

RESOURCES

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**Can We Gauge Environmental Progress
Around the World?**

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RFF Fellow **Urvashi Narain's** research focuses on local environmental and natural resource issues in developing countries and on global climate change policy. One research area centers on whether better management of natural resources can help alleviate poverty in areas where the environment is a matter of survival.

Katherine N. Probst is an RFF senior fellow and Superfund expert. Her work has often focused on information needed to evaluate environmental programs and to inform the public. She was the lead author of *Success for Superfund: A New Approach for Keeping Score*, in which she recommended a "score card" that would include more meaningful measures of success for the nation's Superfund program than what is currently reported by EPA.

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. ■

U.S. Regulatory System Not Prepared for Nanotechnology, RFF Scholar Testifies

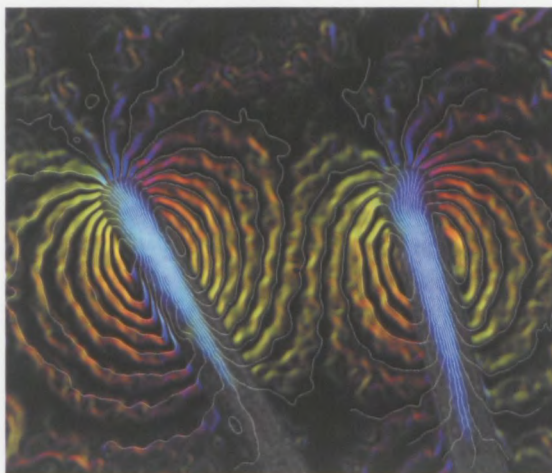
In an appearance before the U.S. Senate Committee on Commerce, Science, and Transportation in February, RFF Senior Fellow J. Clarence (Terry) Davies cautioned that current regulatory structures are not adequate to manage advances in the science of nanotechnology. This rapidly developing field processes materials at sub-microscopic levels—materials that often exhibit very different physical, chemical, and biological properties from their larger counterparts.

However, because the public's views of nanotechnology remain largely unformed, he said, legislators are afforded a rare opportunity to "get it right."

Inadequacy of Current Regulations

Davies' testimony was largely based on his study for the Woodrow Wilson International Center for Scholars' Project on Emerging Nanotechnologies. He began the study in 2005 to assess the strengths and weaknesses of the U.S. regulatory system in relation to nanotechnology. At the outset, he did not believe that new legislation would be necessary but quickly realized that the existing regulatory structure suffers from three types of problems. Davies addressed these shortcomings before the Senate committee.

First, he said, gaps exist in statutory authority, most obviously with respect



Magnetic Nanotubes by Ed Simpson, Yasuhiko Hayashi, Takeshi Kasama, and Rafal Dunin-Borkowski, University of Cambridge Engineering Department.

to two common uses of nanomaterials—cosmetics and consumer products. "A wide variety of nano-based consumer products have already begun to enter the market as sporting goods, clothing, cleaning materials, and kitchen appliances. Similarly, nano-based cosmetic products already range from skin creams to spray-on foot deodorizers, all with significant exposure potential (dermal, inhalation, and ingestion) and little publicly available risk data," Davies said.

He also reported that all federal regulatory programs governing nanotechnology suffer from a shortage of funding and expertise. As an example, he pointed out that the Occupational Safety and Health Administra-

tion (OSHA) has approximately 25 percent fewer employees than in 1980, when its numbers were already inadequate for its responsibilities.

Finally, "none of our health and environmental laws were drafted with nanotechnology in mind," said Davies. This can be problematic because certain guiding assumptions—for instance, about the relationship between quantity or volume of a

toxin and degree of risk—do not hold true for nanotechnology.

These problems, Davies said, have rendered existing laws inadequate, and no amount of coordination or patching is likely to fix them.

Beginning a Dialogue

"We should now begin a dialogue among major interested parties that acknowledges the shortcoming of

the existing regulatory framework and identifies what needs to be done," Davies said. As a starting point, he addressed three questions that he has frequently been asked since the release of his January 2006 project report: Is there any reason to believe that there are any adverse effects from nanotechnology? Can't industry be trusted to test new products since it is in its best interest to do so? Don't we need to wait for more information before we can regulate nanotechnology?

Regarding the first question, Davies pointed out that every technology of the scope of nanotechnology has had adverse effects; for example, decades of study have shown that fine particulates can be harmful. While the current state of knowledge cannot answer how harmful nanotechnologies are, he said, "it raises red flags concerning some materials

and products” and “enables us to ask the right questions.”

The topic of testing leaves less to be optimistic about, Davies said. Currently no laws require manufacturers to test the health and environmental effects of nanomaterials, and because long-term testing in particular is so costly, companies are often tempted to skip it.

Finally, Davies addressed the question of developing an oversight system in the face of knowledge gaps. Although more information is needed before adequate regulations can be put in place, Davies stressed that it is not too early to start discussing the outlines of such a system. He pointed out that early data suggest that at least 80 nanotechnology consumer products are on the market and more than 600 nanomaterials are being used by manufacturers already—adding some urgency to the issue. In addition, the process of discussion can itself “help foster international harmonization, research, and public participation.”

Getting It Right

In his concluding remarks, Davies said that the future of nanotechnology hinges on sustaining public confidence, which in turn depends on adequate government oversight. “Based on polling and focus groups, I believe that the public will hold both government and industry to a higher standard of safety for nanotechnology than it has for any previous technology,” he said. Failure to meet this standard will generate intense public pressure, eliminating the opportunity Davies says the legislative community now has to carefully deliberate with stakeholders. ■

Identifying Disease Control Priorities in Developing Countries

This spring, the Disease Control Priorities Project (DCPP) released its flagship publication, a second edition of *Disease Control Priorities in Developing Countries*. The book features major contributions from RFF Senior Fellow Ramanan Laxminarayan and Research Associate Jeffrey Chow.

A joint effort of The World Bank, the Fogarty International Center of the National Institutes of Health, and the World Health Organization, DCPP was launched as an ongoing initiative to improve the health of people in developing countries by identifying disease control priorities based on scientific evidence and cost-effectiveness.

One of its early goals was to update *Disease Control Priorities in Developing Countries*, first published by the World Bank in 1993. The original volume examined the treatment priority of 25 conditions based on their public health significance and cost-effectiveness—and has become a catalyzing force in the policymaking and academic worlds.

But much has changed in the 10 years since the book was written. Global health has been transformed by the HIV/AIDS pandemic, for example, and more is known today about the global disease burdens of tobacco, psychiatric disorders, and injury.

In 2002, DCPP approached public health and policy experts around the world for contributions to bring the

book into the 21st century. The resulting volume outlines a stark picture of the current and future state of global health but also offers “best health buys”—the most crucial, proven, and cost-effective health care investments for developing countries.

Ramanan Laxminarayan and Jeffrey Chow were co-authors of one chapter, “Intervention Cost-Effectiveness: Overview of Main Messages,” which summarizes the main findings related to the economics of more than 350 health interventions discussed in this 1,401-page volume. Laxminarayan was also lead author of another chapter, “Drug Resistance.”

Laxminarayan and Chow’s research is featured in four additional chapters on diarrheal diseases, helminth infections (intestinal worms), acute respiratory infections in children, and neurological disorders. In addition, RFF hosted technical workshops for DCPP, including one on discounting.

“The first edition of DCPP arguably did more than any other book to draw attention to the critical role of health in economic development,” says Laxminarayan. “The second edition has the potential to vastly improve how health resources are used in developing countries. Our involvement highlights the important technical skills that RFF offers to improve understanding of the economics of global health.” ■

Worldwide Environmental Rankings: Will Nations Compete to Be Green?

A CONVERSATION WITH DAN ESTY AND JIM BOYD

At the World Economic Forum in Davos, Switzerland, in early 2006, a new global survey was unveiled that assigns a numerical ranking to individual nations based on their environmental practices and outcomes.

The Environmental Performance Index (EPI), which has prompted both praise and controversy in the international environmental community, draws on available data to measure 133 countries on 16 indicators in six established policy categories: environmental health, air quality, water resources, biodiversity and habitat, productive natural resources, and sustainable energy. A team of experts at Yale and Columbia University's Earth Institute analyzed the data to produce the rankings.

The EPI is the brainchild of Daniel C. Esty, director of the Yale Center for Environmental Law and Policy and Hillhouse Professor of Environmental Law and Policy. Esty, a member of RFF's Board of Directors, believes that it will be a critical tool in bolstering successful pollution control and natural resource management worldwide. (*Full text of the report and a summary for policymakers are available at www.yale.edu/epi.*)

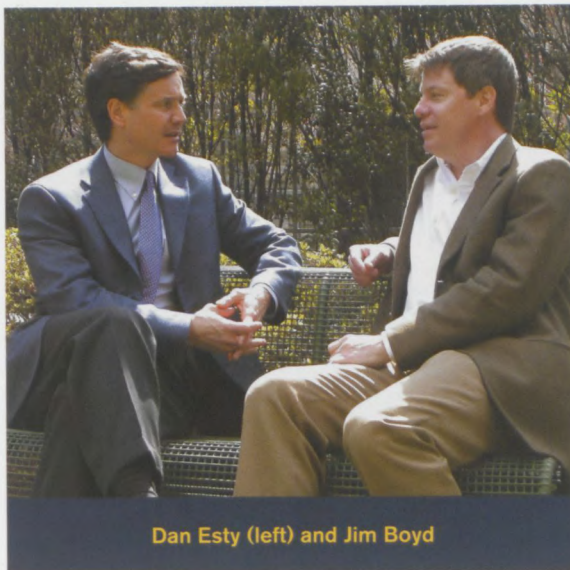
Resources asked Esty to explore the policy aims and outcomes of the EPI with Senior Fellow Jim Boyd. Their conversation follows.

