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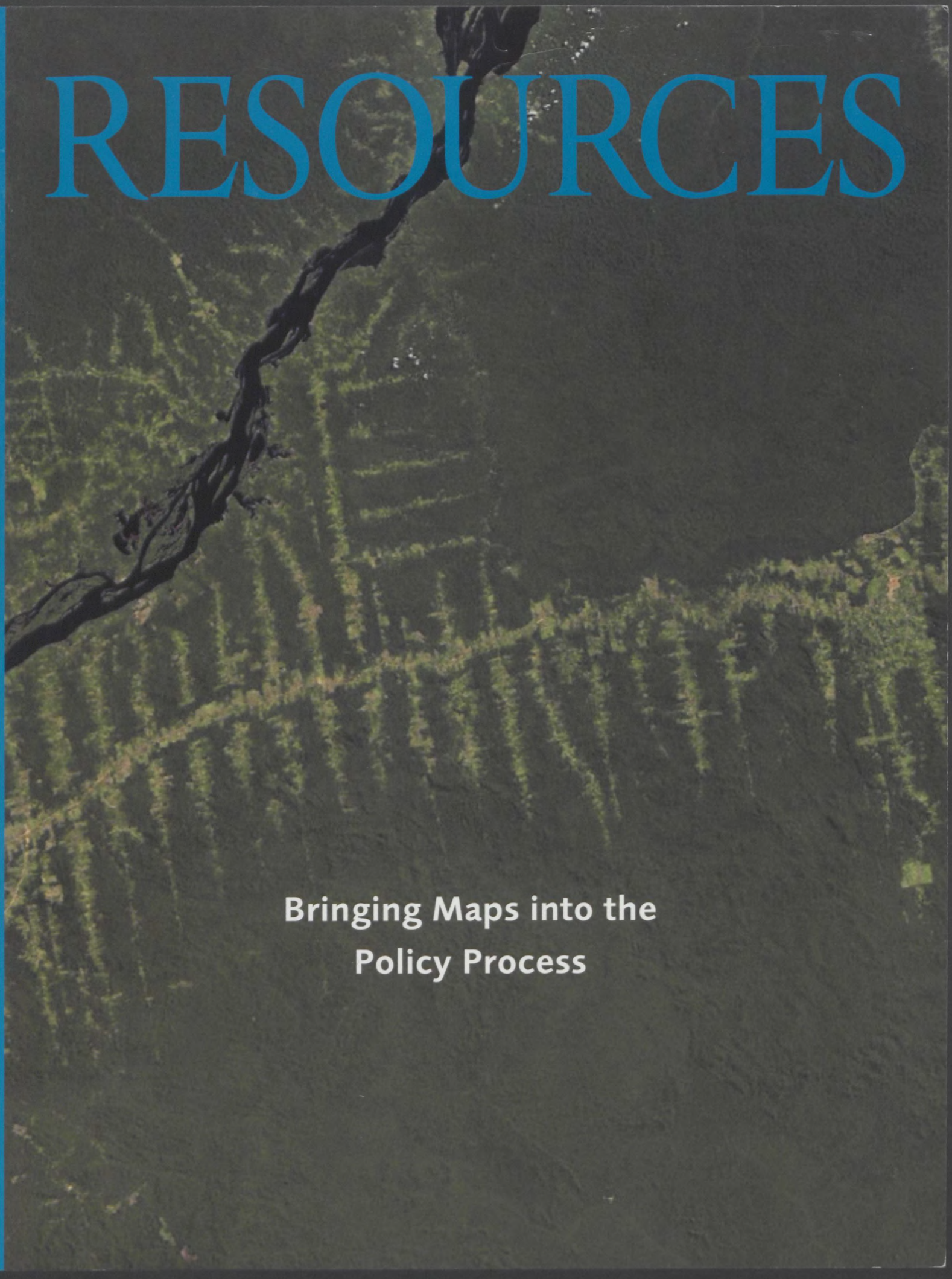
RESOURCES



Bringing Maps into the Policy Process

WELCOME

Reaffirming Our Mission

PHILIP R. SHARP AND EMERY CASTLE

One of the great pleasures and benefits of being president of RFF is the opportunity to interact and consult with my forerunners in the job. Just two months ago, we were delighted to have a visit from Emery Castle, who served as vice president and president of RFF from 1976 to 1986. Today he is a professor emeritus of agricultural and resource economics at Oregon State University. Even now, his beloved rose garden in the RFF courtyard is still in bloom.

Emery talked about one of the most significant challenges he faced as RFF grew to be the multifaceted institution it is today, namely the need to forge our own identity. Foundations wanted us to be advocates, and government agencies were especially aggressive, trying to get the RFF imprimatur on things they wanted. Hard thought had to be given to what was truly important, Emery said. Credibility was number one: RFF needed to be seen as absolutely independent.

Maintaining our scholarly integrity is our highest priority today, coupled with our need to make a difference. RFF has had the most impact when it has identified the emerging issues and shaped the subsequent agenda, in Emery's view.

Emery made a very important point: big intellectual advances come when creative minds take on important *real-world* problems. Emery himself exemplifies this approach.

He is a pioneer in the discipline of place-based economics, having done original research on water issues and rural resource economics, always working closely with engineers, biologists, and soil conservationists. Emery's work brought resource economics to the forefront of U.S. environmental policy, and his interests correspond closely with the thrust of many current RFF researchers tackling real-world problems.

Emery Castle both exemplifies and reminds us of the historic mission of RFF. In the face of daunting economic and energy challenges, we must continue to attract excellent minds and give these researchers real incentives and intellectual freedom. Only then can we continue to provide the seasoned perspectives that will contribute to practical and inventive policy solutions.

Phil Sharp

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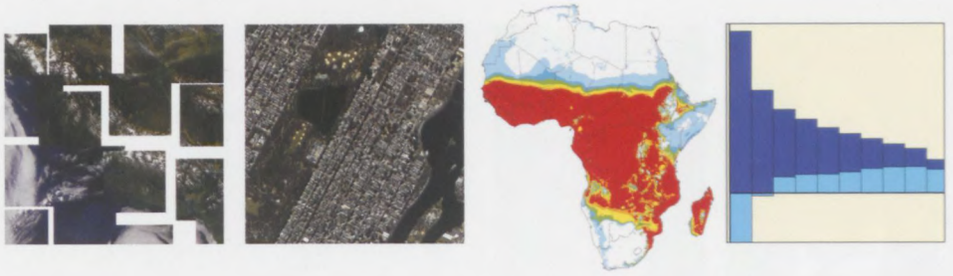

DEPARTMENTS

FEATURES

About the cover: The cover, a satellite photograph depicting logging roads in the Amazon, provides another example of how maps can contribute to the policy process. (Source: ESRI ArcGIS Online).

RESOURCE LINKS

To learn more about the feature stories in this issue, please enter these links listed below in your web browser or, if reading from our online PDF edition, simply select an active link and a new window will open.

▸ This triangular symbol seen throughout *Resources* indicates an active link.

Why Place Matters ▸ www.rff.org/whyplacematters

Location, Location, Location ▸ www.rff.org/location

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RFF Senior Fellow **James Boyd** works in the fields of environmental regulation and environmental law and economics, in particular, the analysis of environmental institutions and policy. Specific areas of expertise include water regulation, environmental and product liability law, and incentive-based regulation.

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Currently Professor Emeritus at Oregon State University, **Emery N. Castle** served as president of RFF from 1979 to 1986 and, before that, was vice president of the organization for three years. He is a distinguished researcher, teacher, administrator, and public servant. Throughout his career, he has made contributions to the studies of land and water economics as well as rural people and places.

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As co-founder of the Environmental Economics Unit in the Department of Economics at the University of Gothenburg, associate professor **Gunnar Köhlin** has spent 20 years working with applications of environmental economics in developing countries. He is also the director of the Environment for Development initiative. Currently, he focuses his research on sustainable natural resource management in Africa.

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Shalini P. Vajjhala, an RFF Fellow, studies the social impacts of large-scale physical and economic phenomena. She has worked extensively on adapting and integrating participatory mapping methods and geographic information systems (GIS) technology to engage citizen participation.

RFF Senior Fellow **Margaret Walls** has focused her recent work on finding practical and effective uses of land, particularly in urban and suburban areas. A key aspect of her research involves analyzing the use of transferable development rights programs to preserve livable communities, ecological habitat, and the aesthetics of open space in urban fringe areas while allowing for judicious business and residential growth and private property rights.

SIXTH ANNUAL HANS LANDSBERG LECTURE

A Job Half-Done: Reform of the U.S. Electricity Sector

Tiffany Clements

In October, noted economist Paul Joskow provided an RFF audience a picture of the fragmented and disjointed U.S. electricity sector and sketched out the implications for addressing current energy challenges. The Alfred P. Sloan Foundation president concluded that major reforms likely are needed in order for the nation to meet its energy demands and deal with 21st century environmental issues like climate change.

Joskow spoke at RFF's Sixth Annual Hans Landsberg Lecture, which honors the memory of Landsberg, a pioneer in energy and mineral economics who was a devoted member of the RFF staff for nearly 40 years. He explained the daunting task regulators face in restructuring America's electricity markets. Antiquated federal policies and contemporary pushes for reform, Joskow said, have led the sector into a fractured state of regulated, deregulated, and mixed systems.

The past 25 years have seen major overhauls to similar energy and infrastructure sectors—like natural gas, trucking, railroads, and telecommunications. But the fundamental functionality of the system and shocks to the electricity market in the early 2000s, including California's energy crisis and the collapse of Enron, stalled full reform of the electric power market, he noted.

"The electricity sector, for a variety of reasons, was the last one on the list and the reforms have never been fully realized," Joskow said.

Consequently, major technological, economic, and environmental factors play a negligible role in current U.S. electricity policy and structuring. Fragmented utilities operate under different market systems, depending upon states' regulatory policies. A concerted push in the 1980s and '90s to reform the electricity sector never turned into a federal effort, he said.

Reforming America's electricity generation and transmission system will be key to establishing the necessary infrastructure to promote America's energy transition. The disjointed system of electricity creation and transmission is a sizable roadblock to putting new and alternative forms of energy on the nation's grid.

Harvesting wind energy in North Dakota and transmitting it to highly populated areas in Illinois, for example, isn't possible because a transmission line infrastructure between the two areas doesn't exist.

Moreover, Joskow argued, without federal guidelines for responsibility and financing, problems—such as whether the state providing or receiving electricity should cover costs—will go unresolved.

Without a unified system it will be difficult to bring traditional sources of generation online and update aging plants to meet standards for cleaner, more efficient operation. Depending upon a state's system, the benefits of investing in new generating capacity may not outweigh the costs.

It has also been nearly 20 years since the sector has added significant generating capacity and there are certain risks inherent to such a time lapse. According to Joskow, many of the people versed in power plant construction have left the industry. There is the possibility that constructing new plants will lead to great expense and result in "costly lemons," plants that fail to meet expectations of utility and electricity generation.

The lack of an overarching national market policy not only presents problems for utilities and consumers but has negative implications for climate change policy. Reforming the electric power sector in the United States will be essential to meeting any potential greenhouse gas mitigation goals because electricity production accounts for 40 percent of carbon dioxide emissions and 35 percent of fossil fuels used in the United States, Joskow said.

"Comprehensive reform of the electricity sector may be necessary to achieve climate change goals efficiently," Joskow warned. "The current system, caught between 1935 and 2001, is simply not well adapted to deal with that and may complicate the efforts to create an acceptable climate change policy because of the way it's likely to work through the different competitive and regulatory regimes."

Reforms should not only be directed to regulation at the supply side, but also aimed at changing customer behaviors on the demand side. Joskow noted that a market system to incentivize consumer conservation would be useful in reaching environmental efficiency standards as well as ensuring a reliable, affordable flow of electricity into the market.

