

K a n s a s S t a t e U n i v e r s i t y

Perspectives

W i n t e r 2 0 1 3

Message from President Kirk Schulz and Vice President for Research Ron Trewyn



Clean air, clean water, clean energy.

Sustainability is key to preserving our environment and our vital resources. As a land-grant university, it is imperative to continually look for ways to preserve our air and water quality and to develop sustainable energy. Many of Kansas State University's most talented scientists focus their research efforts in these areas.

The university's location in the Flint Hills and the Great Plains is an asset to study grasslands and wind energy — research that wouldn't be possible anywhere else.

Grasslands cover about 40 percent of the Earth's land surface, and how these lands are managed affects water safety and prevention of soil erosion. Conserving and sustaining this critical resource is the basis for a great deal of research at Kansas State University, and some is covered in this issue.

The 8,600-acre Konza Prairie Biological Station enables world-class grassland research that attracts international researchers and plays a key role in high-profile national ecological programs. Konza is jointly owned by The Nature Conservancy and Kansas State University.

Kansas State researchers developed a Web-based application to monitor landscape health. They currently use it to monitor land on nearby Fort Riley, home of the Army's 1st Infantry Division, to prevent water pollution and soil erosion and to improve the natural flow of water. In the future, this system may become a model for monitoring other military installations and Department of Defense-owned land.

Water has been identified as one of the most critical resources for the future. Kansas State University is home to the Kansas Water Resources Institute and the newly formed Urban Water Institute, which is located at our Olathe campus in Greater Kansas City. A goal is to develop sustainable water management practices.



Kansas is second in the nation for wind energy production so it's natural to conduct wind energy research here. In fall 2012, the Kansas Statewide Wind Energy Forum was held in Manhattan, with support from Kansas State University and others, through participation in the Kansas Board of Regents Council of Chief Research Officers.

Wind research not only increases access to renewable energy resources, but trains students for clean energy jobs in the fast-growing wind industry.

The projects included in this issue provide a look at some of the impactful research being conducted at Kansas State University. These ongoing efforts help preserve America's resources for future generations. We are confident that such excellent and vital work will help Kansas State achieve our goal of becoming a Top 50 public research university by 2025. We hope you will take a look.

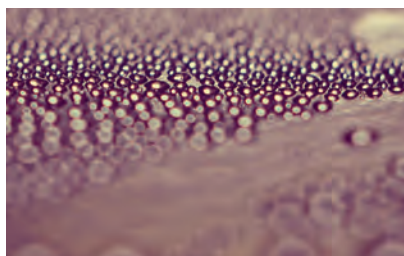
A handwritten signature in black ink, appearing to read "K. Schulz".

A handwritten signature in black ink, appearing to read "Ron Trewyn".

Notice of Nondiscrimination

Kansas State University is committed to nondiscrimination on the basis of race, color, ethnic or national origin, sex, sexual orientation, gender identity, religion, age, ancestry, disability, military status, veteran status, or other non-merit reasons, in admissions, educational programs or activities and employment, including employment of disabled veterans and veterans of the Vietnam Era, as required by applicable laws and regulations. Responsibility for coordination of compliance efforts and receipt of inquiries concerning Title VI of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Section 504 of the Rehabilitation Act of 1973, the Age Discrimination Act of 1975, and the Americans With Disabilities Act of 1990, has been delegated to the Director of Affirmative Action, Kansas State University, 214 Anderson Hall, Manhattan, KS 66506-0124, (Phone) 785-532-6220; (TTY) 785-532-4807.

contents



Thirst quenching

Urban Water Institute focuses on sustainable water supply

2

Water quality 101

Professor aims to change discussion of humanity's value of water

4

Small wonders

How chemistry and nanotechnology are remediating environmental toxins and influencing future scientists

6

The rain, the plain and the drain

How a geographer and an engineer are marrying their expertise to study changing weather, challenging landscapes and the ways we manage water

8

Dust in the wind

Civil engineering professor part of team researching effects of dust deposits on soil formation, water quality in Rocky Mountains

10

Where the river runs

Geographer channels research to understand how dredging affects river health, water supplies

12

Gust of power

Wind Application Center a force for wind research, education

14

A bumpy ride

Researcher studies turbulence in wind turbines to ensure their viability

16

Digging deep

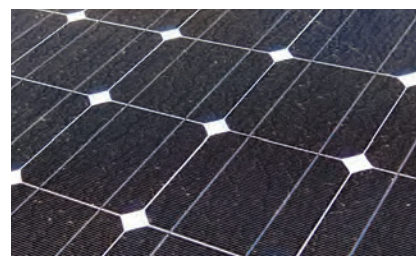
Geological research may reveal secrets to contamination, pollution remediation mysteries

18

Brightening Afghanistan

Researchers study renewable energy to power electricity-scarce country

20



Visit k-state.edu/perspectives
to see videos from this issue.

Contributors



Errin Barcomb-Peterson
Director of News/Editorial



Matt Binter
Photographer



Beth Bohn
Writer/Editor



Trevor Davis
Writer



Lindsey Elliott
Video Producer



Stephanie Jacques
Writer



Steve Logback
Asst. Vice President



Cheryl May
Assoc. Vice President



David Mayes
Mngr. of Photo Services



Katie Mayes
Director of Marketing



Jeff Morris
Vice President



Kristi Northcutt
Writer



Abigail Polys
Graphic Designer



Jim Rigg
Design Director



Megan Saunders
Writer



Greg Tammen
Writer



Jennifer Tidball
Writer



Guolin Zhao
Sr. Graphic Designer

Kansas State University's Olathe campus, in the Kansas City metropolitan area, is home to the Urban Water Institute, bringing together industry, researchers, policymakers, advocates and educators.



THIRST QUENCHING

Urban Water Institute focuses on sustainable water supply

The world is thirsty for water — and it is likely to become one of the most pressing resource issues of the 21st century. Kansas State University has a vision for the new Urban Water Institute to develop as a premier center of knowledge and outreach focused on sustainable water management in urban and urbanizing environments.

Established in 2011, the institute, located at the Olathe campus and under the leadership of founding director Alok Bhandari, civil engineering, will realize this vision by advancing and promoting public policy, water management approaches, and innovative treatment technologies that support sustainable use of water.

Positioned at the center of K-State Olathe's mission, water crosses all disciplines and is pertinent to both animal health and food safety. The campus is located in a metropolitan area home to a variety of world-renowned agencies, businesses and organizations including major international water-related consulting firms, equipment manufacturers and testing service providers.

The institute brings together industry, researchers, policymakers, advocates and educators to identify and develop solutions for complex cross-disciplinary and cross-boundary concerns related to urban water sustainability. It facilitates industry- and agency-identified research, development and implementation of water-related projects by engaging teams of practitioners, researchers, educators and students across Kansas and the four-state region.

As part of this outreach, the institute participated in K-12 events at K-State Olathe this year, including

a fourth- and fifth-grade “Water Investigation Lab Day – Citizen Action Team” (WILD-Cat). Hundreds of students gathered water samples from the campus's pond, analyzed the samples in the lab, and looked for presence of macro invertebrates, indicator species that are sensitive, somewhat sensitive or tolerant of pollution. Bhandari also led a section of the summer teacher workshop with a day all about water for 20 secondary science educators from across Kansas.

“Water gives us an indication of the health of the planet — human and animal health rely on this water,” said Michael Strohschein, director of K-12 science education partnerships at the Olathe campus. “Looking at the physical and biological indicators of healthy water gives us an insight into protecting species from becoming endangered or extinct. The impacts are magnified in an urban setting because of extreme environmental degradation and population density.”

A search is under way for a program coordinator for the Urban Water Institute to be housed at K-State Olathe on a full-time basis. This position will support the structure Bhandari has established and work with Strohschein, director of corporate and foundation relations Debbie Kirchhoff and others as the institute grows in scope and impact.

The Urban Water Institute is part of the 2025 plan for the university to be recognized as one of the nation's Top 50 public research universities.

