the fishermen face. Because fishermen don't own the fish until they're onboard their boats, a race to fish arises.

Here's a classic example: In the Alaskan halibut fishery, regulators closed the fishing season down when the fishermen caught the target amount for the year.

Over time, the fishermen started investing in faster boats because they wanted to catch as much as possible before the season was closed. But that resulted in shorter and shorter seasons, until all the halibut ended up being caught in two 24-hour periods. The race to fish still occurs in places like the Gulf of Mexico, where the snapper fishery has "derby fisheries." This is a serious threat to fish stocks that we can do something right now about.

### Resources: Can IFQs solve this problem?

IFQs would be one way to offset this race. With IFQs, individual fishermen are allocated a share in the total allowable catch that's determined in a given year. It's a privilege to have that right, and sometimes trading is allowed. So if a fisher doesn't want to fish in a given year, or if he wants to leave fishing, he can trade out his rights for that year to somebody else.

IFQs have worked very well in places such as New Zealand, Iceland, and Alaska. In terms of adopting them on a fuller scale in the United States, it's up to the regional councils and is typically applied to one species at a time. Some support IFQs and some don't, because they change the whole fishing culture. With IFQs, fishers can no longer go out and catch as much as they want, or get that extra large catch. Instead, they are restricted by quotas. Some have done very well under the current management system, and they're afraid that under a new management system they might not do as well.

If you talk to fishermen who have done this, for example, in New Zealand, they initially experienced the same anxiety. But years later, they really see the benefits, and today it's hard for them to think about not having these systems in place.

James Sanchirico

*Resources:* Earlier you said that we need to regulate each fishery differently, but then you just said that we need to address

incentives through the use of IFQs or cooperatives. Is there an inconsistency here?

Good question. No, there is not an inconsistency. You are right that the impetus for regional fishery management was the fact that managing different species requires different tools. This perspective is a consequence of focusing your management on regulating fishing gear and controlling every aspect of fishing activities. But we also know that the need to address incentives is universal. And it does not depend on whether you are talking about a coral reef fish, sea urchins, pelagics, or groundfish. Places like Iceland and

New Zealand have realized this and have applied IFQs to a very broad spectrum of fisheries.

**Resources:** What else on the horizon could bring about change? There are a couple of things. There is currently legislation on setting up national standards for offshore aquaculture operations. With safeguards in place, moving aquaculture offshore can remove some of the current impediments to more large-scale operations in the United States, such as visual blights and some pollution issues in bays.

Fishers also are watching the organic market in agriculture to understand how to develop their markets. A Marine Stewardship Council has formed to certify and label fisheries as sustainable. The Alaskan salmon fishery, for example, is now certified. Their hope is to charge a price premium for their product, much like organic agriculture.

This could lead to a positive feedback loop: If demand is developed for more sustainable fishery products, certification programs can arise. Fishers in turn will want to certify their fisheries, which means that they'll be more inclined to keep the stock at healthy levels and engage in activities that have less spillover impact on the habitat. It is still too early to tell, however, how these demand-side programs will fare.

# "Ground Truthing" Policy

# Using Participatory Map-Making to Connect Citizens and Decision Makers

### Shalini P. Vajjhala

itizen participation has become an increasingly important component of development planning and environmental decision-making worldwide. Stakeholders are becoming more and more effective at derailing projects that are not perceived as responsive to local concerns and needs—one

notorious example is the ongoing controversy over siting wind power off Nantucket Sound. If a planning process isn't seen as transparent, citizens are likely to oppose a project, regardless of its actual costs or benefits. As a result, encouraging public participation has become a high priority for funding institutions, government agencies, planners, and politicians in recent years.

Although new approaches to advance citizen engagement have emerged, participants still typically represent only a small subset of the larger affected population. As a result, the success of new projects increasingly depends on effective communication of participatory efforts and their results to a wider public. Within this broad agenda, reasons for seeking greater public involvement include raising awareness, incorporating public values, improving decisions, and building consensus.

One increasingly common way of engaging citizens and communities is to use mapping and spatial information technologies, such as geographic information systems (GIS). Mapping in this context refers broadly to any method used to elicit and record spatial data. Examples range from handdrawn sketches to group chalk drawings to community "3D" physical and computer models. In all of these cases, mapping comprises not just a set of tools but the participatory process of gathering spatial information and making maps.