Joskow suggested a system that would respect legitimate states' rights but also step in to modify aging, failing protocols and reflect new and evolving technologies for generation and transmission.

As financial and climate change challenges evolve both in the United States and around the globe, the need to address an aging electricity market structure continues to grow. ■

Full coverage of Mr. Joskow's lecture can be found at ▸ www.rff.org/Joskow.

Environment for Development: RFF Joins Initiative to Strengthen Green Policies in Developing Countries

Allen Blackman and Gunnar Köhlin

To improve environmental policymaking in developing countries, RFF is working with the Environmental Economics Unit at the University of Gothenburg in Sweden to establish and support national centers for environmental economic analysis in China, Costa Rica, Ethiopia, Kenya, South Africa, and Tanzania.

The Environment for Development (EfD) initiative was partly inspired by RFF's history of helping to improve policymaking by applying rigorous, objective economic analysis to important environmental and natural resource policy issues. The main activity of the new EfD centers is international research collaboration. Policy instrument analysis, non-market valuation, and behavioral and experimental economics are used to analyze land management, forestry, fisheries, wildlife, climate change, and environmental fiscal reform. The centers will also provide policy advice and training.

RFF's involvement in the program is now at the one-year mark. *Resources* caught up with Senior Fellow Allen Blackman, who is currently in residence at the EfD center in Costa Rica and is RFF's point person for the program, and EfD Program Director Gunnar Köhlin, an associate professor at the University of Gothenburg, to get their perspective on its relevance and goals for the future.

Resources: Why is the program so important, especially now?

Blackman: Many of the world's worst environmental problems are now found in developing countries. But policymakers lack the most fundamental tool they need to take action: reliable, objective information, both about the problems and about potential solutions. The EfD program is helping to fill this gap—the centers emphasize rigorous, policy-oriented research. They are becoming the type of institutions that play a critical role in environmental policy, which have long been present in industrialized countries but are extremely rare in developing countries. For example, the EfD Center for Central America is the first institution of its kind in Costa Rica.

Köhlin: The tools of environmental economics are more important than ever in poor countries with increasing populations and mounting pressures on their resources, not least on land—now with increasing demand for biofuels, food, and climate mitigation. Since the Paris Declaration in 2005 (an international agreement among donor nations to continue to increase efforts in harmonization, alignment, and management of aid for results with a set of monitorable actions and indicators) there are also much greater expectations that developing countries themselves should undertake analysis and develop their long-term strategies. The EfD program supports exactly such strategic domestic capacity by linking up the best domestic environmental economists with international researchers, such as RFF fellows, and putting them to work on the most pertinent policy issues.

Resources: Who is paying attention? What kind of feedback have you received, and from whom?

Blackman: Building a reputation requires establishing a track record and that will take time. But after only one year, the EfD Center for Central America has begun to attract attention in both Central America and overseas. Over the past year, we have been asked by colleagues at the University of California, Berkeley, to co-host an international conference on biofuels; by the InterAmerican Development Bank to analyze quality of life in Central American cities; by an international environmental NGO to evaluate forest concessions in Guatemala; and by the Costa Rican government to provide advice on setting admission fees for national parks and electricity prices for hydropower plants.

Köhlin: The response is actually quite daunting, with a lot of interest shown by domestic organizations, among researchers both in the countries where we work, and in developed countries and international organizations. Many government ministries and agencies are very interested in research coming out of the EfD centers. Although they are vested with a lot of policy responsibilities, ministries have a very hard time recruiting PhDs to do the underlying analytical work. The centers are also acknowledged and appreciated for creating domestic platforms where lawmakers and stakeholders can draw policy implications from ongoing research. Our goal is for each center to pursue a long-term relationship with at least one sector agency.

There is also interest from other directions. With EfD, we have created a research infrastructure where our international collaborators can enjoy our centers' facilities, data collection skills, and local knowledge for joint publications. Needless to say, many researchers are interested in benefiting from this infrastructure.

Finally, international organizations see the EfD centers as a valuable source both to gain important local research insight and channel international findings to the domestic level. For example, the United Nations' Secretariat for the Commission on Sustainable Development at the UN Department for Economic and Social Affairs (UNDESA) wants to use the EfD program both to bring experts to the Commission's attention and to disseminate its findings. Currently, EfD fellows are involved in preparing two "innovation briefs" for UNDESA on sustainable agriculture and sustainable funding of national parks.

Resources: At the one-year mark, what has surprised you the most?

Blackman: In the United States, dozens of universities and research centers are hard at work on important environmental issues. In Costa Rica, by contrast, I've been struck by the range of important, and sometimes even urgent, environmental topics that are more-or-less untouched. For example, anyone who has spent any time in San José, Costa Rica's capital and largest city, will quickly tell you that congestion, air pollution, and accidents related to cars, trucks, and buses are all out of control. Yet there has been almost no research on the benefits and costs of various transportation policies, including policies that have already been put in place, like driving day restrictions.

Köhlin: Because capacity building and institutional development are very slow-moving, long-term activities, I've been amazed by how much the EfD centers have accomplished already. Each center keeps log books of its policy interaction and these lists are already impressive. The EfD discussion paper series, facilitated by RFF, already features 30 papers and many more are in the pipeline. EfD researchers are also publishing articles in leading journals as well as convening workshops and conferences to support and further their work.

Resources: How would you characterize the various centers?

Köhlin: All of the centers are chosen based on their potential to create a good research environment, establish strong links to policy processes, and their involvement in a graduate-level program in environmental economics. The hosts for the centers have also been chosen because they are the leading academic institutions of each country. Still, the centers differ in their profiles. Three of the centers are hosted by large universities (Peking University, the University of Cape Town, and the University of Dar es Salaam), while two are hosted by government think tanks (in Ethiopia and Kenya), and the center in Costa Rica is hosted by CATIE—a regional agricultural research organization. The centers have also developed different specializations—for example, forest-sector reform in China, sustainable land management in Ethiopia, and park management in Central America.

RFF, THE UNIVERSITY OF GOTHENBURG, AND THE 6 CENTERS OF THE INITIATIVE.

Resources: What lies ahead?

Blackman: I think that the key challenge in the short term is to build a solid foundation for the research centers by hiring well-trained, highly motivated staff, putting in place a clear and efficient management structure, choosing important topics for a first round of research, and doing a good job of completing these projects and disseminating the results. In the medium term, I think the centers can focus on broadening their networks and diversifying their funding.

Köhlin: At the moment, we are trying to chisel out and refine the defining characteristics of the EfD initiative. To have real impact, I believe that each center as well as the whole program would benefit from greater specialization—themes that can take advantage of the multi-center, long-term characteristics of the program. The post-doctoral positions for returning PhDs and the opportunities for international researchers to visit the centers have been very successful, and so we are working to expand these capacities.

Resources: While the academic value of this work is clear, what are the policy implications?

Blackman: Academic economists are by no means EfD-Central America's only target audience. Most of our research is motivated by questions of immediate interest to policymakers, such as: How can well-known payments for ecosystem services and national parks programs in Costa Rica and Mexico be made more effective and efficient? Will fuel taxes in Central America impose an unfair burden on poor households? What are the barriers to and opportunities for adaptation to climate change in the agricultural sector? And what role can voluntary regulation play in helping to improve environmental performance?

Köhlin: We are now starting to collect "sunshine stories," by which we can see that our research has come full circle in the policy process. The Chinese center is, for example, the key academic institution analyzing the current forest tenure reform and both the Chinese State Forestry Administration and the World Bank pay close attention to the center's findings. Similarly, the Ethiopian center has played an important role in the evolution of a sector program for sustainable land management within the country. It is important to realize that our role as researchers is only to provide the relevant information to the right people at the right time—not to make the policy. For this to happen, however, long-term investment and domestic involvement in policy-relevant research are necessary, which is the aim of the EfD centers. ■

RFF POLICY COMMENTARY

Driving Restrictions and Air Quality in Mexico City

Lucas W. Davis

Whereas U.S. cities have seen dramatic improvements in air quality over the last three decades, Mexico City has been considerably less successful. Levels of major air pollutants in Mexico City routinely exceed the maximum exposure limits established by the World Health Organization (WHO). For example, the WHO has warned that eight-hour average ozone levels exceeding 100 micrograms per cubic meter threaten human health, causing respiratory infections, chronic respiratory illness, and aggravation of existing cardiovascular disease. Evidence from monitoring stations in Mexico City indicates that during the period 1986–2005, this guideline was exceeded 92 percent of the time. Extrapolations from U.S. studies suggest that these pollution levels lead to thousands of premature deaths a year in Mexico City.

Nearly 20 years ago, record levels of ozone and other airborne pollutants led the Mexico City government to introduce a program, *Hoy No Circula* (HNC), which bans most drivers from using their vehicles one weekday per week, based on the last digit of the vehicle's license plate. (For example, vehicles with a license plate ending in 5 or 6 may not be used on Monday.) The restrictions are in place between 5 a.m. and 10 p.m. and affect the vast majority of residential and commercial vehicles, although taxis are excluded. When imposed in 1989, the restrictions applied to 2.3 million vehicles, or 460,000 vehicles per day.

The policy seemed reasonable at the start. After all, vehicle emissions are overwhelmingly the primary source of air pollution in Mexico City. According to a recent emissions inventory, vehicles are responsible for 81 percent of the nitrogen oxides and 46 percent of the volatile organic compounds in the Mexico City atmosphere. However, when hourly air pollution records from monitoring stations were examined, they showed no evidence that the program improved air quality. While weekend and late night air pollution increased relative to weekdays, consistent with drivers shifting to hours when the program is not in effect, weekday pollution levels did not change at all.

The primary cause of the program's failure turns out to be human adaptation. While the hope was that drivers would shift to low-emissions forms of transportation, such as the subway or the public or private bus systems, no one got out of their cars. Instead, the evidence indicates that HNC has led to an increase in the total number of vehicles in circulation. What is the easiest way to circumvent the *Hoy No Circula* program? Buy a second car. A driver with two vehicles can drive every day of the week as long as the last digits of the license plates don't match. Plus, the data show that most of the new cars are, in fact, used and imported from other parts of the country, and thus tend to be high-emitting.

An additional explanation is the increased use of taxis. There are over 100,000 taxis in Mexico City, or approximately one taxi for every 100 residents. In comparison, New York City has approximately one taxi for every 600 residents and Beijing has one taxi for every 175 residents. Mexico City's unusually large stock of taxis was well positioned to absorb any increase in demand from HNC. Moreover, from 1986 to 2005, taxis in Mexico City were among the highest-emitting vehicles in circulation.

But, given HNC's basic failure to alter driver behavior, Mexico City's highly congested streets are as clogged as ever. Yet the inconvenience of the driving restrictions still imposes costs on vehicle owners; a rough calculation suggest these costs amount to over $300 million per year, or $130 per vehicle owner.

Questions about the effectiveness of this program are relevant to current environmental policy in Mexico City. Air quality remains a severe problem with ozone levels exceeding WHO standards 79 percent of the time in 2005. Despite the contrary evidence, HNC was actually expanded July 2008 to include Saturday driving restrictions. Some see HNC as the central component of Mexico City's strategy for addressing air pollution while others would like to replace it with other forms of pollution control. Either way, reliable estimates of the effect of HNC on air pollution are necessary for evaluating these alternatives.

Carrying out such analysis would have implications for air quality and transportation policies throughout the urban developing world. According to the World Bank, the 10 cities with the highest average levels of airborne particulates are all in the developing world. Trends in population and vehicle growth in these urban areas threaten to exacerbate these problems. Between 2000 and 2030, the number of people living in cities in less developed countries is forecast to increase by 1.96 billion. This represents 97 percent of the projected global population increase during this period.

