

Delaware Environmental Institute



A Network of Discovery & Solutions





A Network of Discovery & Solutions

Table of Contents

- From the Director..... 1
- Core Research Areas2
- Environmental Frontier Grants 7
- Education Programs 8
- Partnerships.....10
- Events..... 12
- Strategic Plan 13

On the cover:

The key elements of the critical zone — land, air, water, and organisms — are captured in a single photograph by Mariana Bucina Roca.

Credits:

Beth Chajes, editor; Lane McLaughlin, graphic design. Photographs by Kathy F. Atkinson, Ambre Alexander, Doug Baker, Shree Inamdar, Evan Krape, Lane McLaughlin, Holly Michael, Danielle Quigley, Angelia Seyfferth and Rodrigo Vargas. Additional photos courtesy of NASA and the UD Coastal Sediments Hydrodynamics and Engineering Lab. Critical zone illustration by David Barczak.

A thin shell of atmosphere, water, and rocky crust encases our planet. This shell — referred to by scientists as “the critical zone” — extends roughly from the tops of the trees down to bedrock, where groundwater ceases to penetrate. All life as we know it resides in this narrow band, reflected in DENIN’s logo, where land water, air, and living organisms meet and interact. Humans are changing and shaping the critical zone as never before, prompting many scientists to call our current era the Anthropocene.



Director’s Message

The Delaware Environmental Institute, founded in 2009, is an interdisciplinary incubator of research, knowledge, and solutions dedicated to safeguarding the environment and addressing environmental issues.

In our first five years at the University of Delaware, DENIN has become a vibrant network of discovery and solutions, uniting 160 faculty affiliates and 20 fellows across disciplinary boundaries in the pursuit of socially acceptable, economically viable, and environmentally sustainable solutions to the complex, multilayered challenges we face if our planet is to continue providing for the needs of future generations.

DENIN leverages the combined talents of natural and social scientists, engineers and humanists to provide the integrated knowledge and perspectives decision makers need to formulate sound public policies. We provide academic, government, and industrial partners broad access to these experts in a collaborative effort to advance environmental science, promote environmental education and awareness, and devise innovative strategies for environmental preservation and remediation.

Thanks to the vision, support, and hard work of DENIN’s affiliated researchers, our dedicated staff, our exceptional advisory board, and the University of Delaware administration, we have successfully navigated these critical formative years. Lately, we have been engaged with internal and external constituents in a strategic planning process to envision our future. This report serves to summarize the accomplishments of our first five years as well as provide a glimpse of where we’re headed next.

At DENIN, we hold fast to the belief that, working together, we can create a world that meets human needs for food, water, energy, and a comfortable standard of living without depriving future generations of the ability to meet their needs or to enjoy the beauty of our planet. We invite you to join us in this endeavor, as a colleague, a student, a partner, or a donor — there is no pursuit more important or worthwhile!

Donald L. Sparks
Director, Delaware Environmental Institute
S. Hallock du Pont Chair of Soil and Environmental Chemistry
University of Delaware



Don Sparks, director of the Delaware Environmental Institute, holds an informal meeting with some of his graduate students and postdoctoral fellows in the University of Delaware’s Interdisciplinary Science and Engineering Laboratory. A leading soil and environmental chemist for more than 35 years at UD, Sparks was awarded the 2015 Geochemistry Medal by the American Chemical Society.

DENIN's Core Research Areas

monitoring

critical zone

climate

human impacts

land use

water quality

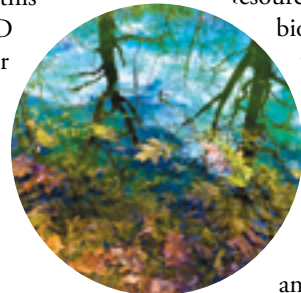
DENIN's mission is to conduct research and coordinate partnerships that integrate environmental science, engineering, and policy in order to provide solutions and strategies that address environmental challenges.

The Institute unites a vibrant network of faculty, students, and partners in pursuit of this mission. Nearly 15 percent of all UD faculty participate in DENIN, either as faculty affiliates or as members of the Council of Fellows, a group of senior faculty that help guide DENIN's research efforts.

DENIN assembles interdisciplinary teams of affiliates and partners to apply for large, multi-investigator research grants. In our first five years, DENIN submitted 57 research grants, securing more than \$54 million in research funding. As a direct result of these grants, some 225 papers have been published in peer-reviewed scientific journals.