Map-making has become more popular with the growing recognition that many development and environment-re-

lated projects are inherently based on spatial information: the locations of key resources, people, and problems are central to the decisions being made. But little attention has been paid to whether maps are effective for eliciting information about peoples' priorities, perceptions, and preferences—and then communicating this information to wider audiences.

To address this gap, I worked with colleagues at Carnegie Mellon University to design and conduct a series of mapping surveys and interviews to evaluate if and how mapping can be used to facilitate public participation in development planning and environmental decision-making. In the remote-sensing field, the term "ground truthing" is used to describe the process of verifying a satellite image with what is already known about the location on the ground. We set out to do the same here, working with hand-drawn maps instead of pictures from space to verify local perceptions and contexts.

The first part of this study involved interviewing individuals and having them draw maps of their communities and environments. We then integrated their "data" (the location of homes, businesses, parks, significant places, etc.) into a standard GIS database and developed digital versions of each individual participatory map for evaluation by different audiences and groups. In the final stage, we looked to see if and how versions of these maps are understood by individuals who are not familiar with either the map-making process or the area being mapped. Reaching a wider public requires both direct participants (map makers) and indirect participants (map viewers)—this study evaluates both groups.

### **Public Participation in Pittsburgh**

Our study group was made up of 32 individuals from several neighborhoods in Pittsburgh, Pennsylvania. In one-on-one interviews, we asked participants to create maps of how they

perceived their community. Using colored markers on  $18" \times$ 24" pieces of paper, each began by drawing a symbol for his or her home at the center of the page and continued by adding frequent routes and destinations in response to a sequence of interview questions. Symbols were selected by each mapmaker to best represent and communicate his or her personal associations with different types of places. Participants then added landmarks, places of special significance, and positive and negative spaces on their maps. Map features and symbols were not limited to physical spaces, but also marked local issues, community benefits, and areas of concerns. For example, various participants' maps included symbols for attributes such as diversity, crime, the rising price of public transportation, abandoned housing, accessibility, and "walkability." Throughout the interview, map makers added information to their maps to describe their activities, their interests, and their perceptions of their communities.

Figure 1 is an example of the type of map generated using this process. The colors on the map are associated with different categories of questions: black represents general activities and destinations, blue indicates places of special significance, orange illustrates descriptive landmarks or locally important markers, red defines any negative places or areas, and green marks positive spaces or things participants would like to change.

As a final step in the mapping interview, participants were asked to draw a red line around all the places that they felt were part of their community. Results of the study show that not only does the geographic definition of community vary among community members, but the perceived boundaries do not correspond with typical, artificial boundaries such as zip codes, census tracts, or other superimposed divisions. Given that individuals' definitions of community and stakeholders' needs for information vary so drastically, communicating with a broad audience requires an acknowledgment of their diverse frames of reference in order to make new development decisions locally relevant, understood, and accepted.

### **Integrating Mapping Methods**

The next part of our study focused on integrating these maps into GIS to bring together the myriad types of information



Figure 1.

Participatory map made by a female resident of an urban neighborhood in Pittsburgh.

# Figure 2.

Right: A digital version of a participatory map by a male resident of a lowincome neighborhood with standardized symbols at their original scale.

# Figure 3.

Below: A scaled GIS version of the participatory map, from Figure 2 above, with standard symbols at their actual locations.





required for effective participatory decision-making. During the process of drawing their maps, individuals provided street addresses and estimated distances to key points. These addresses were then matched with existing citywide GIS data points, and the locations of other elements were extrapolated and added to the GIS based on supporting data. Symbols were scanned into a GIS library as standardized, hand-drawn images (like those on the legend on page 18) and were assigned to the appropriate locations on each map.

Given the diversity of stakeholders in many development and environmental projects, different groups frequently require common information about a project but understand and use this information very differently from one another. For example, planners involved in siting major energy facilities require detailed technical information about possible sites including soil types, tree heights, and other relevant environmental data, while residents are often more generally interested in how a new project might impact their communities and landscape views. Both groups require common information about the same project, but displayed at very different scales and levels of detail.

