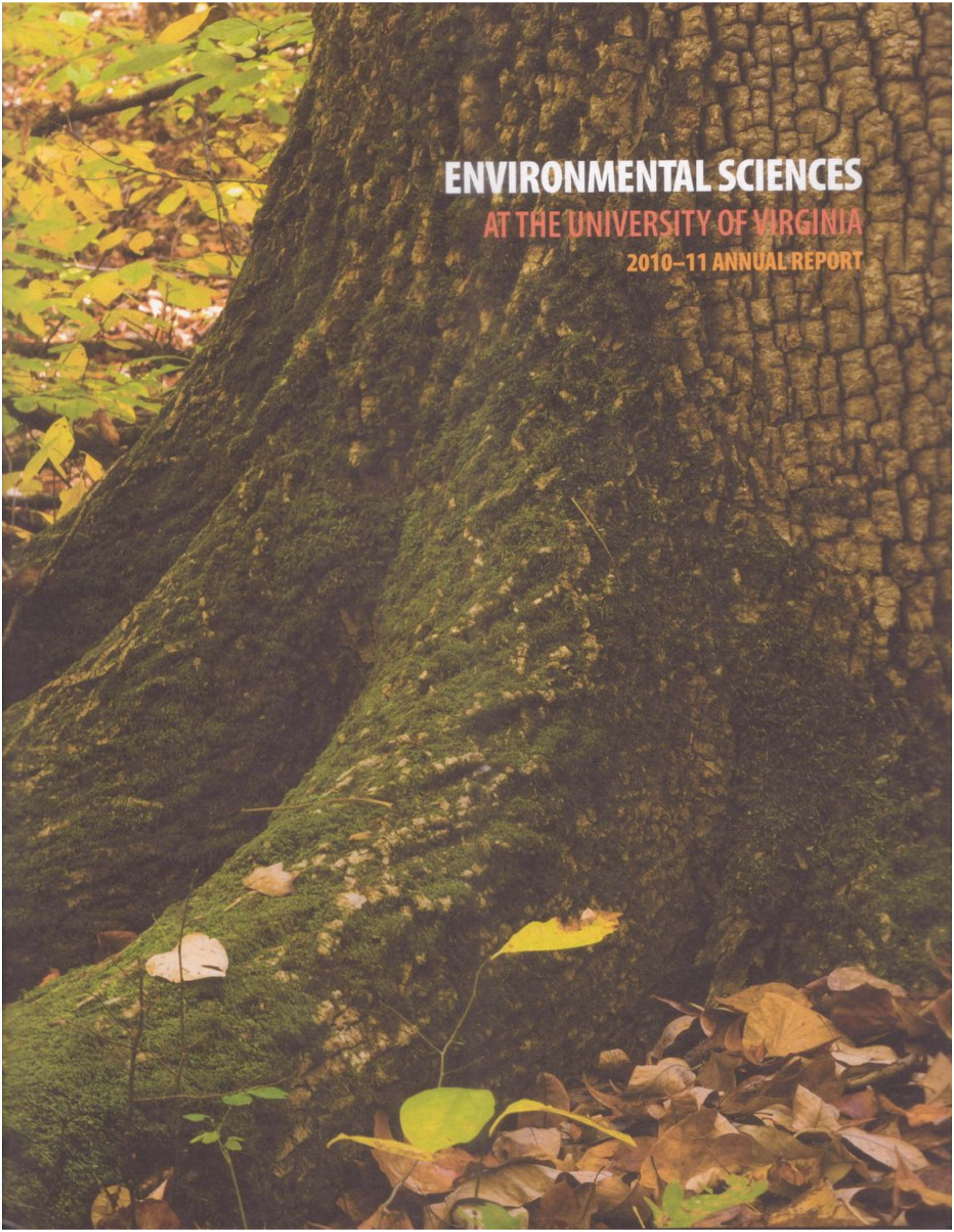
ENVIRONMENTAL SCIENCES

AT THE UNIVERSITY OF VIRGINIA

2010–11 ANNUAL REPORT



THE DEPARTMENT OF **ENVIRONMENTAL SCIENCES**

Established in 1969, the University of Virginia's Department of Environmental Sciences was one of the first to look at fundamental environmental processes from a multidisciplinary perspective and the first in the nation to offer undergraduate, master's, and doctoral degrees in environmental sciences. Today, the faculty includes winners of the prestigious Tyler and Hutchinson awards as well as five professors who are among the most highly cited researchers in their fields.

Departmental field stations and facilities include the Anheuser-Busch Coastal Research Center in Oyster, Virginia, home of the National Science Foundation–sponsored Virginia Coast Reserve/Long Term Ecological Research program, the Virginia Forest Research Facility in Fluvanna County, and the Blandy Experimental Farm near Front Royal, Virginia.

On the cover: An ancient poplar tree in the Landmark Forest at James Madison's Montpelier. Photo by Rollin Stanton.

FROM THE CHAIR

This department has a long history of interdisciplinary research at the intersection of the physical sciences—geosciences, hydrology, and atmospheric science—and ecology. Our ability to draw on a broad range of expertise within the department and with scientists at other universities has allowed us to take on complex environmental issues like arctic warming, coastal dynamics, and carbon sequestration.

As we look to the future, we are expanding our horizons even further. Global environmental challenges such as climate change and sea level rise, eutrophication, desertification, and habitat change are scientifically and socially complex. The role of human activities in environmental change can be as large as or larger than that of climate change. Dealing with these challenges requires that experts from a variety of academic disciplines work in concert to build the necessary understanding of these issues that will ultimately contribute to solutions.

Our faculty members have combined environmental sciences with insights from business to trace the flow of manmade nitrogen around the planet. In the process, they are giving us a broad perspective on a nutrient that has fueled a green revolution while promoting substantial air and water pollution. They have helped to invent an entirely new field—ecohydrology—and framed the worldwide trade in agricultural commodities as a virtual transfer of water, thus reconnecting rising standards of living to their environmental costs. They have uncovered the economic, political, and cultural factors that make subsistence farming successful in some parts of the world and disastrous in others. And they have documented the acidification of the natural world due to human activity, a process that is damaging ocean food webs and diminishing the capacity of farmers to sustain crop growth.

Tackling these projects has led our faculty members to become even more interdisciplinary in outlook, seeking out colleagues from across Grounds and from around the world in such fields as law and business, urban and environmental planning, economics and public policy, engineering and history. Their goal, as is mine, is to serve the larger conversation about environmental sustainability, providing the scientific underpinnings that are essential if society is to make wise decisions about the technologies and policies that will lead to a sustainable future.

