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Protecting the Environment
30 Years of U.S. Progress

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Front Cover: Cupped hands collect water in a Bolivian rainforest that is protected with support from the U.S. Agency for International Development. USAID works with Bolivian nongovernmental organizations and local farmers to manage forest, water, and biodiversity resources for sustained economic growth. (AP/WWP Photo by Dado Galdieri)

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About This Issue

AP/WWP Photo by Kevork Djansezian

Yellowstone National Park in the American West became the world's first national park in 1872. Signing legislation that established the park, President Ulysses S. Grant declared that this area would be preserved forever, "dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people."

The United States has made remarkable progress over the past 30 years in reducing pollution and protecting the environment within its borders. Statistics help tell the story. During this time, the U.S. economy grew by 187 percent, population grew by 39 percent, and energy consumption increased by 47 percent, yet air pollution decreased by 48 percent. In 2002, 94 percent of Americans were served by community water systems that met all health-based standards, up from 79 percent of the population in 1993.

The United States has taken a leadership role as a global environmental steward in developing a better understanding of environmental options and in shaping a sustainable approach to development. Achieving greater sustainability is a key objective in the provision and management of energy. New technologies offer the possibility of renewable energy sources that do not contaminate the air and the water, or release greenhouse gases and destroy Earth's protective ozone layer. New technologies also promise ways in which we may more efficiently utilize traditional energy resources.

Such technological innovation and development demand participation of the broad reach of society. In the United States, business, industry, and science are increasingly playing critical roles in shaping national strategies for greater energy conservation and wiser resource management and disposal.

Environmental stewardship is critical to the promise of a better life for people around the world, and authors on these pages emphasize that theme as they discuss climate change, alternative energy innovations, air quality, forest and freshwater management, and waste recycling. Included are an extensive bibliography and a collection of Web resources. Two photo stories document environmental progress over the past three decades and the development of "green" technologies, which are preparing our world for a better tomorrow.

Our distinguished contributors include Under Secretary of State Paula Dobriansky, White House Science Advisor John Marburger, Environmental Protection Agency Assistant Administrator Jeffrey Holmstead, and many dedicated scientists, activists, and citizens committed to protecting the planet we all share and on whose resources we all depend.

PROTECTING THE ENVIRONMENT
30 YEARS OF U.S. PROGRESS

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The Environment
Shared Goals and a Common Mission

Paula J. Dobriansky

AP/WWP Photo by Luis M. Alvarez

A bald eagle—once an endangered species in the United States and now revitalized—flies over Lake Okeechobee, north of the Florida Everglades.

The United States, a leader in protecting the environment, is committed to helping countries around the world achieve sustainable development while preserving their natural resources and promoting clean air, clean water, and thriving ecosystems.

Dr. Paula J. Dobriansky is the Under Secretary of State for Global Affairs. Her portfolio includes oceans and international environmental and scientific affairs.

The U.S record of achievement in addressing environmental issues over the past 30 years is impressive. Today, we treasure the clear skylines of our great cities, the swimable waters of lakes and rivers, and our national parks, forests, and wilderness areas. The symbol of our nation, the bald eagle, can be seen again nesting within 35 kilometers of the nation's capital.

The modern environmental movement in the United States began with the launch of the first Earth Day on April 22, 1970. Key pieces of U.S. environmental legislation followed, including the National Environmental Policy Act of 1970, the Clean Air Act of 1970, the Clean Water Act of 1972, the Endangered Species Act of 1973, the Resource Conservation and Recovery Act of 1976, and the Superfund Law of 1980, designed to clean up heavily polluted waste sites. Many of these laws and environmental initiatives were among the first of their kind in the world.

In sharing with other nations our experiences of the last 30 years, we have learned that clean air, clean water, and thriving ecosystems are fundamental and shared goals for all nations. We have also learned that environmental issues are not constrained by national borders and that the Earth is an interconnected system.

To address global environmental challenges, the United States is an active partner in more than 200 international environmental treaty negotiations, including agreements to protect the ozone layer, preserve wetlands, safeguard endangered species, conserve natural resources, promote sustainable fisheries, and reduce hazardous chemicals.

The United States is also taking concrete actions to address some of the world's greatest development challenges, such as improving human health, conserving natural resources, increasing economic development, and alleviating poverty. During the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa, the United States was at the forefront of international efforts to champion sustainable development.

The United States put forth nearly $1 billion as part of our Water for the Poor initiative, with the aim of realizing the U.N. Millennium Declaration goal of halving the proportion of people who lack safe water by 2015. In the two and a half years since WSSD, this partnership has improved water and sanitation services for more than 8 million people.

AP/WWP Photo by Natacha Pisarenko

U.S. Under Secretary of State for Global Affairs Paula Dobriansky (left) talks with U.K. Minister of State for Climate Change and Environment Elliot Morley at the 10th International Convention on Climate Change in Buenos Aires, Argentina, in December 2004.

We also have partnered with governments and the private sector to form the Congo Basin Forest Partnership, devoting $53 million dollars and leveraging tens of millions more. This initiative promotes economic development, poverty alleviation, and improved local governance through natural resource conservation and improved resource management, including control of illegal logging and wildlife poaching and trafficking.

The United States is committed to assisting other nations, particularly developing countries, meet the energy needs of their people, grow their economies, and address environmental concerns presented by air pollution and greenhouse gas emissions. These multiple objectives can be achieved by developing clean, efficient, affordable energy technologies for the long term, while continuing to improve and deploy the current generation of lower-emission technologies. This year alone, the United States will spend more than $3 billion to develop, deploy and commercialize cleaner and more efficient energy technologies, such as hydrogen, nuclear, clean coal, and renewables.

The United States is also leading international efforts to build a coordinated, sustained, and comprehensive Global Earth Observation System of Systems (GEOSS). When deployed, GEOSS will help us improve environmental forecasts and provide early warnings of natural disasters. Because effective policies are based on sound science and accurate data, this global system of measurements will help the world community take appropriate actions to protect the environment while safeguarding people and fostering economic growth.

The people of the United States take pride in protecting our environment, and we remain committed to this endeavor for the benefit of future generations. We are fully engaged in leading international efforts to meet the complex challenges of global environmental issues, and we reaffirm the critical role of all nations in this shared mission of protecting the health of our planet.. ■

Thirty Years of Clean Air Progress

Jeffrey R. Holmstead

AP/WWP Photo by Eric Risberg

San Franciscans enjoy clear skies over their California city in April 2005.

The United States made the connection between polluted air and public health decades ago and has worked steadily to reduce harmful emissions, down fully half in 30 years. As science has revealed more about the risks of various pollutants, efforts to monitor, control, and even eliminate these substances have grown ever more ambitious.

Jeffrey R. Holmstead is the Environmental Protection Agency's assistant administrator for air and radiation. Prior to EPA service, he was associate counsel to the president in the White House of President George H.W. Bush from 1989 to 1993, working primarily on environmental policy.

By virtually any measure, the air we breathe in the United States is cleaner today than at any time since we started monitoring air quality back in 1970. This success is all the more remarkable because there was relatively little public interest in air pollution until the 1960s. In fact, it was not until the Clean Air Act of 1963 that the United States began to focus its attention on the link between air pollution and public health. Since then, we have seen the Clean Air Act strengthened and improved—most notably with amendments in 1970, 1977, and 1990.

Where We Are Today

Under the Clean Air Act, the Environmental Protection Agency (EPA) has focused on six key air pollutants that have a significant impact on public health and the environment: ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. Since President Nixon signed the 1970 Clean Air Act, emissions of these pollutants have been cut by more than half—from 273 million metric tons of annual emissions to 133 million metric tons. The reductions for individual pollutants are just as impressive. Over the same period, emissions of lead decreased 98 percent, volatile organic compounds (contributors to ground level smog) 54 percent, carbon monoxide (CO) 52 percent, sulfur dioxide (SO_2) 49 percent, and nitrogen oxides (NOx) 24 percent.

Perhaps most impressive, these reductions in air pollution came during a period of robust economic growth. Between 1970 and today, the U.S. economy grew by more than 187 percent, the number of vehicle miles traveled in the United States increased by 171 percent, and U.S. energy consumption grew by 47 percent.

Particle Pollution—Major Health Threat

Over the past decade, we have learned that particulate pollution, and especially fine particulate matter such as dust and soot (generally referred to as PM fine or PM2.5 which is particulate matter that is 2.5 micrometers in size) is the most serious environmental threat to public health in the United States. Researchers in government and academia estimate that elevated concentrations of fine particles are responsible for tens of thousands of the nation's premature deaths every year.

National Air Pollutant Emissions Estimates (fires and dust excluded) For Major Pollutants

Millions of Tons Per Year

	1970	1975	1980	1985[1]	1990	1995	2000[1]	2004[2]
Carbon Monoxide (CO)	197.3	184.0	177.8	169.6	143.6	120.0	102.4	87.2
Nitrogen Oxides (NOx)[3]	26.9	26.4	27.1	25.8	25.2	24.7	22.3	18.8
Particulate Matter (PM)[4] PM10	12.2[1]	7.0	6.2	3.6	3.2	3.1	2.3	2.5
PM2.5[5]	NA	NA	NA	NA	2.3	2.2	1.8	1.9
Sulfur Dioxide (SO_2)	31.2	28.0	25.9	23.3	23.1	18.6	16.3	15.2
Volatile Organic Compounds (VOC)	33.7	30.2	30.1	26.9	23.1	21.6	16.9	15.0
Lead[6]	0.221	0.16	0.074	0.022	0.005	0.004	0.003	0.003
Totals[7]	301.5	275.8	267.2	249.2	218.2	188.0	160.2	138.7

Notes:

1. In 1985 and 1996 EPA refined its methods for estimating emissions. Between 1970 and 1975, EPA revised its methods for estimating particulate matter emissions.
2. The estimates for 2004 are preliminary.
3. NOx estimates prior to 1990 include emissions from fires. Fires would represent a small percentage of the NOx emissions.
4. PM estimates do not include condensable PM, or the majority of PM2.5 that is formed in the atmosphere from 'precursor' gases such as SO_2 and NOx.
5. EPA has not estimated PM2.5 emissions prior to 1990.
6. The 1999 estimate for lead is used to represent 2000 and 2004 because lead estimates do not exist for these years.
7. PM2.5 emissions are not added when calculating the total because they are included in the PM10 estimate.

Source: U.S. Environmental Protection Agency

The good news is that we have already made significant progress in reducing particle pollution. Since setting a new national standard for fine particles in 1997, EPA has worked with state and local governments on the monumental task of monitoring fine particle concentrations throughout the country. Our most recent Particle Pollution Report shows that:

- In 2003, PM2.5 concentrations were the lowest they have been since nationwide monitoring began in 1999.
- In 2003, concentrations of a related pollutant known as PM10 (10 micrometers) were the second lowest since nationwide monitoring began in 1988.
- Significantly, we have seen the biggest improvements in regions with the worst air quality problems. Between 1999 and 2003, PM2.5 levels dropped 20 percent in the Southeast, 16 percent in southern California, and 9 percent in the industrial Midwest.

Our progress toward clean air is often measured by reductions in individual air pollutants. It is also important to look beyond these environmental improvements and understand what they mean for our health and well being. Such progress means that we are living healthier, longer lives. In fact, EPA's air programs prevent tens of thousands of deaths and hundreds of thousands of illnesses every year, including cancer and long-term damage to the immune, neurological, reproductive, and respiratory systems.

Although EPA is proud of this success, we recognize that there is still more to do. Poor air quality continues to threaten people's health in many urban areas, and emissions often reduce visibility in many parts of the country, including national parks.

Programs That Work

Over the past few years, EPA has worked with government and outside experts to develop methodologies for quantifying the public health benefits of reducing air pollution. These methods, which have been reviewed by the National Academy of Sciences and are now widely accepted, allow us to focus our attention on programs that provide the greatest value to society. They also make it possible to compare the benefits of the many air pollution control programs that have been adopted over time. The top five programs, measured in terms of public health benefits, are:

- The removal of lead from gasoline (adopted by EPA in the late 1970s).
- The acid rain program (enacted by Congress in 1990 to

reduce SO_2 from power plants).

- The Clean Air Interstate Rule (adopted by EPA in 2005 to further reduce SO_2, as well as NOx, from power plants).
- The nonroad diesel rule (adopted by EPA in 2004 to reduce particulate matter and NOx from construction, farming, and other nonroad equipment).
- The heavy-duty highway vehicle and diesel sulfur rule (adopted by EPA in 2000 to reduce particulate matter and NOx diesel trucks, buses, and other on-road vehicles).

One striking thing about this list is that, even after more than 30 years of air pollution regulation, three of the top five programs in EPA history have been adopted in just the past five years—and two in the last year alone. Two developments have made this progress possible: a better understanding by government and industry of the need to address fine particle pollution (including SO_2 and NOx, which contribute to the formation of fine particulate matter), and advances in technology, especially for diesel engines and power plants.

The most recent of these rules is the Clean Air Interstate Rule (CAIR), which will dramatically reduce pollution in the eastern United States by cutting power plant emissions of SO_2 by more than 70 percent and NOx by more than 60 percent. It will also place permanent caps on emissions that lead to smog and soot. When fully implemented, CAIR will provide nearly $2 billion in visibility benefits, significantly reducing haze in eastern national parks.

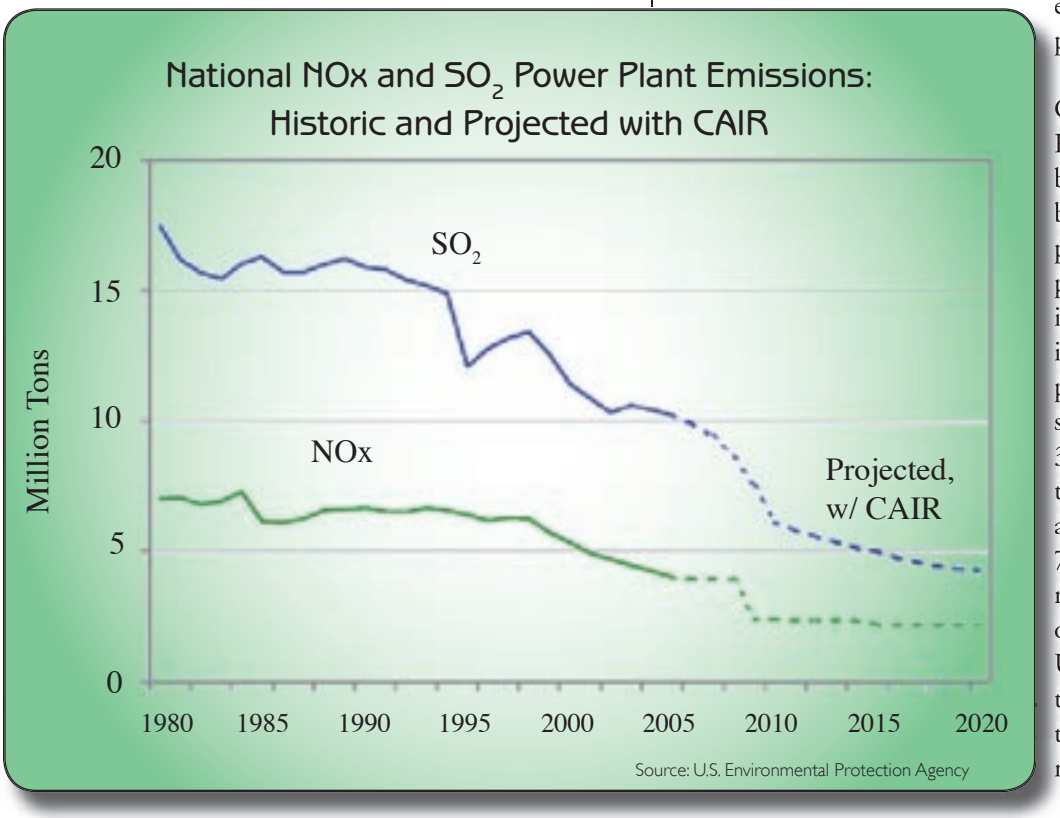
AP/WWP Photo by Dario Lopez-Mills

The World Summit for Sustainable Development meets in Johannesburg, South Africa, in August 2002.

