

IIHR-HYDROSCIENCE & ENGINEERING

IIHR CURRENTS

Winter 2013-14

 THE UNIVERSITY
OF IOWA
College of Engineering

Water for Life: Focusing on Sustainability





Our Mission

To be a leader in fluids-related fundamental and applied research; to provide interdisciplinary education for future leaders in science and engineering; and to advance knowledge in support of sustainable natural and engineered systems.

Our Vision

To be an international leader among academic institutions in hydroscience and engineering research recognized for integrating laboratory, field- and simulation-based experimentation, and participatory interdisciplinary education.



PHOTO BY MIKE STENSON/VUI PHOTO SERVICES

The IIHR Advisory Board was joined at its 2013 annual meeting by members of the Water Sustainability Initiative (WSI) Board, WSI faculty and steering committee members, and several IIHR faculty affiliates and staff members. Participants included (front row, l to r): Peter Thorne, Teresa Gaffey, Randy Beaver, Ananya Sen Gupta, Laurie Zelnio, Carmen Langel, and Kajsa Dalrymple; (second row, l to r): Troy Lyons, Aaron Strong, Kevin Richards, L.D. McMullen, Adam Ward, Joe Fernando, Jennifer Filipiak, David Cwiertny, and James Smith; and (back row, l to r): Mark Wilson, Larry Weber, Todd Ririe, Paul B. Dierking, Jerry Schnoor, Richard Stanley, and Bob Libra.

IIHR Advisory Board Members

Paul B. Dierking (2012–16), HDR Engineering, Inc.

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James Smith (2010–14), Department of Civil and Environmental Engineering, Program in Geological Engineering, Princeton University

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Alec Scranton, Dean, College of Engineering, University of Iowa

Larry J. Weber, Director, IIHR—Hydroscience & Engineering, University of Iowa

Carmen Langel, Director of Development and Communications, IIHR, University of Iowa

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Follow IIHR and the Iowa Flood Center on social media!

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Artist Mark Marturello, known for his work at the *Des Moines Register*, created this illustration for *IIHR Currents*. Look closely and you'll see not only Stanley Hydraulics Lab, but also representations of Iowa Flood Center radars, a wind turbine, fish passage studies, mussels, and more.



A New 'Golden Era' of Water Research

When I started at IIHR as an undergraduate student, I joined an institute that had already reinvented and reimagined itself time and time again since its founding in 1920. As a student, I conducted research on ice mechanics, which I found fascinating. At that time, IIHR was one of the leading centers for ice research. Today, it's an area of research that has all but disappeared from the institute.

When I was hired as an IIHR research scientist, I had the good fortune to work with Jacob Odgaard and others on fish passage research, developing ways to pass fish safely through or around hydroelectric dams. IIHR researchers had been engaged in fish passage research since the 1930s. I became involved in the 1990s, working with various private and public utilities and federal agencies in the Pacific Northwest. It's been interesting and rewarding work, scientifically and personally. (I love to fish, so preserving healthy fish populations is especially satisfying to me!)

Fish passage research, which has been such an important part of my own career and of the life of the institute, is starting to wind down. It's another example of how our research institute evolves, changes, and transforms itself to meet the challenges of the times.

This past year we reached another transformational moment in the life of the institute. I am proud to announce that all nine members of the University of Iowa's Water Sustainability Initiative are now IIHR faculty affiliates. When these faculty joined the institute, we also created a new water sustainability focus area. This change will bring a host of new ideas, approaches, and innovations to our work.

Let me explain what we mean by "sustainability." It's become something of a buzzword, and is often used without much consideration for its meaning and context. At IIHR, sustainability means using a natural resource, such as water, in a responsible way so that it is not depleted or destroyed. Sustainability means keeping the future in mind, and taking care to make sure resources are available for decades and centuries to come.

The Water Sustainability Initiative includes faculty members from eight different academic departments at the university, including civil and environmental engineering, electrical and computer engineering, journalism and mass communication, chemistry, occupational and environmental health, urban and regional planning, geography, and earth and environmental sciences. I am looking forward to working with these young researchers and finding out where this new interdisciplinarity will take us. In these pages, you'll find several stories about the work of the WSI faculty members (see pages 10–17). I also invite you to learn more about their work on the WSI website (www.iihr.uiowa.edu/watersustainability). I predict you'll be as confident as I am about the future of the institute.

One thing I'm sure of — this is a hallmark moment for IIHR. The institute has never been afraid to explore new avenues and perspectives to stay relevant and address the concerns of the day. These faculty members will help us continue that forward-looking strategy.

So, let me welcome you to the new "Golden Era" of water research. IIHR will be in the thick of it, and I for one can't wait to get going.

LARRY J. WEBER

Director, IIHR—Hydrosience & Engineering, Professor, University of Iowa Department of Civil and Environmental Engineering, Edwin B. Green Chair in Hydraulics





PHOTO BY ANETA GOSKA

And the Rains Came Again

It's not all glamour and adulation being a media darling — it can be time-consuming and demanding. Another round of flooding last year made Larry Weber and Witold Krajewski once again the most popular men in Eastern Iowa — just when they least had the time for it.

“No matter how busy we are, we always make time to talk to the media,” says Krajewski, director of the Iowa Flood Center. “The public needs good, science-based information, and we want them to be aware of the flood-information tools we have made available to the public.”

Weber, who is director of IIHR, is also co-chair of the University of Iowa's Flood Mitigation Task Force, and Krajewski serves on the Johnson County Flood Response Team. Their expertise was essential to good decision-making for the university and the county. Both groups met daily during the height of the flooding.

The university took all the lessons of 2008 to heart. Flood protection measures were deployed across campus, including HESCO barriers on both sides of the river. HESCO barriers are four-foot wire mesh containers that can be filled with sand; they were originally designed for erosion control and military fortifications. According to Weber, the HESCO barriers make excellent flood

protection structures and can be stacked up to three levels high.

University officials also put up the “invisible flood wall” around the Art Building West. This temporary installation of snug-fitting aluminum beams can quickly protect against floods.

IIHR took proactive measures to protect the Stanley Hydraulics Lab (SHL) as well. Glass block windows in the sub-basement were boarded up, and sump pumps were deployed to keep up with leaks. For a short time, research in the tow tank was suspended. Built for the ages, SHL came through the flood with minimal damage.

The 2013 flood protection across campus cost the university more than \$5 million — miniscule in comparison to the cost of recovery from the 2008 event, which is expected to approach \$1 billion.

“Although flood protection is costly, it's an investment that has paid off for the university,” says Weber. “We took the floods of 2013 very seriously and responded with an abundance of caution. The plan we developed after 2008 has left us in a better state of readiness to deal with future disasters.”



Living with Floods

You might think Iowa and New Orleans don't have much in common. New Orleans is perhaps the most free-wheeling, fun-loving city in America, and Iowa ... well, we're known for our hard work and strong values. But we do share a bond — Iowa and New Orleans have both withstood major floods, and have fought back to recover, stronger than ever.

A series of events in the spring and summer of 2013 marked the five-year anniversary of the historic Iowa floods of 2008, recognizing and honoring the strength and resiliency of Iowans in the face of repeated floods. Events culminated in June with free outdoor concerts by New Orleans' Preservation Hall Jazz Band. As residents of New Orleans, these musicians know something about flooding. The concerts were lively, fun events that got Iowans up out of their lawn chairs to join the “second line” — a New Orleans tradition



PHOTO BY ANETA GOSKA



in which audience members follow the band, dancing and celebrating as they march through the crowd.

Living with Floods was a statewide project that started at the University of Iowa. Several UI departments and units collaborated on the project, including the Iowa Flood Center, Hancher, the Center for Global and Regional Environmental Research (CGRER), the UI colleges of education and engineering, the Department of Health and Human Physiology, and the State Hygienic Laboratory. These UI partners engaged with seven communities across the state: Davenport, Cedar Rapids, Council Bluffs, Des Moines, Dubuque, Iowa City, and Muscatine.

Living with Floods sponsored a variety of events in these communities, including an Interdisciplinary Flood Workshop for Teachers in the fall of 2012, which brought together teachers from areas affected by recent flood events to learn how to incorporate environmental learning into their classrooms. Throughout the spring of 2013, Living with Floods sponsored community forums, as well as science, technology, engineering and mathematics (STEM) festivals for K-12 students.

The forums allowed Iowans to talk about flood-related issues, examine better ways to cope with future floods, and learn more about local flood mitigation strategies. Nathan Young, associate director of the Iowa Flood Center, was one of the featured speakers at these events, along with local speakers representing each community.

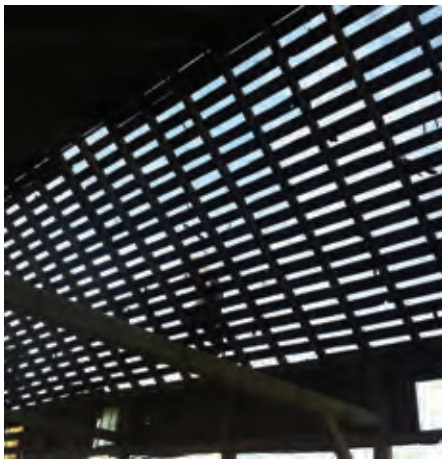
“Community forums like these allow us to share some of the work at the university designed to help Iowans cope with flooding, and that definitely has value,” Young says. “But it was also an opportunity for us all to hear directly from Iowans about local efforts and issues. For me, that’s the really exciting aspect.”

SIHR – Project AWARE

What’s in the river? Water, of course. But there’s also plenty that shouldn’t be there — ovens, refrigerators, tires, bicycles, even light poles. In early July 2013, IIHR’s student group, SIHR, participated in the Iowa Department of Natural Resources’ annual river clean-up event, Project AWARE (A Watershed Awareness River Expedition). Volunteers in canoes collected 34 tons of trash from the Des Moines and Boone rivers, most of which was recycled. IIHR student and SIHR member Daniel Horna Munoz says he and the other SIHR members were stunned at what they discovered in the river. “We couldn’t believe the kind of things we found,” Munoz says. “The rivers are not as clean as we think they are.” He says they had a lot of fun, camping and canoeing while also doing something good for the environment. “I would totally do it again,” Munoz says.



PHOTO COURTESY OF SIHR



PHOTOS BY ANETA GOSKA

This Old Barn

Aging barns dot the Iowa countryside, some leaning a bit, with missing windows and sagging roofs. The numbers are now dwindling, but at one time these barns were at the heart of every farm, providing shelter for cattle and hogs, storage for a winter's worth of hay, and home for platoons of mice and the barn cats who stalked them.

One such barn just west of Iowa City recently woke from its long nap to find itself the center of a whole new buzz of activity. The century-old structure was exactly what IIHR Director Larry Weber was looking for. Weber is restoring a parcel of timber that he has christened Old Man's Timber, and he wanted to find an old mortise-and-tenon, wood-pinned barn to move onto the property to store equipment.

Providence was on his side. When neighbors learned about Weber's quest, they offered him a late 19th-century barn in good shape. Weber took a look at the structure and was excited to see the kind of skilled craftsmanship he admires. The barn's 50-foot beams were held together with long Z-splices and wood pins. In fact, the whole frame is wood-pinned, Weber says.

Weber plans to rebuild the barn at 60 percent of its original size, and he has developed a plan for moving and downsizing the barn. Weber is also working with three Amish craftsmen from Kalona. They hope to have the barn moved and reassembled at Old Man's Timber by the end of next summer.

The project provides a welcome respite from Weber's busy work life at IIHR. "This is a good place to get away," he explains. "I have a great passion for [restoring] the timber. Having a 100-year-old barn on the property is just going to complete my vision."

"I thought it would have been easier to build a new one."

Art Weber, Larry Weber's father



What does Weber's family think of all this — especially his wife Miechelle? “I come up with a lot of wild ideas,” Weber says. “She was pretty supportive of this one, but there was a discussion.” When Weber promised to get plenty of help, she gave it a thumbs-up.

Help has not been difficult to find. Besides the Amish craftsmen, Weber's friends, family, and even some graduate students have been regular helpers. Larry's father, Art, has also been on hand off and on to help. A farmer himself, he brings a bit of practicality to the conversation.

“I thought it would have been easier to build a new one,” Art says.



Stern Named Ashton Professor

IIHR Research Engineer Fred Stern was appointed the George D. Ashton Professor of Hydroscience and Engineering at the University of Iowa on July 1, 2013. Stern is known worldwide for his expertise in computational and experimental fluid dynamics and ship hydrodynamics.