Boyd: Give me the big picture as a place to start. What was your primary motivation for doing this? And how does your ranking system relate to other performance measures, such as national welfare accounting?

Esty: Our goal is to shift environmental decisionmaking onto

firmer analytic foundations. We're trying to make policy-making—across the full spectrum of pollution control and natural resource management issues—more empirical, more fact based, and more durable.

One of our motivations was to provide a counterbalance to the emphasis on GDP growth, which is taken so seriously, not only by economists, but also by decisionmakers in government. We believe the index provides a fairly clean and clear look at current government performance across a spectrum of core environmental challenges.



Dan Esty (left) and Jim Boyd

Boyd: One of the things that will immediately jump out at people is the fact that the United States ranks 28, not far from Cyprus. That's a little surprising to me personally, but how do you view that?

Esty: When I present the EPI in the United States, people are often surprised—even shocked—that the United States ranks as low as

28. When I present the EPI in Europe, people are often surprised—even shocked—that the United States ranks as high as 28. The United States does very well on some issues, like provision of drinking water—it really is unsurpassed in the world in terms of the percentage of the population that has access to safe water. But it does much worse, if not quite poorly, on a range of other issues, like greenhouse gas emissions. So, if you are sitting in America, where the air looks pretty clear and the drinking water looks pretty clean, you might say, gee, why aren't we closer to the top? But in Europe, where people are very much focused on the U.S. failure to step up to the climate change challenge, people think the United States should rank about 130 out of 133 countries.

Environmental Performance Index - Rankings & Scores

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
1	New Zealand	88.0	46	Gabon	73.2	91	Malawi	56.5
2	Sweden	87.8	47	United Arab Em.	73.2	92	Namibia	56.5
3	Finland	87.0	48	Suriname	72.9	93	Kenya	56.4
4	Czech Rep.	86.0	49	Turkey	72.8	94	China	56.2
5	United Kingdom	85.6	50	Bulgaria	72.0	95	Azerbaijan	55.7
6	Austria	85.2	51	Ukraine	71.2	96	Papua New Guinea	55.5
7	Denmark	84.2	52	Honduras	70.8	97	Syria	55.3
8	Canada	84.0	53	Iran	70.0	98	Zambia	54.4
9	Malaysia	83.3	54	Dominican Rep.	69.5	99	Viet Nam	54.3
10	Ireland	83.3	55	Philippines	69.4	100	Cameroon	54.1
11	Portugal	82.9	56	Nicaragua	69.2	101	Swaziland	53.9
12	France	82.5	57	Albania	68.9	102	Laos	52.9
13	Iceland	82.1	58	Guatemala	68.9	103	Togo	52.8
14	Japan	81.9	59	Saudi Arabia	68.3	104	Turkmenistan	52.3
15	Costa Rica	81.6	60	Oman	67.9	105	Uzbekistan	52.3
16	Switzerland	81.4	61	Thailand	66.8	106	Gambia	52.3
17	Colombia	80.4	62	Paraguay	66.4	107	Senegal	52.1
18	Norway	80.2	63	Algeria	66.2	108	Burundi	51.6
19	Greece	80.2	64	Jordan	66.0	109	Liberia	51.0
20	Australia	80.1	65	Peru	65.4	110	Cambodia	49.7
21	Italy	79.8	66	Mexico	64.8	111	Sierra Leone	49.5
22	Germany	79.4	67	Sri Lanka	64.6	112	Congo	49.4
23	Spain	79.2	68	Morocco	64.1	113	Guinea	49.2
24	Taiwan	79.1	69	Armenia	63.8	114	Haiti	48.9
25	Slovakia	79.1	70	Kazakhstan	63.5	115	Mongolia	48.8
26	Chile	78.9	71	Bolivia	63.4	116	Madagascar	48.5
27	Netherlands	78.7	72	Ghana	63.1	117	Tajikistan	48.2
28	United States	78.5	73	El Salvador	63.0	118	India	47.7
29	Cyprus	78.4	74	Zimbabwe	63.0	119	Dem. Rep. Congo	46.3
30	Argentina	77.7	75	Moldova	62.9	120	Guinea-Bissau	46.1
31	Slovenia	77.5	76	South Africa	62.0	121	Mozambique	45.7
32	Russia	77.5	77	Georgia	61.4	122	Yemen	45.2
33	Hungary	77.0	78	Uganda	60.8	123	Nigeria	44.5
34	Brazil	77.0	79	Indonesia	60.7	124	Sudan	44.0
35	Trinidad & Tobago	76.9	80	Kyrgyzstan	60.5	125	Bangladesh	43.5
36	Lebanon	76.7	81	Nepal	60.2	126	Burkina Faso	43.2
37	Panama	76.5	82	Tunisia	60.0	127	Pakistan	41.1
38	Poland	76.2	83	Tanzania	59.0	128	Angola	39.3
39	Belgium	75.9	84	Benin	58.4	129	Ethiopia	36.7
40	Ecuador	75.5	85	Egypt	57.9	130	Mali	33.9
41	Cuba	75.3	86	Côte d'Ivoire	57.5	131	Mauritania	32.0
42	South Korea	75.2	87	Central Afr. Rep.	57.3	132	Chad	30.5
43	Jamaica	74.7	88	Myanmar	57.0	133	Niger	25.7
44	Venezuela	74.1	89	Rwanda	57.0			
45	Israel	73.7	90	Romania	56.9			

Source: Pilot 2006 Environmental Index,
www.yale.edu/epi.

Boyd: Certain things that you are measuring are more amenable to control by government or society, while others seem more like a country's natural resource inheritance, such as its geography or climate. Are areas for improvement things that all countries can act on—or are some countries stuck with their bad environmental luck?

Esty: All six of the core policy areas that we are looking at represent important challenges that governments can be held accountable for: the quality of their air, water, land-use, and biodiversity, how they manage productive natural resources, habitat protection, and energy and climate change.

Clearly, some governments are better positioned to hit the established targets because of their underlying natural resource endowments or, for example, because of their relatively low population density so they don't strain the resources of their land—a good example would be Sweden. But are these things that governments should be looking at? Absolutely. Are governments being held accountable for these things? All across the board.

Boyd: When you come up with a ranking like this, there's a power in boiling it all down to that one number. Talk to me about your philosophy of doing that versus disaggregating what you have done and going deeper on the specific issues.

Esty: What we found is that there is enormous power in presenting a single, overarching score and a ranking related to that. This is what attracts top-tier government officials, presidents, ministers, and the media. Everyone loves rankings, and everyone wants to know who is up and who is down. From a policy point of view, however, that's just a hook to draw people into a dialogue.

What we are really excited about—and where I think we are succeeding—is what comes after people look at that top-line number, when they get a chance to drill down to the underlying rankings that relate to the core policy categories and even below that, to the issue-by-issue analyses that are the foundation of the index. The rankings lure people into a policy dialogue that can surface best practices that put some nations nearer the top of the ladder.

Boyd: Tell me your thoughts on how this work relates to the Millennium Ecosystem Assessment, issued in 2005.

Esty: The Millennium Ecosystem Assessment and the EPI share a common vision of a more data-driven approach to environmental decisionmaking, where we really look at on-the-ground facts and results so that policy priorities can be based on good information and good science. What differentiates the EPI and gives it particular traction is that it is aligned not on an ecosystem basis, like the Millennium Ecosystem Assessment, but rather on a national basis. Nation-state boundaries are the true lines of accountability.

In our index, where countries rank low, there's no ducking, there's no hiding. The political officials find they are called upon to answer for poor performance, and we think that's a very powerful tool. No one wants to be at the bottom of the rankings: every country would like to be higher up. We made particular efforts to group countries with regard to appropriate peers so that they are not ranking themselves against the top of the spectrum, per se, but against others that are similarly situated.

Take Haiti, for example, which ranks really quite low on our scale, at 114 out of the 133 countries we ranked. It's not Haiti's job to figure out why it is not number 2, like Sweden, or number 3, like Finland. But it is interesting, if you are Haiti, to figure out why

you are doing so much worse than the Dominican Republic, at number 54. These are two countries that share an island, that have a lot in common. And obviously, something is going seriously wrong in Haiti with regard to natural resource management and pollution control. But for a poor country, the Dominican Republic is doing quite well. So we think there is some learning there for Haiti, and perhaps for the Dominican Republic as well, because across 16 issues, there are probably some things that Haiti is doing better.

Boyd: Inherently this is a global data exercise. Comment on the increasing availability of spatial data on environmental conditions, but also about where a government, particularly the U.S.

Everyone loves rankings and wants to know who is up and who is down. But from a policy point of view, that's just a hook to draw people into a dialogue.

government, stands on its ability to produce and present information that people like you would find useful.

Esty: We are moving into an era of information-age environmental protection, which is exciting. There is a great deal of data that weren't out there before, which gives us a much better handle on problems, the chance to track trends, and a better basis for evaluating policies and understanding what's working and what's not. Having said that, I think the U.S. government still underinvests in producing relevant data.

Boyd: In that regard, how close a connection is there between the top five countries in the ranking and the quality of the data you are getting about those countries? Or is there no correspondence?