Driving restrictions are one of the tools available to policymakers as they confront this growing problem. Indeed, since HNC began, similar programs have been implemented such as *pico y placa* in Bogota, *restricción vehicular* in Santiago, *rodízio* in São Paolo, and, most recently, restrictions in Beijing prior to the 2008 Olympics. In total, over 50 million people live in cities with driving restrictions based on license plates.

Evidence, at least from Mexico City's experience, suggests that these policies to restrict driving are misguided. More effective environmental policies are probably those that have worked best in the United States, namely progressively tighter emissions standards for mobile and stationary sources, as well as better enforcement through, for example, stricter requirements for regular vehicle emissions inspections. ■

▸ For the full discussion on this topic, see www.rff.org/weeklycommentary.

Why Place Matters In Environmental and Resource Economics

Emery N. Castle

Emery Castle joined RFF in 1976 as vice president and senior fellow and became president in 1979. During his tenure, Castle played a pivotal role in guiding RFF as it transitioned to financial independence from the Ford Foundation and developed its endowment and headquarters. In 1986, he returned to Oregon State University, where he taught and held various administrative positions before coming to RFF, to serve as the first chair of the University Graduate Faculty of Economics. He is currently Professor Emeritus at Oregon State.

The study of land and water economics, especially comparative measurements of market and non-market goods and services arising from natural resources, was a prominent theme in Castle's research prior to coming to RFF. Upon his return to Oregon State his research shifted to the study of rural people and places. He conceived and subsequently served as chair of a multi-disciplinary committee to study problems of rural America. The National Rural Studies Committee, funded by the W. K. Kellogg Foundation and in existence from 1986–98, engaged scholars in the study of rural problems on a regional basis, with the objective of assisting colleges and universities to better address rural issues.

A great deal of traditional micro- and macroeconomics is "placeless." Microeconomics is concerned mainly with producers and consumers in decentralized markets, and macroeconomics is the study of aggregates for an entire economy. Consequently, relatively little emphasis is given to group decisions associated with people and places intermediate to these two extremes.

From the outset RFF has directed attention to place-related economic decisions. RFF helped establish urban economics as a respected specialization in economics. RFF staff such as Harvey Perloff, Lowden Wingo, and Edgar Dunn directed attention to urban place-related issues and problems associated with economic growth. RFF also served as an important catalyst in the development of resource and environmental economics. As this field developed, it became apparent that a theoretical framework was needed that would permit non-market values, such as access to wilderness and water quality associated with particular places, to be recognized. Pioneering RFF literature by Marion Clawson, John Krutilla, and Allen Kneese contributed greatly to the emergence of resource and environmental economics as a recognized specialization in economics.

A precise definition of place is necessary if place is to be accorded an important role in economic and public policy discussions. Place is defined here as a nexus of geography or natural environment, community of interest or shared objectives, and formal or informal jurisdiction. In economic terms, this means that place can be determined by the output judged to be important and the mechanisms that allow that output to be changed, just as firms are defined by the goods and services they provide. With this definition, it is possible to construct economic models of group decisions in a place.

All resource and environmental investigations need not give explicit attention to place, of course. This is unnecessary and inappropriate in some instances. Nevertheless there are two basic reasons I believe place should not be neglected in contemporary discussions. First, the quality and nature of many non-market goods and services forthcoming from natural resources and the environment vary among places. In other words, place cannot be separated from the good or service desired. Second, it is not obvious that decentralized markets and public policies serve people equally well regardless of population density. In recent decades per-capita income has risen more rapidly in densely populated than sparsely populated places, even though younger people have migrated in record numbers to metropolitan places. These two basic considerations are supported by the following generalizations based on a decade of work by the National Rural Studies Committee:

Rural America is highly diverse, but with commonalities, a vast place with a varied landscape. Rural places, with their uniqueness and diversity, are subject to common, rapidly changing external economic, institutional, and natural forces. Many localities exercise a degree of autonomy in addressing common concerns. The division of powers between federal and state government with delegated local autonomy is relevant.

Powerful exogenous economic, institutional, and natural environmental forces affect rural as well as urban places and regions. Contemporary examples abound—globalization, environmental mandates, and the demand and supply of energy. Yet such forces do not affect every place in the same way. For example, since 1980 per-capita income has risen much less in rural Oregon than for the entire state.

Rural resource use and relative economic well-being have profound implications for environment and resource policy. An inevitable tension exists between those who make use of natural resources to produce food, timber, and energy and those who desire access to the natural environment for ecosystem services, such as natural amenities and recreational opportunities. These tensions come into the open and revolve around the use of, and access to, natural resources in less densely populated places.

Local group decisions matter. In every rural community, there's at least one group focused on an issue of common concern. Common objectives and mutual trust apparently permit group, relative to individual, decisions to be an effective way to achieve individual goals. Yet, taken literally, much economic theory would have us believe that important economic decisions are made at either the micro (household or firm) or the macro (federal government) level of the economy. This would not matter if all places were identical.

False choices arise from an assumption that public policies should emphasize either people to the exclusion of places or places to the exclusion of people. In fact, in many circumstances public policies need to address the two simultaneously. This false choice is the source of a divide between economics and ecology.

An evolving curriculum

Three subject matter groupings would better integrate considerations of place in resource and environmental economic literature.

The changing comparative advantage of particular places. Even though the features of a place on which its comparative advantage is based are relatively stable, the external environment may not be. The greater the capacity of a place to adjust to external change is an important dimension of comparative advantage. As this is written, resource use conflicts in coastal areas are in the headlines; national energy concerns conflict with regional interests in environmental amenity protection.

An important issue is whether a place can offer a good or service that commands a premium over its closest substitute available in another place. And this has to be related to who has control over the resource or environmental feature that gives rise to comparative advantage. For example, at one time the Yaquina Bay in Oregon was a desirable site for the location of pulp or paper mills. This estuary also provided unique environmental amenities that would have been destroyed by the uncontrolled discharge of pollutants. When these two potential uses came into conflict some years ago, the relative desirability of the place as a pulp and paper mill site as contrasted to other possible locations permitted the community to impose environmental controls on a pulp and paper mill such that key natural amenities were preserved.

If a single owner had controlled access, a different outcome likely would have resulted. Existing local decisionmaking at a given time or place is not necessarily optimal or benign. Even so, there are practical reasons for local involvement in environmental and resource management apart from local control of the final outcome. Those with experience in local resource and environmental conflicts will know that it is not unusual for local interests to make information available that otherwise would have been overlooked.

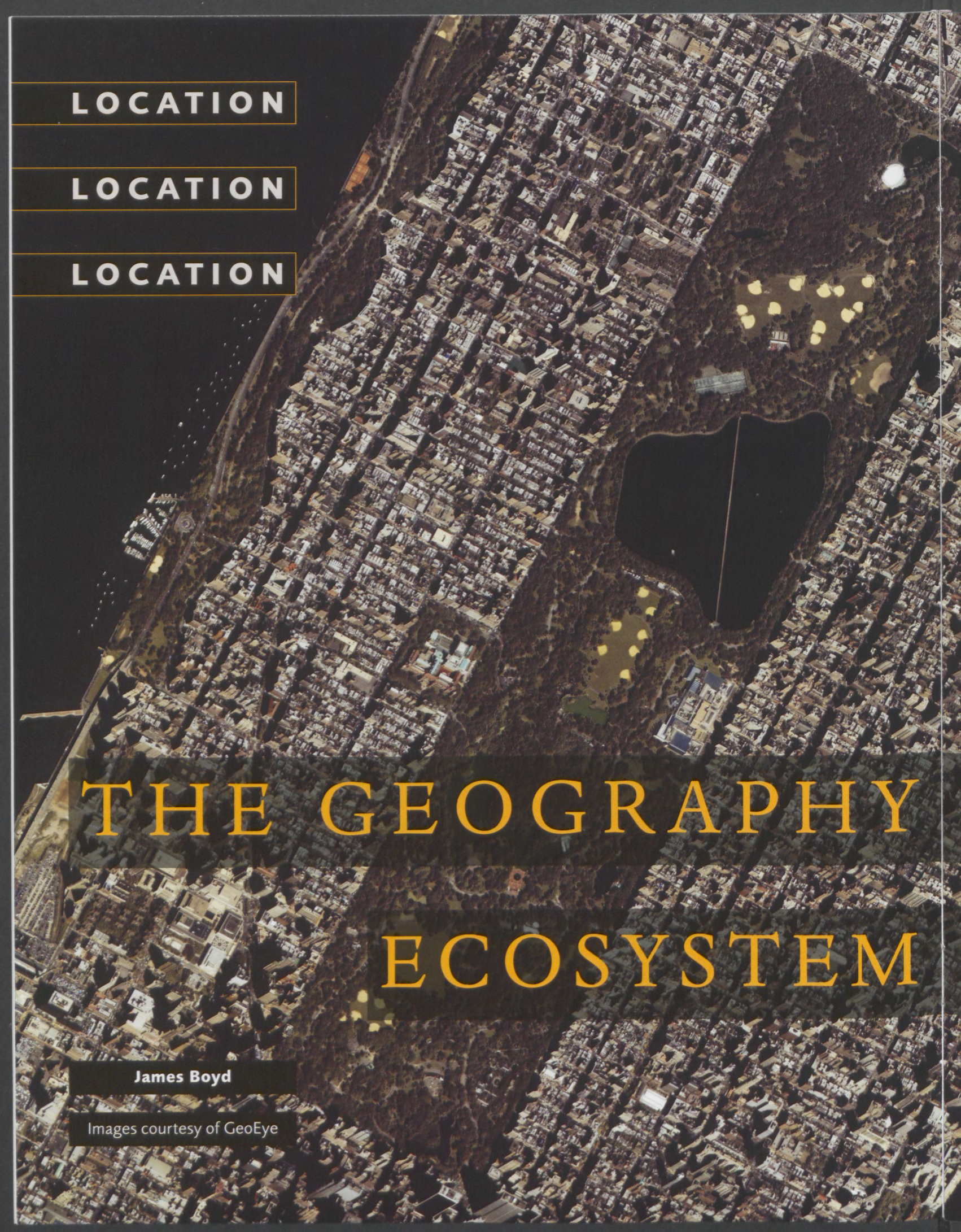
Exogenous economic, institutional, and natural world forces are always undergoing change. Three contemporary examples come to mind: globalization, the Endangered Species Act, and the demand and supply of energy. Given the division of power among national, state, and local government, it is clear that a multiplicity of interests will want to participate in public policymaking about such matters. This is not to argue that local interests should prevail but it is important to know who is affected and in what way.

Place-based decisionmaking needs to be considered in the technical aspects of environmental and resource economics. Techniques such as benefit-cost analysis used for public policy purposes tend to be oriented to economywide conditions and national objectives. They often assume full employment and homogeneous goods and services. Such assumptions often do not describe regional or local conditions accurately. Not surprisingly, when local and regional group decisions are made, such measurements typically do not carry great weight. The application of technical resource and environmental economics in regional and local group decisions is a neglected subject.

In conclusion, thoughtful analysis of resource and environmental problems, together with empirical measurements in particular places, provide environmental and resource economists with opportunity for great service. A caution flag is raised regarding the mechanical application of traditional micro- and macroeconomic decision models to problems of particular places. Assumptions of featureless plains, homogeneous products and services, and constant costs may yield results that are more misleading than helpful.