Stern, who is also a professor of mechanical and industrial engineering and a faculty research engineer at IIHR, employs computer modeling and on-the-

Engineering Fun

It was a soggy, rainy day, but that didn't discourage more than 500 people (and Herky) from participating in the IExploreSTEM Festival on May 4 at the Lucille A. Carver Mississippi Riverside Environmental Research Station (LACMRERS) on the banks of the Mississippi River near Muscatine. K-12 students found out how much fun science, technology, engineering, and math (STEM) can be by trying out a variety of hands-on activities. These included an interactive flood model from the Iowa Flood Center and the National Weather Service, an opportunity to build a robot with the Iowa State Extension Office of Muscatine County, and the chance to run through a pit filled with gooey, oozy glop called “oobleck” (a fluid made of cornstarch and water), sponsored by Grain Processing Corp.



PHOTOS BY ANETA GOSKA

water testing in IIHR's state-of-the-art Wave Basin Facility to create software codes that analyze the flow of water around ships.

Stern has high ambitions for the IIHR ship hydrodynamics program. "My vision for the future acknowledges the need for continued emphasis on international collaborations and the building block, step-by-step approach," he explains. "This will help ensure the continuation of Iowa's considerable external funding and international leadership in ship hydrodynamics for the foreseeable future."

The professorship is named in honor of UI engineering alumnus George D. Ashton, an international expert on the study of ice jams, ice control, flooding, snow drifting, snow loads, and river ice.



Eichinger Awarded Hancher-Finkbine Medal

Leadership, learning, and loyalty — for his exceptional embodiment of these three characteristics, IIHR Research Engineer William E. Eichinger was named the 2013 Faculty Hancher-Finkbine Medallion recipient. Eichinger received the honor at the annual Finkbine Dinner on April 9.

Eichinger, who is also the William D. Ashton Professor of Civil Engineering and a professor of civil and environmental engineering, focuses his research on hydrology and fluid mechanics in the environment, atmospheric pollution control and remediation, optical remote sensing, LiDAR (laser radar), and nuclear physics. His present interests are in the

development of wind LiDAR capability, flow and emissions from confined animal facilities, long-range particulate transport from urban areas, and development of the boundary layer.

Eichinger leads a team of student researchers who use LiDAR to measure emissions near large livestock confinement facilities. His students appreciate Eichinger's informal, collaborative leadership style. Recent graduate Brad Barnhart says, "Bill is a great mentor. He lets students choose their projects and allows them the time needed. We have very few rules. We're not required to stay late, or even stay for set hours. This puts the responsibility in our hands. We do our work because we love to do it, not because we have to."

The Hancher-Finkbine Medallion was established in 1964 to recognize exceptional leadership, learning, and loyalty. It is named for the founder of the Finkbine Dinner, William O. Finkbine, and Virgil M. Hancher, a student guest at the first dinner, who later served as president of the University of Iowa.

Making Waves

Associate Research Scientist Yugo Sanada (left) and graduate student research assistant Haitham Elshiekh take the Delft catamaran model for a test run in the IIHR Wave Basin. The wave basin's unique data acquisition system allows researchers to analyze the performance of ships in the design phase. IIHR's ship hydrodynamics team can analyze model-scale ships' performance in real-life situations, using six-degrees-of-freedom motion and wave makers to simulate actual conditions.





A Tale of Two Rivers

Pulled from her peaceful home along the Mississippi River, the turtle peeked tentatively out of her shell. She wondered where she was, and what was happening to her. The classroom was as foreign to her as the dark side of the moon. Students crowded around, pointing their cameras and laughing. One young woman in particular was captivated by the turtle. The student's smile lit up the room — even the turtle stretched her neck out a little bit farther to see her more clearly. Who were these people, the turtle wondered? And why had they come here?

The young people were some of China's finest high school students who had come to learn about the Mississippi River. For the second year in a row, the Lucille A. Carver Mississippi Riverside Environmental Research Station (LACMRERS) welcomed the students as part of "Rivers as Bridges," an international exchange program sponsored by Environment and Public Health Network for Chinese Students and Scholars (ENCSS). The students spent almost two weeks visiting three states (Iowa, Wisconsin, and Illinois) to learn about the importance of rivers in the environment.

The students arrived at LACMRERS, operated by IIHR—Hydrosience & Engineering, on July 24. The program included a rigorous educational curriculum. "Every day, they're basically in a mobile classroom," said Curriculum Director Jack Palmer. It is considered an honor to be a part of the group.

At LACMRERS, researchers had prepared five different hands-on science activities to help the students get acquainted with river, including an introduction to the wildlife of the river — including turtles. Later, the students enjoyed a picnic lunch and boat rides on the Mississippi. They also got a chance to speak with representatives from the

UI International Studies program and an admission counselor.

The students came to the United States with impressions based on American TV and movies, said student Guo Yu. She was surprised by the beauty of the landscape, especially the blue sky and white clouds. She said she had already learned much on her visit. "The Mississippi and Yangtze have the same problems," she said, adding that we should all pay more attention to the environment.

"The United States is very beautiful," said Zon "Steven" Yudong. "This experience has encouraged me to study hard."



PHOTOS BY ANETA GOSKA





Starry Night Over Iowa

IIHR Research Engineer Ching-Long Lin took this photo of the night sky over the Elk Wind Farm near Greeley, Iowa. Wind power continues to be an important area of research for IIHR, a significant step toward sustainable energy, and an economic boon to the state of Iowa.





Welcome to the New Golden Era of

Water Sustainability Brings IIHR into the

THERE'S A SEA CHANGE GOING ON AT IIHR.

Nine new faculty affiliates from across the academic spectrum are transforming the institute with fresh ideas and new focus areas, all in support of an issue that affects every man, woman, and child on the planet: water sustainability.

The University of Iowa's Water Sustainability Initiative (WSI) began in 2009, when the university announced it would create a cluster of new faculty positions to advance research, education, and outreach on water sustainability.

IIHR Director Larry Weber says that the addition of the WSI affiliates and the creation of a new water sustainability focus area will position IIHR to retain its status as a global leader in fluids-related research, education, and service. This may well be a defining moment for the institute, he adds.

"Water is becoming a central focus that cuts across all boundaries," Weber explains. "The enhanced focus on water sustainability will be a hallmark change for the institute as we enter what I think may be a new 'Golden Era' of water research."

The faculty members span the disciplines, from engineering and economics to public health and communications. In 2013, all nine WSI members became IIHR faculty affiliates, while still retaining primary appointments in their home departments. This new focus on sustainability will reinvigorate and refocus IIHR's research, while building on the institute's longtime interest in this issue.

The Water Sustainability Initiative IIHR faculty affiliates are: David Cwiertny, civil and environmental engineering; Kajsa E. Dalrymple, journalism and mass communication; Tori Z. Forbes, chemistry; Ananya Sen Gupta, electrical and computer engineering; Hans-Joachim Lehmler, occupational and environmental health; Craig Just, civil and environmental engineering; Aaron Strong, urban and regional planning; Eric Tate, geography; and Adam Ward, earth and environmental sciences.



PHOTO BY MIKE STENSON/UI PHOTO SERVICES

Sustainability Focus into the 21st Century

An H2O Revolution

Water issues present the perfect combination of complexity and global scale for a multidisciplinary group effort such as this. The collaborative nature of the Water Sustainability Initiative makes many new and fruitful avenues of study possible, allowing the researchers to consider problems they might not have been able to address alone. A better understanding of the broad context for their research enables the WSI affiliates to more completely address complicated water problems.

Why does a water sustainability focus make sense at Iowa? WSI builds on the university's established strength at IIHR and the Iowa Flood Center. Although Iowa is also subject to drought, the state is, for the most part, blessed with an adequate (and sometimes excessive) supply of water. WSI considers the entire spectrum of water issues, from drought to flood, impaired to clean, and rural to urban.

Iowans put their water to work in many ways: for transportation, for irrigation, for drinking water, for recreation, and recently, for ethanol production. But even a water-rich state like Iowa can stretch resources too thin. Many of the WSI affiliates believe that now is the time to consider water sustainability in Iowa, rather than waiting for a serious problem to develop. Since water is a critical resource that touches many aspects of society, it makes sense to address the sustainability of water resources in a multidisciplinary manner.

Iowa is also ripe for change. The repeated floods of the last 20 years have created a population eager to learn how to better manage water resources. Here in Iowa, we have a community that is receptive, and in many cases acutely aware, of how water impacts them.

The Power of Collaboration

How does an alliance between nine academics from very different fields work in the real world? So far, it's working very well. IIHR Research Engineer Jerry Schnoor, the group's mentor and leader, has organized regular water sustainability seminars, with a different cluster member presenting his or her work at each meeting. The WSI members have gotten to know each other quite well, and with a good understanding of each member's research interests, they can look for synergies and opportunities to pursue together.

And collaborating can be exciting. As part of the university's Water Sustainability Initiative, IIHR's new faculty affiliates are part of an important new research focus that will positively impact IIHR, the state, and the world for decades to come.

Nine new faculty affiliates from across the academic spectrum are transforming IIHR with fresh ideas and new focus areas, all in support of water sustainability. The Water Sustainability Initiative (WSI) includes (clockwise from center): David Cwiertny (seated, back), Craig Just, Eric Tate, Kajsa E. Dalrymple, Adam Ward (seated, front), Tori Z. Forbes, and Hans-Joachim Lehmler. Not pictured: Ananya Sen Gupta and Aaron Strong.

All Iowans benefit from cheap and plentiful food ... but are we sacrificing water quality?

Farmer Brian Scott turns to look over his shoulder at the 60-foot wide, 24-row corn planter as it rolls through the field. Soon, however, Scott's eyes settle back on a computer screen in the tractor cab. The screen shows a digital map of the route he set up for the tractor to follow through the field. Even though he sits in the driver's seat, Scott will quickly tell you that most of his equipment basically drives itself. He believes in precision agriculture, from GPS-based yield and application maps to smart tractors. "I'm all about the latest and greatest in ag tech," Scott says.

Another example of precision agriculture: Scott uses variable rate technology (VRT) to apply fertilizer, based on soil tests he conducts on a third of his fields each year. The data are used to create maps showing the optimum fertilizer rate for each zone. It's an efficient method that closely matches the need for fertilizer to the amount applied. For corn, Scott also uses a split application schedule, applying part of the fertilizer in the fall or early spring before the corn is planted, and the remainder after the corn emerges, when it needs nitrogen the most. He believes the split application helps prevent the fertilizer from leaching into the groundwater and ultimately will save him money from over-application.

Agriculture these days is a high-tech business. Farmers like Scott use technology to boost yields and profits, and potentially to manage environmental issues as well. But 2013, which brought floods to Iowa followed by a drought, also delivered a record pulse of nitrogen from the Midwest into the Mississippi River and ultimately the Gulf of Mexico.

So What's Going On Here?

IIHR Assistant Research Engineer Adam Ward studies how water and pollutants, such as nutrients, pharmaceuticals, nanoparticles, and more, are transported through the landscape and eventually into our streams and rivers. Ward, who is also an assistant professor in the University of Iowa Department of Earth & Environmental Sciences, is interested in where contaminants enter the natural system, how they move through and between streams, wetlands, and aquifers, and how we can better manage for or clean up these contaminants.

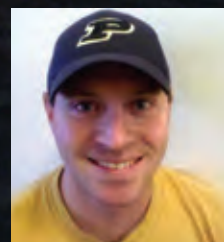
"I'm a stream-hugger, to coin a phrase," Ward says. Iowa in particular, he says, faces major water-quality and quantity challenges — addressing these challenges will mean balancing our actions on the landscape with sustainable resource management. Given the efforts to make fertilizer use more efficient, Ward wants to understand why we have large nitrogen pulses like the one recorded in 2013.

Weather plays a major role. In a drought year such as 2012, plants don't use as much water and nitrogen to grow, resulting in smaller yields. Fertilizer applied in the spring, with hopes for ideal rainfall and a bumper crop, lingers in the soil through the growing season and on into the winter. Spring rains the next year mobilize the nitrogen, sending it downstream in large amounts. The drought of 2012, followed by a wet spring in 2013, made this year's pulse worse and moved a lot of nitrate very quickly, Ward explains.

Crop yields are controlled by nutrient availability and weather. We control nutrients through crop rotation, soil conservation practices, and fertilizer application. Farmers apply fertilizer strategically in anticipation of what they hope will be ideal weather conditions. But when we draw less than ideal weather, there are economic and environmental consequences. Ward is quick to point out that farmers are not the bad guys in this scenario. Farmers and land managers are stewards of



AGRICULTURE THESE DAYS IS A HIGH-TECH BUSINESS. FARMERS LIKE BRIAN SCOTT USE TECHNOLOGY TO BOOST YIELDS AND PROFITS, AND POTENTIALLY TO MANAGE ENVIRONMENTAL ISSUES AS WELL.