Esty: Much better data sets are available for the top 30 countries—basically the ones that are part of the Organisation for Economic Co-operation and Development, the Paris-based, “developed country” think tank. Beyond that, the data become very thin, and frankly, after about 130 countries, it becomes so thin that we can't include all the countries that we would like. So if this move toward a more data-driven approach to environmental protection is to gain further traction, we are going to have to collect data on many more countries. We are also going to have to go after some issues that aren't tracked at all, not even in the most developed countries. These include exposure to toxic chemicals, waste management practices, releases of SO₂ and acid rain, recycling rates, lead and mercury exposure, and wetlands loss.

Boyd: In principle, a country could do poorly because it is using its resources to produce commodities, like cutting trees for lumber. How do you handle the fact that some of those crops and therefore the benefits of that land use are exported? In effect, you are measuring the negative consequences in one country but countries elsewhere are benefiting from that degradation. Is there any way to factor that into your index?

Esty: We took a hard look at this question in the context of exporting dirty businesses and whether countries benefit because someone else is willing to take up the challenge of

producing things like steel or aluminum. And it turned out to be very difficult to get at that and hard to do consistently with our model, which centers on the government's responsibility for what it can achieve within its borders. For example, the United States imports steel from Korea but the numbers don't exist to allow us to shift some of the public health and environmental burdens that Korea faces back to this country. It's a weakness of the structure and means that in some respects we haven't captured the full picture.

Boyd: When you unveiled the index at the World Economic Forum in Davos, what indications did you get that the environment is present in the minds of these world leaders?

Esty: It's a very exciting place to release a study because you have lots of people producing reports, businesses releasing statements, major world leaders talking about critical questions, and business leaders like Bill Gates speculating on the future of the information world. So the competition for air space is tough. In that regard, we were very pleased, first by the good turnout for the release in Davos itself, and then, by the stories around the world in the weeks that followed that came from more than 100 countries and appeared in more than 500 newspapers. To date, there have more than half a million downloads of the report from our website.

Speaking more broadly, business leaders overseas take environmental protection very, very seriously, incorporating it into their operating strategies—it's one of their top concerns, falling behind only globalization and competitive strength. A dominant theme at Davos was the rise of India and China and the enormous implications this will have, both positive and negative. Obviously, it means that many, many people will be rising out of poverty, and hundreds of millions, if not billions of new consumers will be driving the economy of the world. But it also means a vast consumption of natural resources and potentially significant rates of pollution, locally and at a global scale, threatening to exacerbate problems like climate change. ■

Business leaders overseas take environmental protection very, very seriously, incorporating it into their operating strategies—it's one of their top concerns.

Combating Global Warming One Car at a Time

CO₂ EMISSIONS LABELS FOR NEW MOTOR VEHICLES

As Americans become increasingly concerned about global warming, carbon dioxide (CO₂) emissions labels on new cars could be an effective and relatively painless way to inform them that the cars they drive are a major source of CO₂ and contribute to the buildup of greenhouse gases in the atmosphere. Putting a CO₂ emissions label on all new cars and light trucks would make this clear for all to see.

Katherine N. Probst

Each new car and truck sold in the United States is required to bear a label on its window that indicates the vehicle's fuel economy, in terms of miles per gallon (mpg) for city and highway driving. Every word and inch of this sticker is determined by federal regulation.

On January 10, 2006, U.S. Environmental Protection Agency (EPA) Administrator Stephen Johnson announced the agency's proposed new approach for calculating these fuel economy estimates, along with four proposed designs for the required window label. What is most notable about the proposed label designs is the information that is not included: estimated annual CO₂ emissions.

For every gallon of gas burned, a car produces roughly 20 pounds of CO₂. The average car (in terms of fuel economy) driven the average number of miles per year (15,000) produces approximately 13,000 pounds of CO₂ annually.

Few consumers are likely to think about their impact on global warming when deciding which new car or truck to buy. Prominently displaying a "global warming performance" label on the window of each new vehicle could help educate consumers about the fact that fuel economy relates not just to the cost of operating their vehicle, but also to the environment.

The global warming performance label we have designed includes the estimated amount of CO₂ (in pounds) produced annually for each vehicle make and model and also places cars and light trucks into five distinct groupings based on different categories of estimated annual CO₂ emissions from "best" to "worst." This would allow a prospective purchaser to view information about CO₂ emissions for each vehicle and easily make comparisons among alternatives.

The goals of requiring a CO₂ emissions label are twofold: First, a label would help consumers make the link between their cars and increased CO₂ in the atmosphere. Second, a label would make it easier for those consumers who are already concerned about global warming to identify cars with lower CO₂ emissions.

Behind the Curve

Sharing CO₂ information with consumers is not a new idea. Beginning in January 2001, countries in the European Union (EU) were required to display information on estimated CO₂ emissions on all new cars. The EU directive also required that member states subsequently evaluate the effectiveness of the directive. In the United Kingdom, the initial approach was deemed ineffective as the way the information was presented was too complicated for consumers to understand. As a result, car manufacturers in the United Kingdom voluntarily agreed to put a more “consumer-friendly,” color-coded label displaying CO₂ emissions on all new cars beginning in September 2005. The goal of the new “green label” is to give consumers clear information about the environmental performance of different vehicles. Other EU member countries are also in the process of introducing consumer-friendly labels.

Within the United States, a California law enacted in October 2005 requires that information on CO₂ emissions be displayed beginning with 2009 model-year cars sold in the state. The law mandates that the new car label include a global warming index that contains quantitative information in an easy-to-read scale, such as the one on our proposed label.

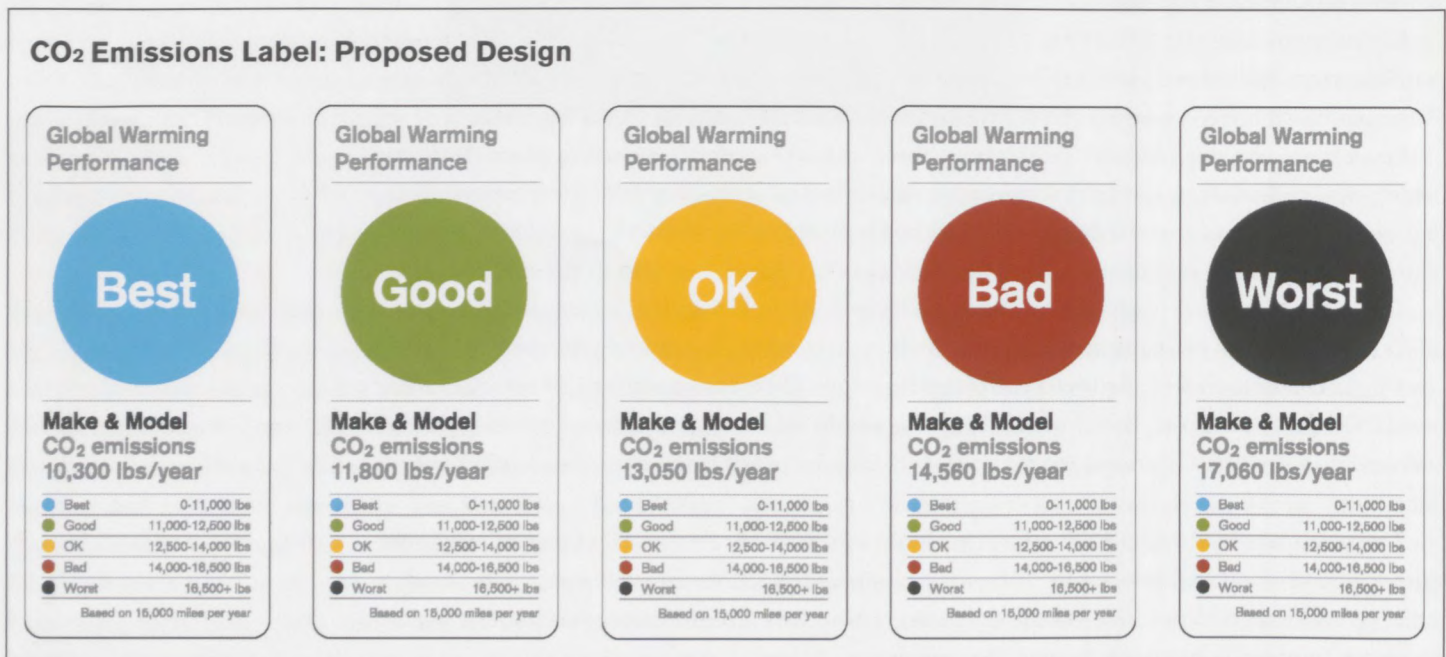
EPA could get ahead of the curve by requiring a uniform CO₂ emissions label on all cars and light trucks sold in the United States. Or, automobile manufacturers could decide to voluntarily display this information.

Cars and Global Warming

Carbon dioxide is the most ubiquitous of the six greenhouse gases. It is produced by burning fossil fuels—coal, petroleum, and natural gas. The rising concentration of CO₂ in the atmosphere contributes to climate change. As a result, reducing CO₂ emissions is the major focus of most countries seeking to combat climate change and stave off possible global warming.

The United States is the world’s largest emitter of greenhouse gases in general, and of CO₂ in particular. We are responsible for a whopping 23 percent of all CO₂ emissions worldwide, even though the United States is home to less than 5 percent of the world’s total population.

A third of national CO₂ emissions comes from the transportation sector. Within this sector, passenger cars and light trucks (a category that includes pickups, minivans, and sport



DESIGN: KEVIN ROBERSON

utility vehicles) account for almost two-thirds of CO₂ emissions.