Not all important environmental and resource problems are captured by inside the Washington, DC Beltway policy debates. ■

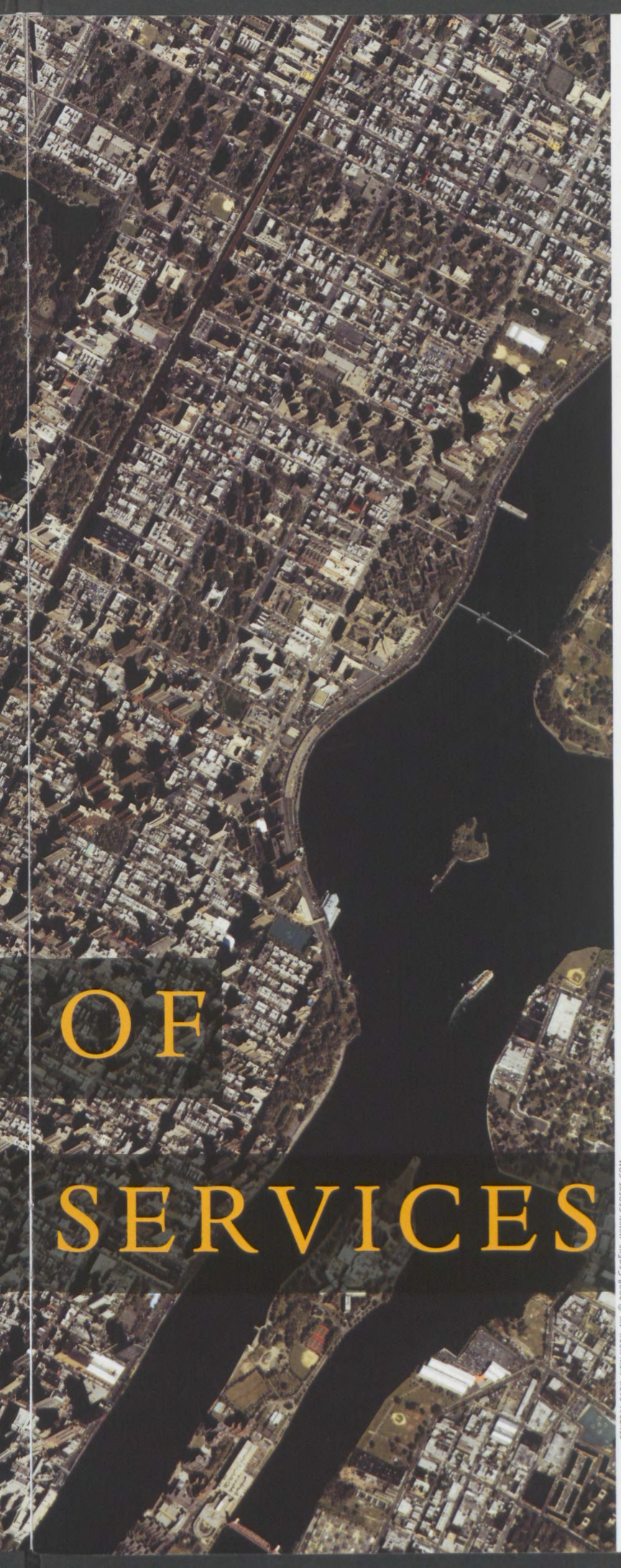
False choices arise from an assumption that public policies should emphasize either people to the exclusion of places or places to the exclusion of people.



THE GEOGRAPHY ECOSYSTEM

James Boyd

Images courtesy of GeoEye



CENTRAL PARK, NEW YORK, NY. © 2008 GeoEye WWW.GEOEYE.COM

The study of ecosystem services involves two broad missions. The first is a *biophysical* one associated with ecology, hydrology, and the other natural sciences. How can we protect—or, ideally, enhance—the biophysical goods and services necessary to our well-being? If we want clean air and water, healthy and abundant species populations, pollination, irrigation, protection from floods and fires, how can we take action to preserve these things?

The second is an *economic* mission to measure and communicate the value of those goods and services. Quantitative measures help justify interventions to protect natural resources and systems. They also spur government and other decisionmakers to take ecological gains and losses into account.

Geography is essential to both missions. Ecologists and economists of ecosystem services are scrambling to develop skills in mapping, visualization, and the manipulation of data via geospatial information systems. These skills aren't optional. We eventually need to be able to see and manage what can be called the "missing economy of nature," which is absent for several reasons. In general, markets and business activity do not produce and trade ecosystem goods and services. Consequently, the information we use to measure the conventional economy doesn't capture the free public goods provided by natural systems. Besides, nature is inherently complex. How does an action taken in one place affect conditions in another?

In Nature, Some Things Move, Others Stay Put

From an ecological perspective, geography matters because *nature moves.* Air circulates. Water runs downhill. Species migrate. Seeds and pollen disperse. Not only that, the movement of one thing—say water—tends to trigger the movement of other things, like birds and fish. With the goal of managing and protecting ecosystem goods and services, we must understand this web of movement. You could say that in nature, *nothing stays put.* Ecologically, the constant movement and mixing of natural systems is what generates the need for geographic science.

Interestingly, you could also say that in nature, *everything stays put*—an apparent contradiction. A distinctive feature of ecosystem goods and services—once produced—is that they are unmovable. You can't move a lake, river basin, or forest. You can't ship clean air from one city to another. Birds will migrate where birds migrate. Beautiful mountain trails and scenery can be found in Colorado. Too bad, Kansas. To economists, it is this property of ecosystem goods and services that triggers the need for geography. As any realtor will tell you, three things matter: location, location, location. The same is true for ecosystem goods and services. They're just like houses: if you want to know their value, it's all about the neighborhood.

The Production of Ecosystem Services: Nature in Motion

Think about anything in nature you care about. It could be the beauty of a park, a species you fish for or hunt, or the quality of the air you breathe and water you drink. Now ask the following question: what do those things depend on?

Downstream water quality depends on upstream land uses. The health of Gulf of Mexico fisheries, for example, depends on agricultural practices in the upper Midwest. Air quality in the Adirondacks depends on pollution emissions from the Midwest. Coastal cities and towns depend on nearby wetlands to absorb flood pulses. The point is that the ecosystem goods and services we care about often depend on physical conditions at a great distance from the thing we actually care about. This is a consequence of the continual movement of nature's components.

Accordingly, the biophysical analysis of ecosystem goods and services must be geographic. Treating an ecological problem at the point where it occurs usually doesn't work. It's like putting a band-aid on a lesion caused by an underlying disease. Our ecological diseases—and their cures—are geographic, because ecological systems are geographic.

The challenge for ecosystem scientists and managers is to scientifically relate cause and effect when the cause-and-effect relationship is spatial. We call these relationships *spatial production functions,* because they tell us how an action (good or bad) in one place affects the production of ecosystem goods and services in another. Broadly, we need spatial production functions that describe the dependence of:

- species on the configuration of lands needed for their reproduction, forage, and migration;
- surface and aquifer water volumes and quality on land cover configurations and land uses;
- flood and fire protection services on land cover configurations;
- soil quality on climate variables and land uses; and
- air quality on pollutant emissions, atmospheric processes, and natural sequestration.

The science of these effects is already well underway. For example, we know that stream bank vegetation can improve water quality, help prevent soil erosion, and provide desirable habitat for certain species. But much more remains to be done. We know much less about the exact, empirical relationship between vegetation and water quality.

Why is it such a challenge? First, nature is a highly complex and non-uniform system. Complexity means that causal relationships can only be tested using rigorous, data-intensive empirical and scientific methods that are difficult and costly to perform. Second, non-uniformity means that even if you establish a causal relationship in one location, that relationship may not hold in other locations. Third, empirical analysis of causality requires collaboration between different disciplines (ecology and hydrology, for example). Cross-disciplinary collaboration in any scientific inquiry is always a practical barrier. Finally, the biophysical scientists have many other things to study and have limited financial support for all they are asked to do.

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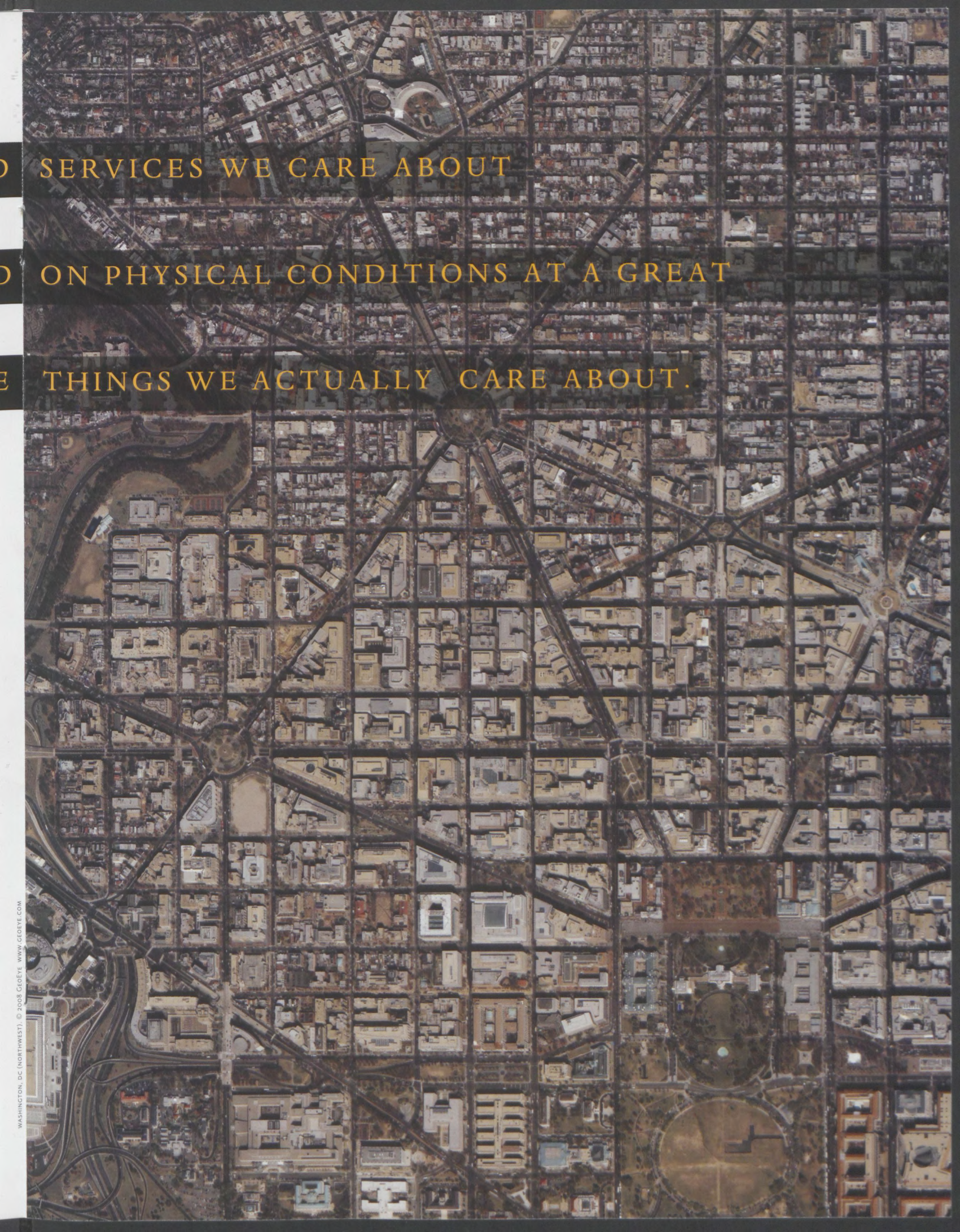
However, deeper understanding of these production functions is necessary if the ecosystem services agenda is to be taken seriously. Ecosystem protection and management will be ineffective at best, and dangerous at worst, if we cannot make credible claims about ecological cause and effect. And the only way to test ecological cause and effect is with spatial—that is, geographic—understanding of biophysical production functions.