By Kristi Northcutt, Kansas State University Olathe




During Water Investigation Lab Day, hundreds of fourth- and fifth-graders gathered and studied water from the campus's pond.

WATER QUALITY 101:

PROFESSOR AIMS TO CHANGE DISCUSSION
OF HUMANITY'S VALUE OF WATER



As water quality issues continue to spring up, so does Walter Dodds' research to solve them.



Recycling, composting and conserving are routine for environmentally conscious people like Walter Dodds, Kansas State University distinguished professor of biology. But Dodds, an ecologist, takes it one step further.

His professional career is dedicated to researching Earth's freshwater systems and encouraging others to take an active role in being eco-friendly. Dodds' research on nitrogen cycling in freshwater systems has been published in such major scientific journals as *Nature* and *Science*, and in 2010 he was part of a national research team that discovered that streams and rivers produce three times more greenhouse gas emissions than estimated by the Intergovernmental Panel on Climate Change. As water quality issues continue to spring up, so does his research to solve them.

Developing a better model for determining large-scale water quality

Most recently, Dodds has taken on a \$3.3 million National Science Foundation project called Scale, Consumers and Lotic Ecosystem Rates, or SCALER. The project aims to improve freshwater research by creating a more accurate model for determining large-scale information from small-scale studies. Dodds is collaborating with eight universities across North America to determine water quality in different biomes.

"We hope we can figure out a way to do the small-scale sampling to truly capture what's going on with the large scale, because logistically and economically it is easier to conduct small-scale sampling," Dodds said.

Providing baseline data for good water quality

Dodds is heavily involved with Konza Prairie Biological Station — 8,616 acres of tallgrass prairie dedicated to long-term ecological research and jointly owned by Kansas State University and The Nature Conservancy. He uses data gathered from watersheds on Konza Prairie to form baseline data of what a freshwater system without human influence looks like. Because finding an entire watershed unaffected by humans is difficult in a world of 7 billion people, scientists around the world have used data collected on Konza Prairie.

"I am trying to get an idea of what the natural situation was before humans affected the system so I can form a baseline for how freshwater systems respond biologically to nutrients," Dodds said.

Aiding land managers with information about new management techniques

Patch burning is an emerging management technique gaining popularity among ranchers, but its effect on watersheds is unknown. The technique divides the land into three sections on a rotating burn schedule. One section is burned and gets grazed heavily as the cattle prefer the new regrowth in the burned area. The other two sections rest and are much less preferred by cattle. To assist land managers in conserving the whole prairie, Dodds is conducting a patch burn and grazing study on Missouri's Osage Prairie to study the technique's effect on the watershed.

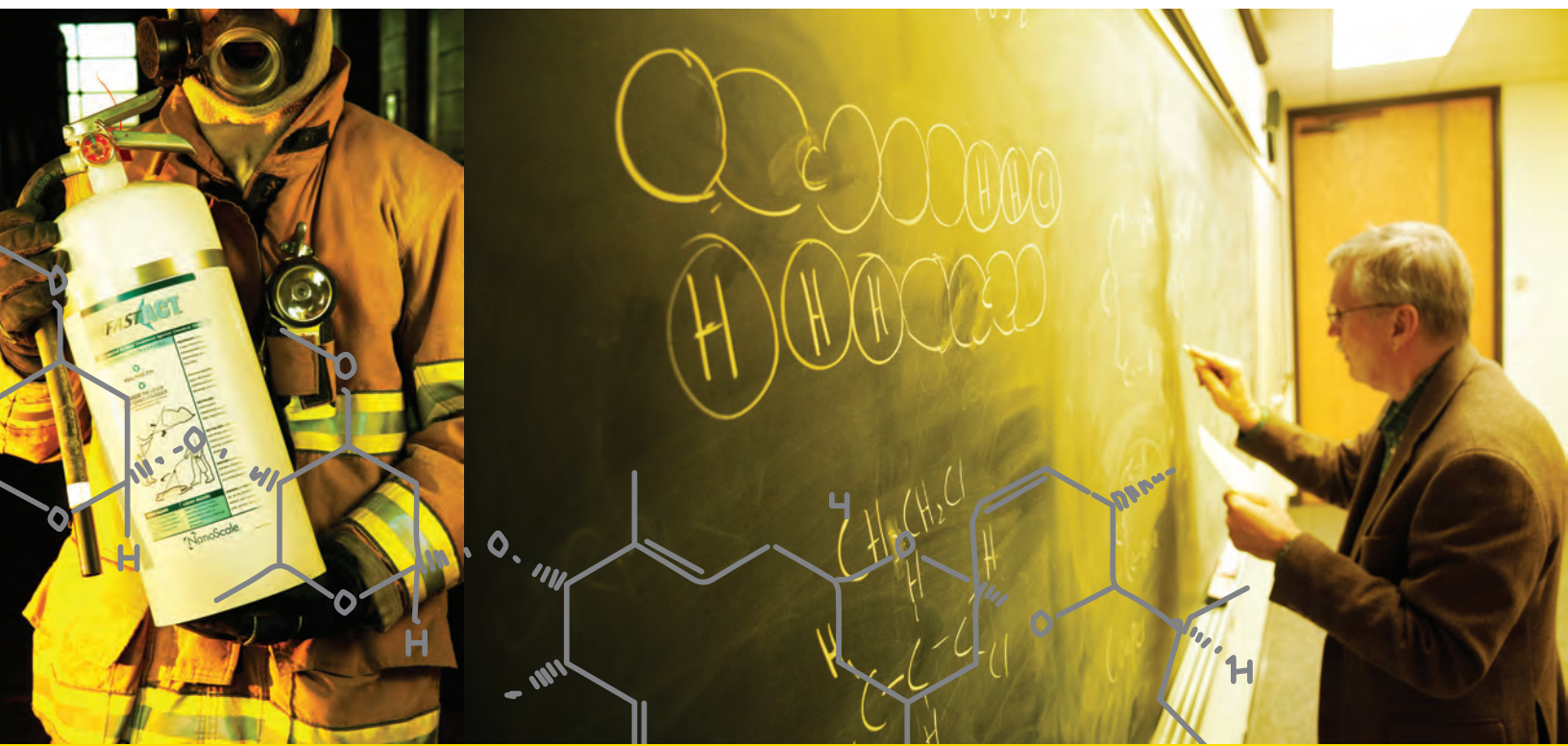
"The patch burn grazing is a way people have proposed to manage the prairie and perhaps put grazers on prairie that is being preserved," Dodds said. "It can clearly increase terrestrial plant and animal diversity, but how that influences watersheds downstream is not well understood."

Speaking out on freshwater management and environmental issues

Dodds' books — "Humanity's Footprint: Momentum, Impact and Our Global Environment," "Freshwater Ecology: Concepts and Environmental Applications of Limnology" and "Laws, Theories and Patterns in Ecology" — have stimulated teaching and discussion about environmental issues. However, recent droughts and building of dams have raised another issue that concerns Dodds: fragmented freshwater systems and their effect on the biota.

"Currently, the discussion is about how much flow makes it down to the Missouri and Mississippi rivers for barge traffic versus how much water to hold in reservoirs so they are high enough for boating," Dodds said. "There isn't much discussion about the effects the fragmentation has on the biota. In times of drought such as this, we have set up a situation where species may go extinct as the stress of low or no flow pushes endangered organisms over the brink."

By Stephanie Jacques, Communications and Marketing



SMALL WONDERS

How chemistry and nanotechnology
are remediating environmental toxins
and influencing future scientists

As environmental challenges grow, one chemist has been looking to smaller solutions.

Kenneth J. Klabunde, university distinguished professor of chemistry at Kansas State University, has spent more than 35 years fusing his expertise in nanotechnology and chemistry into materials that help maintain a cleaner and safer environment. His research has positioned him as an international leader in energy and environmental issues, and has led to mentoring many of the next generation of environmentally conscious scientists.

"I realized a long time ago that we must develop cleaner technologies without significant loss in our standard of living," Klabunde said about his efforts.

