

# Executive Summary

## Fiscal Year 2007-2008 At-A-Glance

### Mission

The faculty, staff and students of the Center for the Management, Utilization and Protection of Water Resources (Center), at Tennessee Technological University, work to enhance research by addressing diverse water-related problems in Tennessee, the nation and the world; enhance educational opportunities through research, university instruction and educational outreach; and enhance citizens' quality of life by providing technical assistance and technology transfer to peers, citizens and industry.

### Accomplishments/Awards

Faculty and associates with the Center secured more than \$1.7 million in external funding to seek solutions to environmental problems.

Center faculty and associates are recognized nationally for research in environmental resource management and protection — including natural ecosystems, fisheries management, engineering natural systems, watershed resource management, and the emerging research areas of organic farming, fisheries habitat conservation planning, and big river endangered species protection; environmental hazards — including fate and transport of contaminants, pesticides research, wastewater treatment, and anaerobic fermentation, and the developing areas of emerging pathogens, microconstituents, hazardous substances, and advanced oxidation processes; and environmental informatics — including geographical information systems (GIS) applications and the emerging research area of rainfall forecasting using satellite data.

Center faculty and associates published 20 refereed papers and 3 book chapters and made 43 presentations at professional organizations' conferences.

In December 2007, the Center sponsored a presentation by Abu Saleh Khan, the head of the Flood Management Division of the Institute of Water Modeling (IWM). Hydrologist Faisal Hossain coordinated the presentation, titled "Institute of Water Modeling: IWM-TTU Memorandum of Understanding and Avenues for Joint Collaboration," as a part of the collaborative relationship the Center is nurturing with the IWM. Hossain also coordinated another Center-sponsored presentation. This one was part of the Civil and Environmental Engineering Graduate Seminar Series and featured Douglas Alsdorf, from the School of Earth Sciences at Ohio State University. Alsdorf's talk was titled "Measuring the Amazon from Space and Modeling Its Flow."

Chemical engineering graduate student Rupesh Puttagunta won the Best Poster Award at the Tennessee Technological University Student Research Day held in April 2008. His advisors were Dennis George, Center director and environmental engineer, and Pedro Arce, professor and chair of the Chemical Engineering Department.

Sharon Berk, microbiologist, was chosen to participate in a collaborative research exchange as part of the visiting scholar program at Flinders Research Centre for Coastal Catchment Environments in Adelaide, Australia. Berk will help train students — as well as be trained herself — in various research techniques in the month-long visit. She was also invited to present "Pathogenic Bacteria Associated with Free-living Amoebae" for a Special Topics Session for the American Water Works Association Water Quality Technology Conference in Charlotte, North Carolina, in November 2007.

A poster presentation, titled "Environmental Survival of Novel Amoeba-associated Bacteria," won the Best Poster Award at the 2007 American Society for Microbiology Kentucky/Tennessee Branch Meeting, held Oct. 5-6 at Cumberland Falls State Park in Corbin, Kentucky. This poster was the work of biology undergraduate student James White, chemistry undergraduate student Wesley Willeford, biology undergraduate student Michelle Lowe, Middle Tennessee State University biology assistant professor Mary Farone, and Center faculty Sharon Berk.

Hydrologist Faisal Hossain won the NASA New Investigator Program Award to pursue his work in satellite-based forecasting. He was also invited to contribute a book chapter on hydrologic data fusion for the book *Advancing the Use of Satellite Rainfall Datasets for Flood Prediction in Ungauged Watersheds: The Role of Scale Hydrologic Process Controls and the Global Precipitation Measurement Mission*, published in 2008 by Springer-Verlag. Former Center-supported graduate student Nitin Katiyar co-authored this chapter. Hossain was also invited to contribute a paper, titled "Satellite-based Flood Modeling Using TRMM-based Rainfall Products," to the journal *Sensors*. He is also leading an international effort to develop a scientific society and a journal on transboundary water resources management.

Don Visco Jr., associate professor of chemical engineering, won the Outstanding Teaching Award through the Southeastern Section of the American Society for Engineering Education in 2008, and he was named a Distinguished Faculty Fellow at Tennessee Technological University (TTU) in 2007.

James Layzer, biologist and leader of the Tennessee Cooperative Fishery Research Unit, was one of 16 U.S. Fish and Wildlife Service partners honored with the 2007 Southeastern Regional Director's Conservation Awards, given for accomplishments toward fish and wildlife conservation.