The choice of a new motor vehicle is one of the few opportunities Americans have to make a personal decision that can reduce CO₂ emissions. For every 100 gallons of gas saved, one less ton of CO₂ is emitted.

If you are an intrepid consumer, you can find information on CO₂ emissions on a car-by-car basis on two government Web sites, one maintained by EPA (www.epa.gov/greenvehicles) and the other maintained by EPA and the U.S. Department of Energy (www.fueleconomy.gov).

Why not make it easier for consumers to understand the link between the cars they drive and global warming? The cost of implementing this approach is minimal. Calculating annual CO₂ emissions for new cars requires only information that is already available: the estimated fuel economy of each car make and model, and the average number of miles traveled annually.

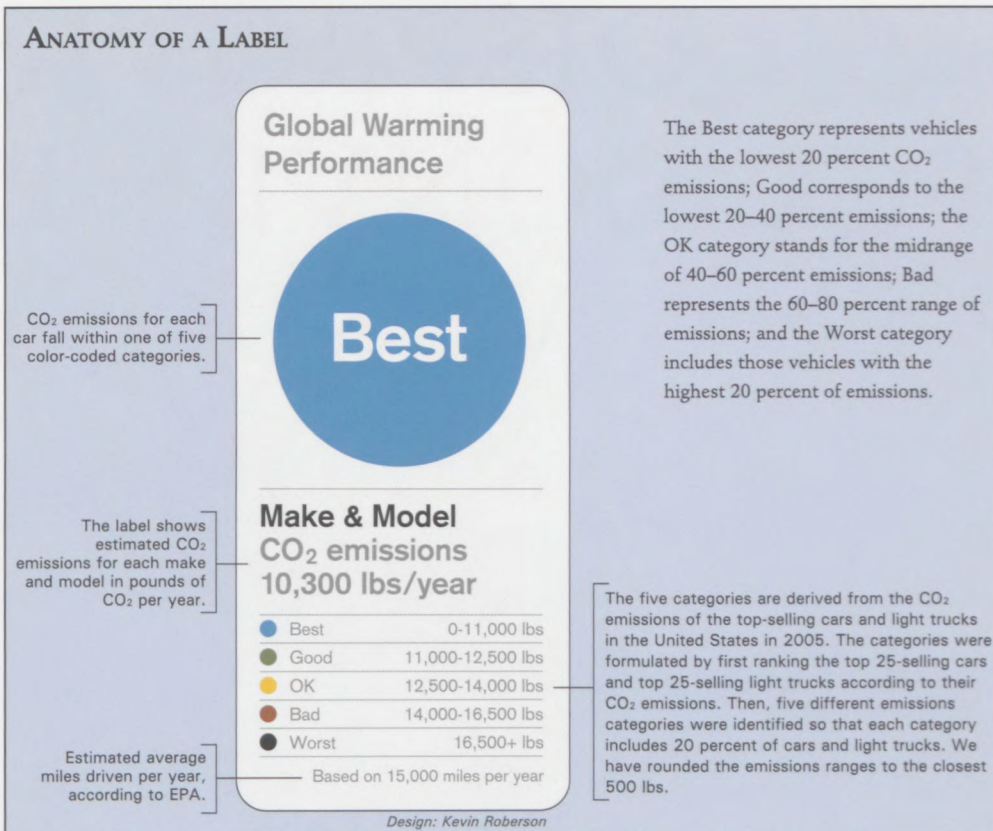
For maximum scope and impact, this information needs to be clearly displayed directly on the vehicle where hundreds of thousands of people choose their new cars each year: in the showroom. In 2005 alone, more than 16 million new cars and light trucks were sold in America. If a label is implemented, as in the EU directive, follow-up evaluation to assess whether it is effective—and how it could be improved—should be required.

What is the downside to providing consumers with this kind of information? Some argue that people don't care, that information on CO₂ emissions will not change buying habits. Others argue that labels are inefficient as a mechanism for educating consumers.

Yet in recent years, consumer labels have become more popular as an important means for educating the public and helping them make informed choices. In February 2006, the National Highway Traffic Safety Administration announced a proposal to require a safety-rating information label on all new cars beginning with the 2008 model year. The Honda Motor Company is already voluntarily displaying the results of its crash ratings on 2006-model window stickers.

Certainly, requiring CO₂ labels on every new car will not change consumer behavior tomorrow. The goal of the label is to educate American consumers about the link between the cars they drive and global warming—with an eye toward ultimately encouraging them to drive more fuel-efficient cars and to drive them less. A global warming performance label is only one component of what must be a multi-pronged approach. Still, it is a place to start.

Requiring a global warming performance label on all new cars and light trucks sold in the United States is an inexpensive and important first step in educating the public about something they can do to combat global warming. The information is already available online from two government agencies. Why not make it visible to all car buyers? ■



DISPROVING THE CONVENTIONAL WISDOM

Both Poor and Rich Depend on Natural Resources in Indian Villages

Urvashi Narain

In the face of growing fears that the Indian computer software industry is stealing American jobs, it is often forgotten that India is still a predominantly agrarian economy. According to India's 2001 census, more than 70 percent of the population lives in rural areas, and mostly in conditions of desperate poverty. The economy of these poor, rural households is intimately connected to the village natural resource base—its forests, grazing lands, and water resources. Whether households are able to make a living from agricultural income depends, in large part, on the amount of water available for irrigation. Similarly, the availability of fodder on village grazing lands affects the income that households derive from livestock rearing.

Given then the dual existence of high levels of poverty and dependence on local common resources, the question arises as to whether improved natural resources management can form the basis of poverty alleviation policies in rural India. Working with my colleagues, Shreekant Gupta of Delhi University and Klaas van 't Veld of the University of Wyoming, we have set out to explore this and other dimensions of the relationship between poverty and the environment in rural India. Our focus—Madhya Pradesh—is the largest Indian state in size and is located in the center of the country. Its capital is Bhopal. We began our research by collecting household and village-level data from a random sample of households. We supplemented the data with remote-sensing information on forest and fodder biomass to construct a comprehensive data set that combines information on household income with information on the local natural resource base.

A key finding of our research contradicts conventional wisdom: dependence on natural resources does not decline with rising income, where dependence is defined as the share of

total income that households derive from natural resources. Instead, dependence follows a U-shaped relationship with income, that is, dependence on natural resources first decreases and then increases with income.

OUR FIELDWORK

We carried out our field research from June 2000 to May 2001 in the Jhabua district, a hilly region located in the western part of Madhya Pradesh. More than 50 percent of its total land area is classified as agricultural land, 20 percent as forestland, and the rest as land not available for cultivation. Jhabua is one of the poorest districts in the state, and about 30 percent of the district's rural population lives below the poverty line. Agriculture, predominantly rain-fed, is the main occupation. Households often supplement their income through livestock rearing and through the collection of various forest products—construction wood, fuel wood, Tendu (*Diospyros melonoxylon* Roxb.) leaves, and Mahua (*Madhuca indica*) flowers and seeds.

Data for the study were collected through surveys from 550 randomly selected households spread across 60 villages in Jhabua, covering the period from June 2000 to May 2001. In doing so, we also tried to fill an important gap in the economic development literature: most studies that look at the relationship between poverty and the environment are based on a few carefully selected villages.

The Madhya Pradesh Groundwater Department has monitored the groundwater level since 1973 in all 89 villages from which we drew our sample of 60. A list of households, in turn, was constructed for each sample village from land ownership records and from the Madhya Pradesh government's list of



households living in poverty. Finally, we relied on remote-sensing images to obtain village-level measures of forest and fodder biomass.

DIFFERENT COMPONENTS OF HOUSEHOLD INCOME

To determine the extent to which households in rural Jhabua depend on common natural resources, we calculated what we call the "current income" that each household derived over a year from seven major sources: agriculture, livestock rearing, common-property resource collection, household enterprise, wage employment, financial transactions, and transfers from relatives and the state government. Income from each of these sources was calculated as the difference between total revenue obtained and total costs incurred.

Common-property income, in turn, was comprised of income from the main resources collected from village commons: wood for fuel, wood for construction, fodder, Mahua flowers used to make local liquor, Mahua seeds used to make cooking oil, Tendu leaves used to make local cigarettes, and animal dung used as agricultural manure and cooking fuel.

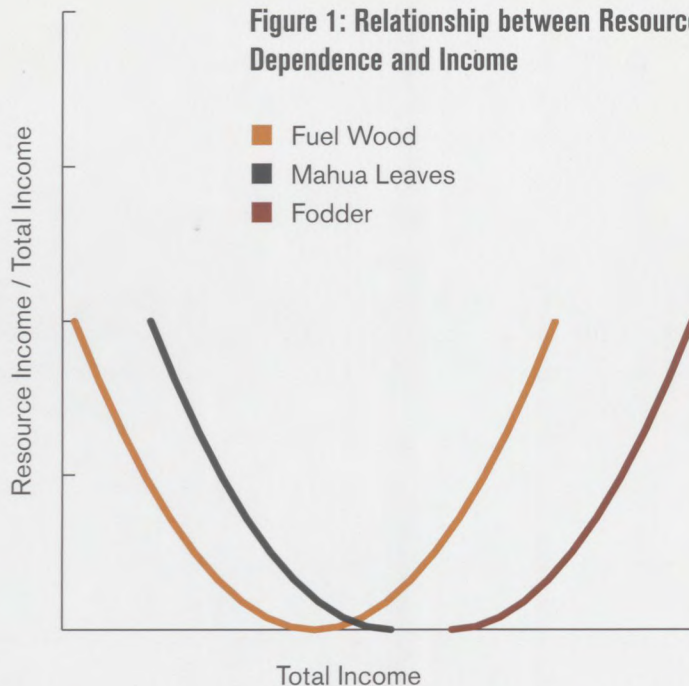
Once income from the different sources was calculated, we made these numbers comparable across households by dividing the income obtained by the number of adults in the household.