The Institute has funneled almost \$17 million to our statewide higher education partners at Delaware State University, Delaware Technical Community College, and Wesley College and \$8.4 million in research support to UD's colleges.

DENIN focuses on research that is relevant to environmental and sustainability challenges facing the state of Delaware, the nation, and the world. We group these challenges into six broad, interrelated research areas that form the core of what we do.

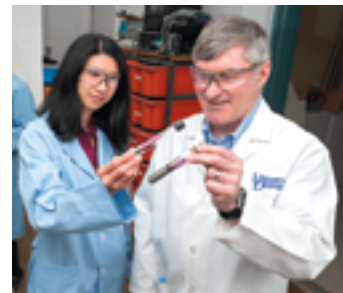


The Critical Zone

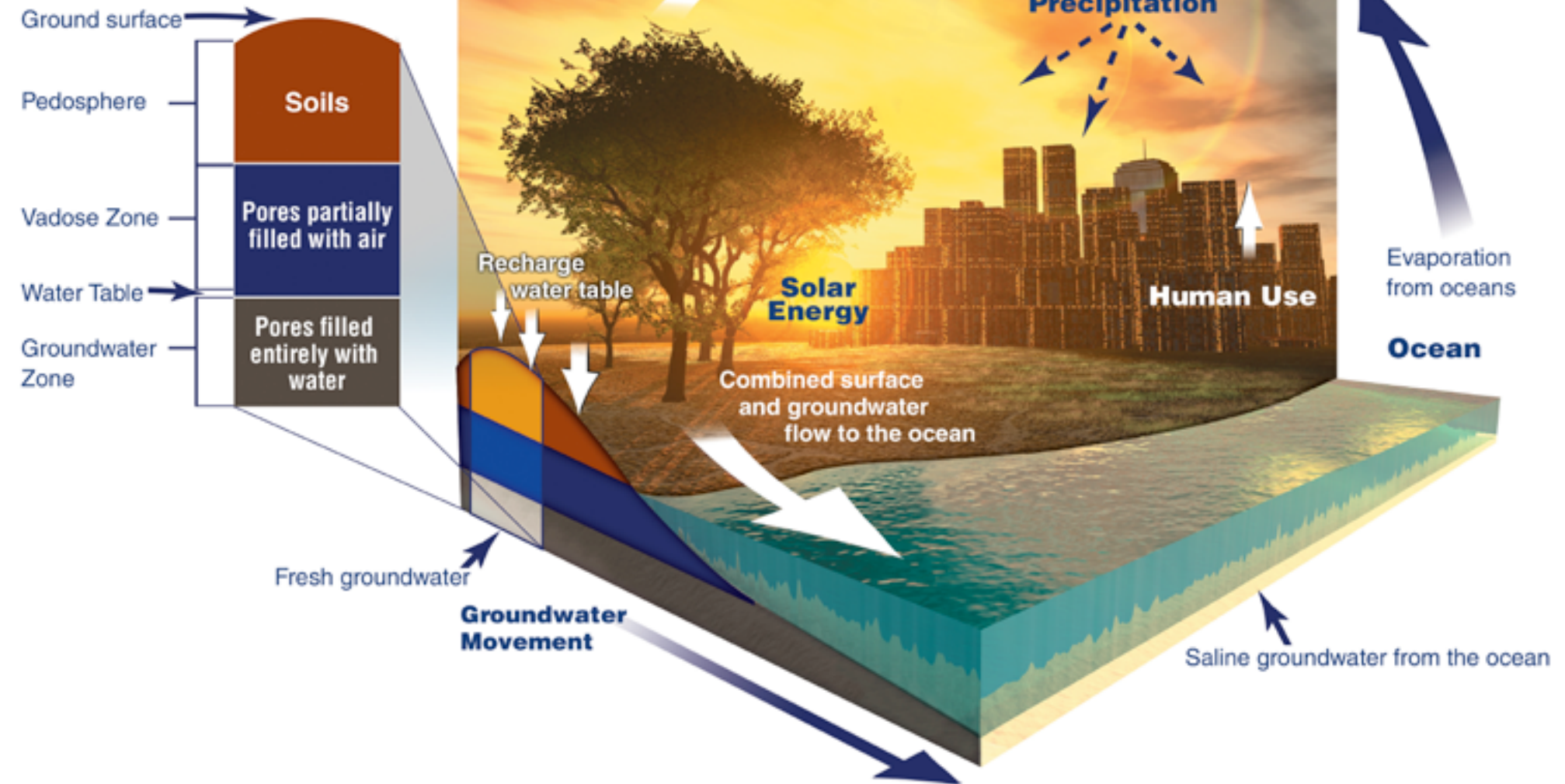
The critical zone is the heterogeneous, near-surface environment in which complex interactions involving rock, soil, water, air, and living organisms regulate the natural habitat and determine the availability of life-sustaining resources. Important physical, chemical, and biological processes and reactions occur in the critical zone over a range of scales, both spatial (global to atomic) and temporal (millennia to nanoseconds).