Most importantly, CAIR will result in the greatest health benefits of any rule initiated by EPA since the late 1970s—almost $100 billion per year by 2015. By 2015, CAIR will annually prevent approximately 17,000 premature deaths; 1.7 million lost workdays; 500,000 lost school days; 22,000 nonfatal heart attacks; and 12,300 hospital admissions.

Days after CAIR was signed, EPA released a related rule designed to reduce mercury emissions from power plants. This rule, known as the Clean Air Mercury Rule, is designed to work with CAIR and provide a flexible multipollutant approach to reducing SO_2, NOx, and mercury emissions from power plants.

Like CAIR, the Clean Air Mercury Rule limits emissions by using a market-based, cap-and-trade program that will permanently cap utility mercury emissions in two phases. The first phase will reduce emissions from 48 tons to 31 tons by 2010, and the second phase will achieve a reduction of 70 percent from current levels. As a result of this action, the United States is now the only country in the world to regulate mercury emissions



Real Air in Real Time

AP/WWP Photo by Matt York

National Park Service Web cam allows views of air quality at Arizona's Grand Canyon.

The EPA has been working to reduce air pollution for more than 30 years, but the Internet has taken that pursuit to an entirely new level. Web cams allow anybody to go just about anywhere in the country to check out air quality for the day. The EPA maintains a portal for these sites at http://www.epa.gov/airnow/webcam.html

The National Park Service maintains a similar portal, providing views of the air quality over some of the most breathtaking landscapes in the nation at http://www2.nature.nps.gov/air/webcams/

The U.S. Forest Service keeps a Web cam trained on the Mt. Saint Helens volcano in the state of Washington at http://www.fs.fed.us/gpnf/volcanocams/msh/

The National Oceanic and Atmospheric Administration provides a variety of views from different points surrounding the Great Lakes in the Midwest at http://www.glerl.noaa.gov/webcams/

from coal-burning power plants.

The success of EPA's air programs is not limited to legislation and regulation. Much of our progress can be attributed to voluntary programs developed in concert with states, industry, and environmental organizations. An example of this is Energy Star, a government-backed program helping businesses and individuals protect the environment through superior energy efficiency.

Through partnerships with hundreds of organizations, Energy Star has eliminated millions of tons of greenhouse gas emissions and saved consumers money at the same time. In 2004, EPA's voluntary programs reduced greenhouse gas emissions in an amount equivalent to the greenhouse gas reductions that would be achieved by eliminating 32 million cars.

EPA's International Efforts

Because air pollution does not respect geographic boundaries, the United States has been engaged internationally to translate its domestic successes into solutions around the world. For example, less than half of the mercury deposited in the environment in the United States is from sources located in this country.

Airborne mercury is a global problem, requiring global solutions. Moreover, even if we could completely eliminate mercury deposition in the United States (from U.S. and foreign sources), many Americans would still be exposed to elevated mercury levels. Virtually all mercury exposure in the United States comes from eating mercury-contaminated fish—more than 80 percent of which comes from other parts of the world.

EPA estimates that coal combustion, chloralkali (a chlorine-containing chemical used in chemical processing, plastics, environmental services, and metal cleaning) production, mercury use in products, and mercury use in small-scale gold mining are together responsible for about 80 percent of global anthropogenic (human-generated) air emissions of mercury. It should be noted, however, that almost two-thirds of annual global mercury emissions are from natural sources such as volcanic activity and from the "re-emission" of mercury that has already been deposited in the environment.

At the February 2005 United Nations Environment Programme (UNEP) Governing Council meeting in Nairobi, the United States put forth an initiative to develop multistakeholder partnerships to improve global understanding of mercury transport and to reduce mercury releases in these key sectors. The UNEP Governing Council recognized partnerships as an important way for the world community to move forward in reducing mercury use and emissions. The United States plans to launch partnerships in these five areas over the next few months.

EPA has pursued similar partnership initiatives to address other air pollutants. Because transportation sources are the largest contributor to air pollution in urban areas

of the developing world, one of EPA's key priorities is the Partnership for Clean Fuels and Vehicles (www.unep.org/PCFV), launched at the World Summit on Sustainable Development in South Africa in August 2002. The partnership, which boasts 75 international partners from government, industry, and the nongovernmental sector, is seeking to eliminate leaded gasoline worldwide and simultaneously reduce sulfur in fuels while introducing cleaner vehicle technologies.

Eliminating leaded gasoline in Africa is a focus of the partnership and for EPA. Since 2002, the countries of sub-Saharan Africa have made huge strides in phasing out leaded gasoline. Currently, more than 50 percent of the gasoline in sub-Saharan Africa is lead-free and many more countries have set a date for complete lead phase-out. U.S. funding has supported technical expertise, stakeholder workshops, public outreach, training of gas station attendants, and blood-lead-level studies in Ghana, Kenya, Nigeria, and South Africa.

Under the umbrella of the partnership, EPA also initiated the Mexico City Diesel Retrofit Project in June 2004 in cooperation with the World Resources Institute and the U.S. Agency for International Development. The project is designed to demonstrate how the combined use of low-sulfur fuels and diesel retrofit technologies can improve air quality and reduce effects on human health. It has already shown that newer public buses retrofitted and running on ultra-low sulfur fuel can reduce up to 90 percent of particulate emissions. The Mexico City project is serving as a model for EPA projects in other areas of the world, including Beijing, China; Pune, India; Santiago, Chile; and Bangkok, Thailand.

The Future

Although challenges remain, we have made a great deal of progress in our effort to improve air quality throughout the United States. Because of actions taken over the past five years, we know that this progress will continue far into the future. We look forward to continuing our efforts in the United States and to sharing the lessons we have learned with our partners worldwide. Because pollution can be transported around the globe, these international efforts will-help improve air quality in the United States and the health and well being of people around the world. ■

Environmental Progress
A Portfolio

Photo © Glenn Randall

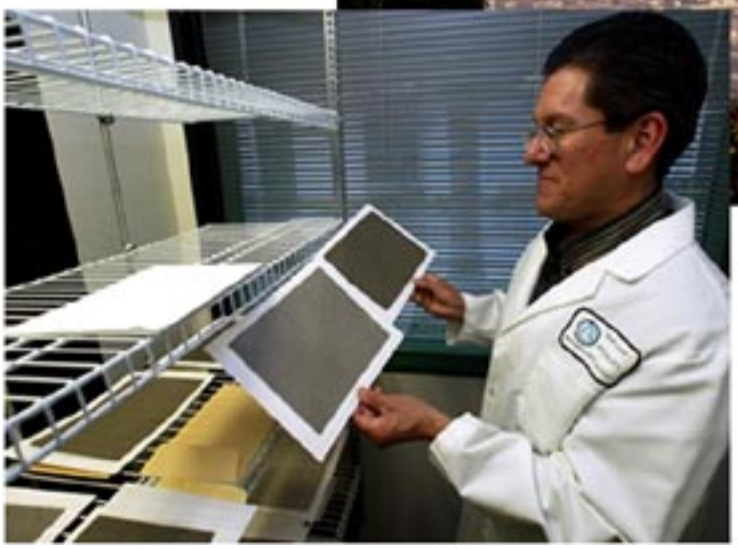
The United States has a record of land stewardship that stretches back more than 130 years to the creation of the first national parks. In the past 50 years, increased understanding of the human potential to harm the environment and its diverse web of life has heightened our vigilance and led us to take corrective measures. The pictures in this gallery reflect the progress that has been made in the United States and continuing efforts to improve the environment.

AP/WWP Photo by Luis M. Alvarez

Above: Rocky Mountain National Park in Colorado offers sweeping views like this one of Longs Peak, Glacier Gorge, and Bear Lake. Scientists closely monitor air and water quality, giving park managers the information necessary to make responsible decisions.
Right: A flock of ibis fly near the Kissimmee River in the Florida Everglades. Over the past 20 years, federal, state, and local partners have joined forces to counteract the effects of overdevelopment and ecosystem degradation. Everglades National Park is designated a World Heritage Site, an International Biosphere Reserve, and a Wetland of International Importance.

AP/WWP Photo by Mark J. Terrill;

AP/WWP Photo by Ric Francis



AP/WWP Photo by Damian Dovarganes

Top: The air is clear in this January 2005 view of downtown Los Angeles, yet smoggy days (above) remain a fact of life in the southern California city.
Left: A chemist compares filters used to collect fine air particulate pollution in Los Angeles and nearby Lynnwood; monitoring is part of the state's effort to achieve clean-air standards in southern California by the end of the decade.

Photo courtesy of the Cleveland Public Library

Left: A fire started in an oil slick blazes on the Cuyahoga river in 1952. Such fires, caused by the dumping of chemical wastes, occurred several times during the 1950s and 1960s. The sight of a river on fire did much to spark the U.S. environmental movement.

Below: The Cuyahoga River in Cleveland, Ohio, is today a picture of health.

AP/WWP Photo by Mark Duncan

Below: Water contaminated with creosote from a wood-treating plant near Seattle, Washington, is cleaned with a naturally occurring, oil-eating microbe. The jars contain water from the same source, before and after treatment.

AP/WWP Photo by Ted S. Warren

Below: Green sea turtles, protected by the federal Endangered Species Act, were raised to maturity at a zoo then released into their natural habitat in the Pacific Ocean.

AP/WWP Photo by Brookfield Zoo, Jim Schultz

AP/WWP Photo by Richard Drew

AP Photo/FILE-Lincoln Karim

AP/WWP Photo by Dawn Villella

Left: Its numbers restored to sustainable levels, the gray wolf was removed from the endangered species list for the eastern United States in 2004. Wolf populations will continue to be monitored closely.

Above: Schoolchildren in New York City anxiously watch a family of red-tailed hawks that nested on the ledge of a luxury apartment building (above right). Many New Yorkers were outraged when apartment owners decided to have the nest, the birds, and the grate that held the nest removed so the birds could not return. Citizens groups protested vigorously until the building management relented and replaced the grate; the birds quickly returned and rebuilt their nest.

The U.S. Climate Change Vision

John H. Marburger III

AP/WWP Photo by Kenneth Lambert

President George W. Bush announces climate study initiatives, as Vice President Dick Cheney (left) and then-Secretary of State Colin Powell look on at the White House in June 2001.

The Bush administration is confronting climate change by making significant investments in new technologies and partnerships with other governments. "The vision here is to forge new energy technologies that all nations can use to meet their goals of limiting greenhouse gas emissions, without compromising the sustained improvements in living standards to which all nations aspire," says the author, science advisor to President George W. Bush and director of the Office of Science and Technology Policy in the Executive Office of the President.

Immediately before taking up his current positions at the White House in 2001, John Marburger, Ph.D., was director of the Brookhaven National Laboratory in Upton, New York. From 1980 to 1994 he was president of the State University of New York-Stony Brook.

"The issue of climate change respects no border. Its effects cannot be reined in by an army nor advanced by any ideology. Climate change, with its potential to impact every corner of the world, is an issue that must be addressed by the world."

President George W. Bush, June 11, 2001

With these words, President Bush clearly acknowledged the reality and seriousness of climate change and launched a responsible and practical climate policy with three primary aims:

- To introduce new technologies for producing and using energy that can dramatically weaken the link between economic growth and the generation of greenhouse gases.
- To improve scientific tools and understanding needed to respond more effectively to the problems posed by climate change.
- To enlist the cooperation of other nations to address the entire spectrum of climate change issues.

To advance these aims, the United States will spend $5.2 billion in fiscal year 2005 on climate change science research, advanced energy technologies, voluntary programs, and related international assistance—far more than any other nation.

U.S. climate-oriented technology initiatives are ambitious on a scale commensurate with the challenges: development of hydrogen technologies that can enable more efficient and carbon-free means of transportation and other applications, new kinds of power plants—"FutureGen" plants—that generate power from hydrocarbons but release no carbon to the atmosphere, and renewed commitment to research on future carbon-free forms of power generation such as nuclear fusion that can be scaled to an economically significant size. The vision here is to forge new energy technologies that all nations can use to meet their goals of limiting greenhouse gas emissions, without compromising the sustained improvements in living standards to which all nations aspire.

Climate science initiatives are critically important for the kind of long-range planning that must be done region by region around the world to rise to the challenge of climate change. Even modest advances in our understanding of weather and climate can have a positive

impact. The United States is spending nearly $2 billion per year on climate science within a well-defined strategic plan, developed and reviewed in consultation with the international scientific community and the National Academy of Sciences.

International cooperation is crucial for observing, understanding, preparing for, and mitigating potential impacts of climate change. The United States is by far the largest funder of activities under the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC).

Bush administration international initiatives include:

The **Methane to Markets Partnership** is an action-oriented initiative that will reduce global methane emissions to enhance economic growth, promote energy security, improve the environment, and reduce greenhouse gases. Fourteen countries launched the initiative at a ministerial meeting on November 16, 2004 in Washington, D.C. [http://www.epa.gov/methane/international.html]

The **International Partnership for a Hydrogen Economy** was formed to implement internationally the goals of President Bush's Hydrogen Fuel Initiative and Freedom-Car Partnership. The Partnership's 15 countries and the European Union (EU) are working together to advance the global transition to the hydrogen economy with the goal of making fuel cell vehicles commercially available by 2020. [http://www.eere.energy.gov/hydrogenandfuelcells/international_activities.html]

The **Carbon Sequestration Leadership Forum** is a framework to work cooperatively with global partners, including developing countries, on research, development, and deployment of carbon sequestration technologies in the next decade. [http://www.fe.doe.gov/programs/sequestration/cslf/]

The **Generation IV International Forum** for nuclear power is a multilateral partnership fostering international cooperation in research and development for the next generation of safer, more affordable, and more proliferation-resistant nuclear energy systems. [http://gen-iv.ne.doe.gov/intl.html]

The **Renewable Energy and Energy Efficiency Partnership** was formed at the World Summit on Sustainable Development in Johannesburg, South Africa, in August 2002 and seeks to accelerate and expand the global market for renewable energy and energy-efficiency technologies.