SMALL PHOTO COURTESY OF BRIAN SCOTT



WARD SAYS THERE ARE BOTH “HOT SPOTS” AND “HOT MOMENTS” ON THE LA
HOT SPOTS ARE LOCATIONS WHERE A DESIRED PROCESS, SUCH AS NITROGE
HOT MOMENTS ARE TIMES WHEN THESE PROCESSES TURN ON AT CERTAIN

WE NEED TO MATCH THE POLLUTANT

important natural resources, and of our food system, he explains. “I don’t know of a single land manager whose aim is nutrient runoff — farmers recognize the economic and environmental costs of nutrient loss.”

Whose Fault Is It, Then?

We all get a share of the blame, Ward says, because we all benefit from the cheap and plentiful food provided by our current food system, which he says is largely subsidized by nitrogen fertilizer. Ward says he wants to help Iowans connect the dots to see how actions on the landscape have environmental, economic, and social consequences. He hopes to help inform Iowans on how climate and human systems interact, so we can more sustainably manage water resources.

Ward’s focus is on how water moves through the landscape, ranging from where the raindrop first touches the ground, through the soil column, into the groundwater, and eventually into the stream network. He asks questions such as: how much water is moving through different locations on the landscape? How long does the water spend in any one place? What contaminants move with the water? What are the ecological costs or benefits associated with this transport?

Ward says there are both “hot spots” and “hot moments” on the landscape. Hot spots are locations where a desired process, such as nitrogen removal, occurs at a high rate. Hot moments are times when these processes turn on at certain locations for a short while. We need to match the pollutant source with the hot spots and moments in the system, Ward explains. For example, if wetlands are hot spots for nitrate removal, but those wetlands are the most efficient in the late summer, their capacity for nitrate removal might not be well matched with peak nitrate loading, which occurred in early spring in 2013. Ward says he hopes to work toward management practices in which nitrate loads and efficient removal are well-synchronized in the system.

Adam Ward, who laughingly calls himself a “stream-hugger,” deploys a water-quality sensor in Clear Creek near Iowa City. Ward studies how water and pollutants, such as nutrients, pharmaceuticals, nanoparticles, and more, are transported through the landscape and eventually into our streams and rivers.

“It’s a matter of identifying the right combination of infrastructure and management to meet multiple objectives,” Ward explains.

What-If Games

Ward and several of his colleagues in the University of Iowa’s Water Sustainability Initiative (WSI) recently applied for a National Science Foundation grant to study the environmental, political, and economic impacts of land management decisions, and the information used to make those decisions. Where does the information supporting decision-making come from? Who could influence land managers to take a second look at their practices?

Being a member of WSI helps build an effective, diverse team very quickly, Ward says. “It lets me think about problems a little differently, because I know I have a team of experts who are excited about these interdisciplinary issues.”

In his research, Ward uses field monitoring to understand how water and solutes move through the system, and numerical modeling to test the variables, whether related to the science or to human decision-making. This combination of observations and modeling allows him to make projections of what might happen in the future. Field monitoring helps us understand the current situation, Ward explains. Numerical modeling allows us to rapidly explore a range of potential futures, and to understand the trade-offs between actions and outcomes.

Ward hopes that with good science and strong leadership, Iowa can become a leader in water quality. “I would love to see Iowa take a leadership role in balancing social, economic, and environmental outcomes of our management activities,” he says. Land management decisions, even the status quo, represent trade-offs between these outcomes. Ward hopes his research can inform decision-makers, ranging from individual farmers to policy-makers.

Midwestern farmers definitely have a keen interest in the research conducted by Ward and his colleagues. “The bottom line is, if I can lose or use less nitrogen, I ought to make more money,” farmer Brian Scott explains. And if less nitrogen leaches into the groundwater, it’s good for everyone downstream who drinks or uses the water.

LANDSCAPE.

NITROGEN REMOVAL, OCCURS AT A HIGH RATE.

AT CERTAIN LOCATIONS FOR A SHORT WHILE.

SOURCE WITH THE HOT SPOTS AND MOMENTS.

The Flow of Information

Talking about Iowa water challenges ...



Kajsa Dalrymple (right) and her research group (“Team Water”) are conducting a study to determine how water-related information is disseminated to Iowans through newspapers. Also pictured here are Team Water members Stephanie Miles (left) and Joanna Krajewski.

Wisconsin Department of Natural Resources to develop messages to help prevent the spread of invasive species in lakes and streams. They studied public attitudes and developed messages to change behavior of boaters and anglers.

One particularly fascinating discovery was the important role of opinion leaders. In this case, they found that bait vendors could influence others to prevent the spread of invasive species.

n’s complicated and listening

ONE of Kajsa Dalrymple’s chores was to help wash the family’s fruits and vegetables with iodine-laced water every day — to an 8-year-old, it seemed like a boring, unnecessary job. Standing at the sink, she sighed and rolled her eyes. “Why do we have to do this?” she asked her mother.

Her mother, a civil engineer, explained why it was important to kill any contaminants on the food — people can get sick, or even die, from water-borne illnesses. Living in Africa, the family also had to boil their water for at least 20 minutes and then filter it before they could drink it. Frequent water shortages also meant they filled buckets and even the bathtub so they would have water to use for bathing and flushing the toilet.

Even at such a young age, Dalrymple began to see how important it is to have access to clean, safe, plentiful water.

Talking About Water

Today, Kajsa Dalrymple is an assistant research scientist at IIHR and a member of the Water Sustainability Initiative (WSI). Her work focuses on water communication — how we learn about water issues, and how information affects our behavior. It’s a new field of study, she says, but one of increasing importance.

Dalrymple, who is also an assistant professor in the School of Journalism and Mass Communication, spent the first 10 years of her life in Africa (Rwanda, Mali, and Chad), where her father organized agricultural cooperatives, and her mother used remote-sensing to study agricultural water use. “It absolutely shaped my worldview,” Dalrymple says of her time in Africa. At an early age, she developed a deep love of travel and languages, while also recognizing that issues of water accessibility and quality were key to human survival in all parts of the world.

After moving back to the United States, the family settled in the small town of Lodi, Wis., where Dalrymple attended high school. After undergraduate study in political communication at Cornell University, she pursued a PhD at the University of Wisconsin-Madison. Dalrymple and Professor Bret Shaw worked with the

Murky Waters

When Dalrymple came to Iowa, she found a completely new environment. In Iowa, agriculture dominates the landscape, virtually border to border. The culture here is unique, Dalrymple says, and developing a thorough understanding of this Iowa ethos is an essential first step to her work. Iowa’s unique culture also requires new, innovative outreach approaches for groups and communities, such as large corporate farms, that might not have been considered before.

Researchers also need to understand the current flow of information and the attitudes that already exist. With this in mind, Dalrymple and her team of graduate students conducted a statewide public opinion survey in late 2013 to learn what Iowans think about water issues and what differences may exist among groups.

Dalrymple is also studying how water-related information is being disseminated to Iowans through the media — primarily newspapers. “Team Water,” as Dalrymple calls her research group, is collecting two years of water-related articles from 11 Iowa newspapers. They sorted and coded the articles by the type of information presented, how it was framed (politically? economically?), and any suggestions for behavior changes that were made.

With WSI colleague Adam Ward (see story page 12), Dalrymple recently applied for a grant from the National Science Foundation to study water sustainability and climate change. She hopes the research will help identify Iowa opinion leaders who could affect behavior among land managers, in the same way that bait vendors influenced Wisconsin anglers. Water management authorities, or WMAs, could fulfill that role, Dalrymple suggests.

Reaching Out

Dalrymple hopes to turn her research into insights on how to communicate more effectively, while providing the information that the public wants and needs. A larger goal for the university as a whole is to enhance engagement with the public, and to improve outreach efforts. Researchers can do a better job of participating in the public conversation about water issues, Dalrymple says, by connecting with journalists and talking about research findings in accessible and useful ways.

She’s excited to be in Iowa, which she believes is well positioned for change. Iowa could take the lead in the efforts to create a more sustainable future with regard to water, Dalrymple says, and have a significant impact on water quality nationally. “I have a lot of pride, not only for this state,” Dalrymple says, “but also for this university.”

IIHR's approach to sustainability evolves with the times

By Cornelia F. Mutel

SUSTAINABILITY. The word, as commonly used, focuses on maintaining life and function today, without compromising the potential of future generations or ecosystems. But it's a word with many meanings, a word that is typically defined by the focus of the speaker and his or her priorities.

At IIHR, sustainability considers the purity and flow of water, a substance crucial to all life. About two-thirds of the human body is water, and nearly three-quarters of our planet is covered by water. Water is elementary to plant growth and food production. Without pure water in the right places at the right time, life systems flounder and fail.

IIHR's research on water sustainability began shortly after the Hydraulics Laboratory first opened its doors, long before "sustainability" became a buzzword. But research here has evolved along with the times.

Early Sustainability Initiatives

Much of IIHR's research has considered guaranteeing water's healthy flow patterns. In the 1920s, for example, Model T Fords were making automobiles accessible to middle-class citizens, and highways were cropping up in response, but haphazardly and without much planning. Thus the federal government started to regulate and standardize road-building. But what was to be done about the water that

flooded and washed out roadways, making them unusable? This question brought some of the first research funding to the laboratory. It seemed clear that flowing water should be transmitted through culverts underneath the new highways, but should the culverts be round or square, rough or corrugated, concrete or clay or metal? The U.S. Bureau of Roads answered these questions by performing more than 3,000 culvert tests in the laboratory's flume next to the Iowa River. This research led to publication of the lab's first research bulletin.

Other early sustainability initiatives considered water quality. Indoor plumbing was becoming more common in America in the early 1900s. But that didn't mean that piped water supplies delivered clean water. Plumbing fixtures sometimes sported pollution-spreading cross connections that pulled wastewater into incoming pipes, co-mingling drinking water and sewage.

Improperly designed or poorly constructed plumbing systems were commonplace enough to draw significant funding to IIHR in the late 1930s and 1940s, when the Hydraulics Laboratory became the official testing center of the National Plumbing Laboratory. Studies were performed on the prevention of back-siphonage, the hydraulics of flush toilets, the intrusion of sewer gas, and similar subjects. Concerns about safe indoor plumbing systems led IIHR researchers to lecture to medical students about plumbing dangers and sanitation and to make educational films on the subject.





PHOTOS COURTESY OF IIHR ARCHIVES

IIHR'S RESEARCH ON WATER SUSTAINABILITY BEGAN SHORTLY AFTER THE HYDRAULICS LABORATORY FIRST OPENED ITS DOORS, LONG BEFORE "SUSTAINABILITY" BECAME A BUZZWORD.



IN THE 1930S, IIHR'S STAFF TESTED DIVERSE FULL-SCALE AND SMALL-SCALE EXPERIMENTAL FISH LADDERS IN THE LAB'S FLUMES, COINCIDENTALLY RECORDING COMMENTS ON THE MIGRATION HABITS OF MORE THAN A DOZEN FISH SPECIES.

New Concerns, New Research

More recent examples of IIHR's water-sustainability research include modern water-pollution projects. These were initiated because of the increasing environmental concerns of the late 1960s and 1970s. Before then, water-pollution regulations did not consider, for example, thermal pollution created when steam-electric power plants dumped heated wastewater into rivers or lakes. That wastewater could raise the temperature of natural waterways by many degrees, but little thought was given to the consequences of heated water on fish and other life. IIHR was involved in remediating this problem from the late 1960s into the 1980s, when it modeled power-plant thermal outfalls, designed better water-discharge systems, and studied the operation of cooling towers and other closed-circuit cooling systems that recirculated and reused heated waters.

In another effort, IIHR developed dropshafts to carry wastewater into voluminous underground storage caverns underneath large cities. These caverns were used when downpours from storms overwhelmed sewage-treatment plants; with the caverns, excess wastewater could be held and withdrawn for processing bit by bit, rather than dumped untreated into natural waters. IIHR's dropshafts are now utilized by major cities around the world.

Page 18: Early research at the institute confirmed the dangers of cross-contamination in indoor plumbing.

Page 19: Plumbing research in the 1930s helped keep the institute alive through the Great Depression.

Left, counterclockwise from top:

Early research on fish passageways began in the 1930s with experimental fish ladders.

(Far left and center photos) Plumbing research was a centerpiece of IIHR's industry-oriented research in the 1930s, here carried out in a "model house" for plumbing studies.

A dropshaft study in the early 1980s showed that swirling flow entering a pipe leaves a core of air in the center. This flow is more stable, pressure is equalized, and cavitation problems are decreased, allowing waste water to safely enter underground storage caverns.

Sustaining the Web of Life

Sustainable water flows are as crucial to the planet's millions of plant and animal species as they are to humans. This recognition has drawn IIHR researchers into one of the largest initiatives of recent years: designing fish passage systems for the Columbia River and its tributaries, whose flows are interrupted by numerous massive electric-generating dams. Without IIHR's highly successful fishways now in operation on these dams, salmon would be unable to navigate to and from their up-river spawning grounds to the ocean, where they live most of their lives. The salmon could not reproduce successfully, and the web of life would be irreversibly weakened.