These processes impact the mass and energy exchange necessary for biomass production, chemical recycling, and water storage. They also control the transport and cycling of contaminants and nutrients and have critical effects on soil, air, and water quality. They determine the health and sustainability of the ecosystem and its inhabitants. Our research in this area places special emphasis on the impact of biogeochemical interfaces on the reactivity, transport, and cycling of metals, nutrients, carbon, and microbes in the environment.

Geomicrobiologist Clara Chan and marine biochemist George Luther examine test tubes filled with nanoparticulate pyrite — tiny particles of the iron-based mineral produced in deep-sea hydrothermal vents that may serve as an important source of iron for ocean life, even far away from the vents.



The Critical Zone



Rodrigo Vargas, who specializes in soil-plant-atmosphere interactions, is collaborating with the U.S. Forest Service and multiple institutions in Mexico to reduce greenhouse gas emissions caused by deforestation and forest degradation.



Land Use

The mid-Atlantic region, drained by the massive Chesapeake and Delaware Bay watersheds, has been subject to rapid urbanization and suburbanization of previously forested or agricultural landscapes. Urbanization has been shown to increase the intensity and magnitude of surface runoff and shorten the time it takes for water and nutrients to reach water bodies. Further fragmentation of landscape parcels will likely continue to have repercussions for hydrology, water quality, and ecology of natural ecosystems, from marshes to forests. These land use challenges are also expected to intensify as future climate change spawns more extreme weather conditions, including droughts, heat waves, and severe storms.

The interests of DENIN affiliates focus on how the coupled influences of land use and climate change will impact the evolving health and integrity of complex terrestrial and aquatic ecosystems, and how we can develop useful predictive models, with emphasis on understanding how these changes will alter the fluxes and cycling of carbon, nitrogen, and phosphorus.



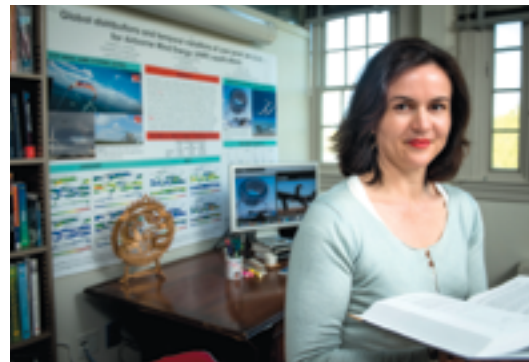
DENIN researchers investigate the effects of land use on water quality, such as how the nutrients in various types of fertilizers applied to croplands appear in runoff to surface waters.



Climate

From remote sensing satellites in space, to pocket-sized instruments that detect minute quantities of trace elements, to microscopes and genetic sequencers that register changes in the microbial ecosystem, researchers affiliated with DENIN are employing every tool at their disposal to investigate the changes taking place on our planet due to climate change.

From changes in the carbon cycle to changes in the frequency and severity of storms and droughts, we are looking at the science of climate change on multiple spatial and temporal scales. Researchers are busy in the tropics, in the polar regions, and at home in Delaware to understand changes that are taking place now and potential changes yet to come, as well as ways to ameliorate these effects through engineering or policy solutions. Research into alternative energy sources including wind, biofuels, and fuel cells as well as technologies for more efficient use of traditional energy sources such as electric vehicles is also being conducted by those affiliated with DENIN.



Wind energy researcher Cristina Archer uses computer simulations to determine the most efficient placement of turbines in wind farms and has found that offshore wind farms could weaken hurricanes before they make landfall.



Water Quality

Monitoring, predicting, and protecting water supplies and water quality that support natural ecosystems and human health are major concerns of many researchers affiliated with DENIN. As in many coastal areas around the world, Delaware's surface and groundwater supplies are subject to significant pollution, particularly from nonpoint sources such as runoff from agricultural fields and urban roadways. The legacy of Delaware's industrial past lingers in numerous brownfields, many located in low-lying coastal

areas, where contaminants remain in the soil. The fate of these contaminants as they increasingly come into contact with saltwater through rising sea levels or water tables, or through inundation by storm surges, is largely unknown and a primary research area for DENIN that has worldwide applicability.