To evaluate ways of combining and displaying information in GIS that address the varying information needs of different stakeholders, participants' original maps were used to create several types of maps in GIS. Two versions of these maps are illustrated on page 16. Figure 2 shows a digital version of a participatory map, and Figure 3 is an accurately scaled GIS version of this same map using standard symbols. The personal digital map is the most similar to the individual handdrawn map and is simply a graphic recreation of the original with standardized symbols at a proportionate scale. As Figure 1 illustrates, respondents' maps were often clear, but rough; therefore, all symbols were redrawn, standardized, and then loaded into GIS. Using this framework, a graphic version of the original map with all of the original destinations and routes was created using the new standard symbols (Figure 2). Finally, spatially accurate GIS maps were developed by referencing points on the digital maps to correspond with the actual locations of places to generate new maps at different scales (see Figure 3 for an example).

### **Evaluating Survey Findings**

The final phase of this project tested how various versions of participatory and GIS maps are understood by different groups to evaluate each map's effectiveness and accuracy for communicating both the actual neighborhood characteristics as well as the original map makers' perceptions. A written survey was conducted with volunteers from community organizations in a town near Pittsburgh. This study area was specifically selected for its relative geographic isolation, in order to work with a survey population that was largely unfamiliar with both the specific neighborhoods mapped in the survey and the process of map-making. Surveys were administered to groups of 15 to 50 volunteers in three moderated sessions. One hundred eleven participants were randomly assigned to receive a written survey booklet with maps representing either of two urban neighborhoods in Pittsburgh, one low income, and the other high income.

GIS versions of the hand-drawn maps described above from four neighborhood residents and a single city-data based GIS map of the same area were collected into two separate survey booklets, one representing each neighborhood. The five maps in each booklet were cropped to describe a common  $2 \times 2$ -mile square area to allow for direct comparisons across maps. We asked a series of questions to test individual understanding of each map, the map makers, and the two neighborhoods. We specifically designed the survey booklets around sets of repeated questions to measure differences between the standard GIS and participatory GIS maps, between selected map makers, and across neighborhoods to evaluate which maps and map makers were most effective at communicating information about each neighborhood.

### **Major Results**

A large majority of respondents correctly interpreted and answered basic symbol and scale-comprehension questions for both standard GIS and participatory digital maps. The ability of respondents to interpret symbols and scales was not significantly different for the standard GIS maps than for any of the participatory maps. Interestingly, those respondents who answered basic symbol and scale questions incorrectly were still able to provide relatively accurate assessments and ratings of the neighborhoods described by the participatory maps and different map makers' perceptions.

The most significant findings from the survey are the result of comparisons of survey respondents' ratings with those of the original map makers for a set of community attributes. Respondents were asked to assess the neighborhood represented in their booklet and to give their own ratings on a scale of 1–5 after viewing only the GIS map and then after viewing all five maps.

After viewing GIS maps, individuals gave overall ratings that were not significantly different for the two very different communities. After viewing all four digital participatory maps in their booklets, however, respondents' overall neighborhood ratings shifted significantly in the direction of the original map makers' own community ratings. Participants who evaluated the low-income neighborhood on average adjusted their ratings downward and moved toward the actual ratings of community residents and the original map makers. Similarly, respondents who viewed maps of the highincome neighborhood shifted their ratings upward to reflect a more positive impression of the community that also aligned with the ratings of that community's residents and map makers.

This change in perceptions and neighborhood evaluations clearly illustrates that the digital participatory maps not only communicate additional information over the standard GIS maps, but they also convey accurate information about the original map makers' perceptions of their neighborhoods. Comparisons of these before-and-after neighborhood ratings provide strong support for mapping as a medium for accurately eliciting and communicating the perceptions of community map makers to wider audiences.

### Conclusions

What our results show is that respondents clearly understood what different maps depicted and had a strong preference for how community map makers represented their communities, over standard GIS maps. By thoroughly testing and evaluating how idiosyncratic symbols drawn by individuals could be translated into stable, replicable data, we were able to address the question of just how well participatory maps could work as a policy tool.

While we focused on individuals in urban neighborhoods, participatory mapping is widely used for more general projects with communities and groups around the world. Examples include studies of how villagers in the Philippines define local forests and watersheds, how residents of informal communities in India can plan for resettlement, and spatial evaluations of the critical differences in how access and mo bility patterns between men and women in rural southern Africa vary.