CURRENT AND PERMANENT INCOME

During our survey year, a large disparity existed between the current per-capita income of households in the bottom three quartiles and that of households in the top quartile. (A quartile, in this case, refers to where a household falls along the entire income distribution.) Households in the lowest quartile, on average, lost 2,024 rupees over the course of the survey year, while the average household in the top quartile earned 10,383 rupees. The large losses in agriculture and livestock rearing are explained by the fact that the survey year was the fifth consecutive drought year in Jhabua.

Surprisingly, households in the bottom quartile were by no means asset-poor. They cultivated as much land per capita as households in the top quartile, and more than households in the second and the third income quartiles. The per-capita value of land owned by these households was also considerably above that of households in the middle quartiles, though below that of households in the top quartile. Similarly, households in the bottom quartile had more farm capital and livestock than households in the top three quartiles.

Figure 1: Relationship between Resource Dependence and Income



All else being equal, households rich in private assets should be considered less dependent on common resources, because their assets serve as a buffer to sudden income losses. A household that owns gold jewelry has the option to sell or mortgage it to make up for losses it may have incurred in agriculture. A household without assets, on the other hand, may have no other option but to rely on the local forest and sell firewood, for example, if its income suddenly falls. There is, in fact, evidence that households in the bottom quartile engage in such buffering. These households typically took on new debt and sold jewelry over the course of the survey year to make up for their income losses.

To account for this difference in buffering capability that stems from differences in private asset holdings, we define what we call the household's "permanent income," income that households can expect to derive from their asset holdings over the long run.

SOME PERMANENT INCOME STATISTICS

In permanent income terms, as opposed to current income, households in the lowest quartile earned 2,420 rupees per capita while households in the top quartile earned 16,275 rupees. After income from agriculture, income from wage employment was the largest source of income for the households in all four quartiles. However, for the first three quartiles, the wage income mostly came from off-village casual employment. Households in these quartiles earned about

70 percent of their total wage income from such seasonal migration. In contrast, households in the top quartile earned only 29 percent from migratory labor, and 64 percent from regular jobs in the private or public sector.

The main source of transfer income for households in all four quartiles was the state; examples include subsidies to deepen wells and for school meals. Households in the top quartile, despite the fact that such government transfers are meant for the poorest of the poor, received substantially higher transfer incomes than household in the bottom three quartiles.

INCOME FROM THE COMMONS

Despite a widely held belief to the contrary, dependence on common natural resources does not decrease as incomes rise, our study shows. Instead, dependence follows a U-shaped relationship with rising income, declining at first but then increasing. Among the households that collected natural resources (400 households in all, dispersed across all 60 villages in the sample), the poorest derived about 12 percent of their total income from resources. Dependence decreased to 9 percent for households in the second income quartile, and then increased again to 11 percent for the third income quartile and to 13 percent for households in the fourth quartile. In short, wealthier households depended on the commons as much as the poorest ones.

This relationship is explained by a combination of trends in dependence on individual resources (see Figure 1). While increasing use of construction wood and fodder account for the increase in overall dependence at higher incomes, decreasing use of other resources (Mahua flowers and seeds, Tendu leaves, gum and dung) accounts for the decrease in overall dependence at lower incomes. The latter trend is best explained by the fact that collection of these resources is a low-return activity, and one that the rich move away from as more productive uses for their labor become available. With regard to fuel wood, dependence first decreases and then increases, suggesting that all households in the village, whether they own private trees or live near a fuel wood market, prefer to gather fuel wood from the commons.

The rich depend heavily on fodder collection because they have larger animal holdings and therefore a greater demand. Similarly, the high dependence of the rich on construction wood is driven by their higher consumption demand, both for larger houses that they can afford to build and also from larger land holdings and, therefore, larger demands for wood for agricultural implements, such as plows.

So far, we have only described income from resources that

are directly collected by households—that is, by hand. Households also gather one resource, fodder, indirectly by letting their animals graze in common grazing lands. Unfortunately, we have no reliable way of converting time spent grazing to a monetary value. We instead consider time spent grazing one's animals as a proxy for grazing income. As with fodder collection, time spent grazing increases with higher incomes, again for the simple reason that it is the rich who have larger animal holdings.

Also, largely due to the difficulties of pricing water, we have been unable to consider how dependence on water changes with household incomes. Given that one of the main uses of water is irrigation, however, we would expect land to act as a complement to common water resources, which would tend to further increase the overall resource dependence of the rich.

CONCLUSION

Previous studies have found that resource dependence strongly decreases with income. But our study finds a more complex relationship—contrary to common wisdom, rich households are just as dependent on natural resources as the poor, though the rich and the poor depend on different resources. This, in turn, implies that households in rural areas do not turn to the environment solely in times of desperation. And rich households, which tend to have a broader set of options to choose from to earn a livelihood, regard the forests and other resources as a profitable source of income.

Our findings have important implications: improving the quality of natural resources will have a lasting impact on reducing poverty. If dependence on resources did decrease with income—the conventional wisdom—then efforts to improve the village natural resource base would help the poorest of the poor immediately. However, as these households made their way out of poverty they would turn to sources of income other than those based on natural resources and would no longer benefit from efforts to improve their environment.

Improvements to the natural resources would, on the other hand, have a lasting impact on poverty if both the poor and the rich are dependent on these resources. Even as household incomes improve, households will continue to draw on natural resources to earn a living. ■

This article is based heavily on Poverty and the Environment: Exploring the Relationship between Household Incomes, Private Assets, and Natural Assets, by Urvashi Narain, Shreekant Gupta, and Klaas van 't Veld. Available at www.rff.org/rff/Documents/RFF-DP-05-18.pdf.

EXPLAINING SPRAWL

How Much Does

Virginia McConnell, Margaret Walls, and Elizabeth Kopits

Do zoning requirements in the outer suburbs encourage the spread of houses on large lots, or are real estate developers simply responding to consumer demands for more room? The answer, not surprisingly, is ambiguous.

Many communities on the urban fringe are implementing a range of policies to preserve farmland and open space, cluster residential development, and promote development in areas with sufficient infrastructure, including roads, utilities, and schools. These efforts are an attempt to control overall growth and to counter a trend toward large-lot development so that the growth that does take place consumes less land.

It is important to first ask why such trends are occurring. Some experts contend that large-lot development specifically, and sprawl more generally, are simply the natural result of household preferences and market forces. Others argue that local government zoning rules in the form of minimum lot sizes are the main reason for current patterns of low-density development.

Drawing on a unique data set, we set out to address two important questions: Do zoning regulations or market forces create low-density, land-intensive development? And if zoning limits cause low-density development in at least some cases, how would development patterns be different if there had been no such rules?

We addressed these issues by analyzing economic factors that explain subdivision density in rapidly growing Calvert County, Maryland, which sits on the fringe of the Washington, DC, metropolitan area. Calvert's long-running transferable development rights (TDRs) program, which allows developers

to increase density above the base zoning limits in some areas by purchasing TDRs, was also considered in the analysis.

How Many Houses on How Many Acres?

Developers in many high-growth suburban areas, such as Calvert County, will build a subdivision on almost any greenfield (undeveloped) land available to them. For each parcel, a developer decides how many building lots to create to maximize profits at that site, given regulatory constraints. This decision depends on variables that affect the revenues and costs of development, zoning regulations about allowable density, and, in the case of Calvert County, whether and how many TDRs can be purchased.

Revenues from development depend on the number of lots built in the subdivision, the total acreage of the subdivision, the natural amenities of the land itself (such as topography and views), land uses of the properties immediately surrounding the site, and the site's location and accessibility to employment and commercial centers. Surrounding land uses can have a strong effect on the value of development; for example, the price of a house may go up if the parcel is adjacent to parkland, or down if it is next to an industrial facility.

The costs of development will be affected by the number of lots; the total acreage of the subdivision; the shape of the parcel of land; and the costs of providing infrastructure at the site, which depend on soil characteristics and topography. Finally, zoning regulations, which establish a minimum average lot size, serve as a constraint on the overall density that a developer can achieve.

s Zoning Matter?

TDRs provide a tool for allowing zoning flexibility in designated regions. If a community wants to encourage protection of undeveloped land in some areas, landowners in these TDR “sending” areas are permitted to sell their development rights, thereby preserving their land in perpetuity. Developers in TDR “receiving” areas can buy these rights in order to build more lots than allowed under the baseline zoning restrictions. (See the box on page 18 for a more detailed description of TDRs.)

Calvert County’s “Tract” Record

In 1967, Calvert County adopted its first comprehensive plan, in which all rural land was zoned to a maximum density of one dwelling unit per three acres. In 1975, the county updated the plan to reflect a “slow-growth” goal and changed the maximum density to one dwelling unit per five acres. Despite the five-acre minimum lot requirement, population growth and conversion of land from agricultural uses to housing developments continued at a brisk pace throughout the county. In 1978, the county adopted a TDR program in an attempt to protect many of its prime farmland areas from development. The first TDR was sold in 1981.

