

Water Currents



Center for the Management, Utilization and Protection of Water Resources • Summer 2008 Newsletter • Volume 7, Issue 1

A recent investigation by the Associated Press has brought to new light a topic that the Center's environmental chemist Martha J.M. Wells already knew was relevant. The AP study reported that small amounts of pharmaceuticals had been found in the drinking water of 41 million Americans.

According to an AP story published in the *Herald-Citizen* newspaper, the "five-month inquiry found [pharmaceutical] drugs in parts per billion or trillion in the drinking water supplies of 24 major metropolitan areas including San Francisco, Washington, D.C., and Tucson." Pharmaceuticals can enter our water systems in four different ways--either from a pharmaceutical manufacturing facility, through human excretion, through direct flushing of unused medications, or through the use of veterinary medications.

Wells, who was interviewed about this subject on an NPR broadcast, believes the AP study is "cause for concern but not alarm."

"This is an area I've been working in for 10 years," she said. "The AP story did not surprise me."

She says that water departments don't test for pharmaceuticals because they aren't required to by the U.S. Environmental Protection Agency and that "monitoring pharmaceutical occurrence in drinking water is very expensive. The advanced treatment processes necessary to remove pharmaceuticals and their degradation products are actively being pursued by researchers, but it will also be expensive. Right now, though, the United States still has the best municipal-treated drinking water in the world."

Wells' work in this area has been funded in recent projects by the U.S. Geological Survey and the West Virginia Department of Natural Resources. In a project titled "An Assessment of the Occurrence of Chemicals Causing Endocrine Disruption in Fish in the South Branch of the Potomac River," Wells and

Recent AP Study Causes Concern About Safety of Our Drinking Water



her research team tried to determine the chemicals involved in the endocrine disruption of reproductive function in smallmouth and largemouth bass collected from sites located within the South Branch of the Potomac River, the North River and the Lost River drainages. The goal of the project was to identify a short list of chemicals that are suspected of being involved in endocrine disruption.

Wells' research also led to her involvement, in 2004, in coordinating an international symposium broadcast across the Internet on the implications of pharmaceuticals and personal care products (PPCPs) being found in drinking water. To do this, she worked with Larry Keith, of Instant Reference Sources Inc., and the EPA, which funded the event.

PPCPs are being used more and more. When they show up in our water systems, they can potentially be harmful to fish, other aquatic life, and even human populations, although no known human health effects have been attributable to pharmaceuticals in drinking water as of yet. Wells believes that we're finding out these things now because we're looking for them, and she applauds the AP story for raising awareness about the potential problems.

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Tennessee Cooperative Fishery Research Unit Leader Layzer Honored by U.S. Fish and Wildlife Service

Biology Professor Jim Layzer has devoted his professional life toward protecting endangered fish and mussel species, and recently, that perseverance was acknowledged by the U.S. Fish and Wildlife Service (USFWS).

Layzer was one of 16 USFWS partners honored with the 2007 Southeastern Regional Director's Conservation Awards, given for accomplishments toward fish and wildlife conservation.

"We applaud their efforts and dedication, which are freely given in service to the natural world," said Sam Hamilton, Southeastern regional director of the USFWS, in a recent press release.

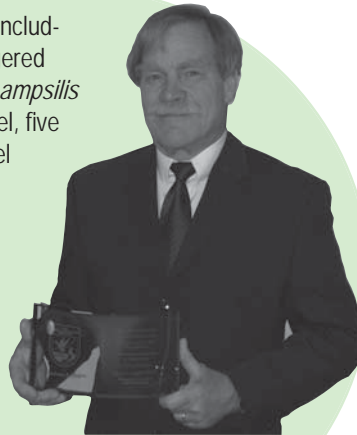
Hamilton presented the award to Layzer and the other honorees in a ceremony on May 12 in Atlanta, Ga.

Layzer's career has spanned more than two decades as he pursued research interests in the areas of stream regulation effects on aquatic wildlife; the ecology and conservation of freshwater mussels; the restoration and maintenance of aquatic biodiversity; and the ecology of stream fishes. Many of his funded research projects have been administered by the Center.

"I consider this award to be really a recognition of the hard work, dedication and enthusiasm of my students and staff who worked alongside me," Layzer said.

Thanks to Layzer and his research team, who

study species including the endangered pink mucket (*Lampsilis abrupta*) mussel, five different mussel species have been cultured through their entire life cycle. And their use of fish raceway techniques to propagate and culture freshwater mussels was groundbreaking in those efforts.