As environmental scientists, we understand perhaps better than others just how critical this undertaking is. We welcome your engagement and support as we build collaborations among faculty and students across Grounds and beyond and address pressing global environmental challenges that threaten the well-being and stability of society and the environment.

Patricia Wiberg, Chair

THE ALTERED WATER CYCLE

"We see large variations in mercury transport efficiencies in different areas of the country."

Changes in regional climate and land use are altering the water cycle, with dramatic consequences for the environment. The flow of water modulates biogeochemical cycles, modifies the shape of the earth's surface, and affects climate dynamics. In a world under growing demographic pressure, water quality and water availability are becoming increasingly crucial both for the success of human activities and for the health of the natural environment.

Undergraduate Thushara Gunda (left) and graduate student Ami Riscassi (right) worked with Todd Scanlon to track the movement of mercury through the environment.

IMPROVING WATER QUALITY AND QUANTITY

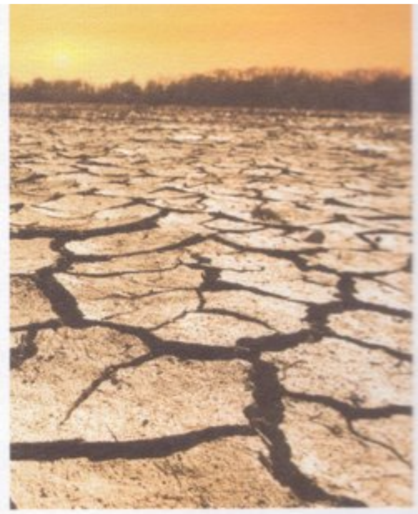
With the world's population now exceeding 7 billion, the quest for clean drinking water and water for irrigating crops will become increasingly destabilizing. The United Nations estimates that one-fifth of the world's population currently lives in areas of water scarcity, a number that is expected to grow sharply under most climate change scenarios.

Associate Professor Todd Scanlon is addressing this issue from a number of perspectives. One of his areas of focus is water quality. Scanlon has been studying mercury contamination in streams in Shenandoah National Park. In the United States coal-burning power plants are a main source of mercury contamination, but people are exposed to mercury, a neurotoxin, not by breathing mercury, but by ingesting it when they consume fish or shellfish. Scanlon's goal is to shed light on the sequence of events that moves mercury from the air to the soil or vegetation and then into streams, where it enters the food chain. He is interested not only in its journey though the environment but also in the factors that might promote or retard its travel.

Over the last four years, Scanlon has made a number of key observations. He and his colleagues have found evidence, for instance, that atmospheric mercury is not taken up by stomata, the pores in a plant's leaves, but by the cuticles, the waxy covering on leaf surfaces. They have also found that in streams, mercury is associated with dissolved organic carbon and that the efficiency of transport appears to be related to the carbon content of soils. "We see large variations in mercury transport efficiencies in different areas of the country," he says. "We would like to identify the causes of this variation."

Scanlon's work on water quantity focuses on methods that can help farmers conserve water. He has developed a theory-based technique for quantifying land-atmosphere fluxes of carbon dioxide and water vapor to determine if farmers are maximizing water use by crops and minimizing bare soil evaporation. "All you need to know is vegetation water use efficiency to employ this technique," he says, which has the added advantage of relying on standard micrometeorological instruments. Scanlon plans to test this method at new sites and compare it to techniques that use isotopes for the same purpose.

"There is a disconnect between societies and the natural resources needed to support them."



VIRTUAL WATER. REAL DROUGHT

There is an ingredient in the food you eat that you won't find listed in cookbooks. Researchers call it virtual water. Virtual water is the amount of water required to grow food—and it moves from one country to another as food is exported. The amount of water this represents is huge. Food production accounts for nearly 80 percent of annual freshwater use.

Professor Paolo D'Odorico and his colleagues have framed the international trade in agricultural products in terms of virtual water, and in the process revealed potential long-term consequences for both the environment and society. As D'Odorico explains, in the past the supply of readily available water played a key role in determining the size of the population a region could support. With the advent of international trade, water-poor countries could sidestep the limitations imposed on them by the environment and support a larger population by importing virtual water from water-rich nations.

In his work, Paolo D'Odorico highlights the long-term risks that develop when water-poor countries come to depend on the flow of virtual water from other countries.

But this trade comes at a cost. A recent study by graduate student David Seekell, Professor Michael Pace, and D'Odorico has shown that the redistribution of virtual water by international trade does not promote equality but increases the inequality of access to freshwater resources. It also has environmental consequences. "While it may optimize the use of food resources worldwide by reducing the redundancy of unused water, this optimization diminishes the ecohydrological system's capacity to respond to disturbances," D'Odorico says.

In other words, as more and more available water is drawn into the system of international trade, the ecohydrological safety net becomes frayed. D'Odorico's analysis shows that when there is a drought in water-rich areas, the water-poor nations are especially hard hit, experiencing much higher levels of famine and mortality than if they had lived within their own water budgets. "Our results suggest that in the long run, the globalization of water resources reduces societal resilience in the face of exceptional droughts and crop failure," he says.

D'Odorico acknowledges that there is no going back, but as a way to provoke creative thinking about the current situation, he and his colleagues posit an alternative scenario, which they call water solidarity. Countries live within their water-carrying capacity and only transport virtual water in times of crop failure and food shortage. In this case, the incidence of drought-induced mortality is much lower. "Right now, there is a disconnect between societies and the natural resources needed to support them," he explains. "We need to restore that connection to recover some of the resilience we have lost."

DYNAMIC COASTAL SYSTEMS

Lying at the interface between land and sea, coastal systems are particularly vulnerable to changes in climate and land use. The coastal zone is affected by changes in water, sediment, and nutrient delivery from watersheds as well as by changes in ocean conditions such as accelerated sea level rise and changes in storm frequency. With more than 60 percent of the world's population living in coastal communities, these changes can be expected to have profound societal and economic consequences globally.

Karen McGlathery and Anthony Priestas, a graduate student working with McGlathery's colleague Sergio Fagherazzi, determine the elevation of the marsh surface at the Virginia Coast Reserve Long Term Ecological Research site.

"The increase of storminess and rising sea levels that we associate with climate change is already having an impact on the salt marshes."

WILL THE MARSH KEEP UP?

Salt marshes are an important linchpin of the barrier island ecosystem. They perform a number of essential ecosystem services, filtering water, providing habitat for wildlife, and providing a buffer from storms—but they are also at risk. In the Virginia Coast Reserve, some marshes are eroding at very high rates, up to two meters a year.