Fisheries biologist Phil Bettoli was a co-winner of the Caplenor TTU Faculty Research Award in November 2007, and he was also invited to present "The Volunteer State's Integration of Imperiled and Sport Fish Management Programs" at the Texas Chapter of the American Fisheries Society Annual Meeting held in Junction, Texas, January 2008.

The Center sponsored a presentation by Gordon Knight, Ph.D. and photonics leader and research operations manager at Trojan Technologies, in April 2008. Knight's talk was titled "Biophotonics in Industry: Water Disinfection and Contamination Treatment" and was coordinated by environmental chemist Martha J.M. Wells.

The Center's research and development engineer Yvette Clark continues work on her \$500,000 grant (dispersed over a five-year

period) with the Tennessee Department of Economic and Community Development (ECD). Through the project, she leads the ECD's Local Planning Assistance Office in researching, designing and implementing a geographical information system, which allows regional decision makers to identify and analyze energy, community facilities and environmental resources; infrastructure features; or programs that have a specific geographically determined location.

With the Environmental Sciences Ph.D. program, the Center co-sponsored a presentation, titled "Will CO<sub>2</sub> Fertilization Counteract Global Warming? Lessons from Forest FACE Experiments," by Richard Norby, an expert ecologist and UT-Battelle Corporate Research Fellow at the Oak Ridge National Laboratory. The presentation was held on April 24 and coincided with Earth Day.

Martha J.M. Wells, environmental chemist, was invited to present "Quality Assurance Issues Related to Environmental Monitoring of Stereoselective Degradation of Metolachlor" at the 234th National Meeting of the American Chemical Society held in Boston, Massachusetts, in August 2007. She was also invited to present "Body Burden and Intersex — Possible Relationships" during the EPA-VA-WV Fish Kill Research Status Meeting in Berkeley Springs, West Virginia, in January 2008.

### Student Support

This fiscal year, the Center supported 31 graduate research assistants

in seven different academic majors. Four of the graduate research assistants were doctoral candidates in the Environmental Sciences Ph.D. program. The Center also supported 62 students (39 undergraduates and 23 graduate students) from 20 majors on an hourly basis to work on service and research projects in the field, in laboratories and in the office. Four of those hourly students were supported by both the Center and project funds; 15 were supported by the Center only; and 43 were supported only through project funds.

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### Investments for the Future

- The Center will begin looking at thermodynamic, holistic approaches to resource use and protection. This will involve understanding how much energy is required to operate a community and how to achieve an overall energy balance environmentally.
- Investing in new faculty with fresh ideas is another way the Center will expand its outreach. An environmental engineer will be hired who will look at various resources for energy production, including solid wastes, algae and anaerobic digesters, to enhance the energy production process.
- The Center will continue to promote and enhance organic farming practices, which are becoming increasingly important in Tennessee, and hydroponic agriculture.
- Fisheries researchers will continue to explore projects dealing with endangered and threatened species in large river bodies.
- The Center will further advance its work in the areas of disinfection by-products and harmful microconstituents, including the recently spotlighted pharmaceuticals and personal care products, that are being found in drinking water supplies.
- The current international partnership with the Faculties of Tunisia will be furthered through a developing research project on waste minimization. Research has also been initiated through the Center's other international collaboration, this one with the Institute of Water Modeling in Bangladesh, which was developed through the work of Center faculty associate Faisal Hossain.

### Research Partners

- City of Cookeville
- Earth Tech
- Great Smoky Mountains National Park
- Green County, Kentucky
- Missouri Department of Conservation
- NASA
- National Park Service
- The Nature Conservancy
- Sandia National Laboratories
- Tennessee Department of Agriculture
- Tennessee Department of Economic and Community Development
- Tennessee Department of Environment and Conservation
- Tennessee State University
- Tennessee Wildlife Resources Agency
- University of Connecticut
- University of Mississippi
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- UT-Battelle
- Washington State University

## Research Project Highlights

• In a project funded by the U.S. Department of Agriculture and titled "Interactions of *Salmonella enterica* and *E. coli* 0157:H7 with Protozoa from Fresh Produce," microbiologist Sharon Berk and her research team are examining protozoa directly from produce to determine whether the protozoa would release vesicles containing *E. coli* 0157:H7, *S. enterica* and *Listeria monocytogenes* bacteria. According to Berk, protozoa may be novel factors that enhance the survival of food-borne pathogens in the environment.