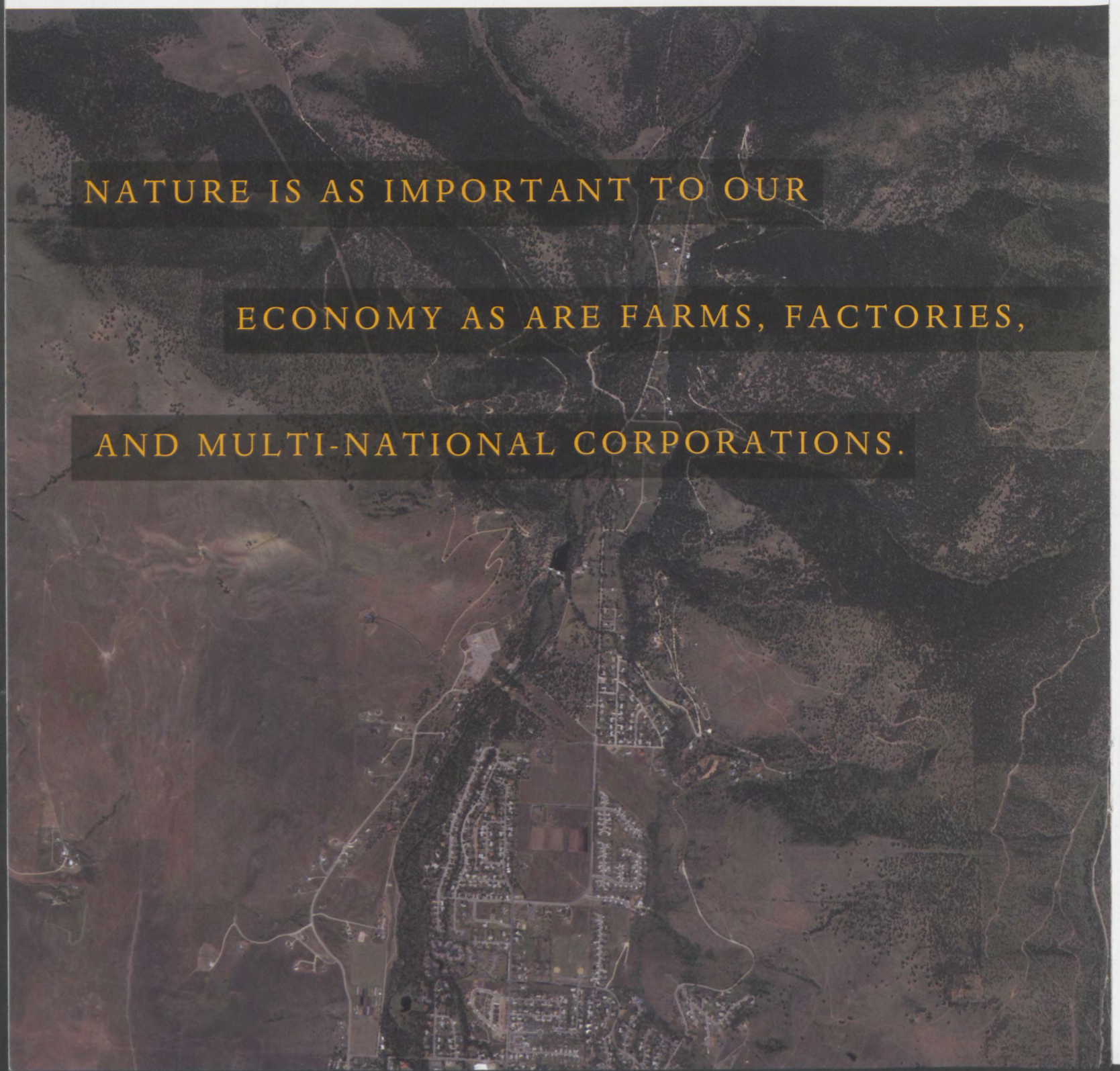
The good news is that maps and mapping technology are increasingly capable of capturing and manipulating this data. Watersheds can now be categorized on the basis of their adjoining land uses. Geographic information system (GIS) tools allow us to "see" migratory pathways and design protections accordingly. As ecology becomes ever more sophisticated in its use of spatial science and data the practical ability to measure cause and effect will become more and more possible.



The Value of Ecosystem Services: Nature's Social Neighborhood

When McDonald's wants to open yet another McDonald's, the first thing the company does is look at a map. Where are the customers? How many competitors are in the vicinity? Do people have easy access from the highway? When economists value ecosystem services, the same kind of things matter. How many people can enjoy the service? Are there other ways to get the service in that neigh-borhood? Do we have easy access to the service?

Ecosystem goods and services are like houses and fast food outlets because we can't have them shipped to us. They don't move to be near us, we move to be near them. This is most obvious when we talk about recreation. Usually, outdoor recreation requires us to travel to a park, stream, or forest. But backyard ecosystem services are the same. Chances are you chose your house based in part on its proximity to large trees, open space, clean air, and the likelihood someone interesting might show up at the birdfeeder.



We can make several broad statements about the value of ecosystem goods and services and all of them relate to geography:

- The scarcer an ecological feature, the greater its value.
- The scarcer the substitutes for an ecological feature, the greater its value.
- The more abundant the complements to an ecological feature, the greater its value.
- The larger the population benefiting from an ecological feature, the greater its value.
- The larger the economic value protected or enhanced by the feature, the greater its value.

New York's Central Park makes this point clearly. It is one of the most valuable sources of ecosystem services in the world. Central Park isn't particularly desirable ecologically, but it is nevertheless valuable because so many people live near it and have so few substitutes within walking distance. Geography tells us about all of the factors noted above. We can map population densities, measure distances to similar parks, and easily detect the presence of other types of recreational open space and forms of access like roads.

The general proposition holds for most kinds of ecosystem services. The value of irrigation and drinking water quality depends on how many people depend on the water—which is a function of where they are in relation to the water. Flood damage avoidance services are more valuable the larger the value of lives, homes, and businesses protected from flooding. Species important to recreation (for anglers, hunters, birders, and the like) are more valuable when more people can enjoy them.

Placing a value on ecosystem goods and services also requires us to analyze the presence of substitutes for the good. The value of any good or service is higher the scarcer it is. How do you measure the scarcity of an ecosystem good? If recreation is the source of benefits, substitutes depend on travel times. What are walkable substitutes? Driveable substitutes? The value of irrigation water depends on the availability (and hence location) of alternative water sources. If wetlands are plentiful in an area, then a given wetland may be less valuable as a source of flood pulse attenuation than it might be in a region in which it is the only such resource. In all of these cases, geography is necessary to evaluate the presence of scarcity and substitutes.

Finally, many ecosystem goods and services are valuable only if they are bundled with certain manmade assets. These assets are called "complements" because they complement the value of the ecosystem service. Recreational fishing and kayaking require docks or other forms of access. A beautiful vista yields social value when people have access to it. Access may require infrastructure—roads, trails, parks, housing. Note that these complements may themselves not be transportable. Again, neighborhood matters.

There are exceptions, in which geography is less important to valuation. For example, many of us value the existence of species and wild places *wherever they are*. When it comes to these kinds of ecosystem goods and services, location doesn't matter to our enjoyment, as long as the services exist somewhere. Another important clarification is that everything in nature is valuable if it contributes to the health of the overall system. Here, though, the value arises from the way nature produces services (the realm of the biophysical sciences). When it comes to the consumption of ecosystem goods and services, value tends to be determined by the social neighborhood.

Geographic Information as Technological Revolution

Geographic science will be challenging for both ecologists and economists of ecosystem services. The good news is that our technologies, data, and culture are becoming rapidly more map-focused. Armchair cartographers can already do amazing things with application platforms such as Google Earth. Government agencies and conservancies are making maps available that allow us to see both natural and social landscapes with remarkable detail. This technological revolution is having a cultural effect: maps are everywhere, changing the way we communicate and helping develop our spatial understanding of social and natural phenomena.

The growing deployment of geographic information systems is not without teething problems, however. This is particularly true when it comes to government creation and distribution of geographic information. The U.S. Census Bureau, for example, produces massive quantities of geospatial information on households and businesses. The integration of this information into widely shared, open-source software applications remains awkward, however. Private individuals are stepping in to help solve these problems, but much more could be done by government providers to aid the distribution of geographic information.

A larger worry is the lack of systematically and consistently tracked environmental information by our government trustees—a worry amply documented by the Government Accountability Office and other watchdog organizations. The greatest need facing us is to understand how we can protect and enhance ecosystem services and predict their loss. Geographic analysis of biophysical production functions is the key. But geographic analysis will rely on detailed ecological information tracked consistently over time. Unfortunately, agencies like the U.S. Environmental Protection Agency, NASA, the U.S. Geological Survey, and the Department of the Interior, among others, are given scant resources and authority to gather such information. Nature is as important to our economy as are farms, factories, and multi-national corporations. Geography is the key to understanding that economy. ■

The New Cartography

Shalini P. Vajjhala and Janet Nackoney

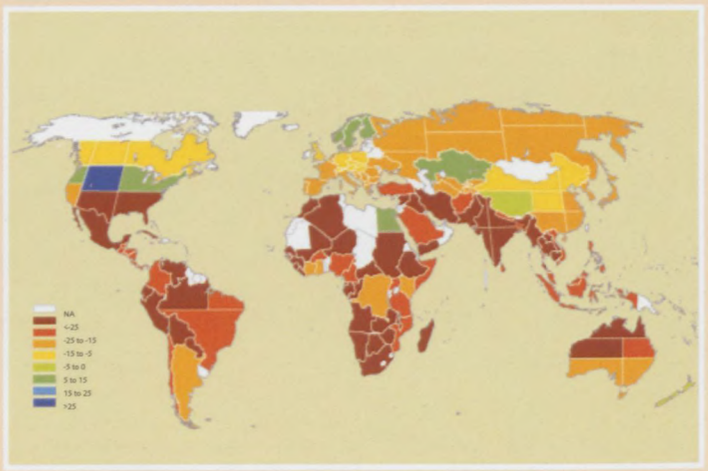


Figure 1. Map of projected climate-induced changes in agricultural productivity from 2003–2080, based on crop- and economic-modeling scenarios without carbon fertilization (Cline 2008). (Source: www.imf.org/exter nal/pubs/ft/ fandd/2008/03/cline.htm)

Maps are everywhere these days. From the daily news to scientific reports, geographic information is increasingly part of our everyday understanding of the environment. Traditionally, maps were static images, painstakingly constructed by experts and used primarily as navigation tools. In the digital age, maps have changed dramatically. Today they are easier to create, thanks to the power of computers and the growing availability of digital spatial data. Maps now serve as dynamic, interactive tools for visualization and communication. Digital mapmaking has shaped the way we view our human and natural environments and allowed us to build a deeper understanding of the complex geographic implications of global climate change.

Using satellite imagery, the 2005 United Nations Environment Programme (UNEP) report *One Planet, Many People: Atlas of Our Changing Environment* highlights how spatial data can be used to monitor the environmental impacts of decades of human activities and changes in natural resources around the world. The maps and data show photographic evidence of shrinking glaciers, shifting coastlines, and disappearing lakes. While available in book form, many of the environmental "hot spots" (a geographic term often used to describe areas of high-impact intensity or conservation priority) are also featured online, allowing armchair cartographers to "fly" to specific regions and observe changes first-hand.

Now that these tools and technologies have become more accessible, the speed and accuracy with which we can access and use spatial information has improved enormously, particularly in the field of climate science. Building effective climate policy in the years ahead will require the ability to predict and manage anticipated climate impacts on fundamental aspects of our world, including our food, health, land, livelihood, and water systems. In this new landscape, spatial data are used as inputs to complex models and studies aimed at predicting how, where, and to what extent our climate is changing, while maps are used as communication tools to assist in visualizing their results. Maps can help distill and communicate the results of studies ranging from projections of temperature and precipitation shifts to the impacts of sea-level rise, and are being used both within and beyond the scientific communities that have developed them.