In the background: The health of millions of people in the Bengal Delta is at risk from arsenic-contaminated shallow groundwater. Researchers affiliated with DENIN are working to understand the hydrogeology of the region so that the population can safely tap into deep wells for their drinking water.

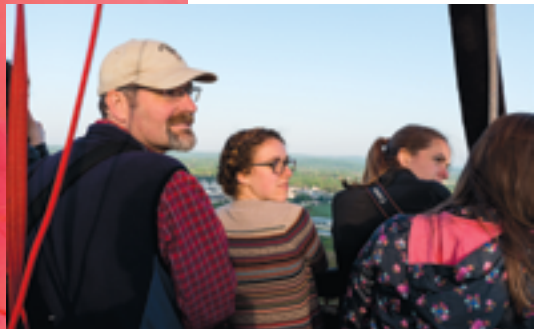


Below left: Graduate student Josh LeMonte, visiting scientist Jörg Rinklebe, and DENIN director Don Sparks work with automated biogeochemical microcosms to simulate real-world soil conditions in the lab.

Below middle: Plant scientist Angelia Seyfferth displays the root systems of rice plants taken from a paddy in Cambodia where she studies factors that affect the uptake of arsenic by rice.

Below right: An experimental setup in the lab at DENIN's partner, the Stroud Water Research Center in Avondale, Pennsylvania, is used to evaluate stream water quality.





Left and top left: Professor Jeffrey Buler's landscape ecology class gains appreciation of the complexities of landscapes in the real world via a field trip in a hot air balloon.

Top middle: Climatologist Dan Leathers and Kevin Brinson, director of the Delaware Environmental Observing System (DEOS), inspect one of the 50 observing stations located across the state.

Top right: Economists Joshua Duke and Kent Messer collaborate with geologist Holly Michael to develop groundwater models that take into account both physical and human use aspects of the resource.



Monitoring & Forecasting

Acquisition of precise and accurate real-time data through monitoring, as well as transformation of these data into a fundamental understanding of environmental change, is essential to developing predictive models and new strategies for responding to these challenges. The Institute facilitates the necessary interplay of the observational science, the engineering required to make the observations and build the models, and the policy innovations necessary to meet these challenges.

Detecting environmental changes while they are still small is essential to heading off irreversible damage. Our researchers are developing tiny, portable sensors that are convenient to deploy and sensitive to minute changes in the chemistry of soil, water, and air. These sensors can then funnel measurements to a network of monitoring systems that aggregate the data for use by other researchers, policy makers, and educators. Thanks to researchers affiliated with DENIN, Delaware has one of the densest networks of environmental monitoring stations and technologies in the nation.



Human Impacts

Hardly an inch of the Earth's surface remains unaffected by human presence, while human health and well being remain inextricably bound to the health of the natural systems on which we depend for food, water, and other resources. Economists, social scientists, policy specialists, and humanists affiliated with DENIN are conducting groundbreaking research, often in collaboration with natural scientists and engineers, to shed light on the impacts wrought by environmental changes on individuals and communities and how we respond to these risks and challenges.

Social science and humanities components are embedded in all of our core research areas whenever possible. For example, hydrogeologists and economists are developing joint models to describe how physical changes in a shared resource such as groundwater intertwine with human responses to those changes such as price and regulation, which together determine the use and quality of the resource. Our sociologists and ethicists are examining how the potential release of toxic chemicals from brownfields inundated by coastal flooding would affect the often-disadvantaged communities surrounding these sites and the state's obligations to respond.

Environmental Frontier Grant Program



Since 2009, DENIN has awarded seed grants for 43 environmental research projects, which in turn have led to \$5.4 million in new, external research awards. Seeking to bolster this relationship between support for early-stage research and future funding, we established the Environmental Frontier Grant Program in 2014.