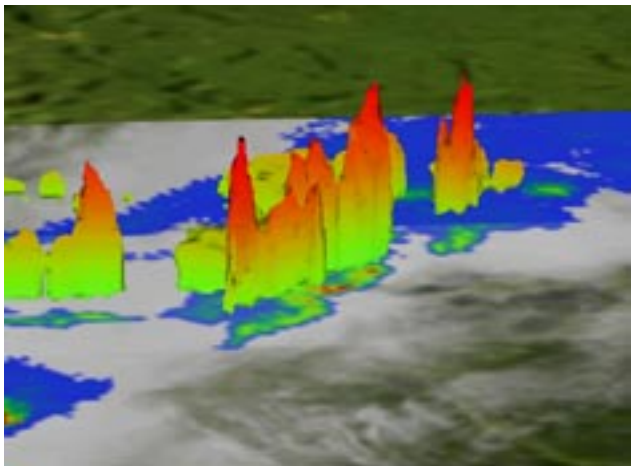
These initiatives and bilateral partnerships bring together approximately 20 developing and developed nations that, with the United States, account for more than 70 percent of global greenhouse gas emissions.

The United States mounted a vigorous and widely supported international initiative on integrated Earth observations, a "system of systems" approach to improving knowledge of global conditions that is engaging 55 countries and the European Union. A 10-year strategic plan, just released, maps out the U.S. component of an integrated Earth Observation System. Guidelines for the global system—the Global Earth Observation System of Systems, or GEOSS—were recently adopted at the third summit of the Group on Earth Observations in Brussels. The end result will be access to an unprecedented amount of environmental information, integrated into new data products benefiting societies and economies worldwide.

These actions add up to a thoughtful, visionary approach to the huge challenge of climate change. In President Bush's words, "My approach recognizes that economic growth is the solution, not the problem. Because a nation that grows its economy is a nation that can afford investments and new technologies." These investments are made on behalf of all nations and are essential for a sustainable global economy in the future. ■

Understanding Climate and Global Change

Richard H. Moss



NASA

Three-dimensional view of a rain squall was captured by the Tropical Rainfall Measuring Mission satellite, a joint endeavor of the United States and Japan.

The United States has made significant investments in advancing human knowledge about climate, its role in the environment, and its impact on human activities. Scientists have identified global-scale climate changes, and they are working to ascertain potential consequences and responses.

The U.S. Climate Change Science Program (CCSP) coordinates the scientific activities of some 13 federal government agencies and departments and seeks to provide the United States and the global community with the science-based knowledge to manage the risks and opportunities of change in the climate and related environmental systems.

Richard H. Moss, Ph.D., is the director of the office of the U.S. government's Climate Change Science Program and senior scientist in the Joint Global Change Research Institute at the University of Maryland.

Climate and climate variability play important roles in shaping the environment, natural resources, infrastructure, economy, and other aspects of life in all countries of the world. Potential human-induced changes in climate and related environmental systems, and options proposed to adapt to or mitigate these changes, are also projected to have significant environmental, economic, and societal consequences.

To make informed judgments and decisions, citizens and decision makers in public and private sector organizations need reliable and readily understandable information. To meet this information need, U.S. research efforts strive to develop and provide information on variability and change in climate and related systems.

Substantial Investment in Research

Over roughly the past 15 years, the United States has invested heavily in scientific research, monitoring, data management, and assessment for climate change analyses to build a foundation of knowledge for decision making. To date, more than $20 billion of research funding has been provided by U.S. agencies and departments.

In 1989, President George H.W. Bush established the interagency U.S. Global Change Research Program (USGCRP), which was institutionalized in the U.S. Global Change Research Act in 1990. The rationale for establishing the program was that global change issues are so complex and wide ranging that they extend beyond the mission, resources, and expertise of any single agency, requiring instead the integrated efforts of scientists and researchers working in or supported by several departments.

During its first decade, USGCRP-supported research demonstrated that global-scale changes are taking place in Earth's environment and that human activities contribute to these changes. Alteration of atmospheric composition, stratospheric ozone depletion, climate change, and land cover change were among the phenomena detected.

The USGCRP also conducted research into Earth's natural variability and laid the basis for developing predictions of shifts in phase of the El Niño-Southern Oscillation (ENSO)—a natural fluctuation of ocean currents that has

major effects on global weather and natural hazards—and identifying other climate oscillations.

USGCRP-supported activities developed and deployed a series of remote sensing satellites that form the basis of a global environmental observing system being developed through the Global Earth Observation System of Systems (http://iwgeo.ssc.nasa.gov). A suite of climate and Earth-system models has been developed under the USGCRP to integrate these observations, to analyze global change processes, and to project changes and their potential consequences.

NASA

Composite satellite images of Earth reflect the latest scientific data about our planet's terrestrial, oceanic, and atmospheric features.

In 2001, President George W. Bush launched the Climate Change Research Initiative "to study areas of uncertainty and identify priority areas" for research. In 2002, the president created a new Cabinet-level management structure to oversee climate change science and technology programs.

The Climate Change Science Program (CCSP) is the part of that structure that coordinates the scientific investments and activities of 13 participating federal government agencies and departments (http://www.climatescience.gov).

CCSP Vision, Mission, and Goals

The seriousness of climate variability and change, and the unique role that science can play in helping determine society's course, give rise to CCSP's guiding vision: *A nation and the global community empowered with the science-based knowledge to manage the risks and opportunities of change in the climate and related environmental systems.*

The core precept that motivates CCSP is to apply the best possible scientific knowledge in managing climate variability and change and related aspects of global change. The CCSP mission is thus to *facilitate the creation and application of knowledge of Earth's global environment through research, observations, decision support, and communication.*

CCSP will add significant integrative value to the individual Earth and climate science missions of its 13 participating agencies and departments and their national and international partners, coordinating research and integrating and synthesizing information to achieve results that no single agency, or small group of agencies, could attain.

CCSP has five goals related to addressing society's information needs.

Goal 1: Improve knowledge of Earth's past and present climate and environment, including its natural variability, and improve understanding of the causes of observed variability and change.

Climate conditions change significantly over time. CCSP research will improve understanding of natural oscillations in climate on timescales of weeks to centuries, including improving and harnessing ENSO forecasts. Improved observations, analysis, and modeling will sharpen qualitative and quantitative understanding of how and why climate is changing and will determine whether changes in the frequency or intensity of extreme climate events (e.g., droughts) lie outside the range of natural variability.

Goal 2: Improve quantification of the forces bringing about changes in Earth's climate and related systems.

Burning of fossil fuels, changes in land cover and land use, and industrial activities produce greenhouse gases and aerosols, altering the composition of the atmosphere and physical and biological properties of Earth's surface. These changes have important climatic effects, some of which can be quantified only poorly at present.

Research conducted through the CCSP will increase confidence in our understanding of characteristics of greenhouse gases and aerosols, their long-range atmospheric transport and removal from the atmosphere, as well as their interactions with global climate, ozone in the upper and lower layers of the atmosphere, and regional-scale air quality.

Research will also improve quantification of interactions among the carbon cycle, other biological/ecological processes, and land cover and land use to better project atmospheric concentrations of key greenhouse gases and support improved decision making. The program will also improve capabilities for developing and applying emissions scenarios in research and analysis, in cooperation with the multiagency Climate Change Technology Program.

Goal 3: Reduce uncertainty in projections of how Earth's climate and related systems may change in the future.

Uncertainty exists regarding precisely how much climate will change overall and in specific regions.

A primary CCSP objective is to develop the information and scientific capacity needed to sharpen qualitative and quantitative understanding through interconnected observations, data assimilation, and modeling activities. CCSP-supported research will address basic climate system properties and a number of "feedbacks" or secondary changes that can reinforce or dampen the initial effects of greenhouse gas and aerosol emissions and changes in land use and land cover.

The program will also address the potential for future changes in extreme events and possible rapid or discontinuous changes in climate. The CCSP will build on existing U.S. strengths in climate research and modeling.

Goal 4: Understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes.

Seasonal-to-annual climate variability has been shown to impact ecosystems and human life. Improving our ability to assess potential implications of changes in climate and environmental conditions on ecosystems and human systems could help governments, businesses, and communities reduce damages and seize opportunities by adapting infrastructure, activities, and plans.

CCSP research will examine the interactions of interdependent changes and effects. Examples are the carbon dioxide fertilization effect, in which some plants' rates of photosynthesis rise with increases in carbon dioxide; changes in landscapes that affect water resources and habitats; and changes in frequency of fires or pests.

CCSP research will improve methods for integrating our understanding of potential effects of different atmospheric concentrations of greenhouse gases, and develop methods for aggregating and comparing potential impacts across sectors and locations.

Goal 5: Explore the uses and identify the limits of evolving knowledge to manage risks and opportunities related to climate variability and change.

Over the past decade, the scientific and technical community has developed products to support the management of risks and opportunities related to climate variability and change. CCSP will foster more studies and encourage evaluation and learning from these experiences to develop processes and products that use knowledge to the best effect, with the ultimate objective of supporting policymaking, planning, and adaptive management.

These resources will communicate critical information and explore the implications of uncertainty for decision making through a variety of means, including observational data, model products, scenario analysis, visualization products, and scientific syntheses and assessments.

International Collaborations

Climate variability and change are intrinsically international in scope. Effective research thus requires international cooperation—cooperation among scientists and research institutions and governmental agencies. U.S. scientists, institutions, and agencies are at the forefront of such international cooperation, reflecting the leadership role of U.S. climate science.

CCSP is a leader in a global network of active and engaged international research scientists and institutions, including the International Geosphere-Biosphere Programme (http://www.igbp.kva.se), the International Human Dimensions Programme (http://www.ihdp.uni-bonn.de), the World Climate Research Programme (http://www.wmo.ch/web/wcrp/wcrp-home.html), Diversitas (http://www.diversitas-international.org), and the Earth Science System Partnership (http://www.ess-p.org).

The United States has also developed bilateral and regional partnerships to advance the science of climate change, enhance the technology to monitor and reduce greenhouse gases, and help developing countries through capacity building and technology transfer.

The CCSP will continue to interact with these organizations and partnerships directly and through support to U.S. scientists providing dynamic scientific leadership.

As a leader in climate change science, the United States assumes responsibility for participating in and providing data to international assessments such as those on ozone, biodiversity, ecosystems, and climate.

An Announcement

As part of its commitment to develop partnerships with those who provide and use climate information around the world, the U.S. CCSP invites participation in a workshop, *Climate Science in Support of Decision Making,* to be held in the Washington, D.C., area November 14-16, 2005 (http://www.climatescience.gov/workshop2005/default.htm).

We encourage the attendance of representatives of international organizations and countries interested in learning from U.S. experiences or helping shape future U.S. activities related to the application of climate information. ■

Methane to Markets

Paul Gunning and Dina Kruger

AP/WWP Photo by Timothy Jacobsen

Dairy cows in Woodsboro, Maryland, wait to be milked. Methane gas from cow manure is a potentially valuable fuel.

Methane is the primary component of natural gas and a greenhouse gas, meaning that its presence in the atmosphere affects Earth's temperature and climate system. A new U.S.-supported international partnership seeks to advance the recovery and use of methane as a clean energy source. The Methane to Markets Partnership is a public-private undertaking that involves 15 national governments and more than 90 organizations committed to achieving economic, environmental, and energy benefits.

Paul Gunning is chief of the Non-CO_2 Programs Branch in the EPA's Climate Change Division.

Dina Kruger is director of the Climate Change Division in the U.S. Environmental Protection Agency (EPA).

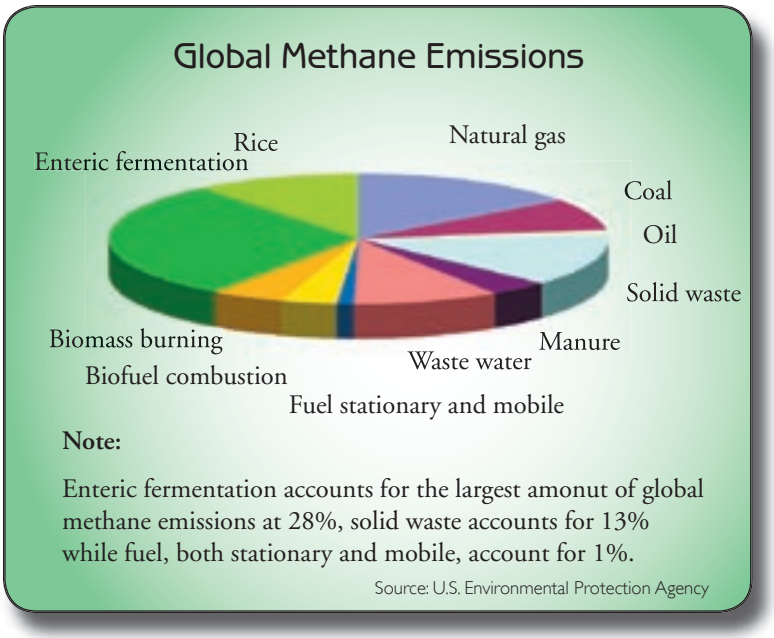
Launched in November 2004, the Methane to Markets Partnership is a multilateral initiative uniting public and private interests to advance the recovery and use of methane as a clean energy source.

Today, 15 national governments and more than 90 organizations are working collaboratively to advance project development in three major methane emission source areas: landfills, underground coal mines, and natural gas and oil systems.

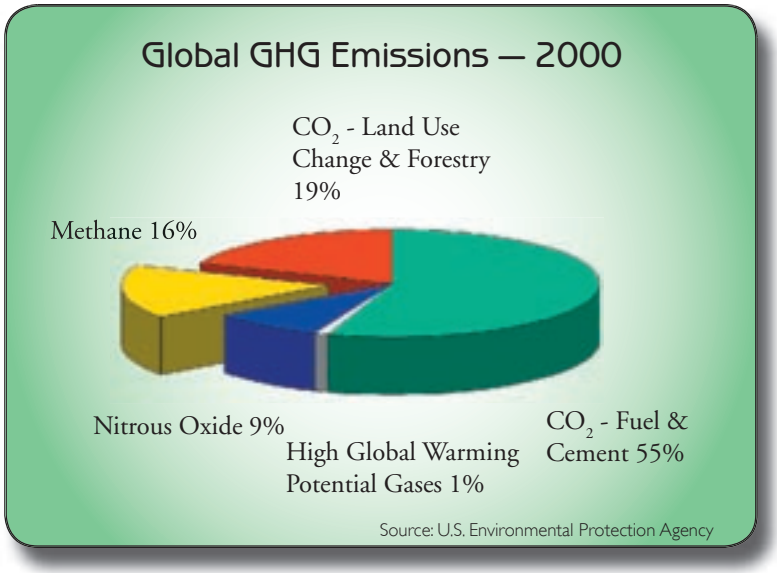
The partnership's activities are expected to yield significant benefits: they will reduce global methane emissions, enhance economic growth, promote energy security, improve air quality, and enhance industrial safety.