"The increase of storminess and rising sea levels that we associate with climate change is already having an impact on the salt marshes," says Professor Karen McGlathery, the principal investigator for the Virginia Coast Reserve/Long Term Ecological Research (VCR/LTER) site. "Our challenge is to be able to understand marshes well enough that we can forecast how they will respond under various conditions." McGlathery is working with Professor Patricia Wiberg and Sergio Fagherazzi, an associate professor at Boston University, to develop models that will indicate the extent and rate of change of marsh habitats under different climate change scenarios.

Two decades of observations at the reserve, 60 years of digitized maps, and numerous short-term VCR/LTER studies on the marshes are a great advantage in this effort. "We know a number of the characteristics that affect a marsh's susceptibility to wave energy," says McGlathery. This includes grain size of the sediment, vegetative networks of roots and rhizomes that bind the marsh together, the burrows of crabs and other animals that fracture the marsh, and mussel beds that blunt the force of waves. By incorporating these factors into their models, McGlathery and her colleagues will be able to forecast the consequences of climate change on the marshes.

These models can also help them understand the factors driving more immediate ecosystem change. A proposed strategy to protect the mainland marshes is to create oyster reefs. Assistant Professor Matt Reidenbach will conduct hydrodynamic studies to see if such reefs successfully dissipate wave energy. Another open question is the effect of seagrass restoration in select areas of the lagoon on the viability of the marshes. "Seagrass could reduce the sediments available for accretion," McGlathery notes, "but it also could buffer wave energy. Models are essential to understanding such an extremely complex system."

TRACKING THE DISAPPEARING NITROGEN

Route 13 runs down the spine of Virginia's Eastern Shore—and for generations the flat, fertile farmland on either side of this highway has supplied vegetables that feed cities up and down the Chesapeake Bay. The lagoons on the ocean side of the peninsula, however, remain relatively pristine despite the substantial amount of agricultural chemicals—mostly fertilizers—that find their way into the groundwater aquifer.

"This was a bit of a mystery," recalls Professor Aaron Mills, a microbial ecologist. Mills has recorded levels of 20 milligrams of nitrogen per liter in groundwater close to the fields, twice the standard established by the Environmental Protection Agency. In streams that discharge this water into the lagoons, he found only 2 milligrams per liter.

To investigate the process, Mills and his colleague Janet Herman, an aqueous geochemist, and their students tracked the groundwater as it made its way through the aquifer. As they moved closer to the lagoons, they discovered a 30-centimeter denitrification zone in the sediments that border several of the streams feeding the lagoons. Examining the microorganisms in this soil, they found evidence of a gene that is activated during the last stages of the process by which bacteria convert reactive nitrogen into nitrogen gas.

Janet Herman and Aaron Mills discovered that bacteria in sediments bordering coastal streams significantly reduce the nitrogen flowing into coastal lagoons.

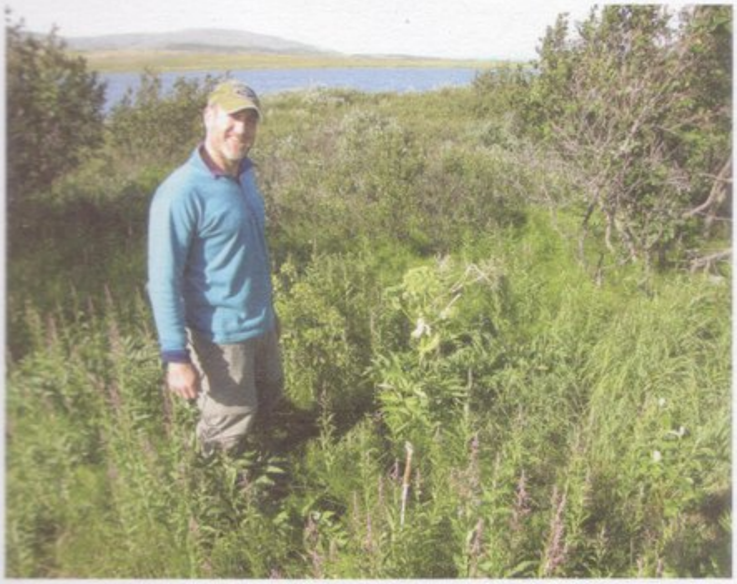
"It is likely that these bacteria are opportunistic," Mills explains. "They metabolize oxygen if it is available, but switch to nitrogen in its absence." This denitrification, combined with the ebb and flow of ocean water flushing the lagoons, accounts for their high water quality.

Mills is hesitant, however, to extrapolate to other areas of the Atlantic coast. "The process itself may not be unique," he says, "but the degree to which it is effective certainly is." On the Eastern Shore, the landmass feeding the lagoons is relatively small, as is the total amount of nitrogen that is removed from the groundwater. In North Carolina, on the other hand, the lagoons butt up against the mainland. In this instance, Mills believes, the microorganisms along the banks of the streams that feed the lagoons may provide a less effective nitrogen buffer.

"They metabolize oxygen if it is available, but switch to nitrogen in its absence."

REGIONAL ECOSYSTEMS AND ENVIRONMENTAL

The regional perspective—from large watersheds to major biomes like tundra, boreal forest, and tropical forests—is a key context for environmental research. Understanding regional-scale processes is crucial, not only because they influence decisions made by local shareholders but also because they contribute feedbacks that can lead to dramatic regime shifts in environmental systems and amplify global change.



In the Arctic, Howie Epstein is tracking the northern migration of tall shrubs as the climate warms. By reducing reflectance, this change is promoting additional warming.

THE TEMPERATE ZONE HEADS NORTH

One of the most obvious and ominous consequences of climate change is the disappearance of the summer sea ice in the Arctic Sea. In September, the University of Bremen announced that the area covered by sea ice in summer 2011 had hit a historic low, a decrease of 50 percent since 1972.

As Professor Howie Epstein points out, this is bad news not just for the Arctic but also for the planet. "You alter surface heating patterns dramatically when you replace more than a million square miles of reflecting surface with one that is absorbent," he notes. In addition, the melting of the sea ice opens great reaches of water to the wind, producing larger waves. It also changes the freshwater content of oceans and alters their circulation patterns.

The Arctic landscape also shows the consequences of climate change. Epstein is part of the Greening of the Arctic study, a multidisciplinary project funded by the National Science Foundation and the National Aeronautic and Space Administration. He and his colleagues and graduate students are combining information from satellites, ground-based studies, and climate analyses to uncover interrelated changes in sea ice, land temperatures, and vegetation. They are examining vegetation changes along two transects, one running toward the pole from Alaska's North Slope and the other north along Russia's Yamal Peninsula.