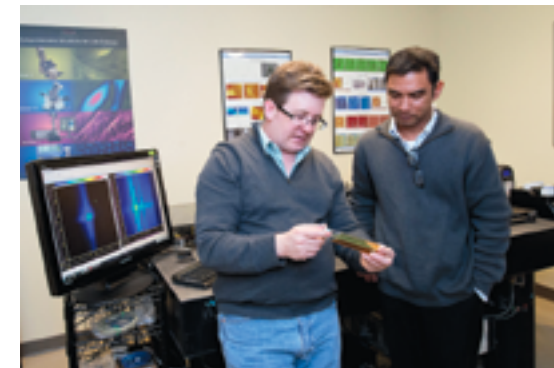
Environmental Frontier Grants aim to build interdisciplinary research teams that will compete successfully for larger federal, state, foundation, or industry awards. The grants enable the researchers to collect preliminary data, formulate and confirm hypotheses, develop and validate methodologies, or otherwise address gaps in knowledge that constitute a barrier to securing competitive funding.

In the first year of the program, grants were awarded to four teams, who investigated new methods of identifying sulfide-oxidizing bacteria responsible for dead zones in the Chesapeake Bay and elsewhere, how a model soil fungus identifies and responds to antagonistic bacteria, new approaches for reducing watershed nitrogen export, and the use of biochar and zero-valent iron to enhance nitrate removal from stormwater runoff.

Left: Eco-hydrologist Luc Claessens and his research team take water samples in Delaware's White Clay Creek to measure the export of nitrogen from the surrounding watershed.



Environmental engineers Pei Chiu and Julie Maresca each led a Frontier Grant research team during 2014.



Microbial ecologist Tom Hanson and biophysicist Chandran Sabanayagam examine samples of bacteria obtained from Chesapeake Bay.



Educating Environmental Leaders

DENIN recognizes that the solutions to environmental challenges are most likely to be found at the intersections of multiple disciplines. We are providing undergraduate and graduate students with opportunities to explore across disciplines and learn the skills they need to take on leadership roles in the partnerships that will be required to address these challenges.

Interdisciplinary Academic Programs

DENIN facilitated the launch of a new interdisciplinary Water Science and Policy Graduate Program in 2011. More than 30 faculty representing four colleges at the University of Delaware are participating. Offering both master's and doctoral degrees, the program has attracted outstanding students who are exposed to both scientific and policy concepts relevant to water issues. As the first graduates have emerged from



Doctoral student Jennifer Egan presents her research at the inaugural Water Science and Policy student research symposium.

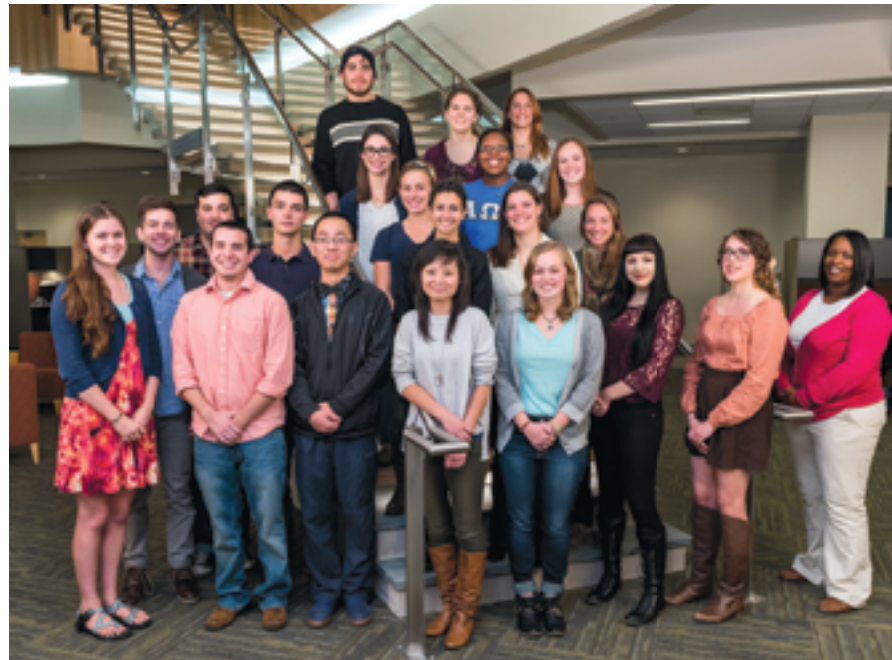
the program, they have proved very attractive to employers. The process of forming another cross-disciplinary program in environmental biogeochemistry is now underway, with DENIN once again playing a key organizational role.

Environmental Fellows

The goal of the DENIN Environmental Fellows Program is to support outstanding doctoral students whose scientific research and interests demonstrate a clear link to societal needs and benefits. DENIN Fellows are selected in two-year cohorts. They receive a generous research stipend and also work together on projects that complement their primary academic programs. Fellows organize and lead a number of events and activities each year to forge connections among their peers and with visiting scientists, policy makers, educators, and the public. We are confident that the DENIN Fellows will be future leaders, capable of bridging science and society.