IIHR has been carrying out Columbia River fish passage research since the early 1980s. But fish passage studies began at IIHR in the 1930s, when Iowa's fish were being similarly hampered by the state's many low-head dams that had been constructed in the 1800s in conjunction with grain and lumber mills. The dams seriously interfered with seasonal fish migrations and threatened the survival of some species. In response, IIHR's staff tested diverse full-scale and small-scale experimental fish ladders in the lab's flumes, coincidentally recording comments on the migration habits of more than a dozen fish species.

Today, as throughout human history, sustainable water systems may be the most elementary requirement of life on earth. The search for sustainability is now intensified by the planet's large human population – seven-plus-billion and growing – and by the emerging pressures of climate change and all it infers – moister air, increasingly heavy precipitation and larger storms, ocean acidification, shrinking clean-water supplies and shriveling lakes, dwindling irrigation reservoirs, and the like. In response, IIHR is broadening its sustainability focus through both the Iowa Flood Center (see page 26) and through the Water Sustainability Initiative (see page 10).

Sustainability. It's a word that looks into the distant future, considers the broad possibilities, and responds. It's a word that describes what IIHR has done now for nearly a century and one that increasingly guides where we will go in future years. It's a word whose meaning evolves with the times and a concept that is now more crucial than ever.

PCBs were outlawed in the 1970s — so why don't levels keep going down?

PCBs: A Disturbing Legacy and Ongoing Threat

UNFORTUNATELY, PCBs ARE ALMOST EVERYWHERE.

IIHR Research Engineer Keri Hornbuckle is well aware of how thoroughly PCBs have permeated our environment. What she wasn't expecting to find was PCB11 — which had rarely before been reported — in the air near Chicago.

Polychlorinated biphenyls (PCBs) were banned by law in 1976. Hornbuckle had never found PCB11 in the 25 years she has spent studying the chemical compounds. Why would it suddenly turn up now?

"I was quite sure we had made a mistake," Hornbuckle says.

A Troubling Legacy

IIHR Assistant Research Scientist Dingfei Hu (now at Smithers Viscient near Boston) had indeed found PCB11. Working with Hornbuckle and Andres Martinez (then a PhD student), he went on to conduct a detailed literature search and additional research to prove it. Using new methods and new analytical standards, Hu published several papers on the subject of non-legacy PCB11. The findings were a surprise to the scientific community that studies PCBs. But the discovery quickly led to worrying questions. Where did the compound originate? Was it increasing, and if so, why?

Hornbuckle and Hu are part of a research center at the University of Iowa, the Iowa Superfund Research Program (ISRP), which focuses on the sources, exposures, and toxicities of PCBs in the environment. The center is funded by the National Institute of Environmental Health Sciences, part of the National Institutes of Health.

Hornbuckle, who is also a professor of civil and environmental engineering, says ISRP is a powerful collaboration. The multidisciplinary center brings together scientists with expertise ranging from engineering to toxicology, microbiology, radiology, public health, chemistry, and more.

"That's one of the great things about the center," she explains. "What we learn as engineers and chemists gets used to promote excellent science in other areas. It's really exciting."

A Painstaking Search

Researchers had for years assumed that all PCBs in the environment were "legacy PCBs," produced before the chemical compounds were banned in 1976. After the ban, PCBs in the environment decreased sharply — but then the decreases slowed down and leveled off. Researchers wondered — why don't PCB levels keep going down?

The evidence seemed to point to a more current source. Hu, an analytical chemist, began a laborious process of detective work, matching up identified PCBs with possible sources.

Almost 10 years earlier, scientists in New York had found PCB11 in water near a paint plant, and Hu suspected the source was current paint pigment production. He set out to prove this startling idea by analyzing pigments he bought at a local home improvement store. He found PCB11 and 50 other compounds, including toxic dioxin-like PCBs.

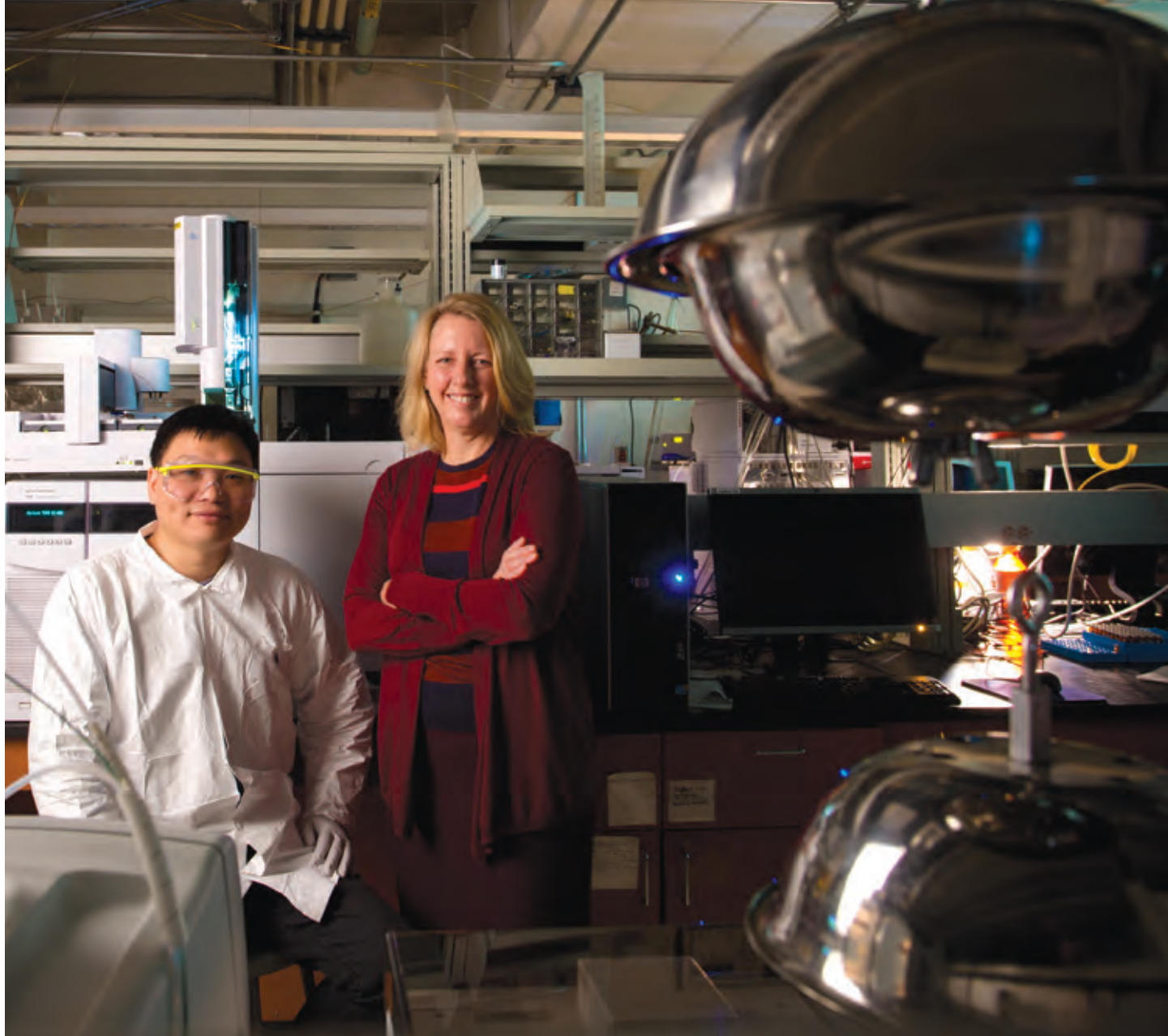
It was a surprising discovery for the whole team. Since PCBs had been banned for decades, Hornbuckle wasn't expecting to find them in products currently being sold and widely used. How did this happen?

A Loophole Exposed

Hornbuckle says that EPA rules appear to exempt pigments and dyes from the prohibition of PCB production. Considering how many products use paints, pigments, and dyes, this rule could have had a major impact.

Pigments are everywhere — from plastic bags and packaging to newspapers, magazines, and more. Now, we realize these pigments can bring PCBs with them. "We know that the magnitude of release is so large that PCB11 and perhaps the other PCBs that are in paint may equal the contribution from legacy PCBs," Hornbuckle says.

Hornbuckle says she's impressed by Hu's determination to uncover non-legacy PCBs. "This part is very clever," Hornbuckle says. Using his findings from individual PCBs in specific pigments, as well as limited literature reports, Hu was able to deduce most of the proprietary processes the industry uses to produce the PCB-laced paint.



'PCBs are Nasty'

Once PCBs are in our bodies, some of them accumulate. Some are also metabolized to other chemicals, or flushed. The most common entry method is in the food we eat. "Old, large, fatty fish are the worst," Hornbuckle says. "You could get a lot of PCBs in a single meal." Once PCBs are in the lower food web, they build up, or biomagnify.

The materials used to build and finish our homes also contribute PCBs to our bodies. Homes, schools, and other buildings built between 1930 and 1970 could include caulking, paint, and electrical equipment with high levels of PCBs. Remodeling done after the 1970s can reduce PCB levels a great deal. Since PCBs affect our hormones, they can have a variety of negative health effects. PCBs are fat soluble, can mimic hormones and act as endocrine disruptors, interfering with the reproductive systems of mammals and birds. Some PCBs are very persistent, and can be passed from mother to child through several generations. For vulnerable populations, such as developing fetuses, PCBs can act as a neurotoxin. They are also known carcinogens.

"That's pretty scary," Hornbuckle says. "Toxicologists don't know what makes one person get cancer, and another person not. They also don't know exactly how these chemicals affect the development of babies."

At some point, Hornbuckle says, it's up to the public to decide if the cost of eliminating PCBs is worth it. If trace levels of PCBs were no longer allowed, paint and other products might be more expensive. Certain dyes might be unavailable or less permanent.

Is it worth it?

Hornbuckle is hopeful. "I think publicizing this science has a potential to make a change," she says. "I think it's going to make a difference."

Dingfei Hu (left) and Keri Hornbuckle were surprised when Hu discovered non-legacy PCB11 in the air near Chicago. The findings quickly led to worrying questions: where did the compound originate? Was it increasing, and if so, why?

Plume Chasers

Iowa City landfill fire sparks research, public service

ON MAY 26, 2012, Diana Thrift was eating dinner with her family when she learned that a fire was burning at the Iowa City Landfill, just one mile away. She rushed outside and saw dramatic, incredibly bright orange-red flames. “For a long time, flames filled the horizon,” she says.

The fire at the landfill started on Memorial Day weekend and burned on for weeks, consuming shredded tires in the landfill’s liner system and creating smoke that was dangerous as well as foul-smelling. According to estimates by the city of Iowa City, the fire burned the equivalent of 1.3 million tires in the 7.5-acre fire area.

Where There’s Smoke, There’s Danger

Landfill fires are difficult to control, and often spew highly toxic emissions into the atmosphere. According to air samples taken two miles from the fire and analyzed by University of Iowa Assistant Professor of Chemistry Elizabeth Stone, the Iowa City smoke plume contained polycyclic aromatic hydrocarbons, or PAHs, at concentrations 100 times higher than normal. PAHs have been shown to cause tumors and reproductive problems in lab animals. Volatile organic compounds (VOCs), such as benzene and benzo[a]pyrene, have also been detected in the open burning of tires. According to the EPA, VOCs can cause a variety of symptoms, including headaches, loss of coordination, and nausea; damage to the liver, kidneys, and central nervous system; and eye, nose, and throat irritation.

Thrift, who suffers from allergies and sensitivity to smoke, became worried by the plume of oily black smoke that darkened the sky for weeks. “The smell was terrible,” she remembers, “And the huge black smoke plume looked and felt menacing.”

Because she spends a lot of time outdoors, Thrift says the situation caused her a lot of anxiety. “It kept going on and on and on,” she says. “I knew it was toxic smoke, very polluting to the environment. It felt like we were having an environmental disaster.”

For IIHR Research Engineer Charles Stanier and his research partners Stone and Scott Spak, news of the fire was a call to action. Stanier deployed his group’s mobile atmospheric sampling unit shortly after the first reports of fire. Stone was already sampling for another project, and increased her sample coverage, and Spak began creating a smoke forecast model. They hoped to offer the Johnson County Health Department

PHOTOS BY ANETA GOSKA





An Iowa Flood Center radar, stationed near the Iowa City Landfill, for a time appeared dangerously close to the fire.

(Left) Charles Stanier quickly deployed his research group's mobile atmospheric sampling unit after the first reports of fire.

information about the smoke plume's movements, which could help concerned residents like Thrift.

Stanier's mobile sampling unit, which was being prepared for another research project, is equipped with instruments that make air-quality readings every 10 seconds. The instruments sample for carbon monoxide, carbon dioxide, and sulfur dioxide, and can also detect particle size. The trailer was moved four times during the fire to capture data within the smoke plume itself, while stationary sampling instruments at two additional locations also made particulate and gaseous measurements.