In Siberia, Epstein and his students are comparing recent satellite images with those from declassified Corona spy missions to track the movement of tall shrubs over the last fifty years. "We've found that tall shrub tundra is advancing north, replacing shorter-stature tundra at a dramatic rate," he says. They correlate these data with temperature, landscape position, and soil type to identify factors that might influence this change.

His next challenge is to determine the consequences of this progression. Epstein notes that the emergence of tall shrubs and small trees changes reflectance patterns, because snow is now shadowed by vegetation. This will promote additional warming. Reductions in snow cover may also cause the permafrost to melt and release greenhouse gases. "The feedbacks are really complex," Epstein observes. "As we learn more in the field, the next big challenge is to develop a model that can help us understand how fast climate change might progress."

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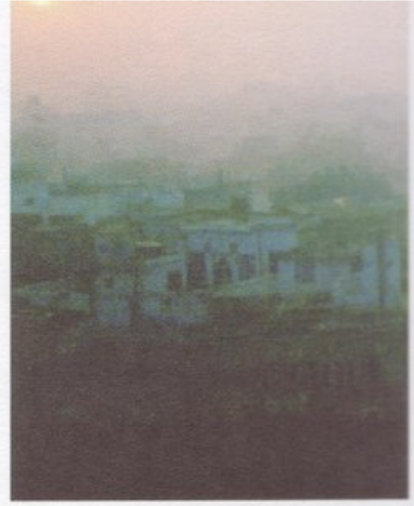
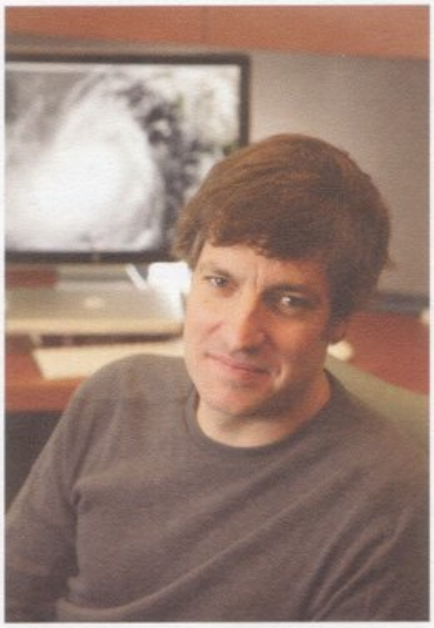
FEEDBACKS



THE BROWN CLOUD AND TROPICAL CYCLONES

During the last fifty years, a vast layer of smog several kilometers deep has formed over the Arabian Sea, the northern Indian Ocean, India, Pakistan, and parts of Southeast Asia. It has been dubbed the Asian Brown Cloud. This toxic mix of airborne particles and pollutants, caused by biomass burning and the exhaust from cars and factories, is responsible for hundreds of thousands of deaths each year.



Amato Evan has found that the Asian Brown Cloud is creating conditions that weaken the monsoon in India while increasing the strength of tropical cyclones.

Recent research by Assistant Professor Amato Evan suggests that the Asian Brown Cloud is not just detrimental to health but also changes the weather, with dire consequences for the region. During the last four decades, tropical cyclones over the Arabian Sea have grown dramatically stronger, while the monsoon, so critical for food production in India, has weakened. Observers have noted that vertical wind shear, which normally hinders tropical cyclones from organizing, has also weakened. Vertical wind shear is a change of wind speed or direction with height. Evan's investigations show how the Asian Brown Cloud could cause these phenomena.

"The Asian Brown Cloud robs the northern part of the Arabian Sea of sunlight."

Evan and his colleagues ran a series of general circulation model simulations, one holding the extent of the brown cloud constant to levels early in the century and the other tracing its known spread over time. In the first, both wind shear and hurricane intensity remained the same; in the second, wind shear decreased and intensity rose.

Under normal conditions, the water temperature in the northern Arabian Sea is hotter than in the south. This north-south temperature gradient produces a northern flow of air above the water surface that pulls moisture from the sea and delivers monsoon rains to India. Once it drops the moisture, the air rises and moves from east to west, setting up wind shear. "The Asian Brown Cloud robs the northern part of the Arabian Sea of sunlight, minimizing the temperature gradient, weakening both the monsoon and the wind shear," Evan says.

These powerful tropical cyclones don't simply pose a danger to the heavily populated eastern shore of the Arabian Sea, Evan points out. They could potentially penetrate the Strait of Hormuz and enter the Persian Gulf, making landfall in Iran. "If this pattern persists, they could disrupt global oil supplies," Evan says. "This is a regional problem with worldwide implications."

LOCAL PROCESSES THAT SHAPE THE ENVIRONMENT

The environment is the sum of fundamental biological, chemical, and physical processes, multiplied countless times. An essential first step in understanding the environment and forecasting its response to human activities is uncovering these processes and determining how they change under different conditions.

FOOD WEBS AND ECOSYSTEMS

> *"In forested areas, fish are about half made of trees."*

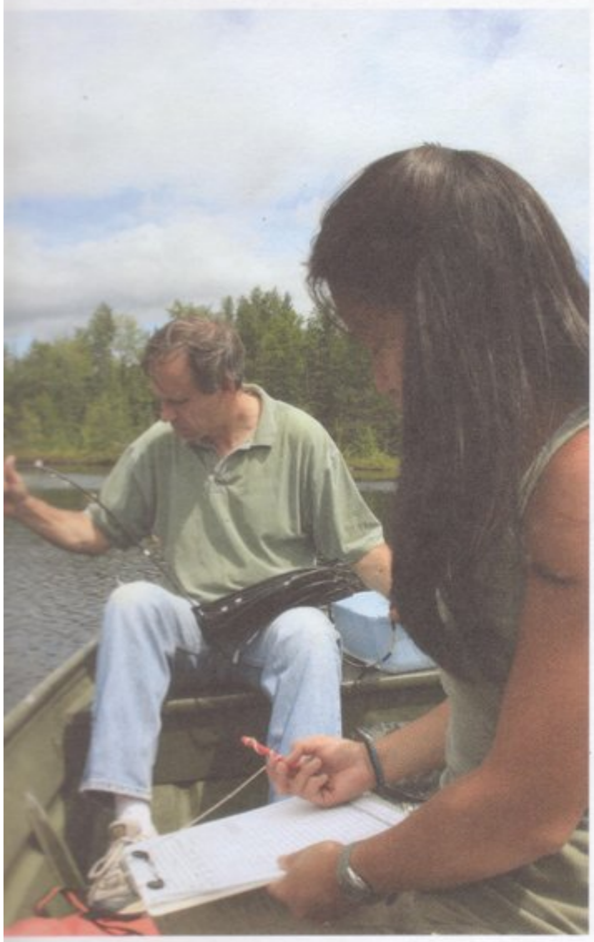
Imagine the effects on the environment if everyone in the United States decided to become a vegetarian. Pastures would be converted to crops or simply abandoned. Millions of acres devoted to corn would be replanted with other crops. And enormous feedlots and industrial poultry operations would disappear. Each one of these changes would set in motion an ever-widening cascade of environmental consequences.