The Importance of Methane

Methane is a hydrocarbon and the primary component of natural gas as well as a potent greenhouse gas. Globally, a large amount of methane is emitted to the atmosphere rather than being recovered and used for fuel. About 60 percent of global methane emissions come from the anthropogenic (human-generated) sources noted below—landfills, mines, and gas and oil operations—and from agriculture. The rest are from natural sources, mainly wetlands, gas hydrates (crystalline solids made up of methane molecules, each surrounded by water molecules), permafrost, and termites.



China, India, the United States, Brazil, Russia, and other Eurasian countries are responsible for almost half of all anthropogenic methane emissions. Methane emission sources vary significantly among countries. For example, the two key sources of methane emissions in China are coal mining and rice production. Russia emits most of its methane from natural gas and oil systems; India's primary sources are rice and livestock production; and landfills are the largest source of U.S. methane emissions.



Methane is the main component of natural gas and an important clean energy source. It also accounts for 16 percent of all global greenhouse gas emissions resulting from human activities. Methane is considered a potent greenhouse gas because, kilogram for kilogram, it is 23 times more effective than carbon dioxide at trapping heat in the atmosphere over a 100-year time period.

Methane is a short-lived greenhouse gas, with an atmospheric lifetime of about 12 years. Because of these unique properties, reducing global methane emissions could have a rapid and significant positive effect on atmospheric warming and yield important economic and energy benefits.

Methane-Reduction Opportunities

Sources for which recovery and use of methane gas for energy is viable include coal mining, oil and gas systems, landfills and animal manure. Below are some methane recovery and use options for these sources:

- Coal mines. To reduce explosion hazards, methane is removed from underground mines before, during, or after mining. Natural gas pipeline injection, power production, and vehicle fuel are all profitable uses for methane from coal mines.
- Landfills. The principal approach to reducing methane emissions from landfills involves collecting and burning or using landfill gas. Landfill gas-use technologies focus on electricity generation and direct gas use. Electricity generation involves piping collected methane to engines or turbines. Direct-use technologies use landfill gas directly as a fuel; other technologies require that the gas be upgraded and distributed to a natural gas pipeline.
- Natural gas and oil systems. Emission reduction activities fall into three categories: technologies or equipment upgrades that reduce or eliminate equipment venting and other emissions, improvements in management practices and operational procedures, and enhanced management practices that take advantage of improved technology. In all cases, reducing methane emissions makes more gas available for sale and use.
- Manure management. Methane and other gases are produced when animal manure is managed under anaerobic (without oxygen) conditions. Methane reduction and other environmental benefits can be achieved by using anaerobic digestion systems that collect and transfer manure-generated gases to energy-producing combustion devices such as engine generators or boilers.

Even with current technology and the benefits of mitigation, methane recovery and use is not widespread for several reasons. First, methane is a secondary issue in the industrial processes that emit the gas. Coal mines, for example, want to vent methane from the mine workings because it is explosive. Mining companies have not historically viewed methane as an energy resource in its own right.

Second, those responsible for the emissions may not be familiar with the technologies available for methane recovery or the potential for profitable projects. This is especially true in developing countries, where increased information and technical training would help generate support for methane recovery projects.

Finally, poorly functioning energy markets and financially insolvent utilities and municipalities in many countries fail to attract investment from the private sector in methane capture and use projects.

Methane to Markets

Addressing these barriers to advance methane recovery and use is the focus of the Methane to Markets Partnership. Through private-public partnerships, the initiative brings together the technical and market expertise, financing, and technology necessary for project development.

Member countries work in collaboration with the private sector, multilateral development banks, and other governmental and nongovernmental organizations. The core goal is to identify and implement activities that advance methane recovery and use project development at landfills, coal mines, and oil and gas systems.

The 15 national governments, or partners, that have already committed to the partnership have signed a voluntary agreement that establishes the partnership's purpose, structure, and organization.

As part of this commitment, each partner agrees to undertake a variety of activities aimed at advancing methane recovery and use internationally in the target sectors. Each partner country manages its own financial contribution and assistance mechanisms based on its national interests and areas of expertise.

Guiding the partners' work is a steering committee supported by an administrative support group, or secretariat, housed at the U.S. Environmental Protection Agency (EPA) in Washington, D.C. Sector-specific subcommittees for landfills, oil and gas systems, and coal mining are also in place.

The subcommittees develop action plans that identify and address key barriers and issues for project development, address market assessment and reform issues, facilitate investment and financing opportunities, and report on progress.

They also engage organizations outside the partner governments, encouraging private-sector entities, financial institutions, and other governmental and nongovernmental organizations to build capacity, transfer technology, and promote private investment.

To this end, the partnership has created Project Network to facilitate communication and coordination among these organizations. Interested organizations can become members of the Methane to Markets Project Network by signing a one-page, nonbinding agreement that is available on the partnership's Web site. To date, more than 90 organizations have joined these efforts.

U.S. Government Commitment

The U.S. government intends to commit up to $53 million over the next five years to facilitate development and implementation of methane projects in developing countries and countries with economies in transition. These technologies will be promoted using a range of activities, such as the export of successful U.S. voluntary programs, training and capacity building, market development, feasibility assessments, and technology demonstrations.

Leveraging the efforts of fellow partner countries and the expertise and investment of the private sector and other Project Network members are other central objectives of the U.S. commitment.

EPA leads this effort for the U.S. government and will build on the success of its voluntary domestic methane partnership programs, which have reduced methane emissions in the United States as of 2004 by 10 percent below 1990 levels.

Conclusion

The Methane to Markets Partnership offers a unique opportunity for governments and organizations around the world to work together to address methane emissions while achieving economic, environmental, and energy benefits. The U.S. government believes significant progress can be made and is committed to working with its domestic and international public- and private-sector partners.

The United States estimates that Methane to Markets has the potential to deliver by 2015 annual reductions in methane emissions of up to 50 million metric tons of carbon equivalent, or recovery of 15 billion cubic meters of natural gas.

If achieved, these reductions could lead to stabilized or even declining levels of global atmospheric concentrations of methane. To give a sense of scale, this would be equivalent to removing 33 million cars from the roadways for one year, planting 22 million hectares of trees, or eliminating emissions from 50 500-megawatt coal-fired power plants. ■

Resources

EPA's Voluntary Methane Partnership Programs
http://www.epa.gov/methane

U.S. government Methane to Markets Web site
http://ww.epa.gov/methanetomarkets

Methane to Markets Partnership site
http://www.methanetomarkets.org

Seal of Energy Efficiency

Energy Star persuades consumers to make smart energy choices

The Energy Star seal is widely known in the North American marketplace. Almost 60 percent of consumers recognize it as a mark of energy efficiency. When stamped on a kitchen appliance, a light fixture, a computer, a television, or any one of thousands of other products, the seal confirms that the product meets government standards for efficient use of energy and that the product will cost less to operate over time than a similar product lacking the Energy Star label.

The U.S. Environmental Protection Agency (EPA) introduced Energy Star in 1992 as a market-based partnership to reduce energy consumption and air pollution. The U.S. Department of Energy and the Canadian government have since joined the effort to develop product manufacturing and performance standards for energy efficiency.

Energy Star operates under the slogan: "The quality of our environment is everyone's responsibility." The program aims to make energy efficiency an easy thing for consumers and business to support. Energy Star performs research, sets standards, and provides information to help consumers make well-informed decisions about energy consumption.

Consumers have confirmed the effectiveness of the Energy Star endorsement, purchasing more than 1.5 billion products bearing the Energy Star seal through the 13-year life of the program. The savings in energy in 2004 alone is the equivalent of that needed to power 24 million homes, according to EPA statistics. In addition, 30 million metric tons of greenhouse gas emissions have been prevented by use of the more efficient products. That emission level is equivalent to what 20 million vehicles would emit in the United States each year. Consumers have saved about $10 billion in deferred energy costs.

Energy Star also benefits more than 7,000 businesses and nongovernmental organizations that are partners in the program. The EPA-DOE program guides businesses in developing energy management strategies that measure energy performance, set goals for improvement, and track the savings achieved.

Many major names in corporate America are Energy Star partners—companies such as 3M, Marriott International, General Electric, Sylvania, Whirlpool, and Canon. The program is also making increasing inroads into the construction industry. More than half of the top U.S. homebuilders now participate as Energy Star partners, building greater efficiency into new structures from the ground up.

Further information is available at http://www.energystar.gov

Wind Power Today

Robert Thresher

AP/WWP Photo by Charlie Riedel

The sun sets behind a wind farm near Montezuma, Kansas. The farm's 170 turbines can generate enough electricity to power 40,000 households.

The U.S. Department of Energy (DOE) has worked with the U.S. wind energy industry for more than 30 years to turn yesterday's dream for a clean, renewable energy source into today's most viable renewable energy technology.

Robert Thresher is the director of the National Wind Technology Center at the U.S. Department of Energy's National Renewable Energy Laboratory.

Wind power—the technology of using wind to generate electricity—is the fastest-growing new source of electricity worldwide. Wind energy is produced by massive three-bladed wind turbines that sit atop tall towers and work like fans in reverse. Rather than using electricity to make wind, turbines use wind to make electricity.

Wind turns the blades and the blades spin a shaft that is connected through a set of gears to drive an electrical generator. Large-scale turbines for utilities can generate from 750 kilowatts (a kilowatt is 1,000 watts) to 1.5 megawatts (a megawatt is 1 million watts). Homes, telecommunications stations, and water pumps use single small turbines of less than 100 kilowatts as an energy source, particularly in remote areas where there is no utility service.

In wind plants or wind farms, groups of turbines are linked together to generate electricity for the utility grid. The electricity is sent through transmission and distribution lines to consumers.

Since 1980, research and testing sponsored by the DOE Wind Program has helped reduce the cost of wind energy from 80 cents (current dollars) per kilowatt hour to between 4 and 6 cents per kilowatt hour today.

One goal of the wind program is to further reduce the cost of utility-scale wind energy production to 3 cents per kilowatt hour at land-based, low-wind-speed sites and 5 cents per kilowatt hour for offshore (ocean) sites. A low-wind-speed site is one where the annual average wind speed measured 10 meters above the ground is about 21 kilometers per hour.

To accomplish this and other goals, two of DOE's main research laboratories, the National Renewable Energy Laboratory (NREL) in Colorado and Sandia National Laboratories in New Mexico, work with industry partners and university researchers nationwide to further advance wind energy technologies. Each laboratory has unique skills and capabilities to meet industry needs.

NREL's National Wind Technology Center (NWTC) is the lead research facility for the wind program. NWTC conducts research and supports industry partners in design and review analysis, component development, systems and controls analysis, testing, utility integration, technical assistance, and more. Sandia conducts research in advanced manufacturing, component reliability, aerodynamics, structural analysis, material fatigue, and control systems.

Thanks to such research and development, global wind energy capacity has increased 10-fold in the last 10 years—from 3.5 gigawatts (a gigawatt is 1 billion watts) in 1994 to nearly 50 gigawatts by the end of 2004. In the United States, wind energy capacity tripled, from 1,600 megawatts in 1994 to more than 6,700 megawatts by the end of 2004—enough to serve more than 1.6 million households.

In 2005, because of a federal production tax credit renewed by Congress in 2004, the U.S. wind energy industry is poised for record growth. The tax credit provides a 1.9-cent per kilowatt hour credit for eligible technologies for the first 10 years of production. Some wind industry experts predict that wind technology installations for 2005 will add more than 2,000 megawatts of capacity because of the tax advantage provided by this law.

The wind industry has grown phenomenally in the past decade thanks to supporting government policies and the work of DOE Wind Program researchers in collaboration with industry partners to develop innovative cost-reducing technologies, cultivate market growth, and identify new wind energy applications.

Developing Cost-Reducing Technologies

Work conducted under DOE Wind Program projects from 1994 to 2004 produced innovative designs, larger turbines, and efficiencies that have led to dramatic cost reductions. Although this drop in cost is impressive, electricity produced by wind energy is not yet fully competitive with that produced by fossil fuels. Researchers believe that further technology improvements will be needed to reduce the cost of electricity from wind another 30 percent for it to become fully competitive with conventional fuel-consuming electricity generation technologies.

Cultivating Market Growth

To cultivate market growth by increasing acceptance of wind technology around the country, DOE's Wind Powering America (WPA) team works with industry partners to provide state support, develop utility partnerships, conduct outreach, and develop innovative market mechanisms to support the use of large- and small-scale wind systems.

The WPA strategy for increasing acceptance of wind technology includes extensive information activities to better inform various publics about the benefits of this technology. In 2004, WPA team members staffed exhibits at 36 events in 20 states and distributed 43,000 copies of WPA publications to state wind working groups and at various events. The number of visitors to the Wind Powering America Web site (http://www.windpoweringamerica.gov) continues to grow.

Through such efforts, the WPA seeks to increase the use of wind energy in the United States with the goal that at least 30 states have 100 megawatts of wind capacity by 2010.

New Wind Energy Applications

Decades of work conducted through public-private partnerships have moved wind energy from yesterday's dream to today's reality.

To ensure continued industry growth in 2005 and beyond, the Wind Program is exploring innovative applications that will open new markets. The applications include installing wind turbines offshore in shallow and deep water, using wind energy to produce fresh water, and developing new technologies that will help wind work in synergy with other renewable energy technologies like hydropower.

Offshore and Deep-Water Development

Offshore wind turbines, now in the early stages of development, are more expensive and harder to install and maintain than turbines on land. Offshore turbines must be designed to survive the offshore wind and wave loading of severe storms and must be protected from the corrosive marine environment.

Some advantages of offshore installation are that turbines can be made bigger than those onshore to produce more power per turbine, and the ocean location provides greatly increased wind speeds and less turbulence. Offshore installations also reduce land-use and could ease aesthetic concerns if the turbines are located far from shore and out of sight.

Recent studies show that there are significant offshore wind resources in regions of the United States near major urban areas in the mid-Atlantic and Northeast. In Europe, offshore wind turbines produce about 600 megawatts, but no turbines have yet been installed in waters deeper than 20 meters.

For offshore turbines in shallow water (less than 30 meters), European turbine manufacturers have adopted conventional land-based turbine designs and placed them on concrete bases or steel monopiles driven into the seabed. An offshore substation collects the energy and boosts the voltage, and then a buried undersea cable carries the power to shore, where another substation provides a further voltage increase for transmission to utilities for distribution to customers.

A large amount of potential U.S. offshore wind resourc-

es are in waters deeper than the current technology limit of about 30 meters, as developed in Europe for the Baltic Sea. Monopile foundations driven into the seabed are less suitable for the deeper waters off U.S. coasts. To produce cost-effective wind energy in deep water, floating platform technologies developed by the oil and gas industries need to be adapted and scaled for application to wind energy and new lower-cost anchoring methods developed. The ultimate vision for this new offshore wind technology would be to build the turbines and the supporting platform in a shore-based dry dock with local labor, tow the floating turbine to its place on the sea, drop anchor, and plug in to the power cable to shore.