In the 1980s, Klabunde began working with oil companies on creating cleaner fuel using nanotechnology and catalysts.

His research led to FAST-ACT, an environmentally safe nanopowder that detoxifies chemical and biological hazards. The powder is porous and has a high surface area, allowing it to trap toxins and odors in a lattice-like structure and break the chemical bonds that form the pollutant. Consumers include the military, used and rental car dealerships, as well as homes and business with odor problems or toxins.

"Chemistry is at the heart of most advanced technologies," Klabunde said. "So, chemistry must also be the foundation for creating a cleaner and safer environment."



FAST-ACT (left) was the byproduct of research by Ken Klabunde (center) to create cleaner fuel using nanotechnology and catalysts. One of his former students, Manindu Peiris (right), looked at materials using light and darkness to purify air.

ILLUMINATING SOLUTION

Removing the smell of fresh paint or new carpet in a room may eventually be a matter of turning the lights on or off.

Manindu Peiris, a May 2012 doctoral graduate in chemistry who studied under Klabunde, looked at materials that use light and darkness to purify toxins in the air. Her research could lead to new air filters, humidifiers and other devices that could detoxify windowless rooms, manufacturing facilities and other indoor areas.

Peiris tested and analyzed photocatalysts and dark catalysts — materials made by chemically bonding metal to oxygen. Photocatalysts react to light while dark catalysts react to darkness. Exposing the catalysts to either light or darkness triggered a chemical reaction that converted the air pollutants into smaller, nonharmful levels of carbon dioxide over time.

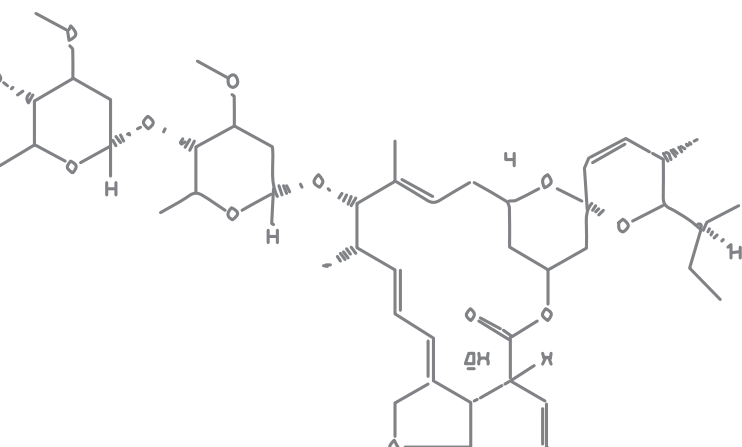
SOLAR POWER

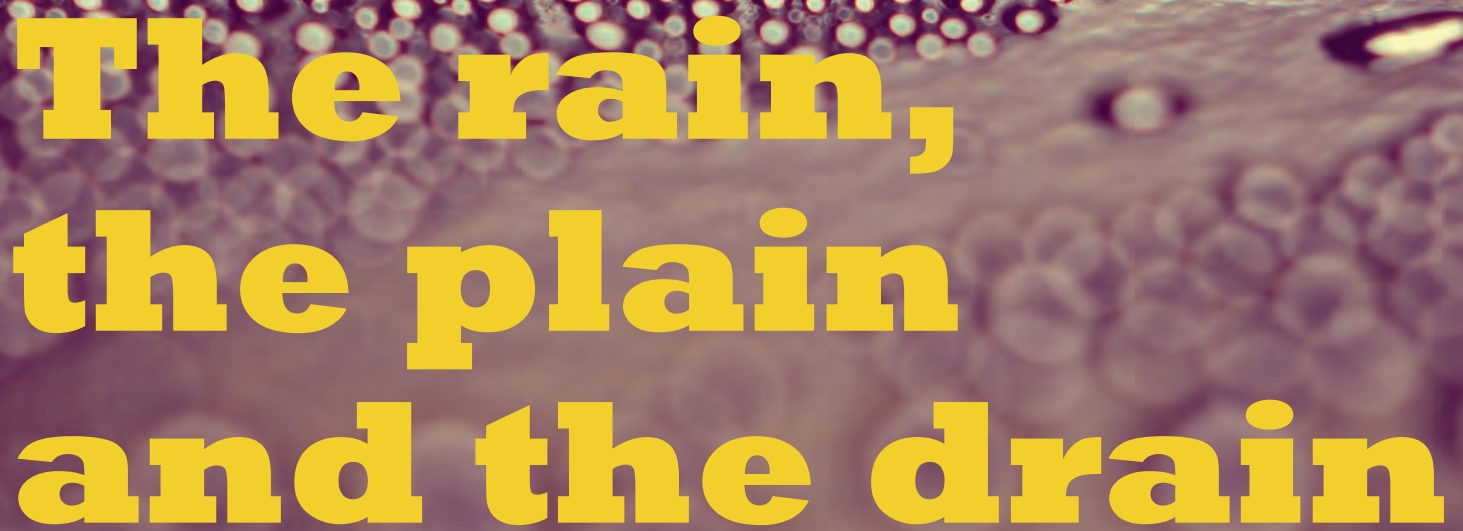
Yen-Ting Kuo, a fall 2011 doctoral graduate in chemistry who studied under Klabunde, helped develop an emerging method of harvesting sunlight to produce fuel.

Kuo's research looked at improving metal-oxide photocatalysts' ability to react with light. Improved reactions result in better chemical reaction performance.

Producing solar fuel involves channeling sunlight into a tank of water containing photocatalysts. The light triggers a series of chemical reactions that produce a synthetic gas called syngas. Syngas can power internal combustion engines and can also be used to create synthetic petroleum fuels.

By Greg Tammen, Communications and Marketing





The rain, the plain and the drain

How a geographer and an engineer are marrying their expertise to study changing weather, challenging landscapes and the ways we manage water

For Shawn and Stacy Hutchinson, several pairings are key to their research. Geography and engineering. Military experiences and academic backgrounds. Husband and wife.

The two married Kansas State University professors are using these partnerships to understand how humans and the military affect landscapes and influence hydrology.

“We are trying to protect natural resources,” said Stacy Hutchinson, associate professor of biological and agricultural engineering. “There is a range of change and human influence on landscapes, and we are trying to figure out how the natural water cycle is affected by this. We also

want to understand how this affects our safety and livelihood, as well as flooding, water pollution, soil erosion and the loss of agricultural crops.”

During the past four years, the husband-wife team has received more than \$1 million to support the research. Shawn Hutchinson, associate professor of geography, studies methods for monitoring and forecasting environmental change — from natural and human causes — and designs digital decision support systems to better visualize landscape dynamics. Stacy Hutchinson uses this information to create better stormwater systems that prevent soil erosion and improve the natural flow of water.

Together the researchers have created a Web application that monitors landscape health.

While much of their research has focused on the effects of urbanization or agricultural production on landscapes, the Hutchinsons are now studying the less-understood effects of military training on landscapes. Both served in the U.S. Army and are using their military backgrounds to help nearby Fort Riley, home of the Army’s 1st Infantry Division.

Military landscape disturbance is driven by national security needs, Shawn Hutchinson said. Nearly every square inch of military land is affected from events and training exercises that use tanks, dismounted

infantry or wheeled vehicles, depending on the current military warfighting doctrine. A healthy landscape keeps soldiers safe and provides realistic training conditions, while mismanaged training lands can cause a variety of issues such as erosional gullies that can damage equipment and injure soldiers.

“Environmental damage can cause a less realistic training environment for soldiers,” Shawn Hutchinson said. “It’s the difference between training on a completely barren landscape versus a landscape with trees and healthy grasses that provide cover. Sustainably managed training lands, then, benefit the environment, soldiers and military readiness.”

To measure landscape changes, the researchers turn to geospatial maps. Shawn Hutchinson is the director of Kansas State University’s Geographic Information Systems Spatial Analysis Laboratory and creates digital maps using Fort Riley satellite images for areas of land as small as 30 meters by 30 meters. The images show how the landscape is affected by various activities — weather, wildfires and even training exercises.