Considered more abstractly, changes in what an organism eats—and the food web that surrounds that organism—have ecosystem impacts. Professor Mike Pace and his students map food webs and identify the effects that changes in food webs have on the environment. They are tracing the flow of terrestrial organic matter into aquatic food webs using stable isotopes of carbon, nitrogen, and hydrogen. Their investigation centers on forty lakes that are small enough to be dominated by inputs from the terrestrial environment. The results are straightforward: "In forested areas," Pace has concluded, "fish are about half made of trees."

Research on food webs has commercial implications. At the Virginia Coast Reserve/Long Term Ecological Research site, Pace is using isotopes to determine the food web for commercial clams. "As a first step, we are trying to determine the fundamental connection between the growth of clams and the resources that support them."

Pace is also using his expertise in food webs to uncover signals of impending ecosystem regime shifts. These could be brought on by the appearance of a new species that alters the food web or by changes in climate. With colleagues at the University of Wisconsin and the Cary Institute of Ecosystem Studies, Pace gradually introduced bass into a lake that had been dominated by smaller fish, which feed on zooplankton.

This is roughly analogous to shifting from eating meat to eating vegetables, and the change in the environment is equally dramatic. As the bass took over the lake, Pace and his colleagues monitored the cascading effects on zooplankton and algae. During the transition to bass dominance, they observed a dramatic increase in the variability of the food web. Once the bass took over the lake, this variability disappeared. "The lake showed evidence of the shift to bass dominance about a year before it occurred," he says. "Tracking variability could help policymakers anticipate ecosystem changes caused by sea level rise or invasive species."



Mike Pace and undergraduate student Carol Yang measure the vertical distribution of temperature and dissolved oxygen at Peter Lake, one of the forty lakes in their food web study

"This work will enable us to identify the species that are vulnerable to climate change as well as those that could be invasive."

COLLABORATING IN CHINA

China is not just an emerging economic power. It is an emerging scientific power, with regional facilities that offer unique settings for research. One such site is Xishuangbanna Tropical Botanical Gardens in southern Yunnan Province near the border with Laos. It has more than 10,000 species of tropical plants in its living collections.

Because Professor Manuel Lerdau is interested in how diversity in tropical forests is maintained, Xishuangbanna is an ideal setting for his research. Lerdau spent four months of his sabbatical at the botanical gardens as a senior international scientist of the Chinese Academy of Sciences, the first professor from U.Va. to receive this honor. He studied the mechanisms that enable plants to survive in the face of diversity that limits their opportunities to reproduce with members of their own species.

As Lerdau explains, the most common cause of extinction is not predation or disease. It is rarity. In a very diverse system, the number of plants of a specific species in a given area is limited. As a result, many plants have worked out a strategy of reproducing with close relatives. Lerdau used genetic models to determine how this can be done and still maintain species consistency. "Trees in diverse forests are long-lived," he says. "As a result, when hybrids grow up, they cross back with their parents. If you backcross often enough you effectively maintain the parent species."

During his sabbatical at the Xishuangbanna Tropical Botanical Gardens in southern Yunnan Province, Manuel Lerdau examined the genetic factors that enable plants to adapt under different conditions.

Lerdau also worked with a Chinese partner on a study linking advances in molecular biology and genomics to the ecological study of diversity. "The incredible diversity of tropical forests is critical to this effort," Lerdau says. "You can sequence scores of species in a genus, look at their genomic patterns, and begin to understand the molecular sources of their ability to adapt." Their goal is to be able to distinguish between the genomic characteristics of a species that enable it to grow in a broad range of environmental conditions and those that limit it to a smaller niche.

"This work will enable us to identify the species that are vulnerable to climate change as well as those that could be invasive," he says. "Ultimately it will help us to understand ecosystem dynamics on the genomic level."

HUMAN-ENVIRONMENT INTERACTION

Enlisting the assistance of geographers, anthropologists, and economists, Deborah Lawrence set out to develop a larger picture of human interaction with the environment.

As with any species, human beings have always had an impact on the environment, but as our population has grown and our technology become more sophisticated, we have gained unprecedented power to shape the world in which we live. Even as we attempt to mitigate the environmental constraints on our lives—for instance by building cities and transportation networks—we must recognize that these actions have their own environmental consequences.

BUILDING PEOPLE INTO ENVIRONMENTAL MODELS

Since she was a graduate student, Associate Professor Deborah Lawrence has been studying the practice of shifting cultivation by subsistence farmers around the world. These farmers cut down trees, burn the land to clear it, and cultivate crops. Lawrence tracks the effects of their practices on soil composition, structure, and biogeochemistry and on the second-growth forests that emerge once the land is allowed to go fallow. She has also widened her scope to include hydrological change, which affects the input of phosphorus into the system.

Deborah Lawrence has shown that public policy and economic necessity must be considered when evaluating the future of an ecosystem.

Shifting cultivation has been sustainable in Indonesia, but not in the Yucatán Peninsula in southern Mexico, and Lawrence is interested in finding out why. She acknowledges that the soil in the Yucatán is highly porous, allowing nutrients to leach out quickly and significantly reducing soil fertility after just a few cycles. She also found that droughts have been more prevalent in southern Mexico than in Indonesia. But she reasons that farmers in the region should have long ago adjusted their practices to local conditions, much as their Indonesian counterparts did.

Enlisting the assistance of geographers, anthropologists, and economists, Lawrence set out to develop a larger picture of human interaction with the environment—and she found that a range of personal and public policy decisions can have a decisive influence on the fate of an ecosystem.

One factor is cultural. Farming in the Yucatán is a relatively recent phenomenon; the first farmers relocated there just fifty years ago. In Indonesia, subsistence farmers have tilled the same fields for generations and preserved oral accounts of their practices going back 200 years. "They have much more knowledge about the best ways to manage their fields than Mexican farmers do," Lawrence says.

Equally influential is the intersection of public policy and economic migration. The Mexican government pays farmers a subsidy to clear land, but some of the men, who do the majority of the farming, migrate to the United States. The women and

children who remain clear land that can be most easily cleared, those plots where trees are small and easily cut down. In other words, in Mexico farmers don't allow the land enough time to recover.

