

## Mission

The faculty, staff and students of the Center for the Management, Utilization and Protection of Water Resources (Center), at Tennessee Technological University (TTU), 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.

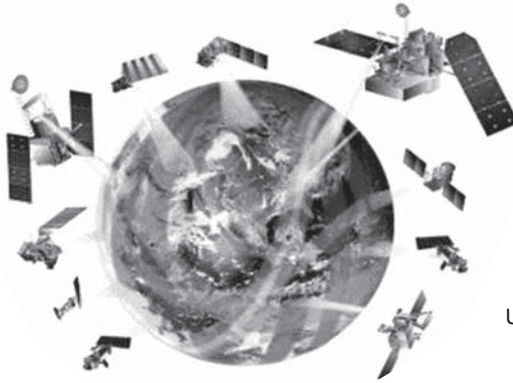
## Accomplishments/Awards

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, including fate and transport of contaminants, water reclamation (advanced oxidation processes), and anaerobic fermentation, and the growing areas of emerging pathogens and microconstituents; and environmental informatics, including geographic information systems applications and the emerging research area of rainfall forecasting using satellite data.

Faculty and associate faculty with the Center for the Management, Utilization and Protection of Water Resources (Center) secured approximately \$1.468 million from state and federal agencies, research foundations, and advocacy groups to seek solutions to environmental problems. The direct monetary return on the State's investment is \$1.25/State-allocated dollar.

Center researchers produced 17 refereed publications and made 64 presentations at professional society conferences.

Faisal Hossain, hydrologist and associate professor, and his research group, called SASWE (Sustainability, Satellites, Water and Environment), won the Education Excellence Award from the National Association of Environmental Professionals on April 29, 2010.



Tom Roberts, biology professor, assisted with wetlands training the U.S. Army Corps of Engineers (USACE) personnel in Annapolis, Maryland, and Olympia, Washington. For this work, he received the Special Commendation Award from the Nashville District Engineer of the USACE.

Biology master's student Drew Russell won the Best Student Paper Award for a piece, co-authored by biology Professor Phil Bettoli and titled "Age and Growth of Lake Trout in Two Tennessee Reservoirs," presented at the Annual Meeting of the Tennessee Chapter of the American Fisheries Society, held March 2010 in Pikeville, Tennessee.

Chemistry Professor Dale Ensor made an invited presentation during the 238th National Meeting of the American Chemical Society held August 16-20, 2009, in Washington, D.C. The presentation, co-authored by John Partridge, Laetita Delmau, Bruce A. Moyer, and Dean Peterman, is titled "Simultaneous Extraction of Cesium and Strontium from Acidic Nuclear Waste." Another presentation that Ensor co-authored, but that was presented by Matt Gott, won second place in the Student Competition at the 16th Symposium on Separation Science and Technology for Energy Applications held October 19-22, 2009, in Gatlinburg, Tennessee. The presentation is titled "Removal of Cesium from Alkaline Solutions Using Extractive Chromatography."

## Investments for the Future

- Addressing the effects of climate changes on endangered species and hydrology.
- Investing in isolation and treatment processes related to waterborne pathogens.
- Advancing its work in the areas of isolating and treating harmful microconstituents.
- Furthering the current international partnership with the Faculties of Tunisia and the Institute of Water Modeling in Bangladesh.

## Research Project Highlights

This fiscal year, Center researchers continued to facilitate and further projects aimed at protecting our natural resources and preserving them for future generations. They garnered \$1.468 million (including indirect costs) in externally funded research toward that aim, and the following write-ups describe some of that work.

Faisal Hossain, hydrologist and associate professor, is involved in several NASA-funded projects that look at the potential for estimating rainfall through the use of satellites. Through this work, he and his students assess the current level of rainfall predictability and look at the improvements, or reduction in uncertainty, that will be provided by NASA's Global Precipitation Measurement system.

Graduate student Njideka H. Okoye and her advisors Dennis George, environmental engineering professor and Center director, and Pedro Arce, chemical engineering professor and chair, are looking at the use of photocatalysts to produce hydrogen and electrical current from H<sub>2</sub>O through solar energy.

Holly Stretz, assistant professor of chemical engineering; Martha J.M. Wells, environmental chemistry professor; and Vasanta Pallem, chemical engineering doctoral student, are looking at the effects of gold nanoparticles — which can be used in drug delivery, biomedical imaging and chemical sensing processes — when they are found in the environment. Because the fate and transport of those nanoparticles in the environment are relatively unknown, researchers are trying to determine how those processes are affected when the nanoparticles interact with environmental entities like humic substances found in natural aquatic systems. If researchers can understand how nanoparticles are dispersed in surface waters, potentially damaging environmental effects can possibly be prevented.