Every 16 days, new images show Fort Riley’s changing landscape greenness, which is closely related to the amount and condition of the installation’s vegetation. The researchers use this information to assess the current health of the training land vegetation and how this will affect water runoff during a storm. They also study weather patterns and various rainfall amounts to determine flooding potential.

“We can delineate a watershed, capture a near-real time estimate of vegetation condition and use this information to design stormwater management systems and size them correctly,” Stacy Hutchinson said. “We also want to

understand how much rain we are getting and how frequently because that helps us to size stormwater systems appropriately so that we don’t have excess flooding.”

Shawn Hutchinson posts the satellite images and information on a custom-designed Web application so that military officials can

Defense-owned land. The department is the steward of the second-highest total area of land in the U.S.

“When you add up all the Department of Defense land in the United States, it makes a huge imprint on air, water and all kinds of pollution and measures of environmental



Professors Stacy and Shawn Hutchinson are looking at how humans and the military affect landscapes and influence hydrology.

quickly see and fix landscape problems before they become too large and even more costly to repair. Using the same imaging technology, the researchers also can apply their work to similar problems that may occur on urban or agricultural landscapes.

As they move forward, the Hutchinsons want their framework for monitoring military lands to become a model for other military installations and Department of

quality,” Shawn Hutchinson said. “The underlying theme of military lands is sustainability. The nation is going to need its military installations, like Fort Riley, well into the future. The Department of Defense can’t afford to do something now that would prevent utilizing the land in a safe manner 20 years from now.”

By Jennifer Tidball, Communications and Marketing

Surveying stormwater

Stacy Hutchinson, associate professor of biological and agricultural engineering, is updating rainfall distribution data to ensure current urban and agricultural stormwater management systems can handle future weather changes. She and her husband, Shawn Hutchinson, associate professor of geography, are studying how climate change and land cover change — which is the conversion of natural prairie and agricultural land to urban and suburban land — affect flooding potential.

That work is funded as part of the \$20 million Kansas National Science Foundation Experimental Program to Stimulate Competitive Research project researching global climate change and renewable energy research.

By Jennifer Tidball, Communications and Marketing

Dust

IN THE WIND

Civil engineering professor part of team researching effects of dust deposits on soil formation, water quality in Rocky Mountains



Natalie Mladenov hikes to an alpine watershed to collect a snow sample for her National Science Foundation-sponsored research on water quality.

What's in the dust that the wind can blow from place to place may not be just affecting air quality — it may affect water and soil quality as well.

That's why an interdisciplinary research team led by a Kansas State University civil engineering professor is studying the effects of wind deposition of dust and other particulates, such as pollen or bacteria, on water quality and soil formation.

Joining Natalie Mladenov, assistant professor of civil engineering, on the project are professors from the University of Colorado at Boulder and a geochemist from the United States Geological Survey. The team was awarded a three-year, \$556,774 grant from the National Science Foundation in September 2011 to complete the research.

The team's project was motivated by newly found connections between atmospheric deposition and water quality. Mladenov and her team believe that dust deposition and other atmospheric aerosols might play a role in increasing nitrate concentrations observed in alpine streams. Nitrates are pollutants that can adversely affect mountain streams, which are an important source of drinking water. Previously, these alpine soils were nitrogen-poor, now they are nitrogen-saturated.

Measuring dust and other Aeolian, or wind blown, deposition is especially important in Colorado's Rocky Mountains, the site of the team's research, because of high rates of nitrogen deposition. The deposition of pollutants to alpine ecosystems can cause high nitrogen concentrations in streams. But there appears to be another driver of the high stream nitrate concentrations — a biological one.

"Over the long term, in particular over the last few decades, scientists have observed that nitrate has been increasing in alpine streams," Mladenov said. "Nitrate is a compound that is regulated in surface waters by the U.S. EPA. Even though the alpine stream nitrate concentrations are far from exceeding the standard, the fact is that they have been increasing."

These changes appear related to alpine bacteria and their additions to nitrate loading. The research team is investigating whether atmospheric deposition of other elements, namely carbon and phosphorus, may be stimulating different microbial communities in the alpine soils and whether these communities are supporting bacteria that produce nitrate. There are limited amounts of carbon in the alpine because of the lack of vegetation, so carbon deposited from the atmosphere could be an important subsidy for microbes living in barren soil, according to Mladenov.

The team's research is being conducted in the Green Lakes Four catchment in the Rocky Mountains. The catchment is the site of a National Science Foundation Long Term Ecological Research Station, which provides considerable historical data to build from. Records of microbial populations and soil and wet deposition chemistry can easily be coupled with soil, stream and atmospheric deposition sampling.

"Our team has been studying the microbial populations in these soils and has found that they are more abundant and active than previously thought," Mladenov said. "What we don't know is where they are getting the carbon they need to support themselves."

Interestingly, Mladenov and her colleagues have found that rain and snow contain fairly high amounts of organic carbon associated with dust, pollen and atmospheric pollutants that could fuel soil bacteria in alpine environments. This is why the team will also be performing experiments in which dust and other aerosols such as pollen are added and then tracking how microbial communities respond to the inputs.

"If we can determine whether atmospheric deposition is a major source of carbon to alpine environments and that this deposition serves as a food source to support bacteria in these environments, then we will have a better grasp of the full story," Mladenov said.



Thomas Barret Wellemeyer, junior in civil engineering, is an undergraduate research assistant working with Mladenov on the project.

If Mladenov and her colleagues find that there are key linkages between atmospheric deposition, soil microbes and alpine streams, this could affect water quality in headwaters, which are drinking waters for a broad portion of the population.

Mladenov's colleagues are also investigating whether atmospheric deposition may be an important contributor to soil in alpine zones. The team has evidence that deposition of dust in these very arid, barren, extreme alpine environments may be responsible for soil formation in addition to weathering processes.

The team's grant will support assistance on the project by several graduate students at both the University of Colorado and Kansas State University. Support also is provided for a high school student from Colorado's Math Engineering and Science Achievement, or MESA, program to lead his or her own small research project. The program facilitates research opportunities for underrepresented students in science and engineering.

"The supported students will lead their own small research projects, so they will have a contribution to the overall project," Mladenov said. "These types of projects are known to have a real impact on students by providing them with a vision of themselves as a future scientist or engineer."

The team has already submitted a paper on the project to Biogeosciences, an interactive open access journal of the European Geosciences Union. The paper is available on the journal's website: www.biogeosciences.net.

By Tyler Sharp, Communications and Marketing

WHERE THE RIVER RUNS

Geographer channels research to understand how dredging affects river health, water supplies

A Kansas State University researcher wants to clear the waters when it comes to dredging.

To improve river health and maintain municipal water supplies, Melinda Daniels, associate professor of geography, is monitoring several in-channel sand dredging sites along the Kansas River. In-channel dredging is the process of taking sand from the river bottom and pumping it onto the riverbank to be processed and sold.

Daniels is studying water and sediment movement to determine the effects of dredging on the Kansas River and its tributaries. Because numerous cities receive water supplies from rivers, Daniels' research on the environmental and economic effects of dredging can apply to rivers nationwide.

"We are studying the specific processes operating in the river," Daniels said. "Much of the research on in-channel dredging has been done in places like California, where the riverbeds are made of gravel and cobbles. We have sand-bedded rivers in the Great Plains and we don't have specific studies to point to from other sand-bedded systems. The basic principles of water and sediment transport tell us that changes will occur faster because sand is easier to remove and a river can erode it more quickly than gravel or cobble."

Daniels' latest research is funded by the Kansas Water Resources Institute at Kansas State University, which is sponsored by the U.S. Geological Survey. Daniels and her research team are sharing their valuable findings with state organizations and the U.S. Army Corps of Engineers, which issues permits regulating the number and scale of in-channel dredges on the Kansas River. Dredge holes in the river have been measured as much as 12 meters deeper than the base elevation of the riverbed, where the flow averages less than two meters deep.