Lawrence's next step is to study the complex of factors shaping the environment on a much larger scale. Due to deforestation, Indonesia is the third-largest emitter of greenhouse gases in the world. Lawrence plans to use crossdisciplinary data to develop models that can help policy makers identify options for reducing greenhouse gas emissions from forest-based development.

DETERMINING ENVIRONMENTAL IMPACTS ON PEOPLE

Most of Professor Bob Davis's colleagues study the impact of human beings on climate. Davis takes the opposite position, investigating the effects of climate—and particularly local weather—on people. In some cases, this effect is hardly benign.

For several decades, Davis, an applied climatologist, has studied the deaths caused by heat waves in cities across the United States. He chose heat because it is the largest weather-related cause of death in the country—and because most of these deaths are preventable.

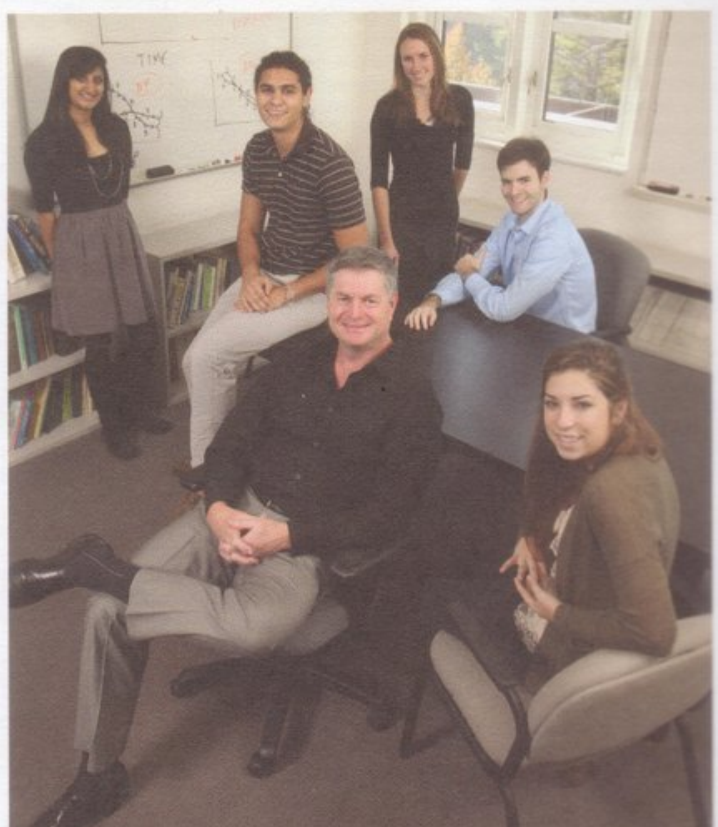
Davis and his colleagues use apparent temperature—a combination of temperature and humidity—as a key indicator. They have found that when the apparent temperature exceeds 100 degrees, people who live in places like Philadelphia or Detroit die at a greater rate than those who live in Phoenix or Miami. "Southern cities are less heat sensitive than northern ones," he notes. "Southerners use air conditioning more, drink more water, and plant more shade trees. These are strategies that people in northern cities could adopt."

With graduate student Dave Hondula, Davis is looking at smaller-scale heat effects in seven metropolitan areas. "Our goal is to come up with fine-scale predictive models that are consistent from place to place," he says. "They can help localities more strategically allocate their resources during a heat wave and save lives. Local officials know when heat mortality will occur, but right now they don't know where."

Davis and Hondula have assembled a team of undergraduates who are assisting in the project. Together, they are examining thermal imagery taken by MODIS and LANDSAT satellites during heat waves, culling zip code mortality data from local departments of health, and examining zoning ordinances to determine building types in a specific area. "Undergraduates here are very inventive and diligent in assembling the data," says Davis. "They will all be coauthors on the papers we publish."

Preliminary results are tantalizing. In most places, for instance, mortality is negatively correlated with income, but in Philadelphia's well-to-do Main Line, heat-related mortality is higher than in less-affluent areas. "We're hopeful that our work

Bob Davis (seated) and graduate student Dave Hondula are working with a team of undergraduates to find ways to identify those urban neighborhoods at risk for high mortality during heat waves. The undergraduates (left to right) are Anjali Patel, Michael Saha, Carleigh Wegner, Matthew Leisten, and Courtney Good.





AWARDS, APPOINTMENTS, AND PUBLICATIONS

UNDERGRADUATE STUDENTS

The department recognizes fourth-year students who have done outstanding work in each of the environmental sciences. This year, the Mahlon G. Kelly Prize in ecology went to **Rebecca A. Oppenheim**, and the Michael Garstang Atmospheric Sciences Award went to **Jeffrey D. Strong**. Both the hydrology award and the Wilbur A. Nelson Award in geology went to **Joseph M. Nelson**.

This year's Wallace-Poole Prize for the fourth-year student majoring in environmental sciences with the highest grade point average went to **Joseph M. Nelson**. He also won the Departmental Interdisciplinary Award and was recognized with an Outstanding Presentation Award at the Environmental Sciences Research Symposium.

Timothy A. Allan, **James Parker Gochenour**, **Paige L. Mische**, **Nathaniel A. Mitchell**, **Joseph M. Nelson**, **Christopher A. Olcott**, **Avery B. Paxton**, **Justin M. Rawley**, **Jeffrey D. Strong**, and **John K. Tran** were named Distinguished Majors by the department.

Michael S. Mason was this year's recipient of the Richard Scott Mitchell Scholarship, which provides $1,500 to a rising fourth-year student who is focusing on geology and who has taken petrology and mineralogy.

The Bloomer Scholarship provides a $1,500 award to a rising fourth-year undergraduate environmental sciences major with a focus on geology. This year's winner was **James Parker Gochenour**.

Chelsea Vonu and **Jay Fariss** received a Community-Based Research Grant from the University for a project titled "Turtles, Tourists, Tropics: Ecotourism and Sea Turtle Conservation in Costa Rica." These grants provide opportunities for students to develop research projects that apply their academic skills, experiences, and ideas to real-world problems. **Chelsea Vonu** presented their findings at the 11th Annual Undergraduate Research Symposium.

GRADUATE STUDENTS

Ami L. Riscassi won the Maury Environmental Sciences Prize. Established by Dr. F. Gordon Tice in 1992, it is the department's premier award.

The department offers a series of awards honoring outstanding graduate students in each specialty of environmental sciences. This year, **David A. Seekell** earned the Graduate Award in Ecology, **Christiane W. Runyan** won the Graduate Award in Hydrology, **Matthew T. O'Connell** won the Arthur A. Pegau Award in Geology, and **Temple R. Lee** won the Graduate Award in Atmospheric Sciences. **Yufei He** received the Ellison-Edmundson Award for Interdisciplinary Studies.