Biologist Jim Layzer
(Photo courtesy of Layzer)

Earning his bachelor's and master's from the University of Massachusetts and his doctorate from Oklahoma State University, Layzer has served as a project leader for the USFWS office in Amherst, Massachusetts; a University Fellow for the Oklahoma Cooperative Fishery Research Unit, at Oklahoma State University; a fishery biologist and ecologist for the Federal Energy Regulatory Commission in Washington D.C.; and as a biology professor and leader of the Tennessee Cooperative Fishery Research Unit at TTU. His extensive research has been published in peer-reviewed journals ranging from *River Research and Application* to *Bioscience*. He has presented numerous papers on his research at scientific meetings throughout the United States and at international meetings in Mexico, Canada, Australia and throughout Europe.

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NEWS NOTE

Graduate student Rupesh Puttagunta won the award for best poster at Tennessee Technological University's (TTU's) Student Research Day, held April 1, 2008. His advisors are Dennis George, environmental engineer and Center director, and Pedro Arce, professor and chair of the Chemical Engineering Department. Their work looks at the chemical composition of food processing exhaust emissions and is done in cooperation with Franke Inc.



Graduate Student Rupesh Puttagunta
(Photo by Amy Knox)

Center Sponsors Presentation by the Head of the Flood Management Division of the Institute of Water Modeling

Presentation comes as part of the five-year agreement for research collaboration and international-level staff training and exchange the Center formed with the IWM



Abu Saleh Khan (left)* head of the Flood Management Division of the Institute of Water Modeling, and hydrologist Faisal Hossain (Photo by Sandra Pigg)

In 2006, a five-year Memorandum of Understanding (MOU) was signed between the Center and the Institute of Water Modeling (IWM) in Bangladesh. Last winter, Abu Saleh Khan, head of the Flood Management Division of the IWM, helped solidify that agreement by visiting TTU and making a presentation focusing on joint avenues for research collaboration.

The IWM is a Center of Excellence and Research in the fields of water modeling, computational hydraulics, and allied sciences. It also provides technical support and day-to-day support to the Government of Bangladesh Flood Forecasting and Warning Center during monsoon season. IWM has the capability to offer services in seven major areas of water and disaster management, which were discussed by Khan during the seminar: (1) river modeling, (2) water resources management, (3) field survey and data acquisition, (4) IT services, (5) coastal hydraulics, (6) geographical information systems (GIS) and remote sensing, and (7) bridge hydraulics. All of these capabilities complement the

TTU water research Center's core focuses, especially in environmental informatics and flood forecasting.

"The MOU between IWM and TTU provides truly unique opportunities for faculty and students to be engaged in research on more pressing global water problems related to sea level rise, trans-

boundary water resources and climate change in the developing world that only IWM of Bangladesh can offer," said Faisal Hossain, TTU hydrologist and coordinator of the MOU. "With its excellent in-house technical capabilities and historical water resources data on Bangladesh, research cooperation with IWM presents TTU with further opportunities to grow in terms of international visibility and continue to enhance the quality of its graduate program."

Khan has more than 25 years' experience in the water sector, earning his bachelor's in civil engineering from Bangladesh University of Engineering and Technology. His higher level education and training came through institutes such as the Danish Hydraulic Institute on River Modeling and Asian Disaster Preparedness Center, Bangkok, Thailand.

Khan's presentation was part of the Graduate Seminar Series and was sponsored by the TTU water research Center and coordinated by Hossain.

Center Welcomes



Sandy Dodson
(Photo by Amy Knox)

Sandy Dodson says she likes to "meet new people," so that makes her job as the new Center receptionist a perfect fit. Dodson took over the position last winter and enjoys the fact that she has varied duties, among them greeting new visitors to the Center.

"Every day is different," said Sandy, whose job involves anything from making Motor Pool vehicle reservations to logging in water samples for the Environmental Quality Lab.

With a bachelor's in agriculture from TTU, Sandy understands the importance of the Center's work and has developed an appreciation for its researchers. "Everything that the Center does is very important to preserving our environment."

Her husband is involved in research at the TTU Waters organic farm and he also manages Shipley Farm. Their oldest daughter also earned a degree from TTU, and their other daughter and their son are working on degrees here as well.

Welcome

Hydrologist Hossain Captures NASA New Investigator Award

Satellite data about global precipitation will soon have something in common with food in your grocery store — and that similarity will improve the accuracy of weather predictions, particularly about floods, around the globe, thanks to a NASA grant awarded to Faisal Hossain, civil and environmental engineering assistant professor and Center associate.