The 2014–16 DENIN Environmental Fellows include Mahfuzur Khan, Jean Brodeur, Kelsea Schumacher, and Audrey Gamble.



The 2014–15 class of DENIN Environmental Scholars gathers for their orientation with education program manager Yolanda Williams-Bey, on the far right.

Environmental Scholars

The Environmental Scholars Program is a paid undergraduate internship opportunity that provides about 20 interested students annually with a sustained research experience over an academic year, including full-time work over UD's five-week winter session. In addition to research supervised by a faculty mentor, DENIN Scholars attend workshops in career development, selecting a graduate program, and effective written and oral communication. The scholars present the results of their work at a spring symposium.

Ambassadors

The DENIN Ambassadors are a small group of specially selected volunteers who assist the Institute in reaching out to students and the general public. They represent DENIN at campus and community fairs, plan special events such as film screenings, seminars, and performances, and help create a sustainable campus community by communicating scientific information effectively to their peers.



Ambassadors Katy Super, Meaghan Krenn, Radhika Samant, and Marisa Andrezza, along with communications manager Beth Chajes, greet visitors to the DENIN booth at Coast Day.

A Home for DENIN



DENIN is housed in the University of Delaware's Interdisciplinary Science and Engineering Laboratory, known as the ISE Lab. Opened in 2013, this 198,000-square-foot facility was designed to promote interdisciplinary collaboration and problem-based learning.

We share an office suite with two other research centers, the University of Delaware Energy Institute and the Catalysis Center for Energy Innovation, while faculty offices and labs, graduate student work areas (above), and shared research equipment occupy the remainder of the research wing.

In the adjoining education wing, state-of-the-art classrooms, teaching laboratories, and study lounges facilitate interactions between undergraduate students and researchers.

One of the core research facilities in the ISE Lab, the Advanced Materials Characterization Laboratory (left), was outfitted and staffed with \$2 million in assistance from DENIN. The AMCL houses an unparalleled collection of instruments for the chemical analysis of materials ranging from engineered nanomaterials to environmental field samples. DENIN also provides small grants to researchers to cover equipment usage fees.



Progress Through Partnerships

“Environmental managers depend on the most up-to-date science to make sound decisions. The partnership between DNREC and DENIN has fostered collaborative learning, spurring research and resulting in innovative strategies and practical policies to address Delaware’s environmental challenges.”

— DNREC Secretary David Small

Without effective partnerships, academic discoveries may simply languish in scholarly journals. By combining forces with key stakeholders and decisions makers, DENIN works to put sustainable solutions into action.

Establishing closer ties between University of Delaware researchers and Delaware’s Department of Natural Resources and Environmental Control (DNREC) has been a priority of DENIN over the past five years.

In 2010, DENIN initiated a series of informal workshops known as EcoCafés, designed to bring DNREC and University personnel together for breakfast, networking, and discussion of a topic of common interest, thereby increasing the environmental managers’ knowledge of UD’s resources and academic researchers’ understanding of the state’s needs.

Right: DENIN associate director Jeanette Miller takes notes as DNREC and DENIN personnel exchange ideas about research priorities and future collaborations at an EcoCafé event.

Far right: Jack Gallagher, professor emeritus in UD’s School of Marine Science and Policy, has devoted years of research to exploring seashore mallow’s potential as a salt-tolerant crop.

The following year, DENIN and DNREC launched a joint internship program that provides environmental policy-making experience to advanced undergraduate and graduate students. DNREC personnel identify projects and serve as mentors to the interns, who are recruited by DENIN. At the conclusion of their internships, the interns present written and oral reports of their work to DNREC’s senior management team.

The internship program has resulted in real policy improvements for Delaware, including a new bill eliminating outdated and inadequate oil spill liability limits signed into law by Governor Jack Markell in 2013.