The program designated the receiving areas broadly; they included town centers, residential areas, and some rural areas. Rural lands considered prime farmland were designated as TDR sending areas only. All other rural regions could either receive or send TDRs. Figure 1 shows the location of lands in these different zoning classifications.

In 1999, as a result of rapid growth in the county and con-



Figure 1.
Zoning Map of Calvert County, Maryland

-  Prime Farmland
-  Other Rural Communities
-  Residential
-  Town Centers
-  Industrial, Commercial
-  Water
-  Wetlands
-  MD Route 2/4

UNDERSTANDING TDRs

In the United States, and in most countries with market-based economies, to own land means to also own a bundle of rights and responsibilities that comes with that land. Although there is often debate over exactly what rights are included, property owners generally have the right to develop their properties in accordance with local zoning laws and other regulations. In residential areas, zoning usually sets a maximum number of dwelling units per acre of land.

A system of transferable development rights, or TDRs, allows ownership of the development rights to be

separated from ownership of the land. Those rights can then be bought and sold. All TDR programs in existence today operate in concert with zoning rules. If an owner of a parcel of land sells her development rights, she preserves her land from development, usually (though not always) in perpetuity. As a result, she relinquishes the right to develop the property (known as a "sending" parcel) in the way allowed by zoning.

The purchaser of the development rights may then develop a different parcel of land more intensively than is allowed by the baseline zoning that

covers that parcel. For example, the "receiving" parcel may be in an area where the baseline zoning rules allow one dwelling unit per acre, but with TDRs, four dwelling units per acre are permitted. Greater density in the receiving area results, while land is preserved in the TDR sending area.

For a good overview and program examples, see *Beyond Takings and Givings: Saving Natural Areas, Farmland, and Historic Landmarks with Transfer of Development Rights and Density Transfer Charges*, by Rick Pruett, 2003 (Burbank, California: Arje Press).

gestion on the county's main commuting road, all regions were "downzoned" to reduce overall development. Density permitted with TDRs, however, remained the same as before the downzoning. As a result, the pre-1999 maximum density levels in all areas still could be attained, but only with more TDR purchases.

Since the TDR program began, TDR sales have preserved more than 13,000 acres of farmland in Calvert County. Developers used TDRs in slightly less than 30 percent of the new subdivisions built between 1980 and 2001; in total, 2,130 additional housing units were created with TDRs.

What Our Model Shows

The TDR program in Calvert, along with the zoning changes that have been implemented there over time, have led to variability in housing density in the county. This variability allows us to statistically analyze the factors that explain density. In addition, Calvert is typical of many fast-growing communities on the fringes of large metropolitan areas where most residential development consists of single-family dwellings on relatively large lots. If we can begin to understand why Calvert has developed the way it has and the relative importance of zoning versus market forces, this could provide important lessons for similar communities.

We constructed an econometric model to explain the number of building lots in a subdivision as a function of several

variables that affect revenues and costs of development. These variables included the total acreage of the subdivision, the quality of the soils, the steepness of the terrain, the location in the county, the distance to bodies of water and to the main commuting highway in the county, sewer availability, and the uses of land surrounding the subdivision. To examine the impact that zoning density limits have on the number of lots, we included the number of lots allowed in each subdivision as an explanatory variable.

We statistically tested for the possibility that zoning alone explains the number of lots built and strongly reject that this is the case. In fact, only about 8 percent of all subdivisions built between 1967 and 2001 have the maximum number of lots permitted by the zoning rules. Nonetheless, zoning is important: the number of lots allowed is a highly significant variable in explaining the number of lots that are actually built. But most of the economic variables are significant as well. The size of the subdivision land area is important, as is the steepness of the terrain. Adjacency of the subdivision to parkland or permanently preserved farmland is associated with lower densities. Availability of sewers, accessibility to the major highway in the region, and proximity to town centers all tend to increase density.

After estimating the model, we used it to predict what development would have looked like in the absence of zoning. Specifically, for those subdivisions developed to the density limit, we determined what the number of lots in each subdivi-

vision would have been, absent any zoning regulations. We found that, indeed, the development would have been denser—approximately 46 percent more lots would have been built in these constrained subdivisions—but even by suburban standards, this development would still be considered low density. Most of these subdivisions had average actual lot sizes of about five acres, whereas our predictions show that average lot sizes without zoning would have been about three to three-and-a-half acres.

In rural areas where developers were permitted to use TDRs, our predictions indicate that subdivision density is less constrained by the zoning limits. Both the predicted and actual average lot sizes in these subdivisions are approximately two acres per lot, suggesting that this new limit is just about what the market demands. Similarly, in the town centers and residential areas (facing minimum average lot sizes of one acre or less), our results show that there was not much excess demand for additional lots beyond what was allowed by zoning.

What This All Means

Concern over urban sprawl is at least in part a concern over dispersed, low-density residential development patterns in suburban and ex-urban locations. In our work, we have looked at a developer's decision about housing density at the subdivision level and studied the relative influence of zoning rules versus market forces. Is zoning contributing to sprawl? And if so, how much denser would development be without it?

Our results show that in the urban fringe county we studied, density was most constrained in rural subdivisions facing very low-density zoning limits (requiring minimum average lot size of 5 acres). Although these subdivisions would have been almost 50 percent denser without the zoning regulations, they would still be considered relatively low-density development. And in the residential and town center areas, the zoning limits do not appear to be binding.

A number of factors affecting both the value and the cost of additional lots were found to be important in determining density outcomes. Physical site characteristics, accessibility measures, sewer availability, and surrounding land uses have a significant influence on subdivision density.

We hasten to point out that although our data may be typical of many exurban, fast-growing rural jurisdictions around large metropolitan areas, the results could be somewhat different in the case of a more urban or an older suburban area. The underlying zoning will be denser in such areas, but the demand for additional density may be greater as well. Much of the new development would be infill in already-built neigh-

borhoods on land that has higher development value. Although there would be pressures to develop at high densities, there are also likely to be countervailing pressures in these areas.

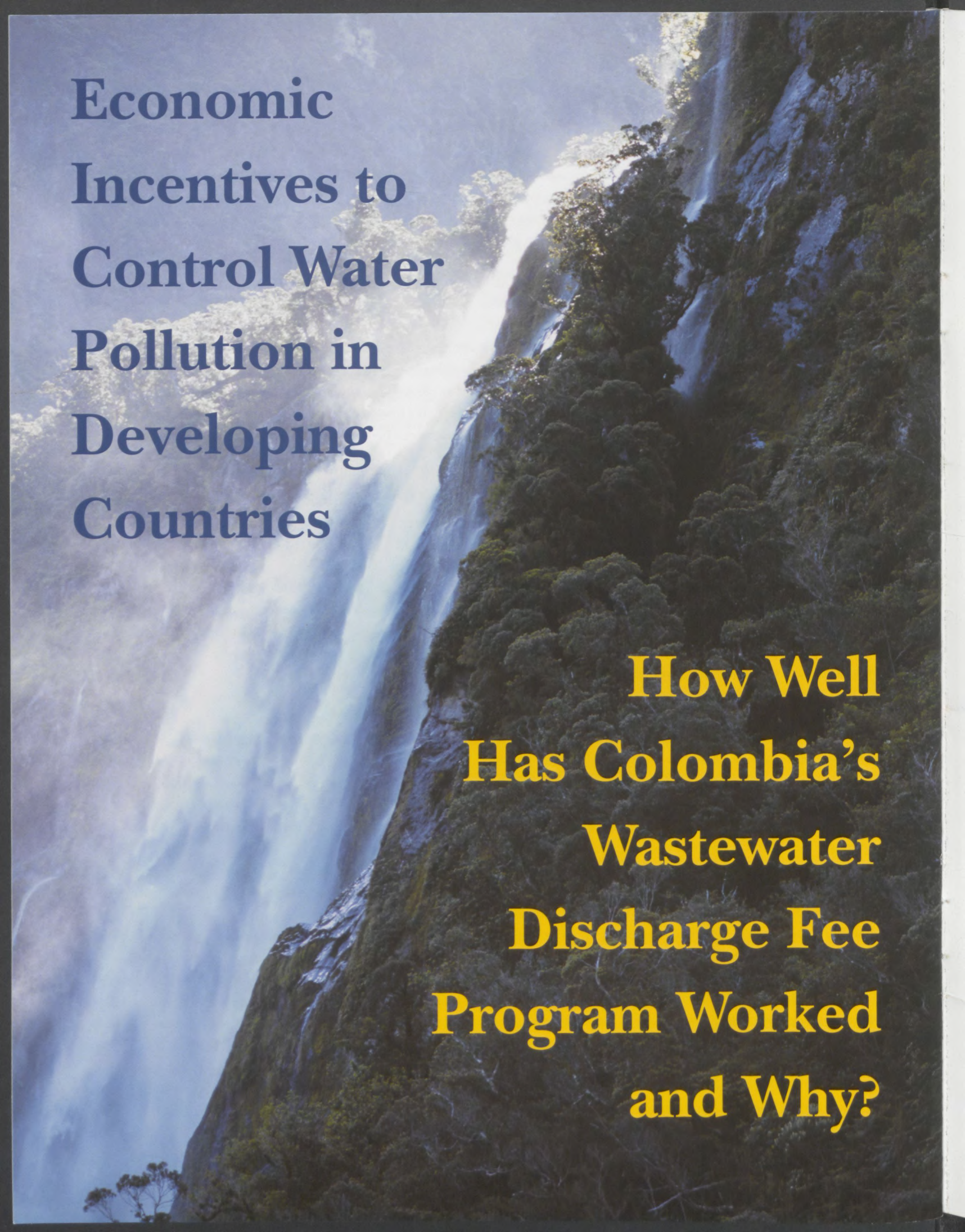
Much anecdotal evidence exists about objections to higher density on the part of existing residents who perceive high costs and reductions in neighborhood quality of life from new development, particularly high-density development. Future research on development patterns and the factors affecting density in these areas would be of great use to local planners and other government policymakers.