"The concern is that when you excavate a hole in a river channel, it causes a chain reaction," Daniels said. "The removed sediment causes the riverbed to incise, or cut downward, so the bed of the river lowers. The upstream edge of the dredge hole starts to move upstream as a nickpoint. What we want to know is whether the nickpoint stays really steep or if it diffuses over distance as it moves upstream. We also want to know how fast it moves upstream."

If the riverbed lowers too much, banks become unstable and start failing. As the riverbed lowers so does the water level in the



Melinda Daniels is researching the effects on river beds caused by river dredging.

river and in the linked floodplain groundwater system, leaving floodplain creeks, wetlands and well fields perched. Perched waters can run dry more often, and perched well fields need to be dug deeper to provide sufficient water supply for cities. Several large Kansas cities such as Manhattan, Topeka and Lawrence all get water supplies from

well fields in the Kansas River floodplain. Other problems occur as riverbeds lower. Bridges become unsafe and must be replaced. Land loss occurs as banks erode and fall into the river. Costs associated with reconstruction, land loss and riverbank stabilization can add up, Daniels said.

"A lot of money is spent repairing bridges, installing bank protection and doing other engineering work to the river," Daniels said. "Preventative measures may not stop the problem. If riverbeds continue to incise, the engineered structures may continue to fail and need to be replaced. These engineering works degrade the river in terms of its ecosystem properties. The end result is that the river is transformed into an expensive-to-maintain, engineered ditch with reduced fish, wildlife, recreation and water supply ecosystem services."

Daniels and her research team will continue performing field measurements in the spring to understand how the dredge sites affect the entire river network. Daniels also presented her research at the Governor's Conference on the Future of Water in Kansas, which took place in October in Manhattan, Kan.

By Jennifer Tidball, Communications and Marketing

Barrett Swenson, master's student in geography, tows a research instrument called an Acoustic Doppler Current Profiler (ADCP) behind a kayak in the Big Blue River. The instrument is used to map the river bed and the return signal is relayed to another device on shore.



Kansas Water Resources Institute

Research from Melinda Daniels, associate professor of geography, is supported by the Kansas Water Resources Institute at Kansas State University.

The institute — funded by the U.S. Geological Survey — develops and supports research on high-priority water resource problems and objectives, as identified through the state water plan. The institute also co-hosted the October 2012 Governor's Conference on the Future of Water in Kansas, in Manhattan, Kan.

"The institute brings together people across disciplines at Kansas State University and brings researchers together from universities across the state," said Dan Devlin, director. "The institute also connects our

research results and our researchers with stakeholders in the state."

Each year, the institute funds research at universities and organizations across Kansas. Two Kansas State University projects were chosen for funding this year: Daniels' research and a collaborative project from Nathan Nelson, associate professor of agronomy, and Dan Sweeney, professor at the Southeast Agricultural Research Center.

The collaborative project involves evaluating phosphorus levels in runoff water throughout the state. The researchers are studying the accuracy of current tools, evaluating best management practices for reducing phosphorus and improving water quality throughout Kansas.

By Jennifer Tidball, Communications and Marketing





Gust of power

Is the answer to the nation's energy problems blowing in the wind? A researcher at Kansas State University believes it could be. She is not only training the engineers needed to harness the wind for power, but she also is helping schoolchildren and teachers across the state learn how wind energy works.

Ruth Douglas Miller is an associate professor of electrical and computer engineering and director of the university's Wind Application Center, one of only 11 such centers in the nation supported by the National Renewable Energy Laboratory.

"The economic advantage of wind energy is that it remains the lowest-cost new source of electricity after natural gas," Douglas Miller said.

Douglas Miller also leads the Wind For Schools program, which helps K-12 schools in Kansas install small wind turbines to educate students about wind energy and interest them in careers in the field. The Wind Application Center, along with other sources, has had a hand in securing 19 turbines for Kansas schools, from the Kansas City area to halfway across the state.

"The teachers I am in regular contact with are using their turbines in their curriculum at some level, though it varies across the board," Douglas Miller said. "We have also sent five Kansas teachers to become Wind Senators by taking one-week workshops run by KidWind. They receive instruction in using the WindWise curriculum."

The teachers received partial scholarships from the National Renewable Energy Lab and additional support from the Wind Application Center to attend the workshop.

Douglas Miller said the center expects to have a couple of the Wind Senators run workshops for other teachers this summer. It also is formalizing the KidWind Challenge the university has conducted for the last two years at its annual All-University Open House in the spring.

"We had a lot of children here last spring, and about six competitive teams from Wichita, Topeka and Bennington," she said. "Wichita will have a KidWind Challenge event in early spring 2013."

Wind Application Center a force for wind research, education

Working with alternative energy sources is the focus of some of the courses Douglas Miller teaches. She's taught about 30 students — 15 on campus and 15 off-campus — in her wind and solar energy design class the last three years. Around half of the students in the on-campus class are graduate students, with most electrical engineers in the power and energy area. The students also come from mechanical, industrial and architectural engineering.

Douglas Miller and her students use wind turbines and solar panels installed at the university and at the nearby Riley County Public Works Facility to study the efficiency of renewable energy generators and how to best integrate them into the power grid.

New for the spring 2013 semester is a wind turbine design contest sponsored by the Department of Energy through the National Renewable Energy Laboratory for students at schools with a Wind Application Center, including Kansas State University.

While the job market for wind engineers has been down because of the economy and other factors, Douglas Miller sees growth ahead, including in Kansas. Several wind farms are under construction or in expansion phases in the state.

More information on KidWind is available at: www.learn.kidwind.org.

By Beth Bohn, Communications and Marketing

Kansas State University's Wind Application Center has several ongoing projects involving multiple College of Engineering faculty and students, including:

Looking at grid integration of renewable energy — how to predict the energy from sources you can't turn on at will, and how to maintain a stable grid under variable load and generation. The work is being supported through funding from the U.S. Department of Energy and the Power Affiliates Program.

A small Kansas Department of Transportation-funded project looking at predicting wind at one site based on measurements at another.

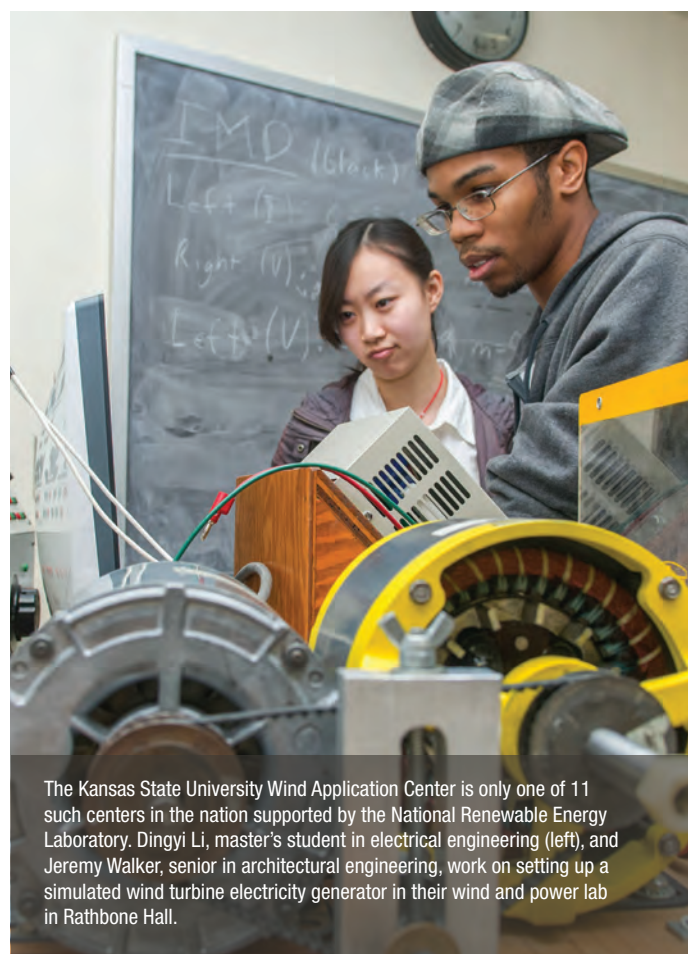
Refinements in power inverter design and control, previously funded by DOE grants, are presently being funded internally.