The Wind Program is evaluating several floating platform concepts for offshore wind turbines for cost-effective electricity generation in water 50 to 200 meters deep. The program is also negotiating a partnership agreement with a domestic company to develop the first U.S. multi-megawatt wind turbine prototypes designed specifically for shallow-water offshore use.

Wind and Water

The Wind Program is investigating how wind and water can work together to provide a more stable supply of electricity and fresh water. The scarcity of fresh water is a growing global problem. According to the United Nations, the world's burgeoning population will need billions more cubic meters of fresh water per day by 2025. The current global desalination capacity is an estimated 28 million cubic meters per day.

An important solution to water scarcity is desalination of abundant ocean salt water, but desalination is a highly energy-intensive technology and is not cost effective in most areas. Among all the desalination process technologies, reverse osmosis has the highest electrical energy efficiency, at 3 to 8 kilowatt hours per cubic meter of water.

Reverse osmosis is a method of producing pure water by forcing salt water through a semipermeable membrane (which allows some molecules through but not others) that salts cannot pass through.

Even with the high efficiency of reverse osmosis, energy accounts for about 40 percent of the total desalinated water cost. From a cost and environmental point of view, inexpensive and clean alternative power sources are needed for a low-cost desalination solution.

Wind power is the most promising and least expensive renewable power source, but, because of its variable nature—because wind doesn't always blow—researchers must determine the effects it will have on desalination systems and their operation.

In 2004, the Wind Program funded a conceptual design study for an integrated wind energy and desalination system. The project is exploring wind and desalination concepts, identifying technical issues, exploring the feasibility of alternative concepts, and evaluating their economic viability.

To provide a stable supply of electricity to the utility grid, the Wind Program is conducting research into the potential benefits of combining wind and hydropower (or waterpower), which harnesses the energy of moving or falling water.

As part of that effort, the United States helped form a working group of the International Energy Agency (IEA) whose participants will focus on integrating wind and hydropower systems (the IEA Research, Development and Demonstration Wind Annex XXIV).

The annex will exchange information and conduct cooperative research into the generation, transmission, and economics of integrating wind and hydropower systems. The annex held its first meeting at the Hoover Dam in Nevada in 2005.

Conclusion

The U.S. Department of Energy's program to make clean and sustainable wind energy cost effective for several market applications has made significant progress in recent years and is on a steady course to further significant improvements. Sound and sustainable development of this renewable energy resource is a key element of the U.S. strategy to reduce national reliance on carbon-based fuels and reduce the production of greenhouse gas emissions. ■

Chemistry Goes Green

Cheryl Pellerin

AP/WWP Photo by Sherwin Castro

Green chemistry aims to reduce or eliminate harmful substances in products starting with their design and development.

New processes in the laboratory can prevent the creation of industrial pollutants and produce more environmentally friendly products. This evolving technology is minimizing the use of hazardous materials in design and development, thus representing a fundamentally different way to reduce pollution.

Cheryl Pellerin is a science writer for the U.S. State Department in the Bureau of International Information Programs.

The term green chemistry refers to the design of chemical products and processes that reduce or eliminate the generation and use of hazardous substances. The practice began in the United States with the passage of the Pollution Prevention Act of 1990, which established a national policy to prevent or reduce pollution at its source whenever feasible.

The act also provided a way to move beyond traditional U.S. Environmental Protection Agency (EPA) programs and devise creative strategies for protecting human health and the environment. Reducing pollution at the source, according to the act, "is fundamentally different and more desirable than waste management and pollution control."

After the act's passage, the EPA Office of Pollution Prevention and Toxics (OPPT) began to explore the idea of developing or improving chemical products and processes to make them less hazardous. In 1991, OPPT launched a model program that for the first time provided grants for research projects that included pollution prevention in the synthesis of chemicals. Since then, the EPA Green Chemistry Program (http://www.epa.gov/greenchemistry) has built collaborations with academia, industry, other government agencies, and nongovernmental organizations to promote pollution prevention through green chemistry.

Green Chemistry at Work

Chemical manufacturing is the source of many useful products. These include antibiotics and other medicines, plastics, gasoline and other fuels, agricultural chemicals such as fertilizers and pesticides, and synthetic fabrics like nylon, rayon, and polyester. These products are important but some of the chemicals and processes used to make them harm the environment and human health. Green chemistry aims to reduce pollution by preventing its creation in the first place.

In designing a chemical reaction according to the principles of this discipline, chemists pay close attention to what is known about possible hazards a chemical presents to health or the environment before using the chemical in a reaction or creating it as a product. In other words, they treat the hazard a substance poses as a property that must be considered along with other chemical and physical properties and select substances that minimize harm.

In their 1998 book, *Green Chemistry: Theory and Practice* (Oxford University Press), Paul Anastas and John Warner developed 12 principles that give chemists a road map for implementing green chemistry. Four of the principles follow.

1. Get off to a safe start: Identify reactions that use nonhazardous starting materials to make a desired product.

This minimizes danger to workers in manufacturing plants when they handle chemicals and prevents accidental release of harmful chemicals from leaks or explosions. A new way to make an important industrial chemical, adipic acid, illustrates this principle.

Almost 2 billion kilograms of adipic acid are needed each year to make nylon, polyurethane, lubricants, and plasticizers. The standard way to make adipic acid uses

benzene, which can cause cancer, as the starting material. In a newly developed process that uses genetically altered bacteria called biocatalysts, the simple sugar glucose is substituted for benzene.

Starting with a safe substance like glucose to make adipic acid means that the use of large quantities of a harmful chemical can be avoided if new processes like this one become widely used.

2. Use renewable resources: Put more emphasis on renewable starting materials, such as substances derived from growing plants, rather than irreplaceable materials like petroleum and natural gas supplies.

The glucose mentioned in the example above as a starting material can be derived from cornstarch or the cellulose found in plant materials. Even corncobs, stalks, and fallen leaves can yield glucose. In another example, cornstarch is used to produce the small, puffed packaging pellets that cushion materials shipped in containers. These pellets can replace plastic packing materials made from petroleum-based chemicals.

3. Find safer solvents: Eliminate the use of toxic solvents to dissolve the reacting materials.

Solvents are chemicals that can dissolve another substance. Many solvents used in large quantities in industry are harmful to health or can create other dangers like explosions or fires. Widely used solvents that carry health risks include carbon tetrachloride, chloroform, and perchloroethylene.

It is sometimes possible to substitute safer solvents like water or liquid carbon dioxide. For example, new dry-cleaning processes for clothing have recently been developed that dissolve grease and dirt using liquid carbon dioxide rather than the toxic chemical perchloroethylene.

4. Economize on atoms: Design reactions in which most or all of the atoms you start with end up in the product rather than in waste byproducts.

Stanford University chemist Barry Trost developed this concept, which he calls atom economy. An example of this principle is an improved process designed in 1991 to make the pain reliever ibuprofen, the active ingredient in the brand name drugs Motrin, Advil, Nuprin, and Medipren.

In the original six-step process developed in the 1960s, only 40 percent of the reactant atoms ended up in the product (ibuprofen) and 60 percent ended up in unwanted byproducts or waste. Trost's new process has three steps, and 77 percent of the reactant atoms end up in the ibuprofen. This green process eliminates hundreds of thousands of kilograms of chemical byproducts every year and reduces by hundreds of thousands of kilograms the amount of reactants needed to make ibuprofen.

Attention to these principles helps the environment and can save companies money in the long run by lowering the cost of pollution control and using less energy.

International Interest

Since the 1990s, many organizations around the world have embraced green chemistry.

The Green Chemistry Institute (CGI) (http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=greenchemistryinstitute%5cindex.html) is a nonprofit organization of the American Chemical Society, founded to promote green chemistry through research, education, information dissemination, conferences, symposia, and international collaboration. More than 20 international chapters are affiliated with the Green Chemistry Institute, including ones from Canada, India, Italy, China, South Africa, and Thailand.

In the United Kingdom, the Royal Society of Chemistry launched the Green Chemistry Network (GCN) (http://www.chemsoc.org/networks/gcn), based in the Department of Chemistry, University of York. The GCN promotes awareness and facilitates education, training, and the practice of green chemistry in industry, commerce, academia, and schools.

The CRYSTAL Faraday Partnership (http://www.crystalfaraday.org) in the United Kingdom is a virtual center of excellence in green chemical technology that accesses the resources of industrial and academic participants to promote lower-cost, sustainable manufacturing for the chemical industry. Its three core organizations are the Institution of Chemical Engineers, the Royal Society of Chemistry, and the Chemical Industries Association. Ten consortia and network technology organizations and 18 universities also participate.

In Japan, the Green & Sustainable Chemistry Network (GSCN) (http://www.gscn.net/indexE.html) promotes research and development on green and sustainable chemistry through collaboration, including international activities, information exchange, communication, education, and proposals to funding agencies. Members include 24 major societies, associations, and industry organizations. ■

Thinking Green:
Environmental Efficiency, Technology, and Creativity

From insulation made from old blue jeans to hydrogen fuel cells used in hybrid electric motors, the United States is producing and using an array of environmentally friendly technology.

The photographs here depict examples of progress being made in environmentally friendly architecture, alternative energy sources, materials recycling, and new fuel technology.

Photo courtesy of the David L. Lawrence Convention Center

The David L. Lawrence Convention Center in Pittsburgh, Pennsylvania, is the world's largest "green" building. The 140,000 square-meter facility uses natural daylight and ventilation for light and heat, and it is equipped with a water reclamation system that reduces potable water use by nearly 60 percent.

Photo courtesy of the Georgia Department of Natural Resources

At left, one-third of the building materials used in the Suwannee River Visitor Center in Georgia were made from recycled content, including decking made from plastics, insulation made from newspapers, and a retaining wall made from old automobile dashboards and electrical cables.

Photo courtesy of Ford Motor Company

At right, workmen lay a 4.2-hectare "living roof" of sedum plants at the Ford Motor Company's Rouge Center truck factory in Dearborn, Michigan. The plants absorb and filter water from rain and snow, absorb carbon dioxide, and give off oxygen.

AP/WWP Photo by Wade Payne

Windmill turbines, right, erected on a reclaimed strip mine by the Tennessee Valley Authority, have the power to generate 6 million kilowatt hours of electricity each year.

AP/WWP Photo by Leigh T. Jimmie

In Frisco, Texas, a solar energy contractor, above, displays a polycrystalline solar panel that will be installed in this "zero-energy home"—a home designed to generate as much energy as it consumes.

At right, a builder installs underground seawater pipes at the University of Hawaii in Honolulu. The pipes will tap into cold water beneath the surface of the Pacific Ocean to generate air conditioning for the seaside medical school buildings.

AP/WWP Photo by Lucy Pemoni

A third grader in Laurel, Maryland, sorts trash from his lunch into bins for recyclable and nonrecyclable materials. To help students become more aware of how much they throw away, trash is weighed every Wednesday to see which classes do the most recycling.

AP/WWP Photo by Matt Houston

AP/WWP Photo by John Bazemore

Cell phones and cell phone batteries await recycling in Tucker, Georgia. In observance of Earth Day 2005 in the United States (April 22), environmentalists launched campaigns to increase awareness about recycling cell phones, music players, handheld gaming consoles, and other electronic devices.

AP/WWP Photo by Stan Gilliland

Above, this piece of insulation made from old blue jeans is used to conserve energy in the offices of Brown & Jones Architects in Raleigh, North Carolina. Other "green" materials used in the facility include special light fixtures, skylights, ceiling fans, and a rainwater recycling system.

In March 2004, California Governor Arnold Schwarzenegger (below, second from left) and other officials display a new, low-emission, hybrid electric motor that will be installed in FedEx delivery trucks operating in and around the state's capital city, Sacramento.

AP/WWP Photo by Rich Pedroncelli

At left, a representative of Hyundai Motor Company views a hydrogen fuel cell hybrid electric automobile—the Focus, manufactured by Ford Motor Company—during the North American International Auto Show in Detroit, Michigan, in January 2005.

AP/WWP Photo by Paul Sancya

At right, a bus powered by compressed natural gas (CNG) carries passengers along the streets of Washington, D.C. The Washington Metropolitan Area Transit Authority (Metro) began operating CNG buses in 2002. By the end of 2005, Metro's bus fleet will consist of 414 CNGs and about 1,440 diesel buses that operate on ultra-low sulfur fuel.

Department of State Photo by Tim Brown

Exporting America's "Best Idea"
Sharing Our National Park System With the World

John F. Turner

AP/WWP Photo by Kevork Djansezian

Yellowstone National Park covers more than 890,000 hectares in Idaho, Montana, and Wyoming.

The United States launched a conservation ethic with establishment of Yellowstone National Park in 1872 and today manages some 34 million hectares in parks and 36.4 million hectares in wildlife refuges. The country is committed to helping other countries share in the conservation and economic benefits of land and wildlife preservation. Examples include its participation in the Congo Basin Forest Partnership to protect lands and combat illegal logging in West Central Africa and a debt-for-nature swap with the Republic of Panama that allows the Central American nation to reduce a portion of its debt to the United States in exchange for generating funds to protect its biologically rich tropical forests.

John F. Turner is Assistant Secretary of State for Oceans and International Environmental and Scientific Affairs. Prior to joining the State Department, Turner served as president and chief executive officer of The Conservation Fund, a national nonprofit organization dedicated to public-private partnerships to protect land and water resources.

More than 270 million people visited the United States' national parks last year, inspired by their beauty and wildness. Our country's park system, once described as America's "best idea," includes 388 parks and encompasses some 34 million hectares, an area roughly the size of Germany. In addition, the United States has established 545 national wildlife refuges, protecting more than 36.4 million hectares to benefit wildlife, fisheries, and biodiversity. The government manages another 186 million hectares of protected land, including national forests, wilderness areas, and marine sanctuaries.

Americans treasure wild public lands because they offer opportunities for solace and recreation and a chance to reconnect with the outdoors, learn about our nation's history, and recharge our batteries. They provide critical habitat for wildlife, a vital ecological and economic resource that also embraces important scientific, cultural, aesthetic, and spiritual values. Moreover, public lands serve as engines of economic development by attracting tourists and, in some instances, providing a source of revenue for schools, transportation, and other needs.

We take pride in the fact that our nation is home to Yellowstone National Park, the world's first national park. The establishment of this park in 1872 launched a conservation ethic in the United States and prompted the preservation of wild places and wild resources for their own intrinsic values and for the benefit of future generations. Individual states, conservation groups, local communities, and private landowners have protected vast areas of open space, watersheds, and wildlife habitat.

We are sharing with other nations the experiences we have gained in developing a network of protected lands. This is an important task because increasing competition for natural resources, growing scarcity of these resources, changes in land use patterns, economic development, political stability, and climate change can have enormous effects on the well-being of our lands.

People around the world are tackling these problems, seeking to build an enduring conservation movement that reaches to the corners of the globe. There are now more

than 102,000 protected areas in the world, covering more than 10 percent of Earth's land surface. They encompass ecologically and economically important ecosystems, from mountain ridges to coral reefs, and total 18.8 million square kilometers—an area twice the size of Europe. The number of these areas continues to expand.