Janet L. Miller received the Trout Unlimited Award, which was established by the Thomas Jefferson Chapter of Trout Unlimited for "significant contributions to research concerning cold-water fisheries or related ecosystems."

Laura K. Reynolds received the Thomas Jefferson Conservation Award, which supports basic research related to the conservation of the earth's resources.

A reservist in the U.S. Army Corps of Engineers stationed in Baghdad, **Jodi Smith** received a Bronze Star, awarded for bravery, acts of merit, or meritorious service.

Charles E. Clarkson and **Catherine V. Wolner** were honored for making outstanding graduate student presentations at this year's Environmental Sciences Research Symposium.

Gerald V. Frost won the department's Fred Holmsley Moore Teaching Award. An endowment set up by Fred H. Moore funds this award, along with matching donations from Mobil Oil Company.

Christiane W. Runyan received the Graduate Student Research Publication Award.

Michael L. Tuite, Jr., won a Moore Research Award. Based on merit, this award was initiated to help sponsor the dissertation and thesis work of environmental

Jonathan A. Walter, and **Grace M. Wilkinson** received Exploratory Research Awards. These awards are meant to support preliminary research leading to a thesis or dissertation proposal.

Charles E. Clarkson won the Joseph K. Roberts Award, which is given to a student who presents the most meritorious paper on geology at a state, national, or international conference. He also won the Best Student Paper award at the annual meeting of the Waterbird Society.

Dirk Koopmans and **Rishiraj Das** received Dissertation Year Fellowships from the Graduate School of Arts & Sciences for 2010–11.

Amy Grady and **David A. Seekell** were selected to receive Graduate Research Fellowships from the National Science Foundation.

Kimberly Holzer received a Sea Grant Knauss Marine Policy Fellowship, which matches highly qualified graduate students with agencies in the legislative and executive branches of government in Washington, D.C. The award is sponsored by the National Oceanic and Atmospheric Administration. The January 2011 issue of *Estuaries and Coasts* featured her research on its cover.

Three graduate students won awards at the 11th Annual Robert J. Huskey Research Exhibition, open to all students in the Graduate School of Arts & Sciences. **David Hondula** placed third in the physical sciences and mathematics oral presentation, **David A. Seekell** placed second in the social and behavioral sciences oral presentation, and **Ami L. Riscassi** placed first in the physical sciences and mathematics poster competition.

Katie Tully secured a highly competitive postdoctoral fellowship at the Earth Institute of Columbia University. She also won a Fulbright Scholarship to support her work in India.

David Hondula was one of two graduate students selected to participate in the National Academies Keck Futures Initiative Imaging Science Conference.

STAFF

Pamela M. Hoover received the Environmental Sciences Organization Award, while **Mario P. Biazon** won the Graduate Student Association Award.

The Chair's Award was presented to **Henry G. White**.

FACULTY

We are proud to have five faculty members—**Jack Cosby**, **James Galloway**, **Michael Pace**, **William Ruddiman**, and **Hank Shugart**—designated highly cited researchers by the Institute for Scientific Information. Highly cited researchers constitute less than one-half of 1 percent of all publishing scientists.

Linda Blum serves on the National Research Council's U.S. Army Corps of Engineers Water Resources Science, Engineering, and Planning Committee.

Jack Cosby is a fellow of the University's Brown College.

Robert Davis is a contributor to the Intergovernmental Panel on Climate Change.

Stephan De Wekker is on the editorial board of the journal *Atmospheres*.

Paolo D'Odorico, the Ernest H. Ern Professor of Environmental Sciences, was awarded a Guggenheim Fellowship to study the globalization of water resources and its effects on societal and environmental resilience. He also received designation as a Fulbright Distinguished Lecturer. He will work with experts in the water engineering department of the Polytechnic University of Turin, Italy, and at the École Polytechnique Fédérale de Lausanne, Switzerland. He is the editor of *Geophysical Research Letters* and chair of the Ecohydrology Technical Committee of the Hydrology Section of the American Geophysical Union.

Howard Epstein is associate editor of *Plant Ecology* and *Ecosphere*. He serves on both the Promotion and Tenure Committee and the Committee on Budget and Personnel Policy for the College of Arts & Sciences. He also codirects the College Science Scholars program and is a member of the Vice President for Research's Internal Review Committee.

James N. Galloway, the Sidman P. Poole Professor of Environmental Sciences and associate dean for the sciences, was named a trustee of the Marine Biological Laboratory at Woods Hole, Massachusetts. This year, he presented the Distinguished Guest Lecture to the Environmental Chemistry Group of the Royal Society of Chemistry. Professor Galloway continues to serve as a member of the EPA Science Advisory Board, the Board of Trustees of the Bermuda Biological Station, and the International Nitrogen Initiative Steering Committee. He is also a lead author of the Intergovernmental Panel on Climate Change's Working Group 1, which assesses the physical scientific aspects of the climate system and climate change.

Bruce Hayden is associate editor of the *Journal of Climate Research* and chair of the national Long Term Ecological Research Network Climate Committee.

Janet S. Herman was elected a councilor of the Geological Society of America. Councilors set direction and policy for the society, oversee the society's journal publications and meeting plans, and watch over fiscal activities. She also serves on the Committee on Educational Policy and Curriculum for the College of Arts & Sciences.

Alan D. Howard serves as vice chair of the Executive Committee of the Earth and Planetary Surface Processes Focus Group of the American Geophysical Union.

William Keene was elected a fellow of the American Geophysical Union for his research on the composition of precipitation, origins of marine aerosols, and the role of halogens like chlorine in the chemistry of the troposphere. Those elected fellows have attained acknowledged eminence in the Earth and space sciences. He has an Intergovernmental Personnel Act rotator position with the National Science Foundation as director of the Atmospheric Chemistry Program. In addition, Keene serves as the department's representative to the U.Va. Faculty Senate.

Deborah Lawrence was the first U.Va. faculty member named a Jefferson Science Fellow by the National Academy of Sciences. As a fellow, she consulted for the U.S. Forest Service and the Climate Office of USAID on scientific and technical aspects of forest carbon measurement and monitoring under SilvaCarbon, the U.S. contribution to the GEO Forest Carbon Tracking Task.

Manuel Lerdau was elected a 2011 senior international scientist by the Chinese Academy of Sciences. He was also 2011 climate science fellow of the American Association for the Advancement of Science. Professor Lerdau is a member of the Board of Directors of the University of Virginia Press and serves as the editor of *Oecologia*.