Chemical engineering master's student Chinyere Mbachu, who received an Ivanhoe Foundation Fellowship, and her advisors including Pedro Arce; Dennis George; Ahmed Elsayy, professor of manufacturing and industrial technology; Martha J.M. Wells; and John Gunderson, associate professor of biology, are evaluating the degradation of humic acids in drinking water by a high-voltage pulsed corona power system. Pulsed corona systems can lead to safer drinking water and food irradiation and have been shown to be effective in degrading small-sized organic molecules.

Nanoparticles are increasingly important in a wide variety of processes and applications but have been generally assumed to be as mild or detrimental as larger samples of the same material. Convincing research about the behavior and transport of nanoparticles in the environment is lacking since these studies require an understanding of their physicochemical properties and their impact on organisms and ecosystems. In one project, chemical engineering Assistant Professor Ileana Carpen and her students are assessing the fate and distribution of nanoparticles in the environment to prevent or minimize their unintended exposure to the ecosystem.

Microbiology Professor Sharon Berk and her research team are studying pathogens as they relate to food-borne illnesses and how protozoa can affect transmission of these illnesses. According to Berk, protozoa could enhance the survival of food-borne pathogens in the environment. In their preliminary studies, Berk and her team examined how *Salmonella enterica* bacteria found in food were affected when they

interacted with protozoa, which feed on bacteria. They were especially interested in the protozoan *Tetrahymena*, which live in water, even the water in soil. In some of their work, they are examining protozoa directly from produce to determine whether the protozoa would release vesicles containing *Escherichia coli* O157:H7, *S. enterica* and *Listeria monocytogenes* bacteria.

The Center also continues its work in fisheries species protection and conservation through the Tennessee Cooperative Fishery Research Unit on campus. This work benefits the state's \$480 million annual fishing industry, which reaches approximately 900,000 anglers.

Civil and environmental engineering master's student Yamini Sadasiyam worked with her advisor, Dennis George, to develop a cost-effective system of removing phosphorus from wastewater. The researchers evaluated greensand as a potential media for phosphorus removal under oxic and anoxic conditions. The presence of phosphorus in water systems can lead to eutrophication, a condition in which nutrient enrichments have led to increased plant growth (which can cause depleted oxygen supplies for aquatic fauna) and other potentially harmful water quality conditions. Jacob Van Dyke, civil and environmental engineering graduate student, will be testing a system to remove phosphorus at the Sewanee Utility District.

Chemical engineering master's student Kiran Thota worked on a project, guided by his graduate committee — including Dennis George, Pedro Arce, and Martha J.M. Wells — to understand the cleaning of surfaces in industrial air ducts exposed to the deposition of fatty acids from, for example fast-food processing units. The objectives of this project was to determine the factors that affect the photochemical oxidation of stearic acid on the surface of fast-food exhaust ducts irradiated by ultraviolet light, which causes a weight change in the stearic acid.

In one project, civil and environmental engineering graduate student Ryan Clark is creating a model that developers can use to determine the optimal design for minimal runoff and lowest cost associated with installation and maintenance of different Low Impact Development (LID) methods. As urbanization continues, the amount of impervious areas increases, creating more stormwater runoff. LID techniques are an attempt to decrease the amount of direct runoff by using more permeable material and vegetation in developing areas.

Kim Stearman, along with his collaborative partners, is opening doors to the environmentally sound techniques found through organic farming and thereby building a name for TTU as an organic research center. Some of the projects utilize Waters Organic Farm, under the guidance of horticulturist Randy Dodson, and focus on season-extending growing techniques using high tunnels and other emerging techniques that will help build soil quality. That, in turn, will improve the farmers' yields and also reduce runoff and improve water quality in the streams and rivers. In one project, which is led by agricultural economics professor Michael Best, educational programs will be developed to involve farmers more in high-tunnel techniques. High tunnels are not conventional greenhouses because, unlike in greenhouses, crops are planted directly in the soil. But like plastic-covered greenhouses, high tunnels are generally constructed of metal bows attached to metal or wooden posts driven into the ground.

Melinda Anderson, associate professor in the School of Human Ecology, and her research team are working on a project funded by the U.S. Department of Agriculture that deals with hydroponic growing techniques and examines the cost-effectiveness of growing hydroponic vegetable gardens in high school vocational classrooms for rural adolescents and their families. The project also looks at the impact of class-produced hydroponically grown vegetables on obesity indices in participants.