# of Climate Change

Although climate maps are being created by mapmakers from diverse disciplines to display increasingly sophisticated data, the gulf between simplified snapshots of environmental changes and the complexities associated with the underlying studies and models has widened. Even the most casual map-reader must carefully consider three overarching elements of nearly all climate maps—scale, scenario, and baseline—which pose new challenges for both cartographers and citizens. Figures 1 through 5 illustrate how these primary map elements vary across five major sectors—food, health, land, livelihood, and water – where natural and social scientists, development practitioners, and policymakers are all working to better understand and respond to climate risks.

Figure 1 displays mapped results of global crop and economic models estimating temperature and precipitation changes on country-level agricultural productivity. Figure 2 highlights the geographic distribution of areas where current climatic conditions could lead to greater susceptibility to malaria in Africa. Figure 3 shows relative risk from sea-level rise by highlighting elevation differences along the coastline of Bangladesh. Figure 4 consists of a portion of a nautical chart from the Gulf of Maine used in a participatory mapping process aimed at understanding how local fishing communities respond to environmental change. Finally, Figure 5 illustrates differences between two global climate models predicting changes in annual water runoff at the grid-cell level across the world.

It is important to note that while each of these maps illustrates an aspect of the potential impacts of climate change, no single one provides a comprehensive view of the overall global climate problem. The maps also vary in how they represent past and projected environmental changes across scales, scenarios, and scientific disciplines. Understanding the strengths and limitations of such different studies and map displays is an essential window into the big picture view of climate science and policy.

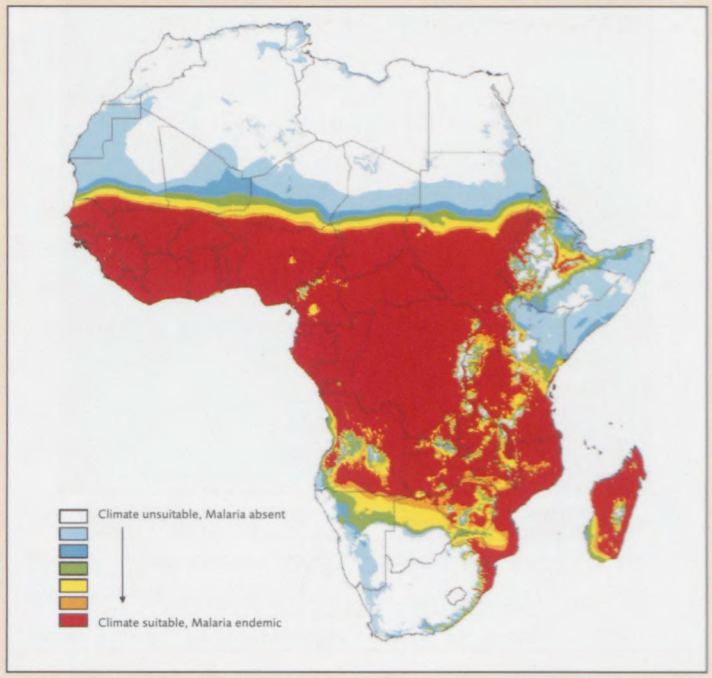


Figure 2. World Health Organization map of climate conditions necessary for malaria transmission in Africa (MARA/ARMA Project 1998). (Source: www.who.int/heli/tools/maps/en/index1.html).

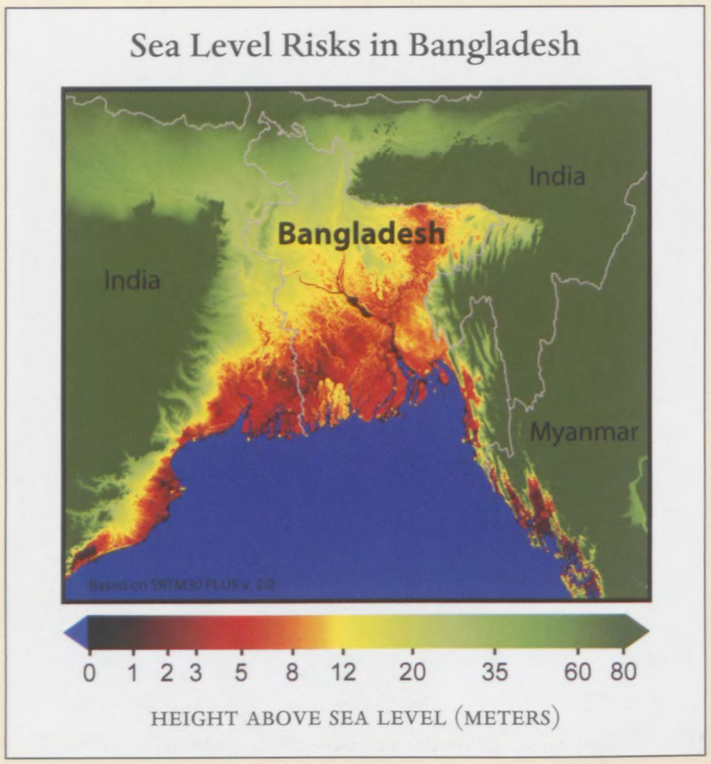


Figure 3. Low-elevation areas in coastal Bangladesh at risk of inundation from climate change induced sea-level rise (Source: www.globalwarmingart.com/wiki/ Sea_Level_Rise_Maps_Gallery).

Now let's take a closer look at these figures to see how three particular primary map elements mentioned above—scale, scenario, and baseline—can vary and influence the interpretation of climate change research.

Scale and Resolution: Perhaps the most visible differences between climate maps lie in the scale at which data are presented. Maps can be displayed at the global scale, representing the entire world (Figures 1 and 5) or be displayed at the regional, national, and local scales (Figures 2–4 respectively). While many studies focusing on the impacts of climate change on natural systems are large scale, other studies focusing on social and natural impacts of climate change can reach down to the small scale of a single community or ecosystem. Maps at any scale can also vary in the resolution, or level of detail, at which data are displayed. Some spatial data are based on an assembly of grid cells that are consistent across a given scale but whose resolution can vary between datasets, from a coarse 50-kilometer grid resolution to a fine 1-kilometer grid resolution, for example. While some spatial climate data are mapped on a grid, other spatial data are displayed as polygons representing administrative, ecoregional, or watershed units, to name a few.

Scenario and Forecast: A second major element of interpreting climate change maps lies in understanding the scenario, or alternative future, represented by a map. The Intergovernmental Panel on Climate Change (IPCC) has developed several scenarios portraying how climate change could occur under different pathways of human development. Most mapped global climate model results are presented based on these different scenarios and predicted ranges of global average temperature changes. For example, Figure 1 combines the results of several studies that encompass temperature change scenarios with increases ranging from 2.6 to 3.7 degrees Celsius.. In contrast, Figure 5 shows the extent to which estimated climate impacts on water systems vary using an older and newer version of a major global climate model for the same scenario.

Baseline and Assumptions: The third essential component of evaluating climate maps is understanding the baseline from which any environmental change is forecasted. Projections of climate changes and the uncertainty surrounding the projections can vary depending on which baseline year is selected and how far into the future a study goes. Figures 1 and 5 show how baselines can vary across sci-

entific studies and maps. Figure 1 illustrates changes in agricultural productivity from 2003–2080, while Figure 5 assumes a baseline period from 1961–1990 with forecasted changes extending to the year 2050. Similarly, many studies contain certain assumptions that determine which variables are included in a modeled climate projection, and which ones are not. Understanding the differences in assumptions across different climate studies and their spatial models and maps is key, as these assumptions often strongly influence a study's results. For example, some climate studies that predict impacts on agricultural systems do not take into account future changes in water systems. Other climate studies consider multiple stressors or feedback loops between simultaneous impacts on more than one sector.

The differences illustrated above highlight the extent to which modeling and mapmaking decisions can change how maps should be interpreted and if, or to what extent, data and results from different studies might be aggregated. Despite the focus on variations between maps here, mapping has the potential to play a unifying role across the many fields of climate science, policy, and practice. Climate change is inherently a spatial problem, where the locations of impacts, people, and resources are critical.

As climate scientists around the world are redrawing familiar landscapes, we need to remind ourselves that maps are limited by the quality and accuracy of the underlying studies and data that they represent. The necessary simplifications that are often an implicit part of making maps can obscure the uncertainty surrounding many studies and cloud the ways in which different maps are interpreted, compared, and combined.

Because climate change is a global problem, climate information needs to be accessible to a global audience. Making good use of this information will require scientists, policymakers and increasingly all of us to be aware of seemingly small variations in scales, scenarios, and baselines in the maps that are created and interpreted. With greater map literacy in these particular areas related to climate change, we can develop a more common understanding of the problem and further harness the power of maps to communicate the ideas that shape the many lenses through which we view both climate science and policy." ■

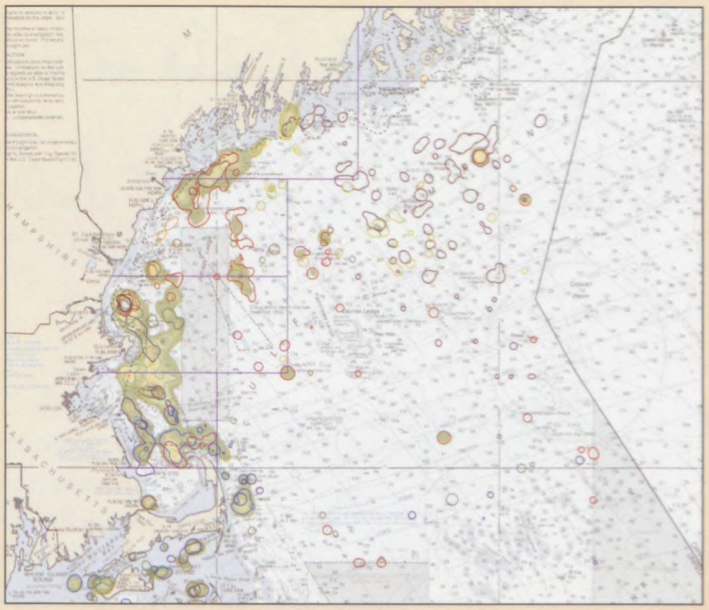
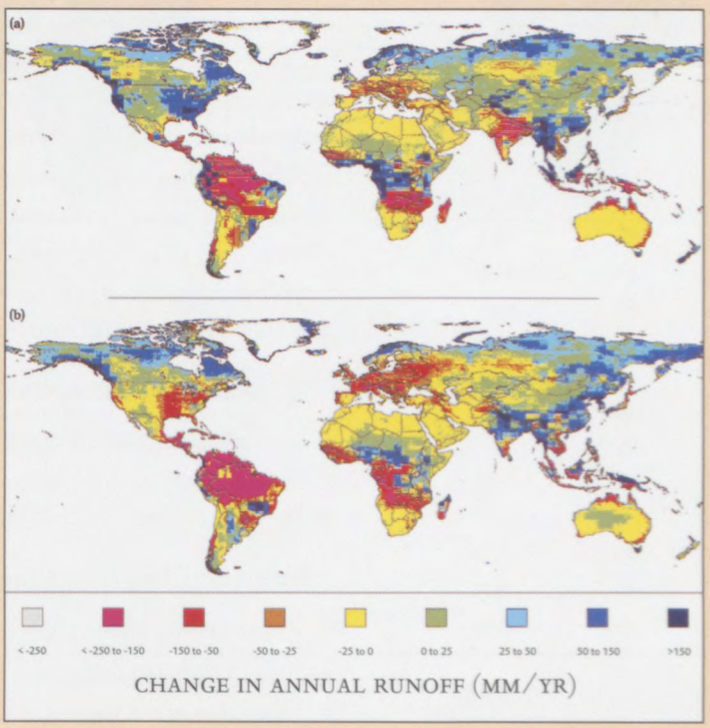


Figure 4. This nautical chart is being used by St. Martin and Hall-Arber (forthcoming) in a National Oceanic and Atmospheric Administration (NOAA) funded project involving a series of participatory interviews to better understand how local fishing communities are affected by environmental changes. For more information, see http://geography.rutgers.edu/people/faculty/stmartin/ St.%20 Martin%20and%20Hall-Arber%20%20 Creating% 20a%20Place% 20for% 20Community.pdf

Figure 5. Change in annual runoff estimated using the global climate models HadCM2 (a) and HadCM3 (b) from IPCC Working Group II, 2001. (Source: www.grida.no/climate/ipcc_tar/wg2/figts-3.htm).