The High Plains Small Wind Test Center, a partnership between the Wind Application Center and Colby Community College, in northwest Kansas, is funded by the U.S. Department of Energy/ National Renewable Energy Laboratory.

As for the future of wind energy research in Kansas, collaborations by the state's research universities are being planned. The first Kansas Statewide Wind Energy Forum in Manhattan in fall 2012 brought together about 60 researchers, educators and industry representatives from across the state to share their current activities and plan future collaborations. The forum was sponsored by the research offices of Kansas State University, the University of Kansas and Wichita State University. Representatives from the three schools are working on state funding proposals for a Kansas wind research consortium.



Scan with smartphone for video of Ruth Douglas Miller and the Kansas State University Wind Application Center.



The Kansas State University Wind Application Center is only one of 11 such centers in the nation supported by the National Renewable Energy Laboratory. Dingyi Li, master's student in electrical engineering (left), and Jeremy Walker, senior in architectural engineering, work on setting up a simulated wind turbine electricity generator in their wind and power lab in Rathbone Hall.



A bumpy ride

Researcher studies turbulence in wind turbines to ensure their viability

The concept of a wind turbine seems simple enough: The wind blows and the blades spin. Warren White, associate professor of mechanical and nuclear engineering at Kansas State University, said this is a common misconception.

“A wind turbine doesn’t produce more power the faster it spins,” he said. “Many problems pop up when you deal with turbines and capturing wind power, and we’re trying to figure out how to reduce them.”

For several years, White has been researching the problems causing a shortened lifespan for wind turbines, especially turbulence. He said that turbulence in the air could damage the turbine as the blades shake and vibrate.

“If you take a wire and bend it back and forth, fatigue will eventually make it come apart,” White said. “The same thing happens to a turbine after years of vibrating in the wind — it looks steady, but it can give out and break.”

Any time a turbine breaks or is not capturing the maximum amount of power, it becomes an economic issue. The revenue and cost of production of a turbine is what will make or break the wind energy industry, White said.

The goal is to decrease the payback time by getting as much power out of the turbine as quickly as possible.

“You design a wind turbine to last for 20 years, but that doesn’t always happen,” White said. “If turbines last for significantly less time than expected, wind energy won’t be viable. It is viable; we just have problems to work out.”

One of White’s projects examining turbulence involves an instrument from the National Renewable Energy Lab. The device would allow researchers to predict what the wind will do one second in advance by using the wind profile of the turbine to measure wind velocity and direction.

With this device attached to the turbine, researchers hope to change the turbine’s blade pitch — turning the blade so it is more parallel or less parallel to the wind — to maximize power.

“The blades have so much inertia, it would take too long to change their speed,” White said. “Everything happens so fast, it would only be possible to change the pitch.”

White also is working with other electrical and computer engineering university researchers — including Behrooz Mirafzal, assistant professor, and Ruth Douglas Miller, associate professor — to get additional funding for a lab simulator that models the vibrations and mechanical aspects of the turbine.

This simulator uses software developed by the National Renewable Energy Laboratory. White said the simulator calculates the torque that’s delivered to the shaft of the turbine, which is done by using an electric motor. The scaled torque produced by the motor would closely model the torque delivered by the wind turbine rotor to the generator.

“The simulator models the vibrations and mechanical aspects of the turbine,” White said. “If we are able to detect the vibrations that the wind produces, then we may be able to eliminate and control them.”

Solving issues with turbine reliability like turbulence is vital to the future of wind energy. White said wind turbines are now producing power at a rate comparable to coal, but increased research funding is needed to help even the playing field.

“For a long time, coal was king,” he said. “Turbines are still not as cheap as natural gas, but they will continue to become more economical. In order to build better turbines, we need federally funded research, and that’s been continuously declining. We need to make the investment to move forward.”

By Megan Saunders, Communications and Marketing



Continuing the discussion

Kansas is second in the nation for wind energy production. Warren White said it is important to continue the industry's development for both the economy and education.

Recently, the state took strides to underscore the importance of wind energy. The 2012 Kansas Statewide Wind Energy Forum was Sept. 26-28, 2012, in Manhattan, Kan. The forum was made possible by funding from several universities, including Kansas State University, through participation in the Kansas Board of Regents Council of Chief Research Officers.

Keynote speakers included Fort Felker, director of the National Wind Technology Center. The purpose of the forum was to develop a road map for Kansas higher education institutions to collaborate in conducting wind energy research and development, as well as to educate and train the future Kansas energy workforce.



Warren White and Zhichao Yu, senior in mechanical engineering, discuss a wind turbine simulation.

A group effort

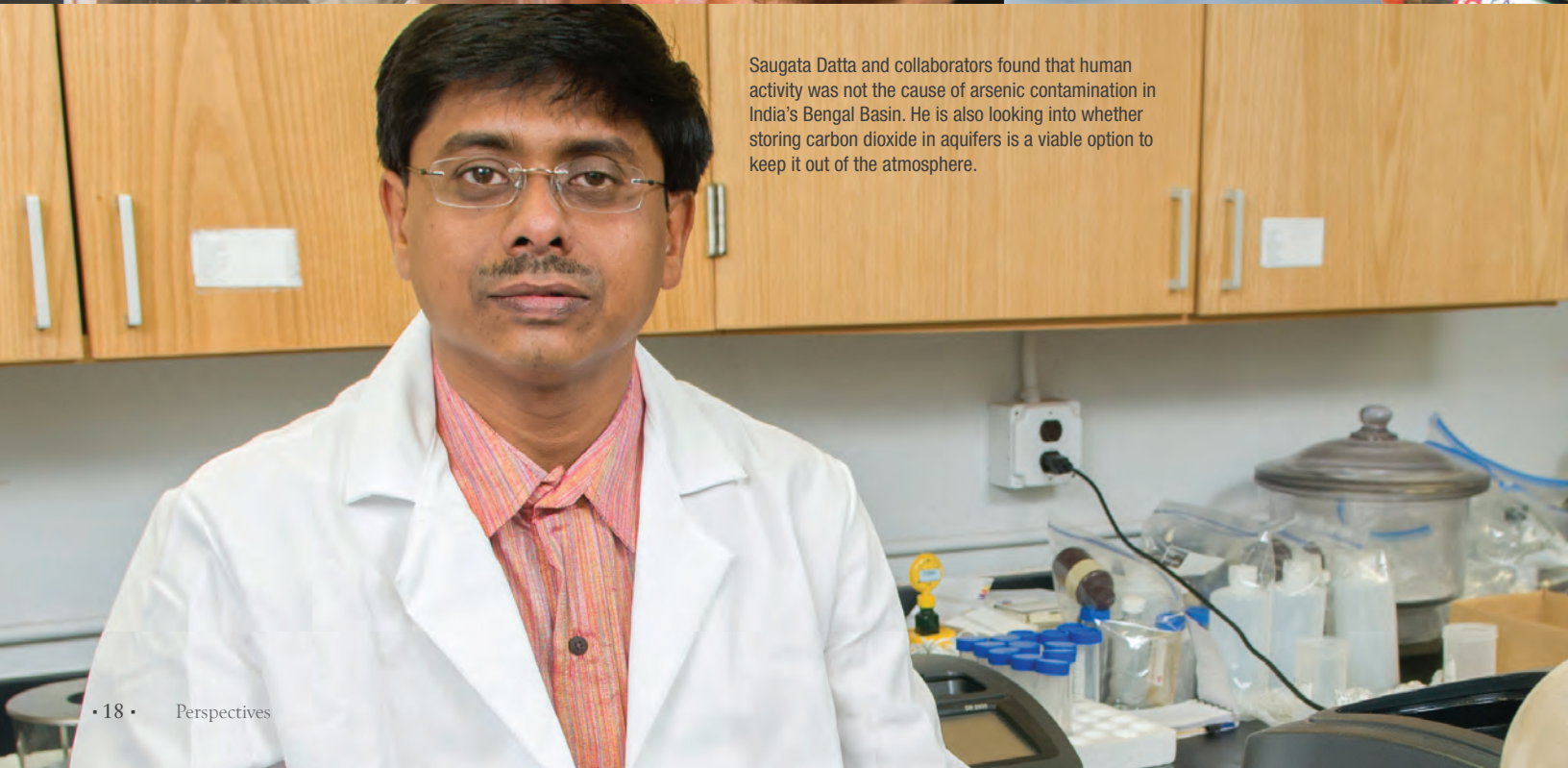
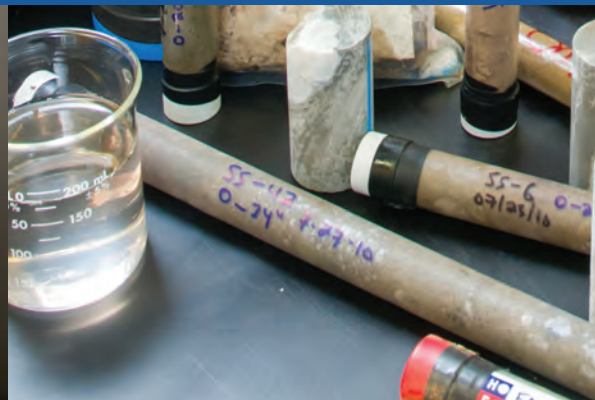
Warren White is a leading researcher in wind energy at Kansas State University. He also works with researchers like Behrooz Mirafzal and Ruth Douglas Miller to improve the efficiency of wind turbines.