Like all participation strategies, mapping methods have to be tailored to local settings and issues. However, the results of this study and the process of integrating participatory maps and GIS maps used here are relevant in a wide variety of projects where the goal is to bring together information on local perceptions and planned developments for effective communication with wider audiences. Overall, participatory mapping in combination with GIS can help planners and policy makers "ground truth" new projects in both local realities and perceptions.

House	X Breten shor	As travel
Pool -Swining	COFFEC Show	Da Library
and and and Hirise	AN ANT	Fuod place
My Row House	\$ BANK	flm + Honc
al lesount	Å	BASKET BASKET BALL COMA
	ALLE RUCH	the church
印本 Trees	Fish store	TP clothing stone
Stehool	Dore Dore	Gun Cun
Ž Ban	Restant	T Hospital
2 cleaners	RECREPTION	Surannuket

# Figure 4.

A sample of the standardized symbols and icons identified by a participant and used as the legend in a symbol comprehension test of both participatory and GIS maps.

# The Role of Forest Sinks in a Post-Kyoto

# World

By Roger A. Sedjo and Masahiro Amano

oday, most scientists, as well as the Bush administration, agree that global warming is indeed occurring and that it is a significant problem. The question of the efficacy of the Kyoto Protocol as a remedy, however, is another story. While some European countries are on schedule to meet their emissions targets, others are not. Two of the largest carbon emitters, China and India, are not even required to comply-they have no carbon targets. Two others, the United States and Australia, have chosen not to ratify the protocol, and now Canada, which did ratify, has announced that it does not expect to comply. But even if all the global Kyoto Protocol targets are met, the global temperature in the year 2100 will be only about 0.3°C lower than "business as usual," because just 7-10 percent of the expected temperature rise would be prevented if the Kyoto targets were met.

As the first compliance period (2008–2012) approaches, analysts and policymakers around the world are considering how to evaluate the protocol's effectiveness and anticipating what a post-Kyoto world will look like. Criticisms of the Kyoto Protocol are many, centering on the high cost of compliance and the lack of flexibility. There is widespread recognition that continuing the Kyoto process without the involvement of China, India, Brazil, and other major countries of the developing world would not only ensure that the United States will not participate in the future but would be fundamentally futile for meeting long-term targets because of the dominant place these countries have as emitters of carbon dioxide and other greenhouse gases.

While the diplomats continue to wrangle over emissions targets, compliance, and monitoring, one abatement tool deserves greater attention. Forest sinks hold enormous potential as one of the most efficient, low-cost ways to capture or Forest sinks hold enormous potential as one of the most efficient, low-cost ways to capture or sequester carbon.

sequester atmospheric carbon. For example, a 2006 study organized by the Energy Modeling Forum of Stanford University found that using biological sequestration can reduce the costs of meeting certain 2100 climate objectives from 3.3 percent of the gross domestic product (GDP) to 2.3 percent, which amounts to literally trillions of dollars. And according to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), up to 20 percent of excessive emissions can be captured in forests and biological sinks over the next 50 years. The Kyoto Protocol as it now stands does not take fully into account several opportunities for biological sequestration. But what role could forest sinks play in a post-2012 world?

### **Global Carbon Sinks: Some Basic Concepts**

Global carbon is held in a variety of different "stocks." Natural stocks include oceans, fossil-fuel deposits, the terrestrial system, and the atmosphere. In the terrestrial system, carbon is sequestered in rocks and sediments; in swamps, wetlands, and forests; and in the soils of forests, grasslands, and farmland. About two-thirds of the globe's terrestrial carbon, exclusive of that sequestered in rocks and sediments, is sequestered in the standing forests, forest understory plants, leaf and forest debris, and forest soils. In addition, there are some nonnatural stocks, such as long-lived wood products (typically wood construction and furniture) and waste dumps that constitute a separate, human-created carbon stock.

A stock that is taking up carbon is called a "sink" and one that is releasing carbon is called a "source." Shifts or flows of carbon over time from one stock to another—from the atmosphere to the forest, for example—are viewed as carbon "fluxes." Over time, carbon may be transferred from one stock to another. Fossil-fuel burning, for example, shifts carbon from fossil-fuel deposits to the atmospheric stock. Biological growth involves the shifting of carbon from one stock to another; for example, plants fix atmospheric carbon in cell tissues as they grow, thereby transforming carbon from the atmosphere to the biotic system.