The land use problems plaguing many high-growth areas of the United States—declining open space, farmlands, and ecological resources—are not likely to go away in the near future. As policymakers and planners struggle to find solutions, a clearer understanding of the underlying forces driving development is needed. Our findings suggest that while planners in outlying suburban areas need to carefully consider whether their zoning regulations are exacerbating these problems, it is likely that market forces do strongly influence large average lot sizes in these locations. ■

This article is based heavily on "Zoning, Transferable Development Rights, and the Density of Development," by the authors, which will be published later this year in the Journal of Urban Economics. It is also available at www.rff.org/rff/Documents/RFF-DP-05-32-rev.pdf.

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A large waterfall cascading down a steep, forested cliffside. The water is white and frothy as it falls, creating a misty spray at the bottom. The surrounding area is covered in dense green vegetation, including trees and shrubs. The sky is a clear, bright blue.

**Economic
Incentives to
Control Water
Pollution in
Developing
Countries**

**How Well
Has Colombia's
Wastewater
Discharge Fee
Program Worked
and Why?**

IN 1997, COLOMBIA INITIATED AN INNOVATIVE NATIONWIDE PROGRAM TO STEM WATER POLLUTION. Instead of requiring firms to cap emissions of pollutants at specified levels—the conventional command-and-control approach—the new program created economic incentives for emissions reductions by charging polluters a fee per unit of pollution emitted. By some accounts, water quality in key watersheds improved soon after the program was put in place, and several well-known evaluations deemed the program a success. Yet many of these evaluations were based on early data and were conducted by parties involved in the design and implementation of the program. Few objective, up-to-date studies have appeared.

One chapter of a recent World Bank-funded RFF report on Colombian environmental policies, which I co-authored, aims to fill this gap. It assesses Colombia's wastewater discharge fee program from 1997 until 2003, when significant reforms were implemented. The chapter finds that although the program was beset by a number of serious problems during this stage, its reputation as a success is not unfounded. In several watersheds, pollution loads do appear to have dropped significantly after the program was introduced. The reasons typically given for this achievement are not the whole truth, however. While many proponents claim the incentives that discharge fees created for polluters to cut emissions in a cost-effective manner were responsible for reduced discharges, the incentives they created for regulatory authorities to improve permitting, monitoring, and enforcement were probably at least as important.

BROADER SIGNIFICANCE: ECONOMIC INCENTIVES IN DEVELOPING COUNTRIES

Over the past two decades, a robust debate has emerged among policymakers and academics about the pros and cons of using economic incentive policies instead of—or alongside—command-and-control policies to control pollution in developing countries. The workhorse of environmental regulatory regimes worldwide, command-and-control policies typically require polluting facilities to use specified abatement devices or to cap emissions at specified levels. Economic incentive policies, by contrast, provide financial rewards for facilities that cut pollution without dictating how or how much they should cut.

The two economic incentive policies that have received the most attention are discharge fee programs, which charge firms for each unit of pollution emitted, and marketable permit programs, which assign firms emissions allowances that they may trade with other firms (for example, EPA's sulfur dioxide emissions trading program). Prevailing wisdom holds that both policies reduce the cost that industry pays to control pollution by: leaving firms free to choose abatement strategies that minimize costs; providing incentives for firms that can cut emissions cheaply to shoulder a greater share of the pollution control burden; and making it profitable for firms to develop and adopt less costly strategies to reduce emissions. All these efficiency properties make economic incentive instruments particularly attractive in developing countries, where industry—whether by necessity, choice, or

some combination of the two—has made minimal resources available for pollution control.

However, more than a few high-profile attempts to use discharge fees and marketable permits in developing countries have foundered, and questions are increasingly being raised about whether these economic-incentive policies are workable in such settings. Some observers argue that discharge fees and marketable permit programs are particularly demanding of regulatory capacity, another resource that is in short supply in developing countries. Specifically, they argue that regulatory institutions often lack the technical, political, and financial capacity needed to set fees, allocate permits, monitor emissions, invoice polluters, keep track of permit trades, and collect payment.

The Colombian experience with wastewater discharge fees provides an opportunity to evaluate the advantages and disadvantages of economic incentive instruments.

COLOMBIA'S COMMAND-AND-CONTROL WATER POLLUTION REGULATION

Colombia's 33 *Corporaciones Autónomas Regionales* (CARs)—regional environmental regulatory authorities with boundaries determined in principle by ecological considerations, not political jurisdictions—comprise the country's front line of pollution control. Endowed with considerable fiscal and policy autonomy meant to insulate them from interest-group pressures, CARs carry out policies and programs designed by the environment min-

istry. As a group, they have a decidedly mixed record in implementing longstanding command-and-control water pollution control policies that require dischargers to obtain permits and meet effluent standards. As late as 2002, CARs had issued permits to less than a third of all dischargers. Moreover, monitoring and enforcement of discharge standards has been lax. The lion's share of both municipal and industrial wastewater violates discharge standards. As a result, many of Colombia's most important rivers—including the Bogotá, Cali, Cauca, and Medellín—are severely polluted.

ECONOMIC-INCENTIVE WATER POLLUTION REGULATION

Although various regional authorities in Colombia have used discharge fees for more than 30 years, it was Law 99 of 1993, a sweeping reform of the country's environmental legislation that established the broad legal basis for the present national discharge fee system. Decree 901 of 1997, an implementing regulation, laid out exactly how the system would work. It mandated that CARs first develop comprehensive inventories of all facilities discharging organic wastes that generate biological oxygen demand (BOD) and total suspended solids (TSS), two of the most commonly measured water pollutants, and that they estimate baseline discharge levels for each facility. Next, CARs were to map key water basins in their jurisdictions and set five-year pollution reduction goals for aggregate discharges into each basin. Having done this, CARs were to charge all polluters a fee per unit of BOD and TSS discharged. The environment ministry was to set a minimum fee, but CARs were to adjust it upward by a specified amount for each six-month period that the pollution reduction target in a given water basin was not met. CARs were to monitor facilities' discharges every six months and invoice them monthly. Finally, every six months, CARs were to present to both their boards of directors and to the environment ministry a report detailing pollution loads, invoicing, and collections.

PROGRAM IMPLEMENTATION

To help CARs implement the discharge fee system, the environment ministry established a technical assistance program. One pillar of this program was a written manual that provided step-by-step instructions on how to build a discharge fee system. In addition, the environment ministry provided as-needed technical assistance to regional environmental authorities, organized expert groups to provide solutions to implementation problems, and

presented two series of workshops—one for CARs and another at national chambers of commerce representing key private-sector participants, such as the trade associations for coffee growers and manufacturers. Finally, the environment ministry created a peer-to-peer system that encouraged the most successful CARs to share their best practices.

Notwithstanding the environment ministry's considerable efforts, implementation of the discharge fee program was marred by several problems. First, not surprisingly, it was uneven across CARs. According to the environment ministry, by 2003, only nine of the 33 CARs had fulfilled all the principal requirements of Decree 901 and had operated a discharge fee program for at least 18 months. Thirteen CARs were collecting revenue but were implementing the program in an incomplete or inconsistent manner, and 11 had begun implementation but had yet to collect fees.

A second problem was incomplete coverage of dischargers. On average, less than half of polluters were actually invoiced. A third problem was low fee-collection rates. Between 1997 and 2002, just 27 percent of all fees invoiced were actually collected, with rates across CARs ranging from 1 percent to 95 percent.

A fourth problem was persistent noncompliance by municipal sewage authorities, a leading class of dischargers. Between 1997 and 2002, they were invoiced for more than 30 percent of all discharge fees, but only paid 40 percent of the amounts invoiced. This noncompliance was a key barrier to the successful implementation of the program. Private-sector water dischargers in industry and agriculture complained bitterly about being made to pay fees when highly visible public-sector dischargers refused or failed to do so. This contentious situation was greatly aggravated by the fact that noncompliance by municipal sewage authorities prevented many water basins from meeting five-year, total pollution-load reduction targets. Under the rules of the fee program, this led to steep automatic increases in fees charged to all dischargers in the water basin.

A final problem was confusion and controversy surrounding the relationship between new and old water-pollution control instruments. The discharge fee system was layered on top of the pre-existing command-and-control system of permits and discharge standards. Decree 901 mandated that polluters pay fees only on emissions in excess of discharge standards, but there was no clear language in the decree about how to handle facilities that were not complying in the first place.

Despite these implementation problems, a wide range of available evidence suggests that in a number of water basins, discharges dropped significantly between 1997 and 2003. For example, according to the environment ministry, during the

first five years of the program, nationwide BOD discharges from point sources covered in the program fell 27 percent and TSS discharges fell 45 percent.

WHAT MADE IT WORK

To what extent was the discharge fee program responsible for the emissions reductions that occurred after the program was established? Not surprisingly, proponents award it virtually all the credit, attributing this success to efficiency advantages that make discharge fees less burdensome to polluters than discharge standards. Although these claims are not baseless, the whole truth is far more complex.