Forecasting the Plume

Using a weather forecasting system developed at the University of Iowa's Center for Global and Regional Environmental Research (CGRER), the team predicted hourly smoke concentrations at 500-meter resolution throughout Iowa City and Johnson County, and generated maps showing where the smoke was expected to go the next day. Spak led this part of the effort, and the team provided these forecasts to Johnson County public health and emergency management officials, offering a timely, valuable public health response to an extreme air pollution event.

Stanier, who is also an associate professor of chemical and biochemical engineering, conducts lab experiments and field sampling of air pollution, particularly aerosol particles. He also uses computer simulations to understand atmospheric aerosol chemistry, and the health effects of airborne contaminants. He recently received the National Science Foundation's CAREER Award for his work on ultra-fine particle generation.

Stanier says the team's efforts during the fire made sense from a public service standpoint as well as a research perspective. "I really do want to understand the atmosphere and its effect on health and the environment," Stanier says. "This extreme event made it possible for us to learn more about the movements and makeup of smoke from a fire like this one, while also serving a vital public health need." He hopes that the team's work on the fire can help provide a response template for other communities that experience a landfill or industrial fire like the Iowa City event.

Stanier says his overarching goal is to develop models that can more accurately predict the concentrations, sizes, and proportions of particles in the atmosphere. If he and his team can achieve that, Stanier says, they will have succeeded.

IFloodS: Adventures in Flood Forecasting

Iowa Flood Center collaborates with NASA to collect a 'gold mine of data'

NICK THOMAS, Mohamed ElSaadani, and the other IIHR students watched with pride and just a hint of trepidation as a crane lifted a 100-foot radar dish, shining brilliant white against the cold blue Iowa sky, high into the air and set it on its pedestal. The students had spent the day tightening bolts and assembling supports, helping a crew from NASA construct the S-band polarimetric NPOL radar in an empty cornfield near Waterloo.

Thomas was selected to climb up into the assembled radar dish to install the waveguides that funnel the electronic signal out from the radar's antenna. For his own sake, Thomas wanted to do a good job – and also for the sake of the Iowa Flood Center and its ongoing relationship with NASA.

IFloodS

The NPOL radar was the centerpiece of the Iowa Flood Studies (IFloodS) project that brought NASA to Iowa to collaborate with the Iowa Flood Center (IFC). The six-week project, which began May 1, deployed state-of-the-art instruments across Eastern Iowa to collect ground measurements of precipitation events. The instruments included six radars and numerous disdrometers and rain gauge platforms equipped with soil moisture probes installed throughout the Turkey River watershed. The IFloodS project was the ground validation part of NASA's Global Precipitation Measurement Mission, an international satellite operation focusing on global precipitation measurements from space.

How do you get NASA to come to Iowa? It doesn't hurt to have friends in high places. IFC Director Witold Krajewski has been working with NASA for decades, and he suggested to his agency colleagues that Iowa would be the perfect place for this project. The Hawkeye State, with its relatively flat terrain and absence of problematic coastlines and mountains, is also home to the Iowa Flood Center and its instrumentation, expertise, energy, and enthusiasm. And in recent years, Iowa has also had experience with repeated flooding.

But the previous year, 2012, had been anything but rainy. A record-setting drought parched crops and turned streams to dust. More than anything else, Krajewski worried that the drought would stretch into 2013. How can you study precipitation if it doesn't rain? All his worrying was for naught, however, because the spring of 2013 set new rainfall records.

Mission: Possible

At times, the IFloodS campaign stretched the IFC team to its limits. Frequent thunderstorms and lightning strikes took down power, and often the IFC radars as well. Krajewski and his team spent many nights babysitting the radars and other equipment. People were stressed and tired, and families felt the strain. "We are very fortunate that we have excellent people," Krajewski says. "Without these guys, you know ... mission impossible."

The IFloodS mission was comprised of three parts: a large network of ground instruments, including rain gauges and disdrometers, which measure raindrop size; advanced precipitation radars, which measure rain as it falls; and satellites passing overhead. "We're trying to figure out how well our satellites estimate rainfall," says Walt Petersen, GPM ground validation scientist at NASA's Wallops Flight Facility in Virginia. "This study was unique in that it took space-borne observations, it took ground-based observations, and it brought those things into a modeling framework that should further our ability to predict flooding."

Nick Thomas (right) was selected to climb up into the assembled radar dish to install the waveguides that funnel the electronic signal out from the radar's antenna.

(Above left) Dan Ceynar and NASA's Matt Wingo adjust a micro rain radar, which measures the velocity and size of raindrops.

(Above right) The S-band polarimetric NPOL radar's 100-foot dish presided over an empty cornfield near Waterloo.

PHOTOS BY ANETA GOSKA



The GPM and IFloodS teams use the ground data as a reference set, information they can then compare to the rainfall measured by satellites. The rainfall estimates also feed into flood prediction computer models, and can be used to evaluate how well the other flood forecasts perform, using data from satellites and radars to compare.

The results will mean a better interpretation of the raw rain data and improved rainfall estimates worldwide from the new satellite. For the Iowa Flood Center, Krajewski says, the benefits could be closer to home. “Our hope is that with all that information, we can really improve our flood forecasting models.”

Living with Floods – Again

Early on, Krajewski had stopped worrying about drought, but as the rain continued to fall, he had to contend with a new worry – floods. In late May and early June, record-setting rainfall in Eastern Iowa conjured up the specter of the 2008 floods that had devastated Iowa City and cost the University of Iowa hundreds of millions of dollars in damages.

“All of a sudden, the field campaign became unimportant,” Krajewski says. The very real threat to Iowa City and the University of Iowa meant that Krajewski had to turn his attention to flood response, and as a member of the Johnson County Flood Response Team, he added daily meetings and frequent media requests to his schedule.

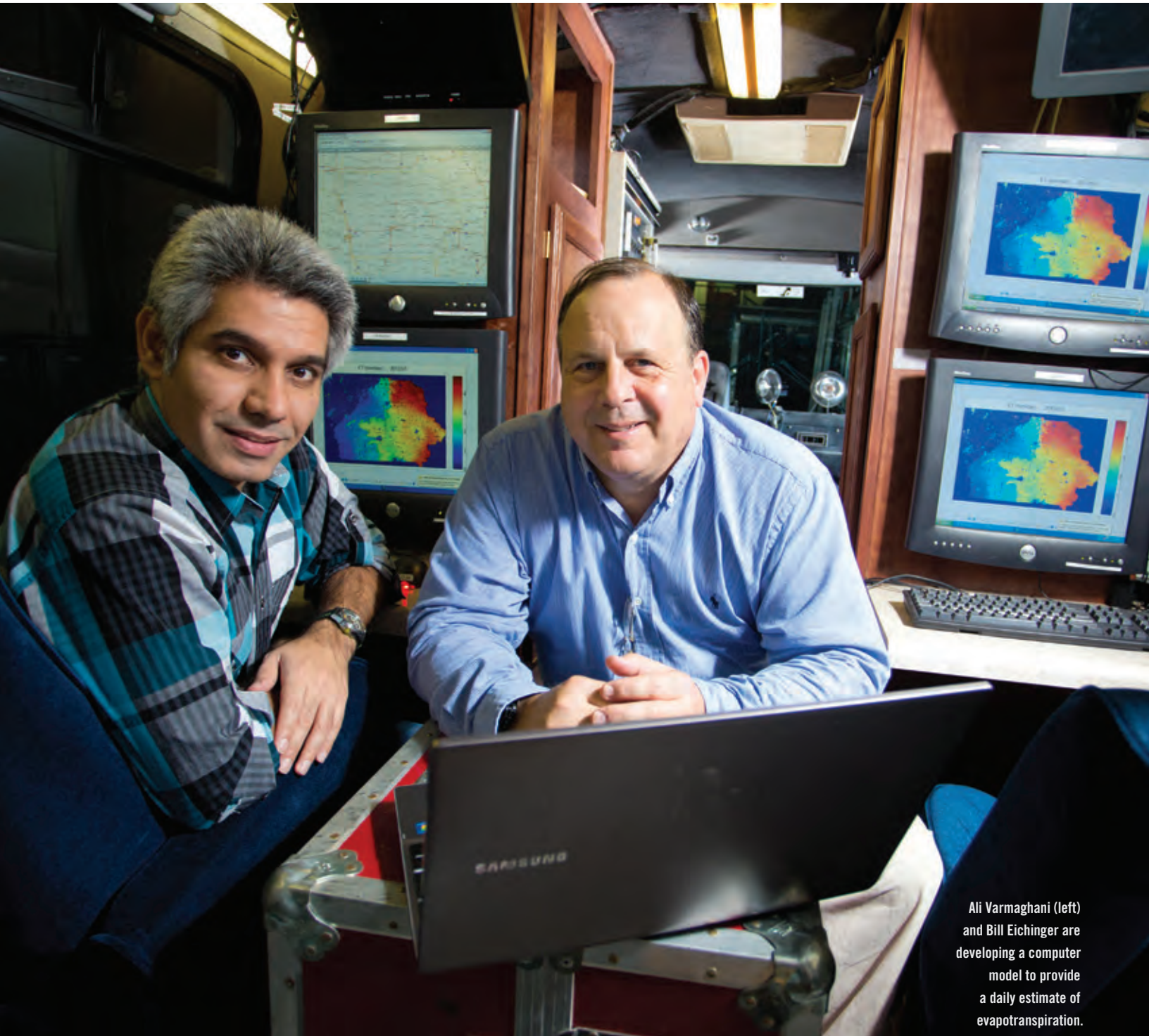
But despite these challenges, the IFloodS campaign was judged an undisputed success, yielding what Krajewski calls “a gold mine of data.” Many of its benefits will likely come down the road, Krajewski says. He’d like to establish Iowa as a permanent validation site for NASA. Students benefitted, too, as many were able to get out in the field to set up and maintain the instruments. “I think that was a great adventure for them,” Krajewski says.

Thomas and ElSaadani would likely agree – they won’t soon forget their adventure with NASA. As they drove home to Iowa City after their day in the field, Thomas says, he was tired but happy. “The experience gave me a vested interest in the project,” he says. “As we left, each and every crew member shook our hands. It was obvious that they were thankful for our help.”



The Challenge of Modeling Evapotranspiration

The Thrill of Watchi



Ali Varmaghani (left) and Bill Eichinger are developing a computer model to provide a daily estimate of evapotranspiration.

ng Plants Sweat

WITH HIS FIRST CUP OF MORNING TEA

in hand, Bill Eichinger switched on the television, as he does almost every morning. Like most Iowans, Eichinger checks the weather forecast out of habit as well as necessity. As he watched the meteorologist work her way through the forecast, Eichinger had a brainstorm: wouldn't it be great if his favorite TV weather team included a weather map showing the previous day's evapotranspiration?

Evapotranspiration — most of us never think about it or even know what it is. But evapotranspiration, or ET, has a significant effect on our lives. When the sun warms the surface of the earth, two things happen: water evaporates from the soil, lakes, rivers, and other bodies of water; and plants “transpire,” or release water that then evaporates.

“Plants get stressed by heat just like we do, and they sweat, just like we do,” Eichinger explains. But instead of perspiring, they transpire.

Add evaporation and transpiration together, and you get evapotranspiration. But that doesn't explain why we should care about ET, or why the TV meteorologists should add it to their weather forecasts.

ET has a lot of applicability as a useful tool, Eichinger says. Farmers can use this data to manage crops and schedule irrigation. Some people even use ET information to play the futures market. But for Eichinger and graduate student Ali Varmaghani, the main purpose of their ET research is flood prediction.

Eichinger and Varmaghani are developing a computer model to provide a daily estimate of the previous day's ET. The research is sponsored by the Iowa Flood Center, because ET is one of the largest components of the water budget, second only to rainfall. ET is an essential component of keeping track of water and potential flooding.

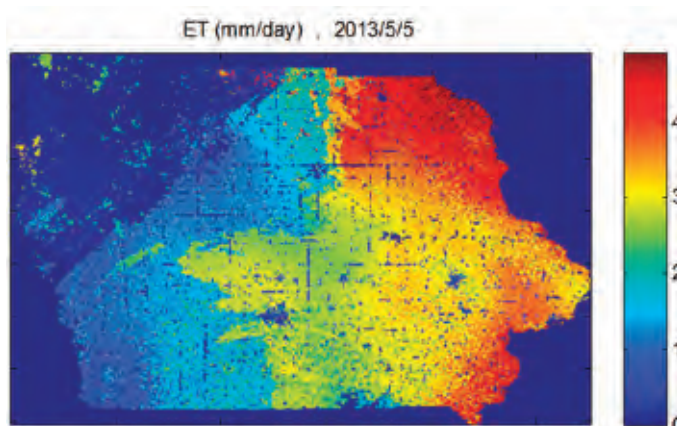
The team began with the Penman-Monteith Model, which was developed by Rick Allen for application in the Klamath River valley in the Pacific Northwest. This product has been in use for a while, Varmaghani says, and has been adopted by the Food and Agriculture Organization of the U.N. With this “reasonably accurate” model as a starting point, Varmaghani has been tweaking the model for use in Iowa — adjusting for different soil types, different planting schedules, and more.