In recent years, developing countries have led the way in setting aside national parks and protected reserves. In doing so, they demonstrate a commitment to conservation that exemplifies great courage and boldness.

AP/WWP Photo by Tomas Munita

Deforestation is a threat to Panama's Rio Chagres basin.

America has been proud to lend a hand to other nations interested in establishing systems of protected areas. For example, we are doing so through the Congo Basin Forest Partnership, an initiative that unites more than 30 governments, international organizations, businesses, and environmental groups. The partnership aims to establish national networks of protected areas across West Central Africa in order to safeguard one of the world's two largest intact tropical forests. At the same time, the Congo Partnership offers local people a stake in the forest by promoting sustainable harvesting and providing livelihoods such as ecotourism.

The six Congo Basin countries that have courageously bet their future well-being on the benefits of forest conservation are driving forces in this partnership. These nations see a future based on respecting, not exploiting, nature.

The United States is contributing $53 million over four years to create the training programs, infrastructure, and management and enforcement regimes necessary to realize this vision of a system of protected areas and sustainable forest management. In total, this undertaking could develop as many as 27 national parks and protect more than 10 million hectares.

The Congo Basin Forest Partnership is also a powerful mechanism for stemming the take of bushmeat and advancing the fight against illegal logging. Illegal logging destroys ecosystems and threatens protected areas worldwide, and it costs governments $10 to $15 billion annually in lost revenues, according to estimates by the World Bank.

That is why President Bush launched the Initiative Against Illegal Logging to help developing countries reduce threats to protected areas. Through the initiative, we are working with other governments and nongovernmental organizations (NGOs) to improve forest law enforcement in Africa, protect orangutan habitat in Indonesia, and monitor forests in Brazil with remote sensing, among many other actions.

The United States is also promoting protected areas abroad through debt-for-nature swaps. These innovative agreements allow eligible developing nations to reduce their debt to the United States while generating funds to protect their tropical forests. Since 2000, we have concluded nine agreements that will generate $95 million to conserve forests in eight countries over the next two decades. Three U.S.-based international NGOs have contributed $7.5 million, in addition to debt relief funding appropriated by Congress, to make these agreements possible.[1]

Recently, the United States concluded an agreement with the Republic of Panama that, with the help of a contribution of $1.3 million from The Nature Conservancy, an international NGO, will generate $10 million to protect and conserve Panama's 129,000-hectare Chagres National Park over the next 12 years. The Chagres National Park provides 50 percent of the water necessary to operate the Panama Canal, supplies the drinking water for that country's two largest cities, and serves as a habitat for endangered species such as jaguars, mantled howler monkeys, and the harpy eagle.

Another agreement with Panama will conserve the exceptionally biologically rich forests of the Darien National Park, which contains a unique biological bridge where North and South America meet and shelters a diverse range of flora and fauna.

In both cases, the funds resulting from these agreements will support specific conservation activities in the national parks and create permanent endowments to provide sustainable funding to the parks.

Americans are proud to share our heritage of land conservation with nations seeking to establish protected areas. By helping citizens around the world manage their natural resources on a sustainable basis, we are fostering a more hopeful world for millions of our fellow human beings and preserving great wild places for the enjoyment of future generations. ■

(1) Nations currently participating in the debt-for-nature swap are Bangladesh, Belize, Colombia, El Salvador, Jamaica, Panama, the Philippines, and Peru. Participating NGOs are The Nature Conservancy, Conservation International, and the World Wildlife Fund.

Tending the Rivers

An Interview with David Allan and Brian Richter

AP/WWP Photo by Bill Haber

The Mississippi River, shown here near New Orleans, Louisiana, is a trade route and recreational venue. The river provides habitat for diverse species of fish and wildlife and supports the largest continuous system of wetlands in North America.

Human life, health, and well-being depend upon clean, fresh water. So, why have we done so much to abuse the freshwater sources that we rely upon for our survival? Rivers and streams that bring us fresh water have been used as dumping grounds for waste, diverted from their natural courses, and drained for the exclusive use of only a few. The past couple of decades have brought a new level of understanding about the detrimental effects of these actions and stronger resolve to use water resources in a manner that can meet the needs of all users while preserving the ecosystems that surround them.

Two professionals in this field discussed these trends with Global Issues *managing editor Charlene Porter. Brian Richter is the director of Freshwater Initiative, a project of the environmental nongovernmental organization The Nature Conservancy and co-author of* Rivers for Life. *David Allan is a professor of conservation biology and ecosystem management at the University of Michigan and co-author of* Streams: Their Ecology and Life.

Question: Mr. Richter, in your 2003 book, *Rivers for Life,* you and co-author Sandra Postel called for a new mindset that would make preservation of ecosystem health an explicit goal of water development and management. To what degree is that idea taking hold today in the United States?

Richter: Interestingly, the development within the United States is a little bit slower, from my perspective, than it is in some other countries. It's an odd coincidence too because the United States began to address these issues in earnest in the late 1960s as national environmental legislation was being passed. Scientists, decision makers, and regulators in the United States started grappling with a lot of these issues then, but the thinking in the scientific community on water quantity management was at a different point at that time than it is now.

Q: In what respect?

Richter: At that time, river ecologists had a fairly broad, general understanding of the importance of hydrologic variability—the changes in river flows and the influences that those changes would have on plants and animals and the overall ecosystem. Regulators were tapping that knowledge to make regulatory decisions, and they moved toward an approach where they generally said the most critical thing is how low the river gets during a dry time of the year or during a drought period. What we saw develop in the United States was a strong orientation toward the question: "What is the minimum in-stream flow level needed to keep the plants and animals in this river in good shape?" We stayed stuck in that focus for the better part of three decades, and it wasn't until the early 1990s that you started to see some differences of opinion and concerns that we needed to pay attention to more than just the minimum stream-flow level. We needed to address the important role that higher river flows—and even floods—play in sustaining the diversity and proper functioning of a river ecosystem. It has been difficult to get water managers and dam operators to understand that some level of flooding needs to be maintained for river health.

Q: Professor Allan, ecosystem management is your specialty. How has the scientific thinking evolved over time?

Allan: Brian put it exactly right. For a very long time the issue was minimum flows. How low could the water levels go? How low could water quality go? What was the minimum standard based on dissolved oxygen [microscopic bubbles of oxygen gas in the water that are essential for aquatic life] which would respond to organic waste loading? Generally, it was a minimum approach toward protecting the environment and a maximum emphasis on making use of that resource.

What the field of ecosystem management brings to the table today is the recognition that our waters offer many benefits that we might have thought of as being intangible benefits, but they're looking more and more tangible all the time.

These benefits only come from healthy ecosystems. Water problems risk the health of fish populations, for instance, or the water purification capacity of the aquatic ecosystem; or the health of the riparian ecosystem, the streamside vegetation and trees that live along the stream and have roots in the shallow ground water. We've seen all those ecological consequences become more and more apparent, and that's leading us increasingly toward thinking of how to preserve those benefits.

So we're realizing the ecosystem is being harmed and that is coming back on us in diminished services [ecosystem services are processes by which the environment produces clean water and air, timber, fish habitats, and plant pollination], which increasingly we can start to value in dollars.

Q: Mr. Richter, you began the discussion saying that some countries may be moving ahead of the United States in developing a holistic approach to managing watersheds and river systems. Expand on that point.

Richter: In the United States, we began heavily developing our water resources and building dams during the 1950s and 1960s, and we began seeing environmental problems—such as the loss of species or reductions in fish populations—soon thereafter. Other countries were slower to develop their water resources. When problems began to develop in their countries in the 1980s and 1990s, their scientists looked around the world to see how other countries and other scientists were dealing with similar problems, how the knowledge base developed over the decades. They ended up fashioning some fundamentally different approaches to the questions that are critical to balanced management of the resource: How much water does the river need? How much of the natural variability in water flows is necessary to sustain the societal benefits that we derive from healthy ecosystems?

In *Rivers for Life*, we highlight advances that were made in places like South Africa, Australia, and some European countries. The scientists are taking a fresh look at how to address these questions. Working with the regulators, decision makers, and water planners, these countries have been developing approaches that better address modern-day interests.

The United States ended up with a legacy of environmental legislation that was developed some decades ago, and it's proven to be more difficult in some respects to modify the legislation and regulatory approaches than it has been in countries that dealt with the issues as fresh cloth. These countries have, in essence, from a policy or regulatory standpoint, leapfrogged ahead of the United States in my perspective.

Q: The legislation you're talking about is the Clean Water Act, passed in the United States in the 1970s, which brought significant progress in calling for wastewater treatment and discharge regulation, and ended by and large the discharge of raw sewage and waste into our waterways. Professor Allan, has the Clean Water Act done what we wanted it to do?

Allan: The Clean Water Act has done a lot for us. I agree with Brian's point that a lot of our water law dates back to the 1970s. In fact, other water law goes back even further, to the Wild West era in the United States.

But the Clean Water Act certainly did good things for us. It instituted a whole lot of wastewater treatment at the secondary level; it definitely made water cleaner; and it brought language into the law about the physical, chemical, and biological integrity of freshwaters that gradually through the 1980s and 1990s led to the establishment of a panoply of biological assessment approaches that are now widely used by the states to assess the ecological health of freshwaters. The Clean Water Act continues to guide that activity, I think, in a very effective way.

But then we come up against new problems and we don't have anything to guide us. Here in the Great Lakes[1] region we're wrestling with the issue of water export. It isn't clear what laws and regulations could or should prevent export of Great Lakes water out of the basin or outside the boundaries of states that ring the basin. Tankers full of fresh water heading for Asia from the Great Lakes—who would have predicted that? So we're scrambling to find the appropriate response and the appropriate tools with which to structure a response.

Q: Certainly in that situation many competing interests need to be satisfied—national governments, states, local governments, scientists, and environmentalists. Trying to

make the right decision about the resource becomes that much more difficult when so many people and groups have an interest.

Richter: Yes. It's important to understand that it is challenging for policy, decision making, and planning to stay perfectly in step with the advancement of scientific knowledge. They're always going to lag behind scientific advancement. That's a universal challenge, and some countries do a better job of translating science into policy and law than others do. All around the world, systems, laws, and practices for managing water have been developed, based on levels of understanding at some time in the past.

So we have to view water-resources management as always being in a very, very long transition, dating back thousands of years to when some of the first irrigation works and dams were constructed in China. Against that long history, we see countries coming into different phases or different eras of water management, water development decision making, and some do a better job of capturing the changing societal values of our modern times than others.

As a scientist who has to work with policy decision makers, I think certain modes of decision making seem to facilitate the translation of science more easily and more quickly into policy, legislation, and planning than others. For instance, some countries provide opportunities for active engagement of their populace to express their values and interests in a safe and constructive environment where other stakeholders and interests can hear them. Those countries seem to foster more rapid and successful evolution in policy and decision making.

Q: On the theme of setting standards, making choices with the best available information, Professor Allan, you recently wrote an article in the *Journal of Applied Ecology* suggesting that river restoration schemes should aim to move a river toward the least degraded and most ecologically dynamic state possible. Is identifying that target as simple as it sounds?

Allan: I agree that's an ambitious goal, but we do have a lot of science that can help guide us in these directions. The emphasis is on moving in the right direction, toward a healthy, dynamic system.

A great deal of knowledge has been gained through scientific research about how to make a system healthier and more sustainable, and a great deal of knowledge has been gained through practice and implementation. The various goals we put forward in that article—the five-step plan for ecologically healthy rivers and for judging the success of restoration efforts—are appraised in a fairly qualitative way.[2] We can determine with reasonable confidence that this action will move the system more in the direction we expect it to be, which could be based on reference conditions, comparisons to other healthy rivers in the area, or experience with similar systems. We generally know when we're moving in the right direction and when we're not. Articulating key aspects of the right direction is what we tried to do in that paper.

NASA

A satellite image of North America's Great Lakes, from left to right: Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario.

Q: Let me play devil's advocate with you for a moment. Mr. Richter mentioned the long history in water management, and certainly there were times along the way when people decided, "Let's build this dam. That's a great idea." Or they said, "Let's build these levees and contain this river and prevent flooding." Decades pass, and it turns out these weren't such great ideas for the ecosystems. Knowing the history, what degree of confidence do you have that you are making the right calls now?

Allan: Well, that's a fair position to take and a very hard one to defend against. There is the risk that the arrogance of the current generation will lead to the conviction that, "We know how to do things right. We won't make mistakes. They made mistakes in the 1950s and 1960s but we're smarter now." I take that as a fair admonition, but we have a better chance today for moving in the right direction rather than the wrong direction. Common sense, along with scientific knowledge, is a useful guide to sensible management decisions.

Richter: It goes back to the definition of sustainability that came out of the Brundtland Commission some years ago.[3]

They put a lot of emphasis on not reducing or negating the possibilities for future generations. That's a wise standard for us to keep in mind. A lot of changes to water resources and freshwater ecosystems in the past are now very, very difficult to reverse in our generation.

Some development decisions that we make will foreclose options for future generations, and we always need to be mindful of that. That being said, societies in different parts of the world will have different imperatives. I just spent a couple of eye-opening weeks in Western China, where there's a lot of discussion about constructing new hydroelectric power dams. The motivation is their interest in providing electricity to the remote villages of Western China. They see that as being a very important aspect of poverty alleviation and improving the quality of the lives of citizens in that part of the country.

These questions are very challenging from a societal standpoint, but to exercise the precautionary principle to the extent that we can and to be careful about not foreclosing on the options of future generations is something we should bear in mind.

Allan: We live in a rapidly changing world. I teach a course this semester on global environmental change, and we go through the litany of things that have changed dramatically since 1950. People were much less concerned about limits at that time. Dams were being built, cities were expanding, water extraction was expanding, and there are still today many people who view resources as essentially without limit and for the use of the present generation. So it is a remarkable transition to be arguing today for limits and ecosystem rights and the resource needs of future generations. These are fairly major transitions of quite recent time.

Echoing the point Brian made, social priorities are going to play out differently in different places based on immediate needs. I spent time in rural Venezuela in the late 1990s and realized that 80 to 90 percent of their electricity was hydroelectric. If you didn't like dams, it meant you didn't want the electricity to have medicine in hospitals—you didn't have any refrigeration. Some fundamental human needs are going to dominate the dialogue in other parts of the world, but it's only recently that we have come up with this notion of being farsighted. We're still struggling with what it means to choose between future opportunities and present-day opportunities. Those are very hard to trade off.

Richter: I'm optimistic because two things have changed fairly substantially in recent decades. One is largely a scientific or technical capability to be able to understand and communicate what you're trading off when you make these development decisions. David mentioned earlier that one example of a very important ecosystem service might be the sustenance of healthy fisheries. In a lot of the developing world, populations are quite dependent at a subsistence level upon having access to fish. Fish protein is a very important part of their diets. And we now are able to foresee and to some limited degree predict what the likely changes will be in things like fisheries. Society can weigh a loss in fisheries capacity with the development of energy availability or flood control. We're able to create a much better-informed decision table. That gives me a lot of hope.