Five pools of carbon are involved in a forest ecosystem: above-ground biomass, below-ground biomass, litter, dead wood, and organic carbon in soil. Carbon is sequestered in the process of plant growth: it is captured in plant cell formation and oxygen is released. As the forest biomass experiences growth, the carbon held captive in the forest stock increases. Simultaneously, plants grow on the forest floor and add to this carbon store. Over time, branches, leaves, and other materials fall to the forest floor and may store carbon until they decompose. Additionally, forest soils may sequester some of the decomposing plant litter through root-soil interactions. Carbon may also be sequestered for long periods in long-lived wood products resulting from forest harvests.

### Forests in Transition

Forests are constantly in transition, being cleared for agriculture and often subsequently replanted or abandoned and left to grow in, for example. The Kyoto Protocol accounts for this in Article 3.3, which calls for the maintenance of forests by afforestation, reforestation, and controlling deforestation (ARD).

Deforestation occurs when forestland is cleared and reforestation does not take place. Commonly, land clearing is associated with the permanent conversion of forestlands to other uses, such as croplands, pasture, or development. When forestland is converted to some other use, there is a net loss of carbon in the terrestrial stock since most other land uses will sequester less carbon than the forest. Under these circumstances, net carbon transfers occur. If the site is cleared and the vegetation burned, most of the carbon is released into the atmosphere. However, to the extent that the vegetation is converted into long-lived wood products or substituted for fossil-fuel energy, only a portion of the carbon in the forest will be a net release into the atmosphere. The creation of a forest on land never forested or not forested for a very long time is called afforestation. Often the distinction between afforestation and reforestation blurs as the period during which the forest has been absent from the land lengthens. Afforestation occurs when forests are established on grasslands never previously forested. It also may be said to occur as lands once in forests but which have been in agriculture for long periods of time, as in parts of the U.S. South, are converted into forests, due to either natural processes or tree planting. On afforested lands, the additional carbon stored in trees and other components of the forest ecosystem constitutes a net addition to the terrestrial forest stock.

# Forest Sequestration and the Kyoto Protocol

Historically, humans have contributed to carbon dioxide emissions in two ways: by burning fossil-fuels and converting forestlands to other uses. Initially, land-use changes (deforestation) were the principle source of carbon emissions. However, starting in the 20<sup>th</sup> century, fossil-fuel emissions rose rapidly, while emissions due to deforestation gradually declined. One way to begin to address the issue of increasing



carbon emissions is to maintain and increase the stock of sustainably managed forests.

Although it is well known that the world's tropical forests are declining, it is less widely recognized that the world's temperate and boreal forests have been expanding. Recent UN Food and Agricultural Organization estimates indicate a net global deforestation rate—that is, the conversion of forestland to other uses—for 2000 through 2005 of 7.3 million hectare (ha) per year. This is a reduction from the 8.9-million-acre net annual deforestation of the 1990 to 2000 period, when deforestation of natural forests at 14.1 million ha per year was partially offset by an afforestation rate of 5.2 million ha per year. So, while the tropical forest carbon stock has become smaller, the temperate and boreal forests have been expanding.

The Kyoto Protocol recognizes the efficacy of forests and sustainable management as a vehicle for addressing climate change in Article 2, which states that each party in Annex 1 (major industrialized nations) shall establish or expand policies and measures that promote sustainable forest management practices. Additionally, according to Article 3.3, afforestation and reforestation credits are obtained, while deforestation is associated with debits. Article 3.4 provides credits for increases in the carbon sequestered by forest management.

But the protocol fails to take full advantage of the potential of forest sinks. Looking toward a post-Kyoto world, how might the role of forest sequestration be expanded to more fully address climate change?

Several northern countries—including France, Portugal, Japan, China, some Eastern European countries, and the United States that are experiencing positive net biological growth—have a wide interpretation of forest management and of forests that are eligible for credits. Although these forests are sequestering large amounts of carbon, much of this would probably occur without a carbon program. The question is how much of the additional carbon reasonably can be viewed as additive, in the sense that they would not have occurred under business as usual.