Varmaghani has done the lion's share of the work on the model, and he finds the complex physics of the process fascinating. Frustrations abound, however — satellite servers go down, and the data is not as accurate as he'd like. But that's to be expected, since this is a “virgin subject,” so to speak, and Varmaghani says he is excited to be making an important new contribution to the world.

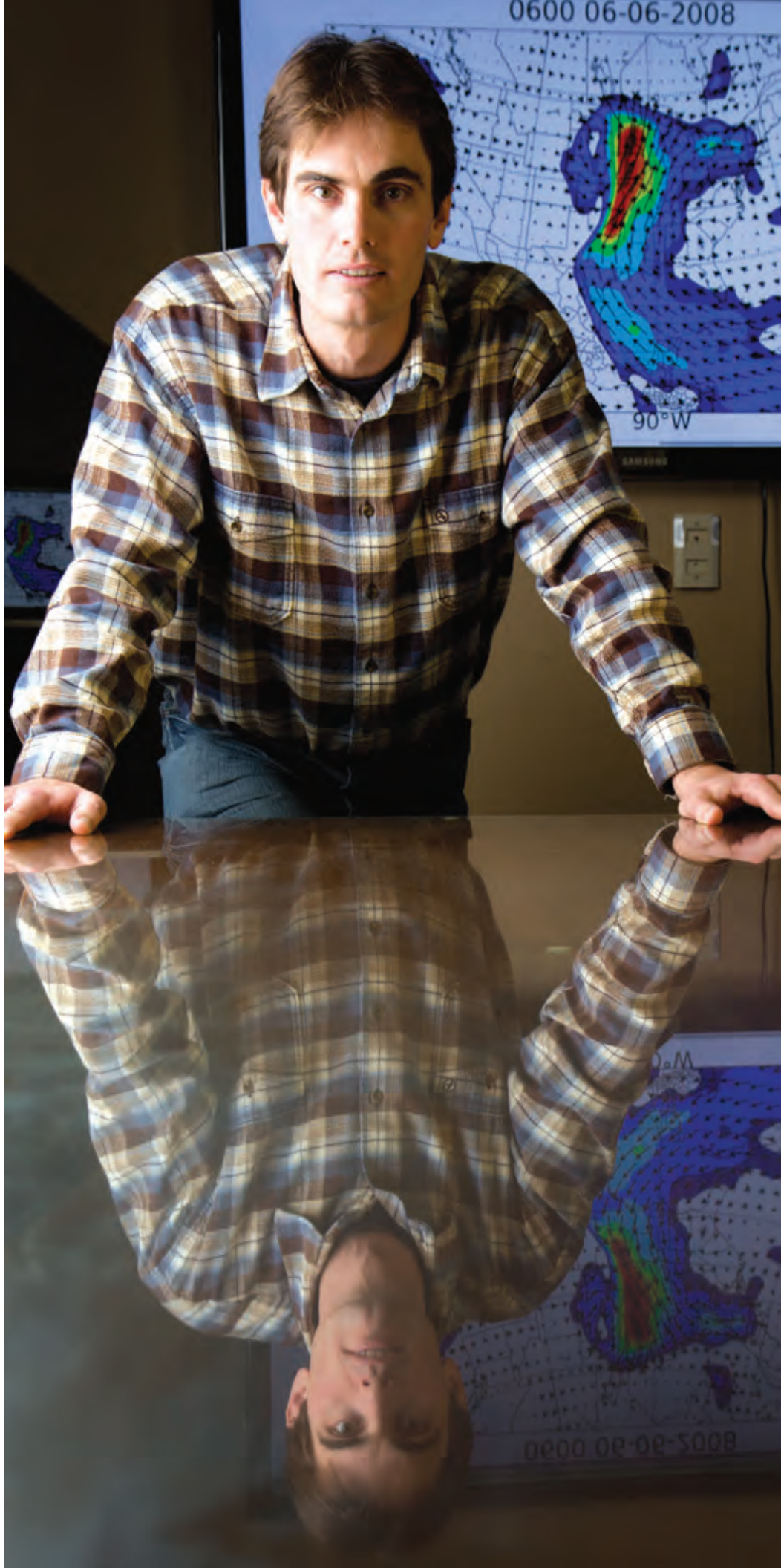
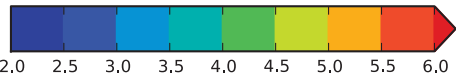
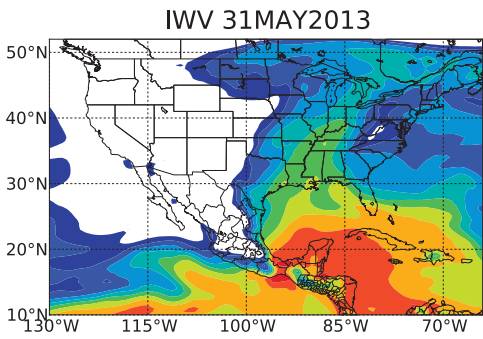
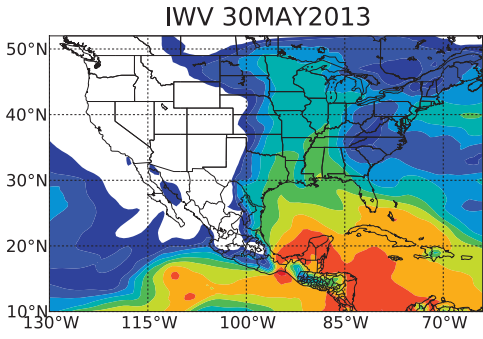
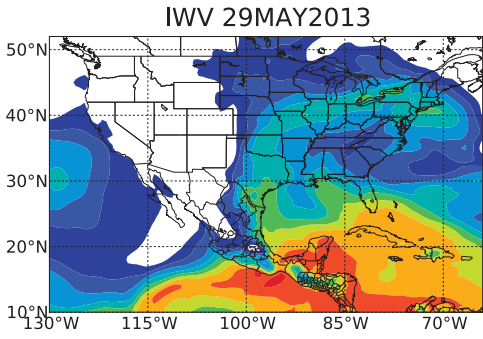
For the flood center's purposes, it's essential to have a daily estimate of ET. Eichinger and Varmaghani feed their model a mix of remotely-sensed satellite and weather prediction data, but the quality is not what it should be. For instance, they're still searching for a good source for humidity data. The information has to be available on a daily basis, it has to be high-resolution, and it has to be accurate.

“You depend really strongly on good data,” Eichinger says. “If it's not very accurate, all the physics in the world isn't going to help.” Precisely modeling ET is a hard problem, Eichinger says. “The fact that there aren't such products available gives you an idea of the difficulty.”

For Varmaghani, the difficulty was part of the appeal. “It's a very complicated subject, so I liked it.”



Eichinger, who has been an ET guy “since forever,” says evapotranspiration is exciting stuff for guys like him who enjoy watching plants sweat. And thanks to the efforts of Eichinger and Varmaghani, maybe someday we'll get daily ET reports during the TV weather forecast.



Atmospheric River Brings Floods of 2008

The 'Maya Express' delivers vast amounts of moisture, and often flooding, to Iowa

IOWA CITY RESIDENTS WON'T SOON FORGET THE SPRING OF 2008.

Hundreds made heroic efforts to try to save University of Iowa landmarks and other structures, filling sandbags around the clock for weeks. Tragically, many of those efforts were in vain, as the relentless floodwaters rose and eventually overtopped some sandbag fortifications.

That 2008 brought floods to the state is not news, but the idea that a vast atmospheric river (AR) delivered the moisture might be a novel concept to most Iowans. The strength of ARs can be staggering, says IIHR Postdoctoral Scholar David Lavers. For instance, the atmospheric river that hit Iowa City in 2008 carried with it 110 times as much flow as the Mississippi River at St. Louis.

Lavers's research focuses on atmospheric rivers, which are defined as regions of very high water transport in the lower atmosphere. ARs have been studied for about 20 years, making them a relatively new concept in hydrometeorology. Satellite observations, field campaigns, and large-gridded globally-observed datasets have made it possible for researchers to analyze what's going on in the atmosphere, and thus to study ARs much more effectively.

In the northern hemisphere, ARs tend to flow northwards from the tropical regions toward the poles. They form within a storm, and the storm's circulation causes the very narrow AR structure to develop. The AR that commonly flows over Iowa and the Midwest is known as the "Maya Express," because it carries moisture northwards from Latin America.

The water that ARs deliver is critical for agriculture, public water supplies, and the environment, Lavers says. For instance, a handful of intense rain events triggered by ARs can deliver up to half of California's water supply for the year.

But that same intensity can have tragic results as well, as extreme rainfall often leads to flooding. "It can be devastating," Lavers says. Scientists have noted a high correlation between ARs and flood events. With improved monitoring of AR conditions, such as those in the western United States, researchers can better understand intense rain events and flooding, Lavers explains. This in turn creates a clearer picture of the characteristics of an incoming atmospheric river, providing a warning system that could save lives and improve flood readiness.

David Lavers's research focuses on atmospheric rivers, or regions of very high water transport in the lower atmosphere. Recent advances in technology have made it possible for researchers to analyze what's going on in the atmosphere, and thus to study ARs much more effectively.

(Far left) Maps illustrating the daily averages of water vapor in the atmosphere over North America in late May 2013.

For the Love of Discovery

Kara Prior sat on the edge of her chair in a classroom in Nanjing, straining to catch every word the instructor uttered in Chinese. Although she had come to China with relatively strong language skills, taking classes in Chinese was proving to be a real challenge. Prior, who was used to being a good student and understanding every word her teachers said, found herself challenged in a way she had never expected.

Looking back now, Prior says, “So much was over my head, especially at first!”

As an undergraduate at the University of Iowa, Prior had earned a BS in international studies and environmental sciences while working for the Iowa Flood Center, building electronic stream sensors. After graduation, Prior spent a year studying in China through a program sponsored by Nanjing University and Johns Hopkins University. “That was definitely the hardest year of my education,” Prior says. She learned a lot about herself, as well as the economics, politics, law, and Chinese studies that were taught in the classroom.

Prior is now a graduate student in the earth and environmental sciences program, working with IIHR Assistant Research Engineer Adam Ward on a project to model water, nitrogen, and carbon as they move through the environment. It’s an interesting challenge, Prior says, because she has no programming background. She



PHOTO BY ANETA GOSKA

recently completed a set of preliminary models, simulating several crop types in the nearby Clear Creek watershed to quantify changes in runoff, infiltration, and nitrogen pollution. Once she confirms that the model is working properly, she will drive the model with different weather and land management variables to test a number of “what-if” scenarios, including flood-after-drought, which played out in Eastern Iowa in 2012–13, leading to record in-stream levels of nitrogen.

Prior never lost the love of discovery that she felt as a young child. The Ames, Iowa, native was home schooled by her mother through age 12. “I credit that with a lot of my excitement about learning,” Prior says. “It allowed me to get to know my own mind.” Since she and her brother weren’t tied down to a school or classroom, they spent lots of time outdoors, exploring the natural world.

Prior has taken inspiration from her mother, who worked exceptionally hard after becoming a single parent at midlife to provide for her family and get an education. With two children to raise, she went back to college while working fulltime, eventually earning two master’s degrees. Today, Prior’s mom is an applied anthropologist who works for the Department of Public Health’s Tobacco Use, Prevention and Control Unit, focusing on statewide tobacco control and the elimination of health disparities.

Prior’s study-abroad experience in China left her even more excited about international education, and with new respect for international students who study at the University of Iowa. After her year in China, Prior taught English in South Korea for two years.

Prior is now working on a master’s degree, and may eventually take on a PhD. She hopes to study abroad again, and eventually to teach in some capacity. She’s excited to be connected with IIHR, Prior says, because of the institute’s interesting confluence of people and programs. She believes the things she’s learning now will be useful wherever she ends up.

“Managing nutrients and pollution is a challenge everywhere,” Prior says.

It Runs in the Family

George Constantinescu relaxes at an outdoor table on the sidewalk in Paris, sipping a cup of espresso as he browses through a book on modern art. Before long, he'll be off to a favorite art museum. Paris feels almost like a second home, Constantinescu says. He spent a year there after graduating from the Technical University of Bucharest, and visits whenever he has the chance.

If he weren't an engineer, Constantinescu says, he might have been an art critic — his love for art is that strong. But, of course, his first love is river engineering.