DENIN has formed additional partnerships and collaborations with numerous other academic institutions, businesses, government agencies, and nonprofit organizations — in each case with the ultimate aim of providing better ideas and better data to create better solutions. Here is a sampling of our regional and international partnerships:

- Argonne National Laboratory
- Brandywine Conservancy
- Brazilian Synchrotron Light Laboratory (LNLS)
- BrightFields, Inc. Environmental Services
- Brookhaven National Laboratory
- Canadian Light Source
- Chesapeake Bay Foundation

- China Agricultural University
- Christina Conservancy
- City of Dover
- City of Wilmington
- Delaware Bar Association
- Delaware Department of Agriculture
- Delaware Economic Development Office
- Delaware Emergency Management Agency
- Delaware Environmental Observing System
- Delaware First Media
- Delaware Humanities Forum
- Delaware National Estuarine Research Reserve
- Delaware Nature Conservancy
- Delaware Nature Society
- Delaware State University
- Delaware Sustainable Chemistry Alliance
- Delaware Technical Community College
- Delaware Wild Lands
- DuPont Company
- Institute of Urban Environment, Chinese Academy of Sciences
- Institute of Soil Science, Chinese Academy of Sciences
- Johns Hopkins Bloomberg School of Public Health
- Nanjing University
- Pacific Northwest National Laboratory
- Pennoni Associates Inc.
- Rhode Island EPSCoR
- Sassafra River Association
- Stanford Synchrotron Radiation Light Source
- Stroud Water Research Center
- University of Rostock, Germany
- University of Wuppertal, Germany
- Vermont EPSCoR
- Wesley College



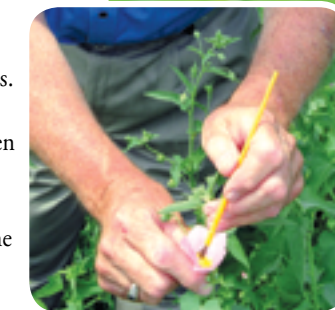
Building the Case for Seashore Mallow

No location in Delaware is more than eight miles from tidal waters, and the average elevation above sea level is only 60 feet. The state’s sea level rise vulnerability assessment concluded that 8–11 percent of Delaware’s total land area could be inundated with saltwater by 2100, with the remaining area more vulnerable than ever to flooding and storm surges. Farmers are already reporting fields becoming unproductive due to increasing salinity of the soil in low-lying areas.

DENIN is facilitating a partnership to explore the viability of seashore mallow, a native salt-tolerant perennial, as an alternative crop on salt-compromised land. The partnership includes plant biologists, cooperative extension specialists, poultry scientists, and the state’s largest land conservancy organization, Delaware Wild Lands. Undergraduate research interns recruited through DENIN’s Environmental Scholars program have been involved in several aspects of the project.

Possible consumer products from every portion of the seashore mallow plant have been identified, ranging from biodiesel derived from oil in the seeds to fiber for textiles to biodegradable cat litter. The poultry industry is a large part of the Delaware and Delmarva Peninsula economy and may provide a large market for milled stems to be used as bedding material in poultry houses.

DENIN provides a hub for these partners to meet and coordinate their efforts, which will hopefully contribute to the resiliency of rural coastal communities in the face of sea level rise.





Pamela Matson, dean of the School of Earth Sciences at Stanford University, was the inaugural speaker in the DENIN Distinguished Scientists Lecture Series.

From seminars to symposia, film festivals to field trips, the hallmark of DENIN-sponsored events is that they bring together scholars from various disciplines for a meaningful dialogue with the public on environmental issues.

In fact, our highest profile events featuring internationally renowned guests are called DENIN Dialogues. They are structured as an on-stage conversation between the guest and a knowledgeable interviewer followed by a substantial question-and-answer period with the audience. Past guests have included Rajendra Pachauri, head of the Intergovernmental Panel on Climate Change; Daniel Hillel, winner of the 2012 World Food Prize; and Terry Tempest Williams, environmental author and activist.

Environmental historian Adam Rome (left) interviews Jeff Goodell, author of the book Big Coal, after a screening of the documentary Dirty Business about the coal industry at the Lights, Camera, EARTH! Film Festival.



An audience member poses a question at a DENIN event, which are designed to encourage discussion among the participants.

The DENIN Distinguished Scientist Lecture Series is designed to engage the audience on a slightly more technical level, while periodic research symposia bring together interested constituencies to explore a particular topic such as sea level rise in more depth.

During 2013, DENIN contributed to conversations beginning in earnest in Delaware about the environmental changes we can expect and the most effective and equitable solutions for dealing with them. Billed as “Challenges and Choices: Preparing for a Sustainable Future in Delaware,” we offered a series of public events focused on climate, land use, food and water security, and energy.

The Lights, Camera, EARTH! Environmental Film Festival, launched in 2014, is co-sponsored by DENIN and the Environmental Humanities Program in the College of Arts and Sciences at UD. It features some of the most creative and provocative voices in the modern environmental movement, both on screen and in person.