The second area that gives me hope is that governments are increasingly moving toward more transparent and inclusive models of decision making. A lot of these decisions used to be made fairly unilaterally by central bureaucracies or a limited number of individuals within a country's water or energy agency, or by the private sector purely for economic considerations. That decision-making process is now beginning to open up and be more receptive to input from other interest groups and stakeholders with an array of values.

Q: Professor Allan, do you have a hopeful note to close?

Allan: The knowledge that ecosystems provide services that are of such great value is only now becoming appreciated, even in this country. Just to mention the valuable uses of fresh water is breathtaking if you run down the list—the water we have for drinking, for domestic use, for agriculture and industry, for employment, and to support healthy fish populations that are an important source of protein, and so on. Healthy ecosystems aid flood control and water purification. There are cultural values in recreation and in the sense of increased well-being that many people feel when visiting a park, a nature reserve, or a river's edge. The water cycle feeds back into the condition of vegetation on land and the ability to maintain healthy forests.

As you start to get a better appreciation of all the reasons that these systems are important to us, you see that healthy ecosystems and healthy human populations go hand in hand. ■

(1) The five Great Lakes on the border between Canada and the United States hold about one-fifth of the world's fresh surface water supply, providing drinking water to almost 33 million people.

(2) Palmer, M.A., E.S. Bernhardt, J.D. Allan, et al. 2005. "Standards for ecologically successful river restoration." *Journal of Applied Ecology* 42:208-217.

(3) The Brundtland Report, also known as *Our Common Future,* influenced the worldview regarding the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. An international group of politicians, civil servants, and experts on the environment and development, chaired by Dr. Gro Harlem Brundtland of Norway, defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This statement has become a core principle in the field of sustainable development.

The opinions expressed in this interview do not necessarily reflect the views or policies of the U.S. government.

The Thousand Ton Cleanup

Living Lands and Waters is removing debris from some of the nation's largest river systems.

AP/WWP Photo by Buzz Orr

Chad Pregracke, founder of Living Lands and Waters, motors along the Mississippi River near East Moline, Illinois, on his mission to clean up the river.

A young man who grew up on the banks of the Mississippi River has spent the past eight years in a true labor of love—cleaning up U.S. rivers, one river at a time, one piece of garbage at a time. Chad Pregracke, 29, worked as a commercial fisherman during secondary school and college. He noticed a worsening accumulation of trash on shorelines and made up his mind to do something about it. So in 1997, Pregracke cleaned 100 miles (160 kilometers) of the Mississippi shoreline with the help of community donations and a small grant from the Alcoa Corporation. The next year, he formed a nonprofit organization called Living Lands and Waters to raise funds and keep the project growing.

And grown it has. Pregracke estimates that he and his crew—with the help of thousands of volunteers—have dredged more than 1,000 tons of trash from American waters. The group has cleaned up hundreds of miles of Mississippi River shoreline and has moved on to the Illinois, Ohio, and Missouri rivers in the Midwest, and the Potomac and Anacostia rivers in the Washington, D.C., area. The organization sponsors community cleanups, educational workshops, reforestation projects, and the Adopt-a-Mississippi Mile program, through which citizens' groups take responsibility for keeping one mile (1.6 kilometers) of the river's shoreline clean.

Surprisingly, Pregracke does not consider himself an environmentalist. "I may be a conservationist, if anything," he says. "I don't like the label of environmentalist because it makes me seem different; I'm just a regular person. I'd like people to remember that anyone can make a difference."

Learn more about Living Lands and Waters at http://www.livinglandsandwaters.org/

Advancing Democracy and Prosperity Through Sustainable Development

Jonathan A. Margolis

AP/WWP Photo by Luis Romero

Residents of a San Salvador, El Salvador, neighorhood receive jugs of water from a well owned by a private water company.

The United States is engaged in international assistance programs that aim to provide individuals with cleaner drinking water and, by so doing, improve health. These efforts strive to involve local communities in making decisions about their water use, promoting democracy, and improving environmental resource management at the same time.

Jonathan A. Margolis is special representative for sustainable development at the U.S. Department of State.

The United States is at the forefront of efforts to help developing countries address their fundamental needs for access to clean water, sanitation, modern energy services, and better health. Promoting such development, which balances economic freedom and growth with social advancement and environmental stewardship, is a hallmark of U.S. foreign policy. Indeed, as President Bush has said, combating poverty is a "moral imperative."

Expanding the circle of development builds prosperity. Healthier individuals with access to basic services are better able to engage in economically productive activities, take care of their families, and pursue their dreams. Furthermore, when done right, the process of enhancing these services can strengthen participatory decision making—strengthening the very fabric of democracy by empowering individuals and making institutions accountable to their constituents. The steady alleviation of poverty in turn enhances security, breaking the cycle of hopelessness and despair that can breed instability.

Water and health are two of humanity's most fundamental needs. More than 1 billion people lack access to safe drinking water, and more than 2 billion lack access to adequate sanitation. Every year approximately 3 million people, mostly children, die from water-related disease, principally diarrhea. Many more become ill or disabled as a result of water-related infections, mostly due to an unsafe water supply, inadequate sanitation, and poor hygiene. In these areas, the United States is supporting activities that are improving peoples' lives and transforming societies.

Lessons From Our Backyard

Integrated water resources management (IWRM) is a process of managing water resources while taking into account the multiple competing uses for water. Truly integrated water management also enables the adequate provision of food, urban infrastructure, energy, and other valuable services while maintaining a healthy environment. In the United States, such activities take place at the local, state, and federal levels, in cooperation with a wide range of agencies, nongovernmental organizations, the private sector, and individual citizens.

New York City provides one of the best demonstrations of the value of this integrated approach. The New York

City water supply delivers 1.4 billion gallons of high-quality drinking water to more than 9 million people every day. This water originates in the Catskill/Delaware watershed. To meet the requirements of the federal Safe Drinking Water Act, the city would have to spend an estimated $8 billion to build the necessary filtration plants.

AP/WWP Photo by Jim McKnight

The Ashokan Reservoir is a source of drinking water for residents of New York City.

The city proposed a different approach for purifying the water for drinking. Rather than build infrastructure, city leaders suggested a comprehensive long-range watershed protection program. Key elements of the program include land acquisition and stewardship, partnership programs, wastewater management, policy and regulatory changes, and environmental education and outreach programs. Working with upstream communities, the city designed projects to maintain and manage the forested and agricultural landscape to protect water quality and to enhance local economic opportunities. The cost: approximately $507 million. By managing the watershed in a sustainable way, New York City was able to dramatically reduce the need for costly filtration and still maintain a long-term supply of high-quality drinking water. Another benefit was preservation of ecosystem values and the upstream economy that depends on the watershed resources.

Promoting Development and Democracy

IWRM is based on stakeholder participation. At its core are processes for participatory decision making at local, national, and regional levels to identify shared interests and define courses of action. Through a U.S. Agency for International Development (USAID) project in El Salvador, for example, the community of Puente Arce recently elected an administrative board to oversee its newly expanded water service. This board now provides high-quality, efficient service rivaling systems in the United States. In some cases, the selection of these local administrative boards represents the first time citizens have been involved in electoral processes. IWRM nurtures a culture of democracy by making participatory decision making a reality and empowering stakeholders to demand greater transparency and accountability from public and private institutions.

The United States has placed a priority on IWRM, devoting a significant amount of USAID's three-year, $970 million Water for the Poor Initiative to these efforts. Above and beyond our bilateral projects, the U.S. government has also worked to raise the profile of IWRM in multilateral discussions and to engage other donors. For example, we recently began working through the Global Water Partnership (GWP) to fund additional IWRM assistance for El Salvador, Ethiopia, and Indonesia. With these funds, the GWP will encourage more discussion among stakeholders on water management to implement an IWRM plan. These new U.S. contributions have given rise to further contributions from other donors; in total, more than 18 developing countries will receive additional support for their IWRM efforts through the GWP.

Reducing Water-Related Disease

Water-related diseases cause human suffering and impose heavy costs on families, communities, and nations. Through traditional bilateral aid as well as private investment and public-private partnerships and multilateral initiatives, the United States is working to reduce these diseases, saving lives and boosting prosperity by allowing people to engage more fully in creative, civic, educational, and entrepreneurial activities.

For example, the United States has joined with the World Health Organization, the United Nations Children's Fund (UNICEF), and others in launching the Partnership to Improve Health through Water (PHW). Growing out of the U.N. Commission on Sustainable Development's recent focus on water and sanitation issues, the PHW brings together several global programs and initiatives dedicated to reducing the incidence of water-related disease. This partnership is working to raise awareness of the health implications of unsafe water and to put in place programs that encourage clean water at the household and community levels.

In one part of this program, the United States is working with the partnership to support "point-of-use" water disinfection programs using locally manufactured products in more than 20 countries in Asia, Africa, and Latin America. These programs empower individuals to take control of their own health by disinfecting their water at

the household level. The Safe Water System initiative has already distributed more than 12 million bottles of disinfectant solution to improve the quality of drinking water at the household level. Each bottle typically provides one household with enough disinfectant to produce drinking water for up to two months.

While these point-of-use programs enable people to take responsibility for their well-being in the short term, they also have a broader effect. By demonstrating the linkage between cleaner water and better health, these programs empower communities to work with their governments for safer, more sustainable water services over the longer term.

Role of Local Financing

Clean water and other essential services often require significant flows of local financial resources. To address this need, USAID has developed innovative financing tools that strengthen local capital markets and mobilize domestic capital, empowering communities to take action. One such tool, the Development Credit Authority (DCA), stimulates lending by offering partial loan guarantees to local banks and financial institutions. In the Indian state of Tamil Nadu, a DCA project facilitated the issuing of a municipal bond to mobilize up to $6.4 million for local infrastructure projects. The township of Valasaravakkam (population 26,260), for example, is using newly available funds to upgrade its water system, increasing the water supply from two liters to 35 liters per person per day.

Promoting IWRM, reducing the burden of water-related illness, and unleashing domestic capital are some of the many ways in which the United States is helping developing countries improve the quality of their citizens' lives and develop a culture of accountability and participation. In so doing, we are fulfilling the mission to create a more secure, democratic, and prosperous world. ■

Reduce, Reuse, Recycle

An interview with Laurie Batchelder Adams and Jaime Lozano

AP/WWP Photo by Rich Pedroncelli

Bales of used plastic bottles are destined for recycling and conversion into such diverse products as chairs, kayaks, jewelry, and clothing.

The United States is now recycling about 30 percent of its solid waste, a percentage that includes source reduction—using less material in the first place—and composting—using degraded organic material as a fertilizer and soil conditioner. The adoption of recycling programs and public support for them has been steadily increasing for the past couple of decades. The U.S. Environmental Protection Agency encourages and promotes recycling and composting of garbage, but no federal law requires local communities, counties, cities, and towns to take this action. Rather, local and state governments, with support of their citizens, are adopting programs on their own.

Global Issues *managing editor Charlene Porter discussed the trends in recycling and waste management with two experts in this field. Laurie Batchelder Adams of Denver, Colorado, is a consultant who advises clients on managing recycling programs. She is also an official with the Solid Waste Association of North America, an industry group. Jaime Lozano is an environmental specialist in the Bureau of Sanitation, city of Los Angeles.*

Question: Why are local governments finding that diversion of waste from landfills is a good decision?

Batchelder Adams: It started back in 1987 when the infamous garbage barge, the Mobro, left a town in New York with more than 3,000 tons of garbage on board. The ship wandered the Atlantic coast for months, unable to find a community willing to take this huge amount of waste. This traveling garbage barge received a lot of media attention, and the message that incident sent to the American public was, "We are out of landfills in this country." A lot of recycling advocates jumped on that bandwagon, but a garbage crisis was only a partial truth as communities were not then, and are not now, out of space for developing and maintaining landfills.

Recycling became very popular after that episode. Everybody was doing it. A wave of publicity swept the country. Recycling was considered one of the sexy new ways to spend public works dollars.

A lot of easy recycling happened at first. A lot of easy materials could be captured and diverted into recycling. The public was very excited to be involved.

Lozano: That barge, the Mobro, represented the moment of reasoning. All of a sudden people started looking at that and saying, "Oh, my gosh, could that be us in the future?" Although there is no federal mandate for recycling or waste diversion programs at the state level, the legislatures started analyzing how their waste programs were designed and whether they made any sense.

The state of California issued a mandate to different jurisdictions at the city and county levels. Assembly Bill (A.B.) 939 mandated all cities and counties to reduce their waste by 25 percent by the year 1995 and 50 percent in the year 2000. This goal was based on studies conducted in 1990 to establish a base year, or a starting point for future waste reduction.

The law said that cities and counties that failed to implement these programs could be fined up to $10,000 a day retroactively. A lot of people, especially the environmental community, were very supportive of that bill. It seemed like everybody decided that it was important to become part of the solution.

Q: The current rates of recycling for different materials certainly vary considerably. What I'm seeing from the Environmental Protection Agency figures is that paper is at 42 percent, aluminum cans at 55 percent, and 60 percent for steel. What affects the different recycling rates on different materials?

Batchelder Adams: Different subcategories exist within certain types of materials, too. Cardboard is a subcategory in paper. The recycling rate for cardboard and some of the higher-value paper materials is in the 70 percent range. The basic curbside, residential recycling program collects about 70 to 75 percent paper, and the rest of the material is containers. Paper recycling is successful because it is collected in relatively large quantities. There are also paper mills operating in this country and abroad such that we have an abundance of end-users who want the paper that we're generating in recycling programs. The market is strong. You've got plenty of it, you've got plenty of people who want it, and the price is high enough to keep it relatively lucrative within the business. Those factors make it win-win.

Aluminum has always been strong in its marketability, but we're seeing aluminum fall now. Less packaging is made of aluminum these days. Other materials are taking over that share of the packaging market, so recycling programs are just not generating as much. Plus, an awful lot of this material is being used away from our homes so it is not getting into our curbside recycling programs.

Lozano: This is so important. You have to have markets for recycled materials in order to pay for the process of collection, sorting, baling, and storing all the materials you collect. So if you don't have markets, you're in a real difficult situation.

One of the things we've been talking about is trying to inject funding into the business community to get startup organizations that will actually take recycled material and make new products out of it. As Laurie said, there are plenty of paper mills that will buy recycled material. That means communities are almost guaranteed that they'll find a market for recycled paper. If you collect it, as long as it's not contaminated, you can take it to market.

But what about the different plastics? Can a community find a buyer for all the different types of plastics being used in the packaging industry? If you were to collect all of them, can you sell them or are you going to be stuck with them?

So this is one of the things that a community needs to start looking at. You need to have an end-use, and that's why it's so important. If you're not buying recycled, you're not recycling. You have to close the loop.

Q: Are manufacturers and businesses seeing this availability of material and coming up with new ideas about what to do with it?

AP/WWP Photo by Jeff Chiu

A classifier sorts various paper materials at the San Francisco, California, Recycling and Disposal Center. The city recycles two-thirds of its trash.