Under Kyoto, European Union countries were given credit for 15 percent of the net growth of their managed forests, with no credits or debits associated with unmanaged forests. This approach assumes that active management is responsible for 15 percent of the incremental addition in forest growth. However, exceptions—based on political, not scientific, considerations—providing for larger amounts of credit were negotiated for some countries, such as Russia. A question for a future agreement is how much sequestration would be allowed for various countries from forest management. In addition, as it now stands, the protocol does not give credit for protecting existing forests, although loss of forests can generate debits for countries with carbon targets. This issue becomes more complex if the countries without carbon targets undertake sequestration programs, as with the Clean Development Mechanism (CDM), in cooperation with industrial countries. Furthermore, if the current system were applied to the next compliance period, these countries could incur carbon debits for forest losses that might occur beyond a base period yet to be determined.

One approach for initially involving tropical countries might be to allow them positive carbon credits for reducing their rates of deforestation below a baseline level. The baseline could be constructed by using the estimate of the forest and its carbon at some time point. Alternatively, a baseline trend might be constructed by projecting the forest carbon through time. Credits could be provided for amounts sequestered in excess of baseline levels. Care must be taken, however, in establishing the baseline. The smaller the area involved, the larger the likely "leakage," that is, the shifting of emissions out of one geographical area and into another. When this happens, credits are obtained for emissions reductions in the one area, while emissions increases that occur simultaneously in another area do not receive debits.

The real solution is to be found in a mix of adaptive actions, as well as a host of new emissions-reducing technologies that are being developed today. A related approach would be to provide carbon credits for acceptable restoration for forests deemed degraded. This wider perspective could generate social benefits, both through carbon mitigation and through other social and environmental benefits associated with forests, such as habitat conservation.

Another element that needs further consideration is the treatment of carbon in wood products like buildings and furniture. The current assumption is that once a tree is harvested, all of its carbon is released. This approach assumes that the net stock of carbon in long-lived wood products is unchanging. In fact, about one-half of the harvested industrial wood goes into wooden products that are in use for extended periods, and so the carbon remains captive for years, decades, and even centuries. Credit could be given for the sequestration of this carbon. However, it must be recognized that while new wood materials are being added to the stock of wood products, the stock also is experiencing releases as wood decomposes, is burned, or otherwise releases carbon.

### **Adaptive Action**

Although consensus grows that the Kyoto Protocol suffers from a number of defects, the bright spot is that the global community can learn a great deal from the Kyoto experiment. A major lesson is that an approach that is hugely expensive but generates small climate benefits is unlikely to satisfactorily resolve the problem of global climate change. The real solution is to be found in a mix of adaptive actions, as well as a host of new emissions-reducing technologies that are being developed today.

Sustainable forestry management is one such approach that can sequester a substantial portion of the surplus carbon in the atmosphere—at a much lower cost than other carbonreducing actions. Additionally, the technology currently is available: the global community knows how to plant and grow trees. These actions can be taken over the next several decades, while improved technologies are developed to address the carbon problem over the long term. Finally, many of the proposed forest-sequestration activities, such as tree planting, provide other substantial noncarbon environmental benefits. Ignoring the sequestration potential of forest sinks would also ignore the array of potential damages from continued deforestation.

This article is based on an RFF Report by the authors, Forest Sequestration: Performance in Selected Countries in the Kyoto Period and the Potential Role of Sequestration in Post-Kyoto Agreements. May 2006. Available at www.rff.org/rff/Documents/RFF-Rpt-ForestSequestra tionKyoto.pdf.

# Inside RFF

# Former Spofford Interns Continue to Work on Chinese Environmental Issues

### Ruth Greenspan Bell

FF established the Walter O. Spofford, Jr., Memorial Internship in 1997, in honor of Dr. Spofford's legacy. During his long career at RFF, his name became synonymous with RFF's work in China. He helped launch RFF's China Program in 1989, mentored Chinese researchers and policymakers, and helped establish the Beijing Environment and Development Institute (BEDI), an NGO loosely modeled on RFF and headed by Ma Zhong, now a well recognized Chinese environmental economist.

Dr. Spofford exemplified RFF's goal to engage in the environmental policy debates of our times. In his memory, every spring we review dozens of impressive applications to select one person with a special interest in Chinese environmental issues to join RFF for the summer. His name has become a noun: we have now hosted nine "Spoffords."