Crafting a Fair and Equitable Climate Policy: A Closer Look at the Options

Dallas Burtraw, Richard Sweeney, and Margaret Walls

When comprehensive federal climate policy is finally enacted, it will impose potentially significant costs on the U.S. economy. Total cost, however, is just part of the story. Policymakers are rightly concerned about how those costs will be distributed. One criterion to be considered in designing a program is the extent to which it disproportionately burdens any one segment of the population, especially low-income households. Another criterion to consider is regional differences in the cost of the policy, especially because this can have important political implications

Today, a carbon cap-and-trade program is the most likely approach to be adopted and is already the focus of the Regional Greenhouse Gas Initiative in the northeastern states, California, and the European Union. For households, the distributional effect is two-fold. First, the introduction of a price on carbon dioxide (CO_2) would be fairly regressive, meaning that it would disproportionately affect lower-income households, which spend a larger portion of their income on energy expenditures. Second, the assignment of the value from the CO_2 price—either the value of emissions allowances, if allocated for free, or the government revenue collected under an allowance auction—has a major influence on how the burden is ultimately shared.

Similarly, the economic costs will not be uniform across various regions. Different parts of the country have both different levels and patterns of energy expenditures. In the Northeast and the Mid-Atlantic area, home heating contributes importantly to expenditures, but not so in the South. In contrast, electricity and gasoline expenditures are substantially greater as a percentage of income in the South than for other regions on average. Moreover, the CO_2 emissions associated with electricity use varies greatly in different parts of the country because the fuel used to generate electricity varies.

Most existing research on the distributional ramifications of climate policy examines only the effects of putting a price on CO_2, and a few studies examine a handful of options about how the value of CO_2 would be distributed in the economy and the impacts at a national scale. We recently evaluated the effect of a set of 10 policy scenarios. Households were sorted into annual income deciles and 11 geographic regions, and effects anticipated for 2015 were estimated based on policies enacted in 2008. The policies we looked at fall into four broad categories:

"Cap-and-dividend" options

- Per-capita (taxable) dividend of allowance revenues to households (for example, income taxes would be paid on those dividends)
- Per-capita (nontaxable) dividend of allowance revenues to households

Adjustments to preexisting taxes

- Reduction in income taxes
- Reduction in payroll taxes
- Expansion of the Earned Income Tax Credit (EITC)

Energy and fuel sector options

- Free allocation of allowances to consumers in the electricity sector (accomplished by allocation to local distribution companies, namely, retail utilities)
- Exemption of transportation sector from the cap-and-trade program
- Exemption of home heating sector from the cap-and-trade program
- Investment in end-use energy efficiency

Free allocation to emitters

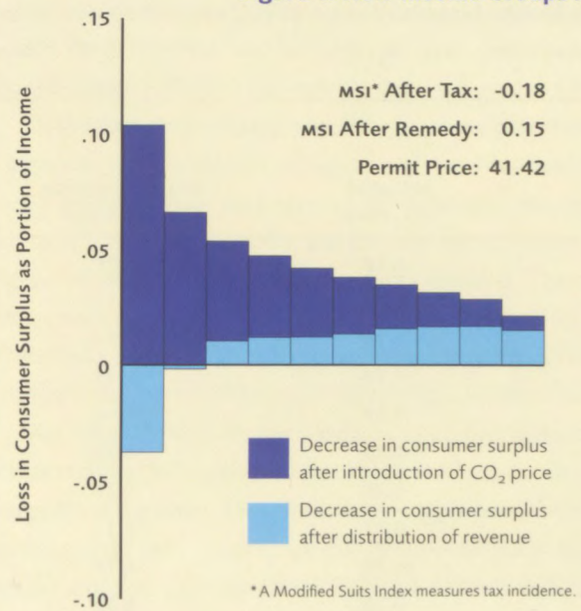
- Grandfathering to incumbent emitters.

Our measure of the incidence (the distribution of costs) of a policy looks beyond simple changes in expenditure to account for changes in consumer surplus from reduced demand. (Consumer surplus accounts for "changes in well-being" resulting from changes in expenditure, allowing for adjustments in spending patterns when prices change. It is larger than the change in expenditure in our analysis.) We assume almost all price effects are passed on to the consumer (the electricity sector being the major exception). Our incidence measure accounts for changes in direct fuel and energy costs along with the prices of consumer goods and services. It also accounts for the net effect of the policy, after redistribution of either the auction revenues or the value of allowances if they are given away for free.

To measure regressivity, we constructed a special index that provides a summary measure of the distribution of the policy's burden as we move up the income ladder. Similar indices have been widely used to measure income equality and tax incidence (the Gini coefficient and the Suits Index, respectively). Positive values of the index indicate progressivity and negative values indicate regressivity. Thus the lower the value of the index, the more regressive the policy. At a national level, before accounting for the distribution of the value of the emissions allowances, the value for our "Modified Suits Index" (MSI) for a CO_2 price of $41.50 a ton is -0.18, which is modestly regressive.

To illustrate the importance of the use of the revenue, the bar graph in Figure 1 shows how income groups are affected by the policy. The bar with darker shading and the greatest vertical height represents the loss in consumer surplus as a share of after-tax income before accounting for the value that is created by putting a price on CO_2. The bar with the lighter shading represents the incidence of a "complete policy scenario" after accounting for the value of allowances—here as revenues raised in the

Figure 1. How Income Groups Are Affected by a Cap-and-Dividend (Taxable) Policy



	Loss of Welfare for Bottom Two Deciles		Average Loss of Welfare	
	DOLLARS	PERCENT	DOLLARS	PERCENT
Southeast	-99	-1.41	748	1.32
CA and NV	-295	-3.25	851	1.24
TX	-342	-3.80	829	1.41
FL	85	0.43	847	1.56
Ohio Valley	85	0.46	1,072	1.78
Mid-Atlantic	-3	-0.37	949	1.44
Northeast	151	1.23	1,150	1.65
Northwest	-262	-3.08	625	1.02
NY	-81	-1.36	844	1.26
Plains	-76	-1.22	1,093	1.73
Mountains	-165	-1.97	828	1.44
National	-145	-1.97	809	1.39

Note: Negative numbers reflect gains in welfare.

cap-and-dividend policy that is returned directly to households as a taxable per-capita dividend. Households in the lowest deciles see a dramatic improvement in their well-being as a result of the lump sum dividend of allowance revenues.

The table below shows the incidence of 10 policy scenarios at the national level; all of the options achieve the same targeted level of emissions but with different costs. Our results show that three types of policies are modestly progressive: expansion of the Earned Income Tax Credit, investments in efficiency, and the cap-and-dividend program that directly returns revenue to households. Because of its simplicity, we treated cap-and-dividend as a benchmark. When policies do not use all of the revenue, the remainder is distributed as (taxable) per-capita dividends.

In contrast, three policies appear severely regressive, even more so than before accounting for the use of the revenue. These include grandfathering (free allocation to incumbent emitters), reducing income taxes, and reducing payroll taxes. The latter two may have important efficiency advantages—many public finance economists have argued for the merits of using revenues from auctioned allowances or emissions fees to reduce other distortionary taxes. Our results thus highlight the tensions that may exist between efficiency and equity in climate policy.

Free allocation to emitters poses no such tension. Our results show that this option is regressive, and many economists have emphasized the efficiency disadvantages of this approach. One reason is that free allocation directs about 10 percent of the allowance value overseas to foreign owners of shareholder equity. Additionally, this option is decidedly regressive because the value of the free allowances accrues primarily to higher-income households, which own a relatively higher portion of shareholder equity.

Other policies we analyze may be progressive but relatively inefficient. The exclusion of personal transportation or home heating fuels leads to higher allowance prices because greater emissions reductions would have to be achieved in other sectors. The same is true if allowances are used to compensate electricity consumers, and the ramifications are even greater. Although all three of these options appear progressive once the allowance revenue is returned as a dividend, this increased progressivity comes at the expense of a higher allowance price and lower efficiency. Moreover, the outcomes are less progressive than cap and dividend.

One option that might have the potential to be both equitable and economically efficient is investment in energy efficiency. Our results show that option to be one of the most progressive we examined. Also, it would lead to lower allowance prices, indicating that less cost would be imposed on other sectors. However, whether this actually is efficient or constitutes a subsidy to the consumption of electricity services hinges on the effectiveness of energy efficiency programs that reduce the cost of meeting the cap in the electricity sector, and whether this is the highest-valued use of the revenue. Im-

Permit Prices, CO_2 Emissions, and Modified Suits Index* (MSI) by Policy

*A Modified Suits Index measures tax incidence

Scenario	Permit Price ($/ton)	Per-capita CO_2 Emissions	MSI after CO_2 Price	MSI after revenue is distributed
Cap-and-dividend (nontaxable)	41.52	17.06	-0.18	0.05
Cap-and-dividend (taxable)	41.52	17.06	-0.18	0.15
Invest in efficiency	37.20	17.06	-0.18	0.16
Exclude home heating	42.80	17.06	-0.18	0.13
Exclude transportation	43.25	17.06	-0.17	0.06
Expansion of EITC	41.52	17.06	-0.18	0.23
Free allocation to emitters	45.65	17.06	-0.18	-0.73
Free allocation to electricity consumers	46.95	17.06	0.17	0.11
Reduce income tax	41.52	17.06	-0.18	-0.79
Reduce payroll tax	41.52	17.06	-0.18	-0.33

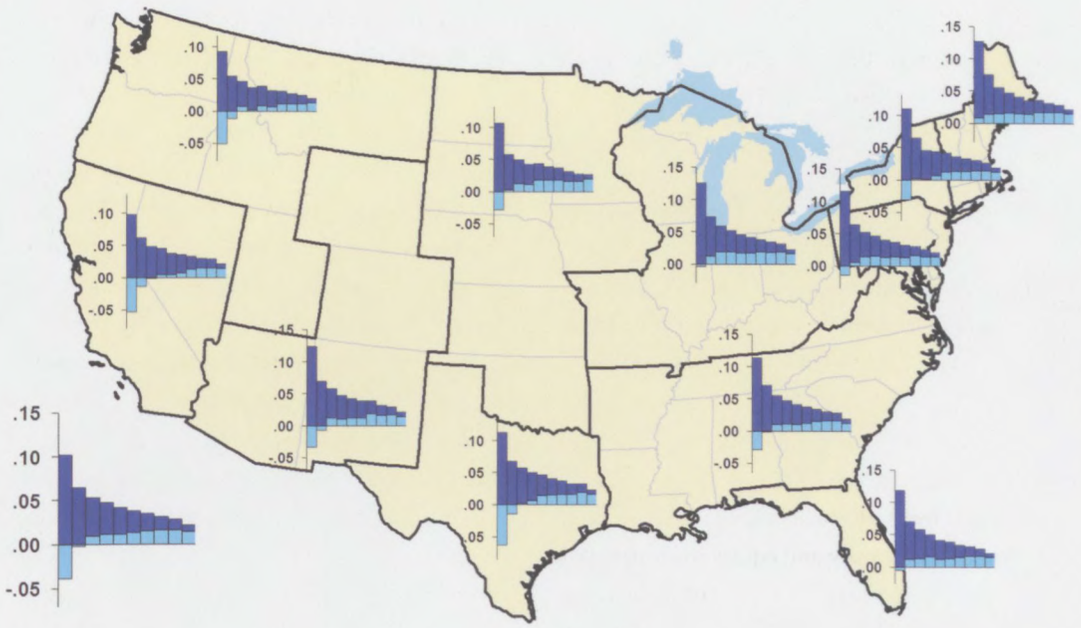


Figure 2.
Regional Incidence of a CO_2 Cap-and-Dividend Policy (Taxable)
Consumer Surplus Losses as a Portion of Income

Decrease in consumer surplus after introduction of CO_2 price

Decrease in consumer surplus after distribution of revenue

plementation of energy efficiency programs has proven uneven in the past, and without additional research into this issue our results merely highlight the potential of this option.