Mirafzal researches power electronic applications in sustainable energy systems, such as wind. Power electronic converters are the points of common coupling between sustainable energy resources and the power grid. Mirafzal conducts applied and fundamental research to improve the productivity and reliability of these systems.

Douglas Miller and her team of student researchers have been working with White to construct a computer model of a wind turbine to test different ways of controlling the turbine for maximum power capture. She said the team believes the model will lead to conclusions about how the electrical parts of turbines should be designed for maximum efficiency.



Scan with smartphone for video of Warren White and Ruth Douglas Miller discussing what powers wind farms.



Saugata Datta and collaborators found that human activity was not the cause of arsenic contamination in India's Bengal Basin. He is also looking into whether storing carbon dioxide in aquifers is a viable option to keep it out of the atmosphere.

Digging deep

Geological research may reveal secrets to contamination, pollution remediation mysteries

Saugata Datta sees some of Earth's largest challenges and opportunities in its tiniest substances.

Datta, associate professor of geology at Kansas State University, specializes in trace elements and their contamination of the environment — particularly groundwater and air. He focuses on understanding why certain elements become toxic when introduced to water, air and other elements, as well as how humans can fight back.

A deepening mystery

It has been called one of the worst mass poisonings in human history.

The groundwater in India's Bengal Basin — an area inhabited by more than 70 million people — contains such high arsenic levels that drinking it causes skin lesions, respiratory failure and cancer. It has resulted in numerous deaths and a continual water shortage in the country. Yet more than a decade after being detected, the source of contamination has continued to elude scientists.

In 2011, Datta, a native of India, and colleagues began studying the basin and the region's man-made ponds, a source many geologists claimed to be the major contributor to the groundwater's arsenic levels.

Researchers determined that the ponds were not the cause of the arsenic poisoning in India's groundwater, but can be a slow pathway for infiltration of organic matter into subsurface aquifers.

They also discovered high concentrations of manganese — another naturally occurring element — in the water. Manganese has been linked to decreased intellectual function in children. Researchers found that if arsenic is in the groundwater, so is manganese. Additionally, the higher levels of arsenic have lower levels of manganese and vice versa.

Datta continues to study the Bengal Basin with Sankar Manalilkada Sasidharan and Md Golam Kibria, master's students in geology, and Sophia Ford, geology undergraduate.

Solid-tary confinement

The solution to keeping carbon dioxide out of the atmosphere may lie in the ground below.

Datta, through a national collaboration, also is looking at trapping and storing carbon dioxide in rocks more than 5,000 feet underground in Kansas' Arbuckle aquifer. It has a thick layer of porous rock that scientists believe could permanently store carbon dioxide.

"Certain minerals within rocks, such as silicates, are able to trap carbon dioxide and transform it into solid minerals," Datta said. "Ultimately what that means is that once the carbon dioxide is trapped in a mineral, there is very little chance of it being dissolved and being released into the atmosphere. This is essentially locking it up forever."

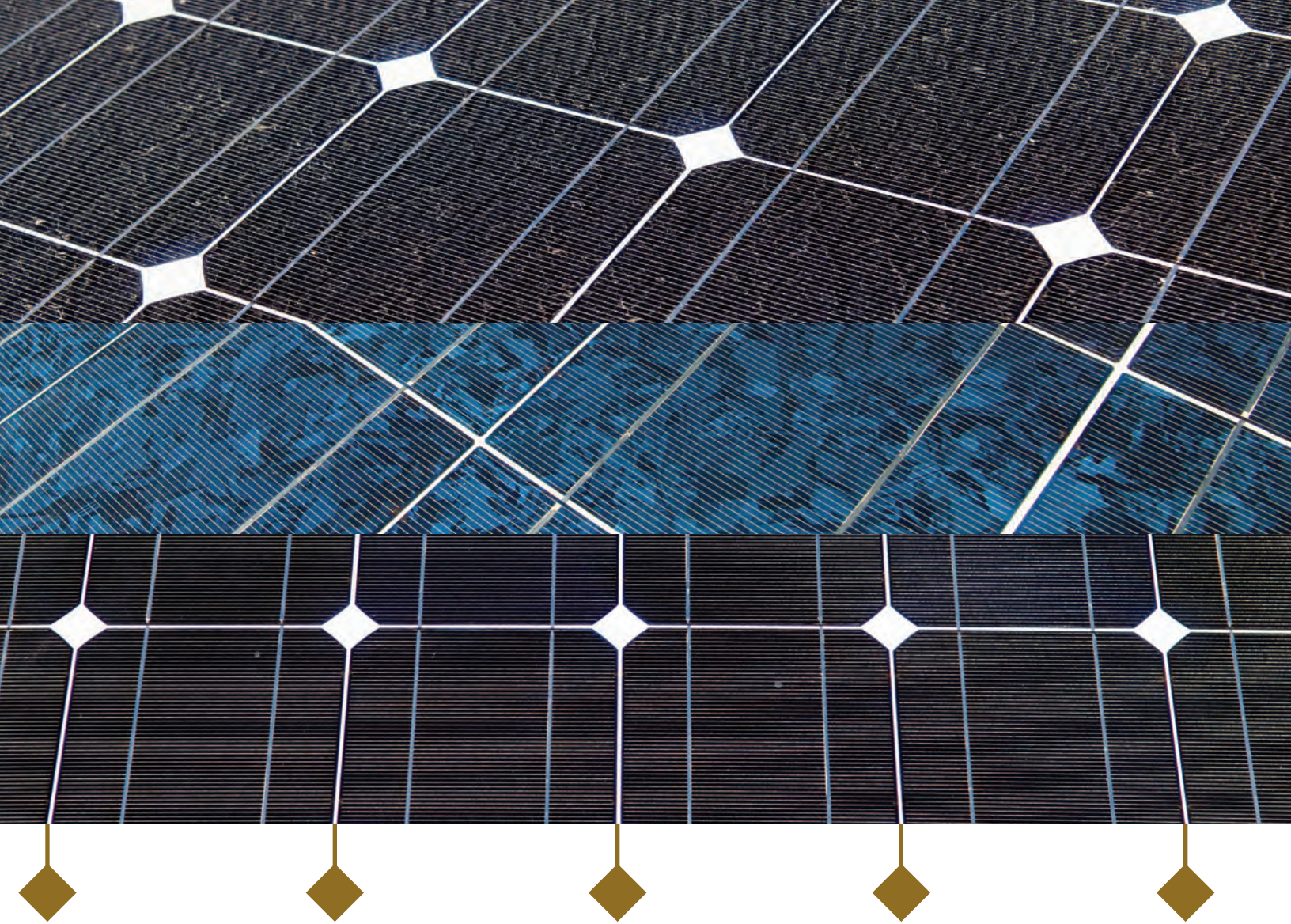
According to Datta, determining whether aquifer rocks are a viable option for carbon dioxide storage could benefit manufacturing and production industries, which currently monitor carbon dioxide levels due to regulations.