Stephen A. Macko serves as an associate editor of *Amino Acids*, *Science of the Total Environment*, and *Environmental and Analytical Toxicology*. He is also education editor of *Eos, Transactions of the American Geophysical Union*. In addition, Professor Macko is a member of the Program Committee of the American Geophysical Union as well as the Committee on Education of the European Geoscience Union and convenes its Geosciences Information for Teachers workshop. At the University, Professor Macko serves on the Summer Session Advisory Committee as well as the University Committee on Information Technology. He is also an at-large member of the Faculty Senate.

Karen J. McGlathery serves as the lead principal investigator of the Virginia Coast Reserve Long Term Ecological Research (LTER) program. She sits on the national LTER Science Council and is associate editor of *Ecosystems*. She is a University of Virginia Pavilion Series speaker and a member of the Research Council of the Office of the Vice President for Research.

Aaron L. Mills is a member of the Faculty of Arts & Sciences Steering Committee.

Jennie Moody is a member of the Board on Oceans and Atmosphere of the Association of Public and Land-Grant Universities. She is also the University of Virginia's representative to the University Corporation for Atmospheric Research.

Michael Pace is associate editor of *Ecosystems* and *Frontiers in Ecology and Evolution*.

Arnico Panday is a member of the Patan Academy of Health Sciences International Advisory Board in Lalitpur, Nepal.

John Porter is a member of the national Long Term Ecological Research (LTER) Network Information System Advisory Committee.

G. Carleton Ray received the 2010 Achievement in Conservation Award from the Wildlife Conservation Society. He is a member of the Board of Trustees of the

Matthew Reidenbach was one of just nine faculty members honored with a 2011 All-University Teaching Award. He is also a fellow of the University's Brown College.

Todd Scanlon is an associate editor of *Water Resources Research*.

Herman H. Shugart, the W. W. Corcoran Professor of Environmental Sciences, was elected a fellow of the American Geophysical Union for his contributions to our understanding of terrestrial ecosystems and how they are affected by regional and global environmental changes. Only one in a thousand members is elected a fellow each year. Professor Shugart is associate editor of *Research Letters in Ecology* and a member of the editorial boards of the *Eurasian Journal of Forest Research*, the *International Journal of Ecology*, and the *International Journal of Environmental Protection*. He is also a member of the Biological and Environmental Research Advisory Committee of the United States Department of Energy's Office of Science, and a member of MEDEA, the special advisory committee to the Defense Intelligence Agency on the environment. In addition, Professor Shugart is a member of NASA's Advisory Council's Subcommittee on Earth Science and is the chief scientist for the Northern Eurasia Earth Science Partnership Initiative. At the University, he serves as a member of the U.Va. Energy Sustainability Group and a faculty representative on the Committee on Undergraduate Admissions. He is also a member of the Committee for Historically Black Colleges and Universities—U.Va. Advisory and Planning Committee.

David E. Smith is one of the developers of the U.Va. Bay Game, a massive computer-generated simulation of the human and ecosystem processes in the Chesapeake Bay. This year, Smith was master of ceremonies for the 2011 Earth Day presentation of the U.Va. Bay Game, which featured online participation from students attending seven colleges and universities in the Chesapeake Bay Watershed. He and colleagues also won first place in their category in the University-wide poster competition organized to celebrate University President Teresa A. Sullivan's inauguration. Professor Smith is a member of the Virginia Sea Grant (VASG) Research and Extension Advisory Committee and is president of the Association of Ecological Research Centers. He serves the University as a member of the Executive Leadership Network, the Facility Management Advisory Board, the Process Simplification Advisory Committee, and the Committee on Undergraduate Admissions. Professor Smith chaired the Committee on Policy/Procedure and Education/Training for the assistant vice president for research administration as part of the Research Time and Effort Certification Project.

Vivian Thomson's recent book, *Garbage In, Garbage Out: Solving the Problems with Long-Distance Trash Transport*, was honored as a finalist for the Southern Environmental Law Center's Phillip D. Reed Memorial Award for Outstanding Writing. She is director of the U.Va. Panama Initiative as well as the Environmental Thought and Practice interdisciplinary major.

Patricia Wiberg is chair of the department. She serves on the National Research Council's Committee on New Research Opportunities in the Earth Sciences. In addition, she is a working group chair of the National Science Foundation's Community Surface Dynamics Modeling System (CSDMS) and a member of the CSDMS Executive Committee.

2010–11 PUBLICATIONS

Annual report of published peer-reviewed papers, book chapters, and books by faculty and graduate students for the 2010–11 academic year (summer 2010, fall 2010, spring 2011).

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Angelini, I. M., **M. Garstang**, **R. E. Davis**, **B. P. Hayden**, D. Fitzjarrald, D. R. Legates, S. Greco, **S. Macko**, and V. Connors. 2011. On the coupling between vegetation and the atmosphere. *Theoretical and Applied Climatology* 105 (1–2): 243–61. doi:10.1007/s00704-010-0377-5.

Bartolini, E., P. Claps, and **P. D'Odorico**. 2010. Connecting European snow cover variability with large scale atmospheric patterns. *Advances in Geosciences* 26: 93–97. doi:10.5194/adgeo-26-93-2010.

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Carr, J., **P. D'Odorico**, **K. J. McGlathery**, and **P. L. Wiberg**. 2010. Stability and bistability of seagrass ecosystems in shallow coastal lagoons: Role of feedbacks with sediment suspension and light availability. *Journal of Geophysical Research—Biogeosciences*, 115, G03011. doi:10.1029/2009JG001103.

Christian, R. R., C. M. Voss, C. Bondavalli, P. Viaroli, M. Naldi, C. A. Tyler. I. C. Anderson, **K. J. McGlathery**, R. E. Ulanowicz, and V. Camacho-Ibar. 2010. Ecosystem health indexed through networks of nitrogen cycling. In *Coastal Lagoons: Critical Habitats of Environmental Change*, edited by M. Kennish and H. Paerl, 73–91. Boca Raton, FL: Taylor & Francis Group, CRC Press.

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Duval, B., P. Dijkstra, S. Natali, J. Megonigal, M. Ketterer, B. Drake, **M. Lerdau**, G. Gordon, A. Anbar, and B. Hungate. 2011. Plant-soil distribution of potentially toxic elements in response to elevated atmospheric CO_2. *Environmental Science and Technology*, 45 (7): 2570–74. doi:10.1021/es102250u.

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Kaushal, S. S., **M. L. Pace**, P. M. Groffman, L. E. Band, K. T. Belt, P. M. Mayer, and C. Welty. 2010. Land use and climate variability amplify contaminant pulses. *Eos, Transactions of the American Geophysical Union* 91 (25): 221–28. doi:10.1029/2010EO250001.

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