Hossain was selected as one of just 18 recipients nationwide to receive a NASA New Investigator Program (NIP) grant in Earth Sciences. His winning proposal, among 78 submitted, is the first NIP award of its kind in TTU history. His goal is to tag information sent from satellites to help users decide whether or not the information is relevant and appropriate for their use.

Just as consumers read nutrition labels to learn about the contents of the food, those who use satellite data to monitor and predict rainfall will be able to use information tags attached to satellite information to learn more.

"We'll try to give you value-added information about the product. Then, you decide how and when to use it. It's almost like reading numbers on a box about cholesterol, saturated fat and calories and then deciding if it is healthy food given your health conditions," says Hossain.

NASA is supporting Hossain's work to tag the information through the NIP in Earth Sciences because NASA has long been concerned with "crossing the Valley of Death," the place, according to the National Research Council, where investments intended to spur useful implementation of ideas go to die.

"I want to try and cross the Valley of Death myself and see what happens," says Hossain. "There is so much satellite precipitation data being misused that practical applications are difficult. Also, there's been a ton of research and publications, but very little of it has crossed the Valley



and trickled down to operational scenarios serving society now.

"The misuse comes when we try to use large-scale data to make predictions on a really small scale," he explains. "It's like trying to use satellite data to predict rainfall in your subdivision.

"On the large scale, the errors that are allowed won't work to make accurate predictions on a small scale," he said. "We've done a pretty good job on a large scale with hurricane tracking, weather forecasting, and climate predictions. But for smaller scale applications on land, where our livelihood is directly affected, there's a gap in our ability to use satellite rainfall data as effectively."

NASA's planned Global Precipitation Measurement (GPM) mission, scheduled for 2013, will represent a unique constellation of rain measuring satellites. Why is measuring rainfall this way so important?

Hossain says there are several reasons. First, researchers studying whether or not the climate is warming must know all about rainfall.

"Rainfall is nothing but condensation that comes with a tremendous release of heat," explained Hossain. "To study climate changes, you have to study how the heat is moving around."

Other vital areas include water management, weather forecasting, as well as forecasting the track and intensity of events such as cyclones and hurricanes.

Ground data is still the standard for rainfall measurement, but as Hurricane Katrina demonstrated, ground equipment is vulnerable and can be disabled at the most

critical times. Hossain says satellite data is most useful where there is no ground information or that information cannot be verified.

Also, the distribution of ground data is inhibited by political and geographical boundaries. The information may never reach those who need the information most.

"Satellites are cost effective and self-maintaining," said Hossain. "They can provide data all over the globe. And we can flag that data so that those receiving it can make intelligent decisions that impact lives and livelihoods in their immediate area."

Hossain says the plan is for data and the information flags to be accessible by the Internet in close to real time when the NASA GPM mission is operational. Hossain's dream, which is in sync with NASA's vision, is to eventually make all satellite-based water information free for planning and managing of resources in poor nations or communities.

Hossain's three-year grant was funded for more than \$300,000 through the ROSES (Research Opportunities in Space and Earth Sciences) Program. NASA established the NIP program in Earth Sciences in 1996 to encourage integrated research and education environments for scientists and engineers in the early stages of their professional careers. The program, designed for investigators at academic institutions and nonprofit organizations, encompasses all areas of research and development in Earth system science, applications and technology, as well as activities in education, science communication and interdisciplinary endeavors.

John J. Harwood, associate professor of chemistry and faculty associate with the Center, leads a project titled "Application of CADDIS to an Impaired Mixed Urban/Rural Watershed," which was funded by the Tennessee Department of Environment and Conservation (TDEC). The project was organized to test the use of the EPA stressor identification process, Causal Analysis/Diagnosis Decision Information System (CADDIS), to identify chemical and/or physical stressors leading to the impairment of the lower section of Falling Water River in the Upper Cumberland Region of Tennessee.

CADDIS, an online application, helps scientists and engineers from different regions and states access, organize, use and share information to conduct causal evaluations in aquatic systems. Based on the EPA's *Stressor Identification Guidance Document*, CADDIS is a formal process for identifying the causes of impairments in aquatic systems. According to the EPA, it is important to use a formal method like this to "increase confidence that remedial or restoration efforts can improve biological condition, identify causal relationships that are not immediately apparent and prevent biases or other lapses of logic."

A five-step process, CADDIS results in the identification of a probable cause of biological impairment. After evidence of impairment is identified and evaluated, a cause is determined; the more evidence weakening the case for a candidate cause, the more likely it is not the true cause of the impairment. The results of a CADDIS analysis inform planning to restore impaired streams, e.g., through the total maximum daily load (TMDL) process.