Along with Robin Barker, fall 2012 master's graduate in geology, the researchers are modeling what happens geochemically when carbon dioxide is injected into the aquifer's bedrock. From this, researchers can predict what happens to the groundwater before, during and after the carbon dioxide injection, as well as what will happen to the stored carbon dioxide decades into the future.

"We're really looking into the geochemical feasibility of this as a solution," Barker said. "So far, the preliminary conclusion is that geochemically, it appears that we will be able to safely sequester the carbon dioxide in the aquifer without affecting any drinking water sources."

The U.S. Environmental Protection Agency has deemed the Arbuckle's groundwater unsafe to drink due to high salt concentrations, making it a safe test bed.

By Greg Tammen, Communications and Marketing



BRIGHTENING AFGHANISTAN

Researchers study renewable energy to power electricity-scarce country

Employees light a candle to see one another during a meeting.

A child reads a book by moonlight before bedtime.

Machines at a factory are at a standstill, sending workers home.

Without electricity in much of the country, these are common scenes in Afghanistan. A severe energy shortage threatens the nation's hopes of building its economy.

The country ranks as one of the lowest producers of electricity per capita in the world. More than 80 percent of the 29 million people in Afghanistan do not have access to electricity. Afghanistan depends on other countries for electric power, importing 73 percent of its electricity from neighboring countries.

Kansas State University researchers have proposed a solution: Harness the power of nature. The researchers include Anil Pahwa, professor of electrical and computer engineering; Ruth Douglas Miller, associate professor of electrical and computer engineering; and Mahdi Sadiqi, a native of Afghanistan who recently earned his master's degree in electrical engineering. They recently presented their findings to the IEEE — Institute of Electrical and Electronics Engineers — North American Power Symposium.



A rural disadvantage

The power supply in urban Afghanistan is sometimes sporadic, giving customers access to electricity just four to six hours a day. The situation is worse in rural Afghanistan. Electricity is scarce in rural areas, where about 70 percent of the country's population lives.

The lack of power makes everyday tasks more difficult. Rural community members are forced to use wood, diesel and kerosene as sources of energy for cooking, heating and lighting. They gather wood for fires to heat water. Schoolchildren have limited time to study in the daylight. Kerosene lanterns emit smoke and pollution inside some homes.

Importing more electricity would not help the country's predicament in rural areas, where the infrastructure does not exist. Expanding the power grid to mountainous rural areas is nearly impossible.

"The central power authority is already having trouble taking care of everybody's needs in Afghanistan, and there are often electricity shortages," said Pahwa, who experienced many power outages while teaching at a university in Kabul, Afghanistan's largest city. "Adding new customers would be an extremely difficult proposition, and the infrastructure does not exist. Alternatives must be found."



Renewable solution

Kansas State University researchers found that Afghanistan can use more renewable energy to power the country.

They created model power systems in the province of Bamiyan in the northern part of Afghanistan using the computer software Hybrid Optimization Model of Electric Renewable, or HOMER, developed by the U.S. Department of Energy's National Renewable Energy Laboratory.

Researchers discovered that the most ideal solution is a hybrid system powered by renewable resources, including water and the sun, and a battery backup. Renewable energy could power an entire system for a rural community. With significant amounts of snow during the winter and sun during the summer, this system could be used throughout the year. Wind energy was not suitable for the selected site because of low wind speeds.

The ideal model would implement energy curtailment a few hours per day for each customer to reduce the cost of generated electricity, encouraging community members to find ways to limit their power usage.



Plugging into benefits

More renewable electricity in Afghanistan could reduce poverty and deforestation, and improve health care, living standards and education. With more electricity, students could access technology using a computer and the Internet. Community members could access electronic news to stay informed. Factories could stay powered and employ more workers.

Researchers said they hoped to encourage private investors and local community members to take advantage of Afghanistan's renewable energy potential.

"We want to show private investors, the government, community members and nonprofits that Afghanistan has enough renewable energy sources that can be integrated affordably in our communities," Sadiqi said.

By Trevor Davis, Communications and Marketing



Professors Anil Pahwa and Ruth Douglas Miller worked with a former graduate student — an Afghanistan native — to improve the country's electricity supply with renewable energy.

BY THE NUMBERS

80 percent of Afghanistan's population without access to electricity

29

million people in Afghanistan

73

percent of Afghanistan's electricity is imported



Solar-powered charging stations for plug-in vehicles

Switching from gas-powered to electric and hybrid vehicles can reduce air emissions and improve air quality. Larry Erickson, professor of chemical engineering, directs a project to help develop solar-powered charging stations for electric and hybrid vehicles.

Engineering and construction firm Black & Veatch awarded Kansas State University a \$200,000 grant for the research. The solar panels will power charging stations for plug-in vehicles, and will provide shade from the sun and protection from rain, snow and ice. The Kansas State University stations will be used for research, development, education and charging vehicles.

The project will allow researchers to better understand the technical, social, environmental and economic issues surrounding plug-in vehicles. Possible research topics include the environmental impact, consumer attitudes and the distribution of electricity.

The grant comes as auto manufacturers have released plug-in models like the all-electric Ford Focus, Chevrolet Volt and Nissan Leaf. The federal government is requiring that auto manufacturers nearly double the average fuel economy of their fleets by 2025.

By Trevor Davis, Communications and Marketing



New material for improved lithium-ion batteries

Steven Klankowski, doctoral candidate in chemistry working with Professor Jun Li, is making new materials that could be used in future lithium-ion batteries. The materials look to improve the energy storage capacity of batteries for mobile devices so they will last longer between charges.

Lithium-ion batteries that can store energy and deliver power more rapidly will be a more viable alternative power source for vehicles and machines powered by alternative energy. Solar- and wind-powered technologies could switch to the battery when there is a lack of wind or sunlight to produce energy.

Klankowski is developing and testing a high-performance nanostructure of silicon coated onto carbon nanofibers for use as an electrode in lithium-ion batteries. The electrodes give the battery greater charge capabilities and storage capacity. The material helps the electrode store roughly 10 times the amount of energy as current electrodes — giving the batteries a 10-15 percent improvement in current battery technology.

The material is also studied for its ability to store energy.

According to U.S. Department of Energy's requirements, a battery must remain at 80 percent capacity after 300 charge-discharge cycles.

By Greg Tammen, Communications and Marketing



Using biomaterials to improve the quality of roads

Dunja Peric, associate professor of civil engineering, and her research team are working with lignin, a plant-based sustainable material that can be added to improve the quality of unpaved roads throughout Kansas. More than 70 percent of the 98,000 miles of roads in Kansas are unpaved and made from loose granular soils with particles that are not bound to each other on the road surface.

This limits the speed of vehicles and often generates dust, denigrating the quality of the road. Travel is impaired because of raveling and washboarding, which are forms of soil collapse on the top surface of the road. These are all things that can be mitigated by lignin because it holds the soil particles together and in place.

In an agricultural state like Kansas, lignin is an abundant resource and has the potential to improve unpaved roads, leading to lower maintenance costs throughout the state.

Lignin can be extracted from many types of crop residue, and it can also be an extra source of income to farmers and the agricultural community if there is a demand for this crop residue. Lignin is a sustainable and non-toxic product, unlike traditional soil stabilizers such as fly ash or cement, which contain some heavy metals that could contaminate soil.

By Jennifer Tidball, Communications and Marketing