We recently contacted the Spoffords to find out what they are doing and how their summer at RFF may have affected their thinking about the environment and their future professional plans.

Several have earned their graduate degrees and are working on Chinese environmental problems. When she returned home to China from her summer with RFF, our first Spofford intern, Shuqin Liu, finished a Ph.D. at Peking University in environmental law, while actively supporting various multilateral development banks and foreign consulting firms developing projects such as sulfur dioxide emissions trading in China. She currently lives with her husband in Nairobi, where she has been freelancing with the UN Environmental Programme and other organizations since 2003. Liu says that her time at RFF gave her welcome exposure to American people and culture and a chance to learn how a U.S. NGO operates.

Jiang Ru, our 2003 Spofford, holds a Ph.D. from Stanford and is living in the Washington, DC, area, where he consults to the World Bank as an environmental specialist. He focuses on projects to help China phase out its production and consumption of ozone-depleting substances, manage and dispose of persistent organic pollutants, and reduce its nutrient discharge into the East Asia seas.

In February 2005, he testified before the U.S. Congressional Executive Commission on environmental NGOs in China.

Many former Spoffords are still in graduate school. Following her 2002 internship, Chunxiang Li is currently studying for a Ph.D. in resource economics at the University of Massachusetts. She says her experience at RFF helped her with the application process and gave her an idea of how people from diverse fields contribute to resource conservation. After graduation, she hopes to continue studying agricultural markets and conducting high-quality research, "just like what the RFF scholars are doing."

Xuehua Zhang, who stayed at RFF for a year after her 2000 Spofford ended to, work on sulfur dioxide emissions trading in Taiyuan, is conducting field research in China for her Stanford Ph.D. There, she is interviewing judges, plaintiffs, and defendants in several Hubei cities to explore the efficacy of environmental legal redress.

Our 2005 Spofford, Hui He, returned to the LBJ School of Public Affairs at the University of Texas, Austin, after her summer at RFF and will graduate later this year. Her work at RFF on local emissions-control initiatives in various Chinese cities and provinces led her to believe in the great potential of "providing multiple incentives to producers and involving more public participation." She will explore this further in her professional report for her master's degree.

Dr. Spofford's efforts still resonate as China struggles to manage its considerable environmental challenges. One legacy is BEDI and the work of now-renowned experts who benefited from his mentorship. Another is the growing number of talented Spofford interns who will provide innovations to improve China's environment and the world's. Mining Executive and New RFF Board Member Calls for Action on Global Warming

Preston Chiaro comes to the RFF Board of Directors with a belief that the energy sector as a whole has yet to take the first step in addressing climate change: "simply to acknowledge the scope, scale, and seriousness of the problem and the need to take action now, even in the face of some remaining uncertainties."

As chief executive of the Energy Division of Rio Tinto, Chiaro has responsibility for the company's coal and uranium mining operations in Australia, Namibia, and the United States. Rio Tinto is a major supplier of uranium to the nuclear power industry, a lowcarbon energy source that is attracting renewed interest as an option for meeting worldwide energy demands. Chiaro is also the senior executive in charge of Rio Tinto's climate change program. Energy companies, he says, need to engage in the policy debate to ensure that the decisions made by governments on behalf of their citizens are well informed and maximize environmental, social, and economic outcomes. Companies must reduce

their "climate footprint," Chiaro says, by conserving energy in their production processes. He also wants to see companies engage with their customers to help them address the issue at home.

Chiaro believes that the critical new technology for fossil fuels, including coal, will be carbon capture and storage. The

components of such systems have long been available, but the technology "package" needed to collect, transport, and sequester carbon dioxide in safe geologic repositories is just coming on line. Rio Tinto is supporting FutureGen, a U.S. Department of Energy initiative to build the world's first near zero-emissions coal-fired power plant, which incorporates the technology on a commercial scale. Alternative combustion processes, postcombustion capture, and monitoring systems for carbon dioxide storage reservoirs will also be important as part of the effort to reduce emissions from coal-fired generators, Chiaro says.