While the case for equity across income groups is straightforward, interregional equity is more complicated due to differences in preexisting policies, incurred costs, energy prices, resources, and lifestyle choices. Some regions, including California, have already enacted policies to reduce their carbon footprint.

Nonetheless, important differences emerge, and the biggest regional differences affect poor households. Low-income households in Texas, California, Nevada, and the Northwest experience large net gains, while these households in the Northeast, Florida, and the Ohio Valley are consistently among the most harmed. The table on the right-hand side of Figure 1 shows these effects as numerical values for the cap and (taxable) dividend scenario. These results highlight important regional differences in the impacts of climate policy. These differences hold up under almost all of the policy scenarios we analyzed and low-income households in the Northeast, Ohio Valley, and Florida are consistently among the most harmed.

Geographically, the range of impacts on average households across regions can be as high as about $550. For example, under a cap-and-dividend policy (with dividends that are taxable) the average household in the Northeast experiences a consumer surplus loss of $1,150 per year while the average household in the Northwest loses only $625 per year. (Note our measure of the change in surplus exceeds the change in expenditures.) However, when expressed as a fraction of income, these differences are small.

To illustrate how interregional differences can complicate the efforts to address income equity, Figure 2 demonstrates the impacts of the cap and (taxable) dividend policy across regions. Again, the bars with darker shading and the greatest vertical height represent the loss in consumer surplus as a share of income due to putting a price on CO2, and the bars with the lighter shading represent the net loss after distributing the value of allowances as a per capita dividend. The figure for the nation is replicated in the lower-left corner, and the region-specific figures are displayed for each of the 11 regions we model. The map indicates that the regional differences come into consideration for the lower-income groups and for the average consumers, but there is relatively little variation among the upper-income groups across regions.

Our research suggests the incidence of climate policies can vary greatly across income groups and across regions. Although climate change is a long-run problem, climate policy has an important short-run political dynamic. Therefore, delivering compensation or finding ways to alleviate disproportional burdens of the policy seem especially important in the early years of climate legislation. Similarly, if all politics are local, then the local and regional effects of policy may be fundamentally important to building the political coalition necessary to enact climate policy. ■

Two respected officials and former RFF researchers died in recent months after distinguished careers in public service.

Blair Bower, an expert on water quality and land resources who worked at RFF from 1965 to 1973, died August 27 at the age of 82.

Bower collaborated with RFF's Allen Kneese on implementing market incentives to promote water supply and quality. He was co-author of several seminal books on environmental policy, including *Managing Water Quality: Economics, Technology, Institutions*—a 1968 volume that became a standard text in the field. In subsequent years, he published 10 other books on water, air, and environmental quality.

Bower was a private consultant to a variety of government agencies and nonprofit organizations, including the National Oceanic and Atmospheric Administration, World Wildlife Federation, Delaware River Basin Commission, New York Tri-State Planning Commission, World Health Organization, and United Nations Environment Programme.

Born in Pennsylvania, Bower graduated from the University of Washington with a degree in sociology and then earned a second bachelor's degree in civil engineering from the University of California at Berkeley. He later received a master's in public administration from Harvard University.

He was a fellow and life member of the American Society of Civil Engineers and the Soil and Water Conservation Society and a life member of the American Geophysical Union and the Water Environment Federation. Bower also was active in local policy organizations in the Washington, DC, region. He was a past member of the Environmental Improvement Commission of Arlington, Virginia, and the Maryland Water Sciences Advisory Board, and headed an Army Corps of Engineers study of the water needs of the Washington area.

> Blair was a pioneer in bringing interdisciplinary research into the service of policy and program design. His books and papers with the late Allen Kneese on water quality management even today remain a model of how to do this kind of work.
>
> —LEONARD SHABMAN, RFF RESIDENT SCHOLAR

GERALD MARTINEAU/THE WASHINGTON POST

NEAL POTTER

Neal Potter, a research economist at RFF in the 1950s who later became a prominent public administrator in Montgomery County, Maryland, died May 27 at the age of 93.

Potter served 28 years on the Montgomery County Council, including a four-year term as county executive beginning in 1990—a time when the suburban jurisdiction adjoining Washington, DC, was one of the fastest-growing and most affluent counties in the nation.

A nationally known proponent of slow growth, fiscal conservatism, and responsive government, Potter worked against considerable political pressures to ensure that commercial and residential development was part of a measured and deliberate process. He had a particular interest in transportation policy, tax legislation, water and sewage issues, inequities in property assessments, and preservation of farmland and scenic rural areas. A *Washington Post* profile of Potter described him as "a tireless worker with an encyclopedic memory for facts and data."

Potter attended Johns Hopkins University and graduated from the University of Minnesota. He later received a master's in economics from the University of Chicago. During World War II, he was an economist with the Office of Price Administration and later taught economics at Carnegie Mellon University and Washington State University. In 1947, he was a founder of the World Federalist Association, which advocates for global peace, human rights, clean environment, and the elimination of nuclear weapons.

In the early 1950s, Potter was one of the first research economists employed at RFF. He worked on several RFF projects aimed at ascertaining potential scarcities of natural resources in the United States. He was co-author with Francis Christy of the 1962 volume *Trends in Natural Resource Commodities: Statistics of Prices, Output, Consumption, Foreign Trade, and Employment in the United States, 1870–1957,* which was acknowledged as a quantitative springboard for much ensuing research at RFF. In 1962, he co-wrote with Joseph Fisher a monograph titled *World Prospects for Natural Resources.* ■

RFF INDEX

The newest feature in *Resources*, the RFF Index, is designed to give you a glimpse of the many ways members of the RFF community—researchers, board members, and University Fellows—are contributing to analyses of critical issues around the world, and to highlight media attention and recent articles by RFF researchers in the leading academic journals.

RECENT NEWS

GAO Climate Report. Three RFF researchers were among experts assembled by the Government Accountability Office to assess policy options to address climate change for the report, "Expert Opinion on the Economics of Policy Options to Address Climate Change." RFF had the largest representation of any institution among the 18 included experts, with participation by Fellow Joseph Aldy, Senior Fellow Roger Sedjo, and former Senior Fellow Billy Pizer.

Fighting Malaria with AMFm: No More "Business as Usual". In September, RFF, led by Senior Fellow Ramanan Laxminarayan, hosted malaria experts from around the globe to debate the merits of the Affordable Medicines Facility-malaria—AMFm, an innovative financing platform for malaria drugs. Kenneth Arrow, the Nobel Laureate in Economics who led the Institute of Medicine committee that recommended AMFm in a 2004 report, was among a dozen speakers to address the public forum, which brought the latest information to bear on remaining questions. The analyses presented at the forum will inform a November vote by the Board of the Global Fund to Fight AIDS, Tuberculosis, and Malaria to begin a large-scale pilot operation of AMFm, involving millions of people.

Preserving Farmland. The American Farmland Trust draws upon RFF research in its new fact sheet on transfer of development rights (TDR), a strategy for preserving open spaces and encouraging prudent commercial and residential growth. The document references extensive research and case studies of TDR programs around the United States by RFF Senior Fellows Margaret Walls and Virginia McConnell.

NASA, Senate Briefings. Senior Fellow Molly Macauley briefed the Senate Commerce, Science, and Transportation Committee staff and conducted a media teleconference at NASA in September on how the U.S. government uses earth science information to manage natural resources and protect public health. Macauley and others assessed the decision-support tools that government agencies use to make predictions in such areas as agricultural productivity, air quality, renewable energy, water management, and the prevention of disease.

New Gilbert White Fellow. Wolfram Schlenker has been appointed as the 2008 Gilbert White Fellow at RFF, where he will examine the impact of climate change on agricultural yields. Schlenker, who did his undergraduate work in Germany, received his PhD from the University of California at Berkeley. He currently is an assistant professor of economics at Columbia University.

JOURNAL ARTICLES OF NOTE

Benefits of Using Multiple First-Line Therapies Against Malaria ■ Maciej Boni, David L. Smith, and Ramanan Laxminarayan; *Proceedings of the National Academy of Sciences* (forthcoming)

Should Urban Transit Subsidies Be Reduced? ■ Ian Parry and Kenneth Small; *American Economic Review* (forthcoming)

Adjusting the Value of a Statistical Life for Age and Cohort Effects ■ Joseph E. Aldy and W. Kip Viscusi; *Review of Economics and Statistics* August 2008, Vol. 90, No. 3: 573–581

BILLY PIZER TO TREASURY AFTER 12 YEARS AT RFF

BILLY PIZER

Former RFF Senior Fellow Billy Pizer has joined the Treasury Department as Deputy Assistant Secretary for Environment and Energy. He leads a newly created office that will "develop, coordinate, and execute the Treasury Department's role in the domestic and international environment and energy agenda of the United States." Its portfolio includes oversight of international financial mechanisms—such as the multi-billion dollar Clean Technology Fund, the Tropical Forest Conservation Act, and the Global Environmental Facility—to support environmental goals worldwide, as well as a focus on climate change and the development of climate-related policy options. While at RFF, Pizer served as a research director and applied much of his work to the question of how to design and implement policies to reduce the threat of climate change caused by manmade emissions of greenhouse gases. Specific research focused on the effectiveness of voluntary programs, the role of technology programs in pollution control efforts, and the effect of regulation on competitiveness.

New Resources from RFF Press

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Stein T. Holden, Keijiro Otsuka, and Frank M. Place, editors

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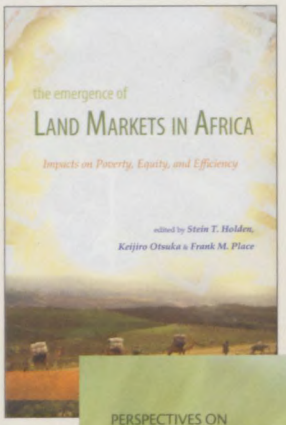

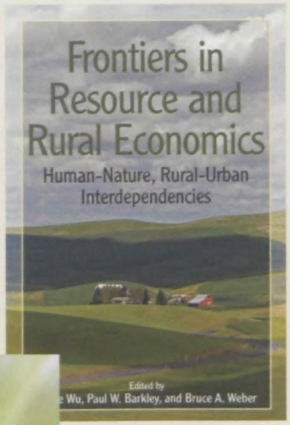

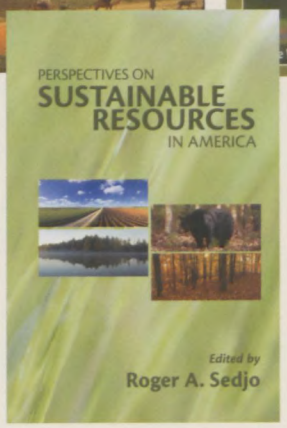

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