STRATEGIC FOCUS

Discover Solutions

1. Provide an incubator for novel approaches to environmental problems that cross disciplinary boundaries.
2. Facilitate and support interdisciplinary research teams that address environmental issues.
3. Recruit, mentor, retain, and engage first-rate faculty, scholars, and graduate students.
4. Compete successfully for multidisciplinary and multi-institutional public and private sector research grants.

Develop Leaders

1. Enhance development of intellectual leaders among faculty.
2. Develop innovative educational opportunities for students inside and outside the classroom.
3. Engage a diverse group of people and institutions in all of our programs and activities.
4. Serve as a go-to source of environmental knowledge for public and private sector leaders and citizens.

Forge Partnerships

1. Connect researchers with relevant decision makers to inform development of policy and management practices.
2. Foster partnerships with private sector organizations that provide opportunities for entrepreneurship, experiential learning, and “green” economic development.
3. Create opportunities for students and faculty to conduct leading-edge research around the world.
4. Improve financial stability through relationships with donors and philanthropic foundations.

FIVE-YEAR GOALS (2020)

Delaware Environmental Institute will have catalyzed multidisciplinary research leading to effective solutions to environmental challenges.

Delaware Environmental Institute will have contributed leaders to a growing international network of environmental experts, decision makers, and problem solvers.

Delaware Environmental Institute will have developed effective partnerships that fulfill emerging demands for environmental information, products, and services.

LONG-TERM OUTCOME

Individuals, organizations, and communities around the world will be able to meet human needs for water, food, energy, and health without degrading the ability of the planet to meet the needs of future generations.

DENIN External Advisory Board

Michael Hochella, *Advisory Board Chair, University Distinguished Professor of Nanogeoscience and Biogeochemistry, Virginia Tech*

Virginia Balke, *Director, DTCC EPSCoR Project, Delaware Technical Community College*

Jeffrey Bross, *Chair of Duffield Associates, Inc., Board of Directors and Executive Committee*

Hugh J. Campbell, Jr., *Director, retired Chemical and Environmental Management Programs, DuPont Company*

Ted Carski, *Global Registration Portfolio Manager in Crop Protection, DuPont Company*

Patricia Dwyer, *Vice President for Academic Affairs, Wesley College*

Scott Fendorf, *Terry Huffington Professor and Chair of the Department of Earth and Environmental Systems, Stanford University*

Helen Fischel, *Associate Director, Delaware Nature Society*

Stephanie L. Hansen, *Associate, Young Conaway Stargatt & Taylor, LLP*

Ruben Kreztschmar, *Deputy Head of the Institute of Biogeochemistry and Pollutant Dynamics, Swiss Federal Institute of Technology, Zurich (ETH Zurich)*

Dyremple Marsh, *Dean, College of Agriculture and Related Sciences, Delaware State University*

Patricia Maurice, *Professor, Civil Engineering and Geological Sciences, University of Notre Dame*

Brad Molotsky, *Executive Vice President, General Counsel and Secretary, Brandywine Realty Trust*

Alexandra Navrotsky, *Edward Roessler Chair in Mathematical and Physical Sciences and Director of the Nanomaterials in the Environment, Agriculture and Technology (NEAT) Organized Research Unit at the University of California, Davis*

Dan Parke, *Director General of Agência Estado, Brazil*

David Small, *Secretary of the Delaware Department of Natural Resources and Environmental Control*

Rick Speizman, *Partner, KPMG LLP, Washington, DC*

Stephen Sutton, *Senior Scientist, Department of Geophysical Sciences and Center for Advanced Radiation Sources,*



DENIN Staff: *Back row, left to right: Donald L. Sparks, director; Cheryl Ackerman, director of evaluation, Kelly Doremus, accountant; Yolanda Williams-Bey, education program manager; Jeanette Miller, associate director, Front row: Kathy Fleischut, administrative assistant; Amy Slocum, assistant director; Beth Chajes, communications manager; Gerald Hendricks, webmaster*

University of Chicago, Argonne National Laboratory

Bernard Sweeney, *Director, President, and Senior Research Scientist, Stroud Water Research Center*

Robert Taylor, *Dean of the College of Agriculture and Food Sciences and Director of Land-Grant Programs, Florida A&M University*

Fu-Suo Zhang, *Dean of the College of Resources and Environmental Sciences, China Agricultural University*

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