Before 1997, permitting, monitoring, and enforcement of water pollution regulations were inadequate in virtually all CARs. To set up discharge fee programs, CARs had to remedy these deficiencies. For example, they had to develop a complete inventory of dischargers, create an information management system, calculate facilities' pollution loads, and develop monitoring systems. Each of these tasks is a precursor to effective implementation of command-and-control emissions standards as well as discharge fees. As a result of this effort, emissions standards in many jurisdictions had a far greater impact after 1997 than before the advent of the discharge fee system.

Consequently, one cannot be certain whether the reductions in emissions that occurred after 1997 were due to the efficiency properties of the new discharge fee program or to more effective permitting, monitoring, and enforcement that enhanced the performance of the new discharge fees as well as the old emissions standards. Although these factors are virtually impossible to disentangle empirically, intuition alone suggests the second factor was critical—permitting, monitoring, and enforcement serve as the foundation upon which both command-and-control and economic-incentive pollution control systems are built.

While the environment ministry's implementation assistance efforts were important, two intrinsic features of the discharge fee system also contributed to improvements in permitting, monitoring, and enforcement. First, the discharge fee program entailed more transparency and accountability

than did the old command-and-control program. CARs were required to report both to their boards of directors and to the environment ministry their progress on a number of fronts, including pollution reduction targets, pollution loads, invoices, and collections. Previously, few CARs consistently kept records of discharges of water users. In a sense, the discharge fee program subjected CARs to performance standards for water pollution control for the first time. Second, by allowing CARs to keep fee revenues, the discharge fee program created an economic incentive for CARs to enforce water pollution control laws.

POLICY LESSONS

What are the implications of this case study for the debate about the use of economic instruments in developing countries? Discussions of the advantages of using discharge fees in developing countries have focused on their efficiency, while discussions of the disadvantages have centered on the notion that they are more demanding of scarce regulatory resources than many command-and-control instruments. Yet, the evi-

dence presented here suggests that other pros and cons may be equally important. Discharge fees potentially create incentives for regulatory authorities to improve permitting, monitoring, and enforcement. However, grossly inadequate municipal wastewater treatment infrastructure—a pervasive problem in many developing countries—is likely to be a key barrier to implementing discharge fee programs. Among other things, the lack of such infrastructure can greatly hinder efforts to develop a culture of compliance in the discharge fee program.

A second policy lesson from the Colombian experience is that the strategy of setting pollution reduction goals for individual water basins, and then ratcheting up discharge fees until these goals are met, is bound to be problematic when leading dischargers (here municipal wastewater authorities) are unable or unwilling to undertake the pollution abatement investments required to meet these goals. In such cases, fees will increase regardless of the investments made by other polluters, a politically untenable situation that is likely to damage the credibility of the program. ■



Former Rep. Greenwood, a Biotechnology Advocate, Joins RFF Board

Biototechnology will prove to be the most transformative human endeavor ever, according to James C. Greenwood, president of the Biotechnology Industry Organization (BIO) and former U.S. House Representative. Greenwood, who was elected to the RFF Board in January, foresees radical changes from bio-engineering that will determine how—and how many—people live on Earth.

“Given the value people place on human health and a sustainable environment, it’s obvious that very large amounts of dollars will flow toward this sector of the economy,” Greenwood says. For countries like China and India, biotechnology will provide economic opportunities for their citizens. For undeveloped countries, he believes, genetically modified crops will increase farmers’ yields, raise standards of living, and enable people to send their children to school.

BIO, based in Washington, DC, represents more than 1,100 biotechnology organizations that conduct research and development in genetic engineering for health care, agriculture, industrial manufacturing, and the environment. The organization advocates the sector’s positions to elected officials and regulators and provides member services. Its most recent convention drew 18,730 participants, including 500 journalists.

To address equity concerns, BIO is exploring market-based systems that will deliver the benefits of biotechnology investments to developing countries. “Companies that make very expensive pharmaceuticals tend to assume that their market is the First World, that there’s insufficient wealth in developing countries,” Greenwood says. An initiative called BIO Ventures for Global Health, premised on the belief that economic mechanisms are a critical driver for broad industry involvement, involves building market opportunities and creating public-private partnerships for the most promising new technologies to fight malaria, tuberculosis, and cholera.

Public resistance to genetic engineering, Greenwood believes, is not rational, but also not surprising. “It’s natural for people to have intuitive skepticism,” he says. “Inserting the genetics of a bacterium into corn sounds weird at first blush.” But he anticipates that acceptance will come, with time and the social imperative of feeding and caring for billions of people.

The Bush administration recently announced the goal of making cellulosic ethanol competitive with gaso-

line in six years. In the future, we could replace all of our gasoline with ethanol but that may require genetic engineering switchgrass to make it a better ethanol feedstock. This could have “tremendous value, if it works,” according to Greenwood, in altering our dependence on fossil fuels, reducing emissions, and sequestering carbon. What is needed, he says, is research on the economics of this concept, with quantification of the energy savings and environmental gains.

Greenwood graduated from Dickinson College in 1973 with a bachelor’s degree in social work and became a social worker with abused and

neglected children in Bucks County, Pennsylvania. A Republican, he then served six years in the Pennsylvania General Assembly and six years in the Pennsylvania Senate, where he specialized in health, environment, and children’s issues.

From 1993 through 2004, Greenwood represented suburban

Philadelphia in the U.S. House of Representatives. He was a leader on health care issues and also served as chairman of the Energy and Commerce Committee’s Subcommittee on Oversight and Investigation. When he decided not to run for reelection in 2004, he wanted to continue to engage in two issues of special concern: human health and the environment. Membership on the RFF Board of Directors, he anticipates, will enable him to continue to contribute to finding solutions. ■

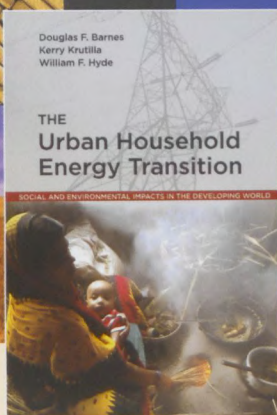


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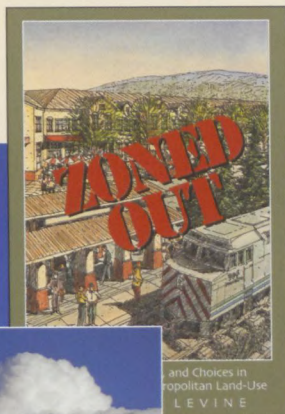


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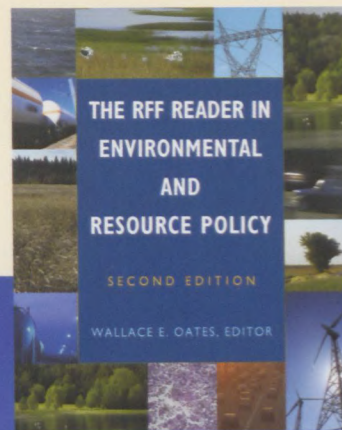


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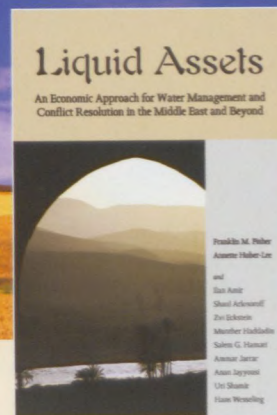
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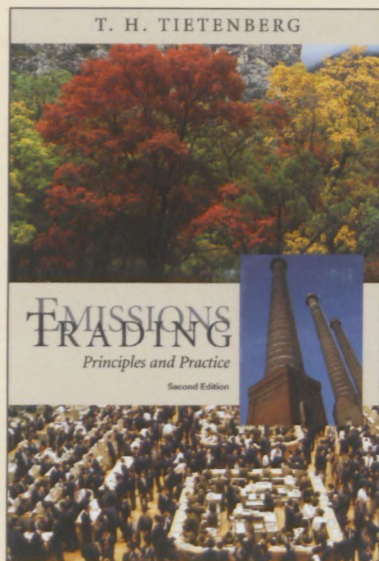


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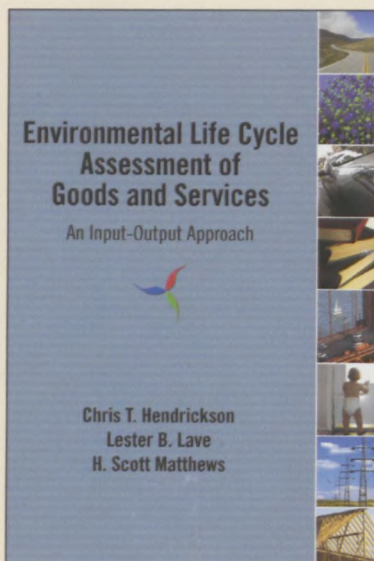
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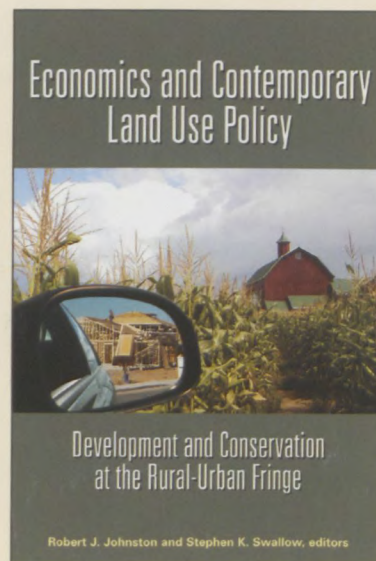
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