An environmental engineer by training—he received his B.S. and



PRESTON CHIARO

M.E. degrees at Rensselaer Polytechnic Institute, New York—Chiaro has a particular interest in sustainable development. He oversaw cleanup projects at the Bingham Canyon Mine, the world's largest openpit copper mine, and has set up a sustainable development leadership panel at Rio Tinto "to

make sure that sustainable development becomes embedded in the organization's DNA."

His background and thinking, Chiaro says, "are very much aligned with what RFF is trying to accomplish—to make a positive contribution toward responsible, pragmatic, longterm policy thinking around resource development." He says he has long respected RFF "for the depth, clarity, and independence" of its research.



RFF sponsors a summer internship program in which students from around the world work with the research staff. Pictured here are some of this year's interns, from left:

Top row-Daniel Shawan, Laura Blessing, Daniel Stone, RFF President Phil Sharp, Yi Jiang, Griffin LeNoir, and Christina Dietrich.

Middle row–Andrew Fleeter, Prabirendra Chatterjee, Tingting Yan (Spofford intern), and John Lekuton.

Bottom row-Francie Streich, Laura Chappell-Campbell, Ada Chen, Roshni Rathi, and Scott Salyer. Not pictured: David Bael, Yu-Ming Chang, Joseph Edemeroh, Radha Jujjavarapu, Leah Menzies, and Nicholas Powers.

# **Recent Titles from RFF Press**





THE RFF READER IN ENVIRONMENTAL AND RESOURCE POLICY



The RFF Reader in Environmen and Resource Policy Second Edition

Wallace E. Oates, editor

Cloth, ISBN 1-933115-16-5 / \$75.00 Paper, ISBN 1-933115-17-3 / \$34.95

New Approaches on Energy an Environment

**Policy Advice for the Presiden** 

Richard D. Morgenstern and Paul R. Portney, editors

Cloth, ISBN 1-933115-00-9 / \$45.00 Paper, ISBN 1-933115-01-7 / \$16.95

Emissions Trading, 2nd Editio Principles and Practice

T. H. Tietenberg

Cloth, ISBN 1-933115-30-0 / \$80.00 Paper, ISBN 1-933115-31-9 / \$38.95 Democracy in Practice Public Participation in Environmental Decisions

Thomas C. Beierle and Jerry Cayford

Cloth, ISBN 1-891853-53-8 / \$50.00 Paper, ISBN 1-891853-54-6 / \$22.95 nal Environmental Accounting ing the Gap between Ecology conomy

Hecht

ISBN 1-891853-93-7 / \$60.00 ISBN 1-891853-94-5 / \$24.95

te Rights in Public Resources y and Property Allocation in et-Based Environmental Policy

Raymond

ISBN 1-891853-69-4 / \$55.00 ISBN 1-891853-68-6 / \$23.95

## a's Forests

**Global Lessons from Market Reforms** 

William F. Hyde, Brian Belcher, and Jintao Xu, editors

Cloth, ISBN 1-891853-67-8 / \$60.00 Paper, ISBN 1-891853-66-X / \$26.95

TO ORDER, VISIT WWW.RFFPRESS.ORG OR CALL 800.537.5487 IN THE U.S. OR 410.516.6965

# New from RFF Press

Environmental Life Cycle Assessment of Goods and Services An Input-Output Approach

Chris T. Hendrickson, Lester B. Lave, and H. Scott Matthews

Cloth, ISBN 1-933115-23-8 / \$80.00 Paper, ISBN 1-933115-24-6 / \$35.00 Leveraging the Private Sector Management-Based Strategies for Improving Environmental Performance Cary Coglianese and Jennifer Nash, editors

Cloth, ISBN 1-891853-95-3 / \$60.00 Paper, ISBN 1-891853-96-1 / \$24.95 Economics and Contemporary Land Use Policy Development and Conservation at the Rural-Urban Fringe

Robert J. Johnston and Stephen K. Swallow, editors

Cloth, ISBN 1-933115-21-1 / \$70.00 Paper, ISBN 1-933115-22-X / \$36.95



# TO ORDER, VISIT WWW.RFFPRESS.ORG OR CALL 800.537.5487 IN THE U.S. OR 410.516.6965



1616 P Street, NW Washington, DC 20036-1400

RETURN SERVICE REQUESTED

NON-PROFIT US POSTAGE PAID PERMIT NO. 3361 BALTIMORE, MD