CADDIS provides several benefits as it can help researchers stay on track and provide the tools and information to make the job of environmental analysis easier. But, it requires data to generate evidence and a thoughtful analysis of what is given.

The project Harwood leads ran from Nov. 1, 2006, through Dec. 31, 2007, and it has been continued for the next two years in Phase 2. In the first year of the project, data were identified and collected in order to evaluate the stressors. The data were compiled and analyzed, leading to the identification of the stressors in the second year through CADDIS. TDEC's quality assurance guidelines were followed in the collection and analysis of the biological and chemical data. Over the next two years, researchers will be using CADDIS to diagnose two systems in eastern Tennessee, and preparing generic tools to assist TDEC staff in applying CADDIS to diagnose stream impairment.

The project was overseen by a panel of stakeholders representing both governmental and nongovernmental entities concerned with the quality of Falling Water River.

CADDIS has successfully been used in places as far away as the Naugatuck River, Conn., where toxicity tests and modeling were used to identify effluent as a probable cause of impairment. For more information about the CADDIS system, visit the EPA Web site at <http://cfpub.epa.gov/caddis/index.cfm>.

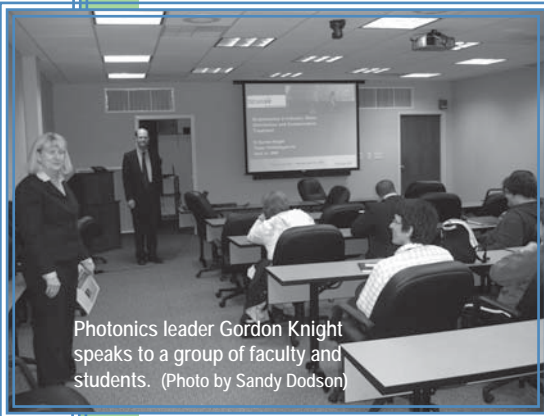
CADDIS

PROGRAM HELPS WATER QUALITY RESEARCHERS DETERMINE BIOLOGICAL FACTORS OF IMPAIRED WATER BODIES



Chemistry professor and Center faculty associate John Harwood puts CADDIS to use in a project dealing with impaired urban and rural watersheds

Photonics Leader Speaks on Water Disinfection and Contamination Treatment



Photonics leader Gordon Knight speaks to a group of faculty and students. (Photo by Sandy Dodson)

Recently, Gordon Knight, photonics leader and operations manager in the Research Department of Trojan Technologies in London, Ontario, Canada,

spoke at TTU on the use of photonics in water disinfection and contamination treatment. Trojan Technologies is the world leader in using water disinfection technologies that incorporate ultraviolet light, treating both drinking and wastewater for harmful organisms and chemical pollutants. Research shows that ultraviolet light is an effective method for neutralizing harmful pathogens and chemical contaminants in water.

Research shows that ultraviolet light is an effective method for neutralizing harmful pathogens and chemical contaminants in water.

"Ultraviolet light has sufficient energy to treat organic contaminants in water by breaking chemical bonds," said Martha J.M. Wells, environmental chemist and coordinator of the event. "This technology has much potential to improve drinking water and wastewater treatment."

During his presentation, Knight discussed the basic mechanism for ultraviolet treatment, and he also discussed and compared the most effective light sources, including the latest developments in mercury and dielectric barrier discharge lamps, light-emitting diodes, and flash lamps.

Knight's presentation also looked at the germicidal action

of ultraviolet light and photolysis of chemical contaminants by both direct and indirect methods.

Related issues of optimum light sensor operation, reactor design, and the optical path for disinfection were incorporated during the presentation to show how a practical industrial disinfection and contamination treatment system is constructed.

Knight received his bachelor's, master's and doctorate in the field of chemistry, with a concentration in laser chemistry, from the University of Waterloo in Ontario, Canada.

Prior to his position at Trojan Technologies, Knight was a senior scientist in materials research and design of high-speed lasers and detectors for the fiber optics communication systems at Bell-Northern Research, which later became part of Nortel Networks. Knight is also a member of the Ontario Photonics Technology Industry Cluster (OPTIC), the Chemical Institute of Canada and the Optical Society of America.

The Center sponsored Knight's presentation.