Lozano: Absolutely. You're seeing different industries springing up that want to take different material and try to make a new product. What's fantastic is you're generating employment in these enterprises. You employ the private waste-haulers or collectors in the city. You employ people who sort, wash, and dry the materials. Then more people are employed at the company that's actually going to take that material and make new products. They make new bottles or plastic lumber. They make yarn for use in pants or jackets, things like that.

Q: Ms. Adams, what are some of the most innovative, exciting uses that you've seen developed in recent years for recycled materials?

Batchelder Adams: The ones Jaime mentioned are great. Products for glass are ones that we are seeing evolve slowly but they are desperately needed. Community recycling programs are really struggling with glass in this country. It becomes a real problem in local programs because it's so heavy and costs a lot to manage, relative to other materials. Some communities are starting to eliminate it from their programs.

For the rural communities where I do a lot of work, and for countries with emerging programs, market development is the greatest emphasis. Areas with lower population densities struggle with two major things. One is low tonnage in collections, so that their per-unit costs of collection are high. The second thing is, these commu-

nities are somewhat geographically isolated. They are a distance from any market and the transportation costs to get that material to a buyer will eat into profits that they might have. Because of these problems, it's critical for these communities to be able to develop local markets, which will utilize at least low-value recycled materials, things such as low-grade papers or glass, as I mentioned. Higher-value materials—cardboard, newspaper, office paper, steel—are likely to bring you a price strong enough that you'll be able to balance high transportation costs and still make a profit. A thriving international market exists in recycled materials. Several developing nations are buying U.S. recyclables, but especially China. The Chinese are buying up secondary material out of this country, and U.S. end markets are being hurt by the competition that trend has created in prices. We are losing end users, such as paper mills, in this country. They are closing because they can't compete with the exports to China.

If processors of secondary materials in the United States close down, we could come to the day when we have insufficient domestic capacity to make use of recycled material.

Q: Local governments have never been involved very much with management of raw materials, collection of raw materials, and these activities. Has that created a huge learning curve for local governments, figuring out how to set these programs up, how to manage something as industrially oriented as recycling is?

Lozano: I think it has. I came from the private sector myself and learned in business how cost avoidance was a major part of a business's success story. In 1995, I was recruited by the city of Carson, California, to develop their recycling program just when A.B. 939 was taking effect. I learned from that experience that people working in these waste reduction programs need to get a grip on how a business works and start understanding how you can get businesses in your community to be part of the solution.

Batchelder Adams: At the local government level, staffs don't often have the luxury of being market savvy. They don't have the time to understand market dynamics. They often privatize or contract for the processing and marketing of the recyclable material they collect. They don't really worry about the whole enterprise, except for how much revenue comes in from the sale of the material. Local governments would benefit from having a broader perspective on waste generation and the entire cycle.

Local governments also really struggle with this concept of "think globally, act locally." Think what that means. It means that the local government pays the money, the resources, the time, and the heartache for the program to benefit the rest of us. That's one of the hard sells for any recycling manager to make to their city council or county commission: They're paying for the good of the world. While it's the right thing to do, resources are limited. That's a real dichotomy.

AP/WWP Photo by Douglas Engle

A worker stacks pressed cans at an aluminum recycling center in Rio de Janeiro, Brazil.

I have a list of three things that I recommend for any community starting a recycling program. First, you need public support. Get your citizens onboard as best you can. But realize the support is going to peak and valley and you need to be prepared for that. Second, your program will always be changing, whether it's your level of public support, markets for materials, or the technology you use. You must be prepared for constant change.

Third, whatever program you have and however much you rely on the private sector, governments need to take control of the services provided by implementing basic policies and pricing strategies that will maintain public participation in the ways you need. I'm talking about policies such as frequency of collection, covered loads, mandates for refuse collectors to also offer recycling services, and directives for setting refuse collection charges that encourage recycling if that is a goal of your program.

Q: Mr. Lozano, you've traveled in Central and South America, talking with local officials about the importance of recycling, how to set up recycling programs. Will Ms. Batchelder Adams' advice serve as good starting points for communities you've seen abroad?

Lozano: That is very excellent advice—most importantly, control and ownership. Officials setting up these programs need to work with the community to educate them that it is not just government's responsibility to minimize waste and operate the landfills. Businesses and residents need to recognize their own contributions to the waste problems in

order for them to become part of the solution.

In the several countries I visited, I saw a hunger from the population to become part of the solution. They really want to participate but they want to learn more. There has to be a lot of education. The state of California has a great, great, program called Closing the Loop. It's a program for the integrated waste program from kindergarten to 12th grade, and it's available in Spanish. I believe El Salvador has formally accepted it and implemented it as part of their national environmental education, at least three states in Argentina are adopting it, and Chile is looking to do that. You need to get educators involved, you need to get the local and national governments involved, and you need to get the businesses involved. Finally, you need to find ways to generate money to make things happen.

Q: Another element in this whole equation is source reduction—reducing the amount of solid waste that is generated in your community in the first place. How successful are local governments in addressing that component of this whole cycle?

Batchelder Adams: I'd have to say low to moderate. It's a hard thing to track and measure. It is also extremely hard to sell to your public because it requires people to change lifestyles, which is about the hardest thing to change.

We're seeing more improvement with green purchasing policies. Local governments are buying recyclable products to fulfill their own supply needs and are helping to stimulate the market.

Lozano: Source reduction is a very difficult goal to achieve but it's very important. In our work now, the slogan is reduce, then reuse, then recycle. It's so important that we start doing more of those reduction activities. Reuse paper, for instance. Why is it most organizations only print on one side of the paper? That's 50 percent being thrown away.

Companies can do simple things to achieve these goals. We did an audit with the Nissan Corporation of North America in Carson at a time when they were getting ready to purchase new copying machines. We made a suggestion that they set up the copiers so that the automatic default would be for double-sided copies versus single-sided. That means if you want a single-sided copy, you have to be proactive, change the default, make an effort, and press the button. All of a sudden, Nissan saw that monthly expenses of $50,000 dollars for paper went down to $25,000. What they were disposing of—whether as a recyclable or as trash—went down by half also.

Q: What are the difficulties that communities have had weighing the costs and benefits of these programs?

Batchelder Adams: Local governments really need to truly and comprehensively track all the costs involved in the recycling program, including equipment life cycle and avoided transportation and disposal costs. In time, we are all going to have the ability to identify and track costs beyond the direct recycle/landfill system. For example, researchers and some leading local governments in the United States are evaluating recycling versus disposal in terms of the impacts on the broader environment. This gets to factors such as pollution prevention and public health problems that might be associated with air pollution and greenhouse gases.

Lozano: And the cost to health can be enormous. In my travels, I've seen people living on landfills. That is a very, very terrible health hazard. I think there's the potential for diseases that we haven't yet come to know that could be transmitted from the landfill to those people and then be transmitted back into the general community. It's a part of a circle that we need to break.

Batchelder Adams: If we look at the full and true costs of disposing of this nation's waste, it is by orders of magnitude more expensive to this country than recycling. Being able to evaluate the complete economic and environmental sustainability of recycling in this manner is a new capability that we will have in the next few months and years. ■

The opinions expressed in this interview do not necessarily reflect the views or policies of the U.S. government.

Recycling Works

Atlanta-based Novelis Inc. leads the world in recycling aluminum cans.

AP/WWP Photo by Shari Lewis

About 50 percent of all beverage cans are recycled, creating a thriving international market in recycled aluminum.

The aluminum can, introduced in 1965, has proven to be ideal as a container for beverages. It is lightweight, resists corrosion, and is recycled easily. In fact, the aluminum can is the most recycled beverage container in use; about 50 percent of all cans produced are recycled.

In February 2005, the National Recycling Coalition (NRC), based in Washington, D.C., presented its seventh annual Recycling Works Award to Novelis, the world's largest recycler of aluminum beverage cans. "Novelis is the only aluminum company that has made its environmental commitment to recycling a fundamental part of its business," said Kate Krebs, executive director of the NRC.

Novelis Inc. is the global leader in producing aluminum sheet, from which cans are made. Headquartered in Atlanta, Georgia, Novelis supplies aluminum sheet and foil to the automotive, transportation, beverage, food packaging, construction, industrial, and printing markets. The company operates 37 facilities in 12 countries and employs more than 13,500 people worldwide. Novelis annually recycles more than 24 billion aluminum beverage cans in the United States and more than 30 billion globally.

Novelis operates seven recycling centers—three in the United States and one each in Brazil, Italy, South Korea, and the United Kingdom. Together, these centers have the capacity to recycle 874,000 tons of aluminum annually.

In addition to making recycling a major component of its own business, Novelis actively promotes the benefits of aluminum recycling to the public. The company, for example, is a major supporter of Aluminum Cans Build Habitat for Humanity Homes. This unique program was established in 1997 as a partnership between Habitat for Humanity International and the Aluminum Association, a trade organization. Cans for Habitat has raised more than $2.5 million through aluminum can recycling to build homes for low-income families.

In partnership with the U.S. Conference of Mayors, Novelis sponsored a competition to encourage greater recycling efforts in cities. The Cans for Cash City Recycling competition inspired participating cities to collect more than 60 million cans over a two-week period, at the same time promoting greater recycling awareness among their populations.

"We are dedicated to fostering efforts to promote the economic, environmental, and social value of recycling aluminum," said Brian Sturgell, the company's president and chief executive officer.

For more information about Novelis Inc.'s recycling activities, visit http://www.recycle.alcan.com/recycle/EN

Also see: The National Recycling Coalition http://www.nrc-recycle.org/

Green Messages

American awareness about the fragility of our planet and the need to protect our environment has grown from many seeds. The following links illustrate ways in which environmental messages reach mass audiences.

Keep America Beautiful, Inc., has been recruiting ordinary citizens to participate in its campaign against litter for more than 50 years. Its "Keep America Beautiful" slogan, posted on billboards and road signs, has been a constant reminder that keeping roadsides clean is everyone's responsibility. http://www.kab.org/

Keep America Beautiful and the Ad Council have produced public service announcements (PSAs) for television to raise public consciousness about responsibility for the planet. The Crying Indian, a PSA first broadcast on Earth Day in 1971, became iconic in the environmental movement. The ad became one of the most memorable and successful campaigns in advertising history and was named one of the top 100 advertising campaigns of the 20th century by *Ad Age* magazine. http://www.adcouncil.com/campaigns/historic_campaigns_

In 1972, astronauts on board Apollo 17 captured the first full view of Earth suspended in space, exposed in full sunlight. Amid a growing awareness of environmental concerns, the "Blue Marble" photograph became a symbol of the planet's fragility in the cold vast blackness of space. More than 30 years later, NASA receives more requests for this photo than any other, and the agency suggests that it could be the most frequently reproduced photograph of all time.
http://earth.jsc.nasa.gov/EarthObservatory/The_Blue_Marble_from_Apollo_17.htm

Prominent film celebrities have contributed their names and faces to PSA campaigns on protecting the environment. For instance, actor Steven Segal urges viewers to properly dispose of used motor oil. http://www.earth911.org/usa/master.asp?s=psa&a=psa/psa.asp

The Globe Program is a worldwide school-based education and science program that encourages students to become directly involved in gathering environmental data, reporting their data through the Internet, and collaborating with scientists in the analysis of that data.
http://www.globe.gov/cgi-bin/resourceroom.cgi?parentid=10&lang=en&nav=1

The youth-oriented network MTV addresses environmental issues with a weekly show, *Trippin,* hosted by film star Cameron Diaz.
http://www.mtv.com/onair/dyn/trippin/series.jhtml

Photographs courtesy of Keep America Beautiful®, Inc. (2); NASA; Earth 911; Globe Program; AP/WWP, Photo by Chris Pezzullo.

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This bibliography reflects a range of current readings.

Internet Resources

Online resources for environmental information

AIRNow Air Quality Web Cameras
http://www.epa.gov/airnow/webcam.html

America's Clean Water Foundation
http://www.acwf.org/

American Wind Energy Association
http://www.awea.org/

Carbonfund.org
http://www.carbonfund.org/

Center for Clean Air Policy
http://www.ccap.org/

Climate Neutral Network
http://www.climateneutral.com/

ConservAmerica
http://www.conservamerica.org/

Earth Day in Your Neighborhood
http://www.allspecies.org/neigh/block.htm

Earth Day Network
http://www.earthday.net/

Earth Day.gov
http://www.earthday.gov/

Earth 911
http://www.earth911.org/

Environmental Defense
Global Warming
http://www.environmentaldefense.org/system/templates/page/issue.cfm?subnav=12

Environmental History Timeline
http://www.radford.edu/~wkovarik/envhist/

Environmental Resources Trust
http://www.ert.net/

Freshwater Society
http://www.freshwater.org

Interfaith Climate Change Network
http://www.protectingcreation.org/

Intergovernmental Panel on Climate Change
http://www.ipcc.ch/

International Rivers Network
http://www.irn.org/

Massachusetts Institute of Technology
Joint Program on the Science and Policy of Global Change
http://web.mit.edu/globalchange/www/

The National Academies
Division on Earth and Life Studies
http://www.dels.nas.edu/

National Pollution Prevention Roundtable
http://www.p2.org/

National Recycling Coalition
http://www.nrc-recycle.org/

National Religious Partnership for the Environment
http://www.nrpe.org/

National Renewable Energy Laboratory
http://www.nrel.gov/

National Wind Coordinating Committee
http://www.nationalwind.org/

The Nature Conservancy
Sustainable Waters Program
http://www.freshwaters.org/studies/

Pew Center on Global Climate Change
http://www.pewclimate.org/

Property & Environment Research Center
http://www.perc.org/

REP America
http://www.repamerica.org/

River Network
http://www.rivernetwork.org/index.cfm

Stanford University
Energy Modeling Forum
http://www.stanford.edu/group/EMF/home/index.htm

U.N. Framework Convention on Climate Change
http://unfccc.int/2860.php

U.N. World Environment Day 2005
http://www.wed2005.org/

U.S. Climate Change Science Program
http://www.climatescience.gov/

U.S. Department of Energy
National Energy Technology Laboratory
http://www.netl.doe.gov/

U.S. Department of State
Bureau of Oceans and International Environmental & Scientific Affairs
Global Climate Change
http://www.state.gov/g/oes/climate/

U.S. Environmental Protection Agency
Clean Water Act
http://www.epa.gov/region5/water/cwa.htm
Climate Leaders
http://www.epa.gov/climateleaders/
EPA's Global Warming Site
http://yosemite.epa.gov/oar/globalwarming.nsf/content/index.html
Methane to Markets Partnership
http://www.epa.gov/methanetomarkets/
Recycle City
http://www.epa.gov/recyclecity/

U.S. Global Change Research Information Office
http://www.gcrio.org/

U.S. Global Change Research Program
http://www.usgcrp.gov/

U.S. Office of the Federal Environmental Executive
http://www.ofee.gov/

White House
Council on Environmental Quality
http://www.whitehouse.gov/ceq/

World Bank
Carbon Finance
http://carbonfinance.org/

World Resources Institute
Climate Protection Initiative
http://climate.wri.org/project_text.cfm?ProjectID=197

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