• Fisheries biologist Phil Bettoli and his research team are tracking the movements of the endangered pallid sturgeon among the reaches of the lower and middle Mississippi River to learn about their habitat and how they live. This is part of a project funded by the Tennessee Wildlife Resources Agency, and the group will also be gathering data on how often the endangered pallid are incidentally caught by commercial fishermen who were actually trying to catch the valuable shovelnose sturgeon.

• Soil scientist Kim Stearman is leading an organic farming effort housed at the Waters Farm in Cookeville, Tennessee. The Tennessee Department of Agriculture provided funding for the farm's infrastructure. The research team includes Stearman; Randy Dodson, farm supervisor; Michael Best, agricultural economist; Janice Branson, soil scientist; Bruce Greene, animal scientist; Jim Baier, agricultural engineer; Jed Young, horticulturist; and Wade Faw, the director of the School of Agriculture. Thanks to funding from the U.S. Department of Agriculture National Research Initiative Competitive Grants program, the researchers are exploring soil, water and crop quality as affected by compost and irrigation rate. They are growing tomatoes, squash, bell peppers, kale, spinach, and lettuce and are also exploring the use of high-tunnel techniques to lengthen the growing season. The environmentally sound techniques being used at the Waters Farm help preserve water and lessen the likelihood that potentially harmful pesticides enter our water sources.

• Through funding provided by the Universities of Mississippi and Connecticut, and indirectly through NASA, Assistant Professor Faisal Hossain is evaluating the use of satellites as ways to achieve better hydrologic data. His projects are titled "Validating Prototype Global Precipitation Measurement Data Product in the SERVIR System" and "Defining Optimality Criteria for the Effective Use of Satellite Precipitation Datasets in Land Surface Hydrology." Hossain says that measuring rainfall through the use of satellites makes studying climate changes, forecasting weather, and managing floods easier.

• Martha J.M. Wells, environmental chemist, and her research team are working on methods to predict the formation of trihalomethanes in drinking water source waters. The new protocol will incorporate specific ultraviolet absorbance measurements with

other analytical data. Trihalomethanes are among the most common disinfection by-products formed from treating drinking water.

• Biologist Jim Layzer, leader of the Tennessee Cooperative Fishery Research Unit, is involved in research dealing with mussel protection and conservation. In one project, titled "Development and Testing of a Protocol for Monitoring Mussels," funded by the U.S. Geological Survey, Layzer and his team are evaluating alternative sampling designs for determining species composition, density and recruitment of the mussel assemblage within the Mammoth Cave National Park; developing a sampling protocol for continued long-term monitoring of the assemblage; and evaluating the effectiveness and efficiency of the sampling protocol.

• Chemical engineering associate professor Don Visco Jr. is working on a project titled "Developing Novel Scaffolds for Biological Molecules by Solving the I-QSAR Problem Using the Signature Molecular Description," funded by Sandia National Laboratories, in which he is developing focused libraries of compounds with specific property values. These compounds can be used for biological sensor development and drug design. This work could have biological and environmental applications in many scientific and engineering areas of study.

• Hydrologist Vince Neary is working on a project titled "Everglades Hydrodynamic Models Review," funded by the U.S. Fish and Wildlife Service. Through this work, he is collaborating with the University of Louisiana-Lafayette to recommend hydrodynamic and water quality models for potential use in the Arthur R. Marshall Loxahatchee National Wildlife Refuge.

• The U.S. Department of Agriculture funded a project titled "Implementing and Testing a Model to Reduce Obesity Indices in Rural Families Through Nutrition Education and Hydroponic Gardening." The project is led by Assistant Professor Melinda Anderson, and one objective of the project is to determine the cost effectiveness of growing hydroponic vegetable gardens in high school vocational classrooms for rural adolescents and their families. The other objective is to determine the impact of class-produced hydroponically grown vegetables on obesity indices in participants.

• Biologist Hayden Mattingly is working with hydrologist Vince Neary on a project titled "Conservation and Recovery of Barrens Topminnow Populations Exposed to Invasive Mosquitofish," funded by the Tennessee Wildlife Resources Agency. Through their work, the researchers are trying to develop an ecologically sensitive barrier that will exclude mosquitofish, an invasive species, from the Barrens topminnow habitat. The Barrens topminnow is a rare fish species, and when mosquitofish are introduced to their habitat, the topminnows decline.