Constantinescu, an associate research engineer at IIHR, grew up in Bucharest, Romania, which was once known as "Little Paris" for its elegant architecture and sophisticated culture, before war and deprivation changed the city. When he was a child in the 1980s, Romania was a Communist country, and the economic situation was dire for many Romanians.

Constantinescu was born to a family of engineers; his mother and father were both environmental engineers, and they hoped and expected that he would follow them into the profession. Even Constantinescu's grandfather was an engineer, more than 100 years ago. Constantinescu, who is also an associate professor of civil and environmental engineering at the University of Iowa, studied engineering at a top university in Bucharest. His diploma project focused on hydraulic engineering; the



faculty leader of the hydraulic group, Professor Constantin Iamandi, had spent a year at IIHR as a Fulbright Scholar, working with Hunter Rouse and John F. Kennedy. "He was very fond of Iowa," Constantinescu says. Iamandi and Professor Andrei Damian both encouraged Constantinescu to apply to the University of Iowa and IIHR to pursue a PhD.

Constantinescu's research continues to focus on using eddy-resolving numerical simulations to predict and understand the physics of turbulent flows. He explores how the presence of vortices and large-scale turbulence can be used to explain transport and mixing in rivers, particularly with regard to flow and local scour around hydraulic structures.

Another area of interest is stratified turbulence and, in particular, the mixing processes that occur when two or more fluids with different densities meet. With modern supercomputers, Constantinescu

explains, it's possible to apply eddy-resolving techniques that were originally developed in aerospace engineering to river engineering problems.

He predicts the next 10 to 15 years will be "quite revolutionary" in his field. "It's going to be quite an exciting time for research," Constantinescu says. He is also interested in the area of eco-hydraulics, which explores the effect of flow on plants, fish, and other living organisms in natural streams. IIHR is a leader in this area, thanks to the pioneering work of Jacob Odgaard and Larry Weber on the design of fish-friendly passage structures at hydropower dams, Constantinescu says. It's an interdisciplinary field that brings together engineers, biologists, chemists, and more. Advanced techniques in numerical modeling now make it possible to simulate almost all the processes in a natural stream, including nutrient and sediment transport, biological processes, and more — simultaneously.

Constantinescu's keen interest in research is supported by his work as a teaching faculty member. He has developed several graduate courses in his areas of research interest, and he says teaching these classes is particularly rewarding. He also appreciates the opportunities to travel that come with being a researcher and faculty member, and he frequently travels for pleasure as well.

To Paris? Mais oui!

Transformations

When Teresa Gaffey was a graduate student at the University of Iowa School of Social Work, she studied something known as the “foot-in-the-door” technique. Just like it sounds, this persuasion strategy begins with a request for something small and insignificant. After an initial “yes,” it becomes easier and easier to get agreement to larger, more significant requests.

Gaffey got her foot in the door at IIHR in 1994 with a half-time position as editorial assistant to IIHR Research Engineer Jacob Odgaard. Odgaard was editor of the *ASCE Journal of Hydraulic Engineering*; Gaffey’s half-time position involved managing the submitted manuscripts, sending them out for review, and keeping the process running smoothly. She did the same for the next editor, IIHR Research Engineer Rob Ettema. As time went by, she assumed more duties and responsibilities, including half-time accounting work.

Accounting had not been part of Gaffey’s plan in 1988, when she began her freshman year at Central College in Pella, Iowa. The North Liberty, Iowa, native majored in psychology, with minors in sociology, German, and Spanish. Gaffey completed her degree at Central in a bit more than three years — “I was very studious,” she says, “and not interested in paying tuition any longer than I had to.” Gaffey went on to earn a master of



social work degree at the University of Iowa.

How do you go from psychology and social work to accounting, you might ask? “I’m interested in everything,” Gaffey explains. By 2010, she was named director of finance for the institute.

Gaffey still has the ability to focus very intently. She can do a tremendous amount of work in a short period of time, and her memory is phenomenal. For example, she can recite the eight-digit grant numbers for IIHR’s 100-plus current sponsored research projects, which come and go on a weekly, if not daily, basis.

You wouldn’t think that she has time for anything else, but Gaffey is also a regular volunteer at the North Liberty Food Pantry, sings in her church choir, and even finds time to crochet. When Gaffey isn’t focusing on work or volunteer projects, she’s most likely

with her four children: James, 19; Alyson, 14; Michael, 12; and Rachael, 8. “I have been a mom for a very long time,” Gaffey says with a smile. Like their mother, the children also have musical talents. James plays all instruments; Alyson plays the clarinet; and Michael the trombone. And Rachael sings “all the time!”

Gaffey’s 19 years at IIHR have given her a front-row seat to the institute’s amazing growth. She has known some of the great names of the institute, including former Director John F. Kennedy; she also witnessed some legendary holiday parties.

Watching the institute’s transformation has been her greatest reward, Gaffey says. She has also watched as graduate students became researchers and eventually leaders in their fields. “That’s just incredible,” Gaffey says.

From the moment when she first got a foot in the door at IIHR, Gaffey herself has transformed, from a part-time editorial assistant into a leader whose work sustains the institute, its people, and its mission of research, education, and service.

Far from the Farm



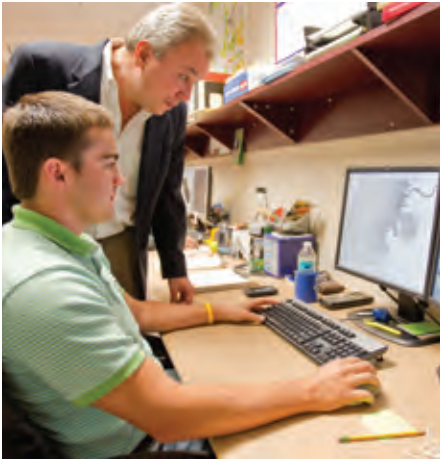
PHOTO COURTESY OF UCF

Scott Hagen jerked awake to find the tractor he was driving slowly veering off course, leaving a meandering trail of newly planted corn behind it. He had nodded off just for a second, after a long night of studying for the three classes he was taking that spring at the University of Iowa. Hitting the books had left him too exhausted to do his day job — farming with his uncle.

Hagen looks back on that stressful semester with amusement. “I just about killed myself,” he says.

After 10 years of farming, Hagen decided that spring to make the break from agriculture and go back to college full-time. He had grown up on his parents’ farm 25 miles west of Iowa City and attended high school at Williamsburg, where Hagen’s favorite teacher and mentor, John Gillaspie, developed math classes to challenge Hagen and other advanced students. Right after high school, Hagen spent one year at Iowa State University with plans to become an architect. It just didn’t work for him then, and he came home to take up farming.

Hagen credits his sister, Patricia Coleman (a civil engineer and a member of the UI Engineering Distinguished Alumni Academy), for encouraging him to give college another try. His parents, Lillian and Richard Hagen Sr., also counseled him not to give up on college.



PHOTOS COURTESY OF UCF

“They were so happy when I left the farm!” Hagen laughs. Richard and Lillian, now 82, encouraged all their children to follow their dreams, even if they led away from agriculture. They still live on the farm north of Little Amana, and Hagen visits as often as he can.

As an undergraduate at Iowa, he was blessed to find generous and talented mentors such as IIHR Research Engineers Forrest Holly, Jerry Schnoor, and Witold Krajewski — “just good people,” Hagen says. Holly shaped Hagen’s career trajectory by advising him to look beyond IIHR for graduate study, to get new ideas, new opportunities, and new influences. “Forrest is always looking out for the students and what’s best for them,” Hagen says. He also met Larry Weber, who was a PhD student at that time, when they were both involved in teaching an undergraduate statics course.

After earning a BS in civil and environmental engineering at Iowa, Hagen followed Holly’s advice and went to Notre Dame, where he worked with Professor Joannes Westerink on hurricane storm surge and tidal modeling. After earning a PhD, Hagen carried these numerical modeling skills with him to the University of Central Florida (UCF), where he is now a professor of civil, environmental, and construction engineering. Hagen has built a flourishing program (from scratch) in tidal studies and modeling at UCF.

Hagen is also director of UCF’s Coastal Hydroscience Analysis, Modeling, and Predictive Simulations Laboratory (CHAMPS). CHAMPS includes faculty and students from a number of disciplines, including engineering, biology, and communication. Researchers focus on current coastal hydroscience challenges, including development of an advanced astronomic tidal model to study rising sea levels.

Hagen is a leader among scientists studying rising sea levels and their impacts. He was recently invited to speak at an event sponsored by the National Oceanic and Atmospheric Administration (NOAA), one of only eight chosen to present at the seminar. He will talk about his study of the Ecological Effects of Sea Level Rise in the Northern Gulf of Mexico, which is sponsored by NOAA. The research focuses on developing models of sea level rise and its impacts along the coast.

Hagen, who enjoys travel and cooking when he has the time, says he’s still an Iowa farm boy at heart. He especially misses Iowa tomatoes and high-quality beef, which is only available at four-star restaurants in Florida. Hagen’s wife, Denise DeLorme, is a Georgia native and a professor of advertising and public relations at UCF. She conducts focus groups and provides social science perspective for Hagen’s research team.

Hagen serves on the board of the American Society of Civil Engineers’ (ASCE) Coasts, Oceans, Ports, and

Rivers Institute and was recently named a fellow of ASCE. He is a technical advisor to Louisiana’s 2017 Coastal Master Plan; and he was selected to lead UCF’s major research focus on the Coastal Dynamics of Sea Level Rise (CDSLRL), which has a goal to establish a national center for CDSLRL.

Hagen has not forgotten about his farm roots — in fact, he hopes to develop a large-scale model that would encompass the Farm Belt of the upper Midwest, the entire Mississippi River watershed, and the Gulf of Mexico. “It would be huge,” Hagen says. This basin-scale model would help scientists understand the transport of nutrients from the Midwest to the Gulf of Mexico where they contribute to the hypoxic “Dead Zone.”

The goal would be to develop better, more sustainable systems to support a healthy ecosystem. It’s a big dream, but Hagen learned how to make it happen — start small and take one modest step at a time. He takes his lesson from his work years ago as a student with Dr. Krajewski in the hydrometeorology lab, which has now developed into the Iowa Flood Center. “It was basically a closet,” Hagen remembers. “And look at what he’s built today!”

Scott Hagen has built a flourishing program (from scratch) in tidal studies and modeling at UCF.

OUR ALUMNI : SCOTT HAGEN

Rex Elder: Friend, Ally, and Benefactor to IIHR

Engineer Rex Elder has been IIHR's friend and ally for more than 70 years, says IIHR Director Larry Weber. In the 1940s, Elder (then on the staff of the Tennessee Valley Authority) attended the Iowa Hydraulics Conferences hosted at IIHR, where he met and became friends with many at the institute. Elder eventually rose to the role of director of the TVA Hydraulics Lab, and later went on to the Bechtel Corporation, where he assembled a team to work on the engineering firm's nuclear power program.

Throughout his career, Elder frequently worked with IIHR researchers and students on contracted projects. Elder stayed in touch with colleagues at the institute, particularly his close friend, then-Director John F. Kennedy.

Later, Elder worked as an independent engineering consultant, particularly in the area of hydropower. It was in this work that Elder became a close friend and collaborator with IIHR Research Engineer Jacob Odgaard, and later Larry Weber. They worked together frequently on fish passage projects in the Pacific Northwest.



Rex Elder (center) with IIHR's Jacob Odgaard (left) and Larry Weber.

Recently, Elder was instrumental in a mini-campaign to raise funds for the John F. Kennedy Scholarship at IIHR. Through his leadership and his own very generous gift, more than \$25,000 was donated to the scholarship fund, which supports outstanding undergraduate students at IIHR with a \$2,500 stipend.

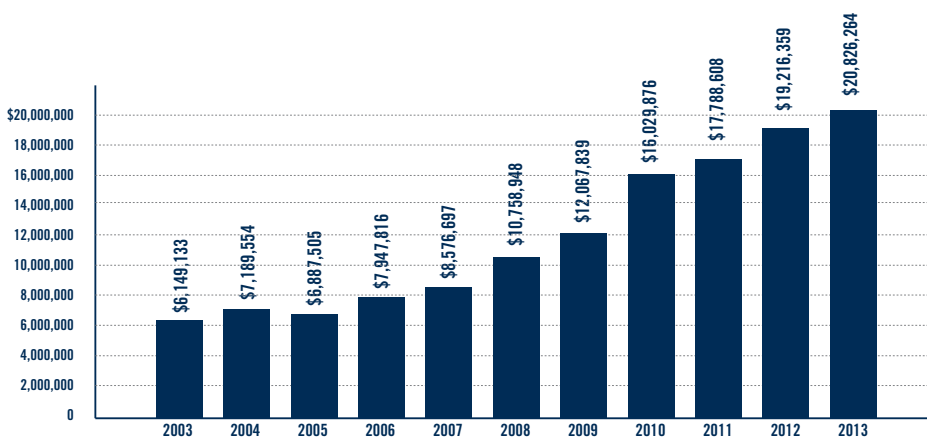
Elder, who continues to enjoy good health and spirits at age 96, visited with Weber and Odgaard recently at his home in California. The three men had dinner together to celebrate Elder's significant gifts and contributions to IIHR. Weber says he was happy to have the opportunity to express the institute's gratitude to Elder in person,

and to listen as Rex shared many stories about the fascinating research that he oversaw at IIHR.