Gordon Knight
(Photo courtesy of Knight)

Photonics
Water
Disinfection
Contamination
Treatment

Center Initiates Fund-raising Campaign to Create Graduate Student Endowment

Last year, the Center initiated a fund-raising campaign to begin a graduate student endowment, which will help alleviate its students' financial burdens. It is hoped that the efforts will grow the endowment from \$10,000 to \$50,000 over the next five years.

"During these times of economic stress, we are trying to find ways to ensure that our graduate students still receive the high-quality educational experience that they expect at the Center," said Dennis George, Center director and environmental engineer.

"The endowment will help alleviate professional travel and other costs students incur."

According to published statistics, enrollments increased at TTU from 2,058 in Fall 2005 to

2,164 in Fall 2006. This leads to more students requiring financial assistance. On top of that, TTU graduate student tuitions are increasing, 15 percent from 2003 to 2004 and 9.6 percent from 2005 to 2006. Growing fees and stipends force the Center to cut back on the number of graduate students it can support, but that doesn't dampen the Center's goal of attracting the best and brightest students to TTU's graduate programs. That is where the need for other funds comes in.

"When people donate," George said, "they help ensure the continuation of research projects, ranging from the study of endangered fish and their habitats, to the examination of mussel propagation methods to the development of best management practices for storm-water runoff prevention in Cookeville."

Some donations can be matched by employers.

If you are interested in making a contribution, please contact the Center at (931) 372-3507 or by mail at P.O. Box 5033, Cookeville, TN 38505, or mail in the form to the right with your donation.

Twenty-four percent of Americans have a bachelor's degree or higher. In Tennessee, only 17 percent do. Those statistics can be improved, and with the help of generous contributors, they will.



TO CONTRIBUTE

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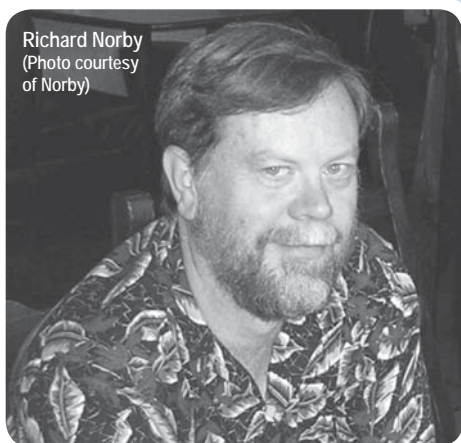
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Expert Ecologist Richard Norby Speaks on Global Warming and CO₂ Fertilization



Richard Norby
(Photo courtesy
of Norby)

Richard Norby, physiological ecologist and UT-Battelle Corporate Research Fellow at the Oak Ridge National Laboratory, spoke on April 24 at TTU in a presentation titled "Will CO₂ Fertilization Counteract Global Warming? Lessons from Forest FACE Experiments."

"Dr. Norby is a pioneer in large-scale manipulative field experiments to study the response

of natural ecosystems to increasing concentrations of carbon dioxide in the atmosphere," said Dale Ensor, chemistry professor and director of TTU's Environmental Sciences Ph.D. program. "The Environmental Sciences Ph.D. program is fortunate to have him speak as part of our Student Colloquium Program."

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If you are an alumnus of the Center, please help us update our records by sending an e-mail to cmupwr@tntech.edu with your current address and employer information.

As a physiological ecologist, Norby focuses his interests in tree growth, forest ecology, carbon and nitrogen cycling, and global change. He is the principal investigator of the Oak Ridge Experiment on CO₂ Enrichment of Sweetgum and the Old-field Community Climate and Atmosphere Manipulation experiment. Since 1982, Norby has been conducting experiments on the responses of trees and forests to elevated atmospheric CO₂. Through these experiments, he has demonstrated the importance of root and soil processes.

Norby has a bachelor's in chemistry from Carleton College and a doctorate in forestry and botany from the University of Wisconsin. He is a fellow of the American Association for the Advancement of Science, member of the Science Steering Group for the North American Carbon Program, and the Environment Section editor of *New Phytologist*.

Norby's presentation coincided with the observance of Earth Day, April 22, which was founded by Senator Gaylord Nelson to raise environmental awareness in the 1960s. The positive public response to Nelson's efforts led to the national observance of Earth Day.

Norby's presentation was sponsored by the Center and the Environmental Sciences Ph.D. program.

"Dr. Norby is a pioneer in large-scale manipulative field experiments to study the response of natural ecosystems to increasing concentrations of carbon dioxide in the atmosphere. The Environmental Sciences Ph.D. program is fortunate to have him speak as part of our Student Colloquium Program."
– Professor Dale Ensor