"How do you thank someone for 70 years of mutual respect, friendship, and cooperation?" Weber asks. "Rex Elder, though not an alumnus of IIHR, is one of the greats here at the institute. Words simply do not say enough, but they're all we have. Rex, thank you for everything you've meant to IIHR."

The Fiscal Year in Review

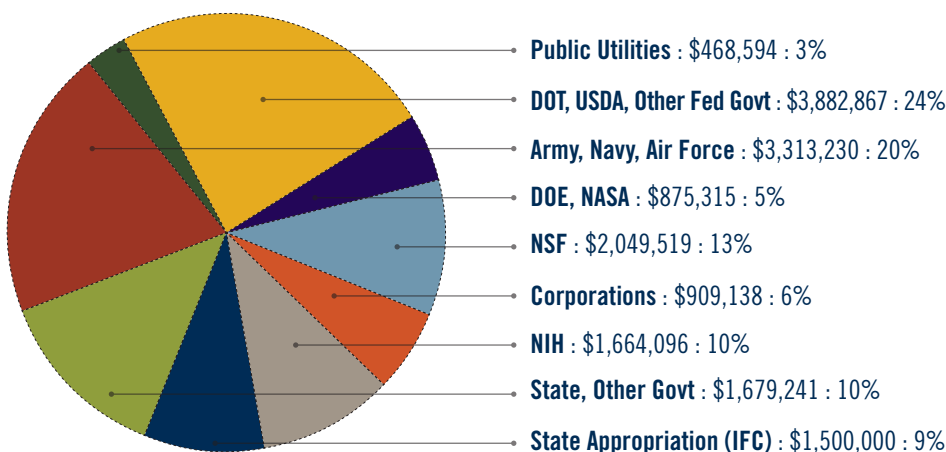
Fiscal Year 2003 to 2013 External and Internal Research Funding



In spite of the federal sequestration, IIHR's overall financial health continues to be strong. The pace of new grant proposal submissions remains brisk, forecasting a vigorous financial future for IIHR.

IIHR's work in the private sector is growing as well. The institute's unique numerical and laboratory modeling tools, backed up by experience and documented success, provide our clients with confidence that their projects will be completed effectively and on time. Undoubtedly, IIHR's international reputation played a significant role in a recent contract to evaluate a sewage tunnel system for the Emirate of Abu Dhabi, and for a current major project to construct physical models to evaluate the design of eight pumping stations for London's Thames Tunnel Project.

Fiscal Year 2013 External Research Funding by Sponsor (\$16,342,000 Total)



IIHR also continues to keep expenses under control, while making investments in key areas. In 2013, investments in facilities and equipment increased significantly, from \$513K in 2012 to about \$1.5M in 2013. This is attributable to significant progress toward repayment of the loan for the Wave Basin Facility at the Oakdale Research Park.

With its renewed focus on water sustainability, IIHR is once again looking to the future. As global water-related challenges increase, we are grateful for the institute's continued vitality and the contributions of new, innovative ideas from all our faculty research affiliates. IIHR is poised to attain a new level of relevance in global fluids-related research.



IIHR Internal Investments

	2012	2013
Graduate Students	\$187,986	\$131,498
Postdoctoral Associates	\$205,032	\$39,669
Research Engineers	\$409,225	\$239,860
Facilities & Equipment	\$513,218	\$1,493,359
Total IIHR Internal Investments	\$1,315,461	\$1,904,386

Major Funding Announcements in Fiscal Year 2013

Integrative Statistics-Guided Image-Based Multi-Scale Lung Model (Ching-Long Lin and K-S. Chan)	\$3.2M	National Institutes of Health
Thames Tunnel — Physical Model Studies (Troy Lyons, Jacob Odgaard, and Andrew Craig)	\$745K to date	Thames Water Utilities Ltd., London (subcontracted by CH2M Hill)
Measurement for Wave Basin High-Speed Catamaran Experiments for CFD Validation (Fred Stern)	\$527K	U.S. Department of Defense
Physical Modeling of Baffle Drop Structures for the City of Akron, Ohio (Troy Lyons, Jacob Odgaard, and Andrew Craig)	\$423K	DLZ Ohio Inc.
Reversible Photohydration in Diene and Triene Steroids (David Cwiertny)	\$395K	National Science Foundation
Reaction of Carbon Nanotubes with Free Chlorine and Monochloramine Disinfectants (Richard Valentine, David Cwiertny, and Timothy Mattes)	\$300K	National Science Foundation



A Precious Resource

By *Matahel Ansar*

As a young boy, I spent every summer vacation with my uncles in the Sahara desert, in Northern Mali. My uncles are Tuareg; they were and still are nomads, living in one of the harshest environments in the world, moving every few weeks in search for pasture and water. These early experiences deeply shaped my appreciation for water.

I am now fortunate to play an important role in managing the water resources of one of the most water-rich and complex water management systems in the world, the Central and Southern Florida (C&SF) project, including the world-renowned Florida Everglades.

Managing water sustainably provides and maintains the quantity and quality of water needed for human life and supports the natural systems, now and into the future. The water sustainability problem in Central and Southern Florida, as in most places, is one of quantity, quality, timing, and distribution of this precious vital resource.

In early days of the C&SF project, from the late 1940s–70s, engineers were mostly concerned with providing flood control and adequate water supply. In the early '70s, concerns about water quality and the deterioration of natural systems grew. Today, one of our most significant challenges is balancing these competing needs. These problems are not unique to Florida. Every place has at least one, if not all four, of these issues to contend with. It is only the prevalence and severity that differ.

The C&SF project was built for about 2.5 million people. Today it supports about 7 million-plus. Globally, the main stressors on water availability are human population and food production. The world population has increased by 1 billion people in just 14 years; we currently welcome 1 million people to our planet every 4.5 days. Globally, agricultural, industrial, and domestic uses account for, respectively, about 70, 20, and 10 percent of the available freshwater resources. To compound the water quantity issue, our climate is

changing; extreme events such as flood and drought are becoming more extreme, and the sea level is rising in most places.

On the water-quality front, the control of nutrients such as phosphorus and nitrogen produced by human activities is a growing priority, especially in the basins that drain into the Mississippi River, the Great Lakes, and the Chesapeake Bay. Higher levels of nutrients are altering the ecological balance of receiving water bodies. Industrial pollution of water is also a major concern, especially in emerging economies. The incidence of pharmaceuticals and personal care products in the aquatic environment is a relatively new issue, with many unknown ramifications.

These water issues are daunting challenges. A key question for water managers is: how can we plan and adapt to meet our water resources needs, given the increasing competing demands and the economic, climatic, and political uncertainties?

Solutions to water sustainability issues would, first and foremost, require innovative thinking fueled by a political will and a common understanding that, despite the competing interests, this is a problem of shared challenges and responsibilities. Alternatives such as

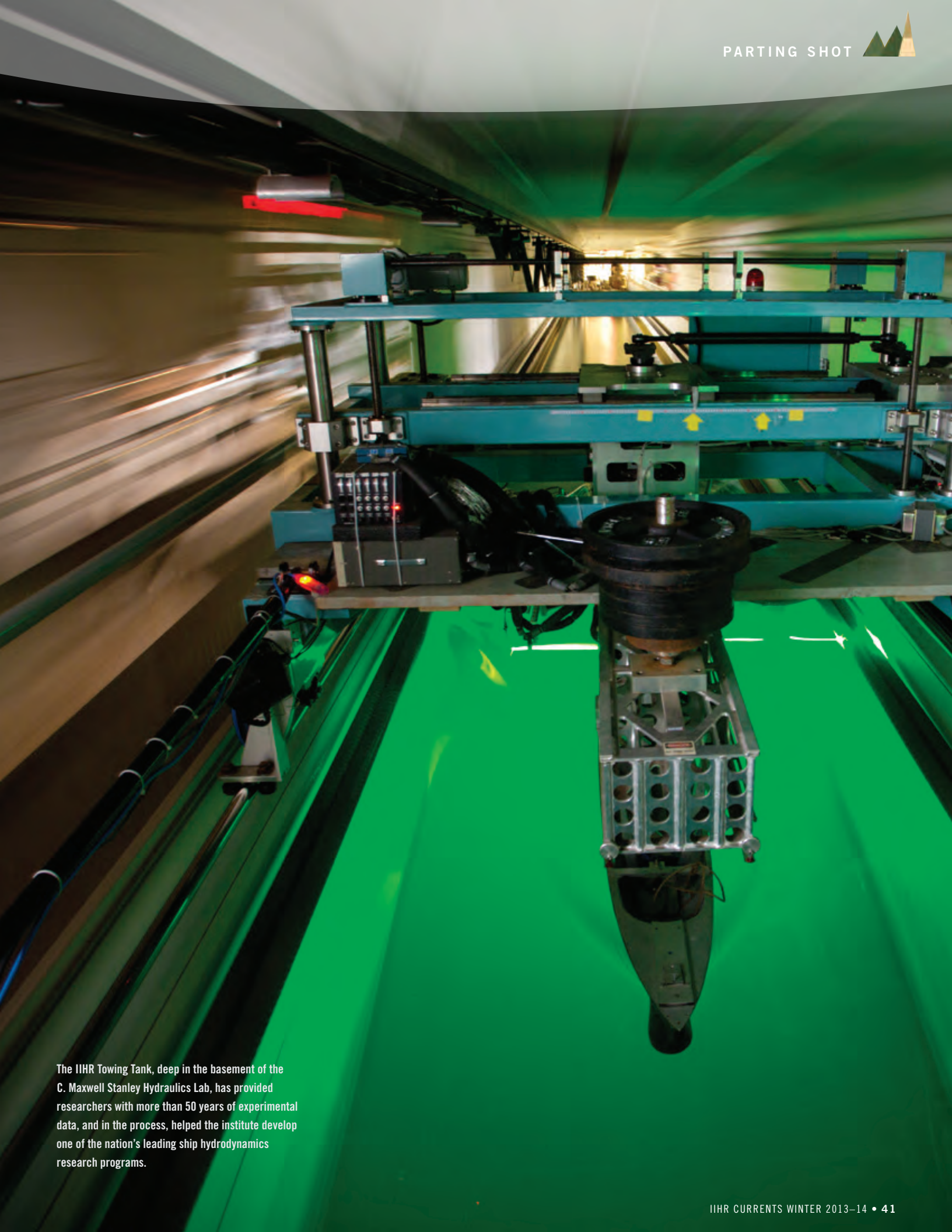
artificial aquifer recharge, desalination, increasing water-use efficiency, water re-use, and inter-basin transfers have proven effective. In Central and Southern Florida, constructed wetlands known as Stormwater Treatments Areas, coupled with Best Management Practices at the source level, have proven effective in controlling phosphorus and nitrogen. However, much more can and should be done at national and global levels.

To solve the water sustainability problem: 1) political leaders and society must care about solving the problem; 2) institutions in the public, private, and academic sectors must support the proposed solutions; 3) we must “approach sustainable water management as a journey along an adaptation pathway, rather than an arrival at a destination” (Loucks, 2012). Adaptive measures should be based on lessons learned from our collective failures and successes; 4) we must invest in rehabilitating and improving our deteriorating human-made “hard” water management infrastructure; 5) we must strive to provide water for all, including the environment (so-called green infrastructure), and the underprivileged and the voiceless; and 6) we must gain a better understanding of the problem through research and development. Examples of relevant research areas include: risk-based conditions assessment of water and wastewater infrastructures; impact of climate change on the hydrological cycle at multiple scales; development of climate-change-adapted engineering standards; impact of sea-level rise on flood control and water supply in coastal basins; and low-energy water treatment technologies.

There is an old saying: “You will never miss the water until the well runs dry.” One may rephrase this today to say, “You will never miss clean water until the well runs dry or the water is polluted.” I am optimistic that we can build a future in which the well is full of clean and accessible water for all.

Read the full version at
www.iuhr.uiowa.edu/last-word-ansar





The IIHR Towing Tank, deep in the basement of the C. Maxwell Stanley Hydraulics Lab, has provided researchers with more than 50 years of experimental data, and in the process, helped the institute develop one of the nation's leading ship hydrodynamics research programs.



IIHR—HYDROSCIENCE & ENGINEERING

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A rainy fall day at dusk, seen from the roof of the C. Maxwell Stanley Hydraulics Lab.

