

# ISSE indicator

Quarterly news from UT's Institute for a Secure and Sustainable Environment

## A MESSAGE from ISSE's NEW DIRECTOR



We have embarked on a new journey at the University of Tennessee (UT) with the establishment of the

Institute for a Secure and Sustainable Environment (ISSE), a truly multidisciplinary research organization. I am honored to have been appointed interim director of the institute and anticipate the many new and productive partnerships that will grow from this innovative venture.

As an associate professor in UT's Department of Civil and Environmental Engineering, I've had many opportunities to collaborate with scientists from other disciplines, other universities, and, in some cases, other countries.

By working shoulder to shoulder with experts from other fields, I've learned that the overlap—and interplay—of disciplines always leads to novel ideas and constructs. The rich potential of such collaboration



DAVID BRILL

ISSE's Interim Director Dr. Randall Gentry

continues to shape and guide ISSE's research agenda.

Beyond yielding important discoveries and new technologies for managing and protecting the environment, these efforts benefit our sponsors, enhance career opportunities for UT's faculty and staff, and add vitality to our students' educational experiences.

We at ISSE remain receptive to new opportunities for research and collaboration, and we welcome requests for more information on our projects, programs, and staff. I invite you to peruse the quarterly editions of the *ISSE Indicator* and our website, and contact me if you'd like to learn more.

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### INSTITUTE FOR A SECURE AND SUSTAINABLE ENVIRONMENT

isse.utk.edu

*UT's Institute for a Secure and Sustainable Environment (ISSE), pronounced ICE, seeks to promote development of policies, technologies, and educational programs that cut across multiple disciplines, engage the university's research faculty and staff, and grow in response to pressing environmental and security issues facing the state, the nation, and the globe.*

Interim Director..... Randall Gentry

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## CHEMBIOSNIFFER GIVES GLOWING REPORTS

A portable, compact, and rugged sensing device capable of detecting minute concentrations of pollutants in soil sediments and in fresh and salt water is currently in development at the University of



Tennessee's (UT) Center for Environmental Biotechnology (CEB). CEB is a research affiliate of UT's Institute for a Secure and Sustainable Environment (ISSE).

The wand-like sensor, dubbed the ChemBioSniffer, adds new features to the existing lab-on-chip bioluminescent bioreporter integrated circuits CEB has developed for NASA to monitor air quality in enclosed areas such as spacecraft.

"This is a totally self-contained wireless device integrated with a sensing device," says Steven Ripp, a research associate professor with CEB and a member of ISSE's Environmental Security Program. "The pieces are all there; we just haven't field tested it."

The ChemBioSensor is designed to measure the presence of water- and sediment-borne contaminants using whole-cell organisms genetically engineered to respond in the presence of target chemicals. The prototype will incorporate two currently available bioreporters engineered to detect mercury and naphthalene: *Escherichia coli* ARL1 and *Pseudomonas fluorescens* HK44.

Naphthalene, the active ingredient in mothballs, is a volatile organic compound made from coal tar. It is considered toxic and a possible carcinogen. Mercury likewise is a known neurotoxin that can cause serious developmental problems in children.

The bioreporters respond rapidly to the presence of target contaminants by emitting bioluminescence. A small sensing device, a micro luminometer, picks up the signal, and a simple light-emitting diode (LED), similar to the readout on a digital clock, lights up if the contaminant is present. The ChemBioSniffer can also operate on a

# FUSION TECHNOLOGY

*Bioreporters meet fiber optic technology  
to create remote sensors  
for environmental monitoring.*

ARTICLE BY: ELISE LEQUIRE

Contamination of soils and water from multiple sources—including oil spills, chemical leaks, and overloading of nutrients in lakes and rivers—plagues all industrial societies.

A new technology promises to make detection and remediation of pollution more reliable and less expensive than current sensors. The goal is to integrate commercially available fiber-optic instruments, developed for use in optical telecommunications, with biosensors that have been pioneered at the University of Tennessee's (UT) Center for Environmental Biotechnology (CEB), a technical research affiliate of UT's Institute for a Secure and Sustainable Environment (ISSE).

To that end, researchers from the Czech Republic and scientists at CEB have embarked on an international, collaborative effort to pool their combined expertise in fiber optics and biosensors.

"The basic goal of the research is to clad optical fibers with various bioreporter organisms," says Steven Ripp, a CEB research assistant professor and member of ISSE's Environmental Security Program. The cables can be deployed underground or underwater to allow continuous, inexpensive monitoring of targeted contaminants.

### MINDS ACROSS THE WATERS

Since 2001, Gabriela Kuncova, a senior scientist with the Institute of Chemical Process Fundamentals (ICPF) Public Research Institution (identified by the ini-

tials v.v.i. in Czech) at the Academy of Sciences of the Czech Republic in Prague, and researchers at CEB have worked together informally.

"The ICPF v.v.i. has a demonstrable research capability that matches the requirements of this project," says Gary Saylor, who directs both CEB and the Joint Institute for Biological Sciences (JIBS). JIBS is a collaborative venture of UT and Oak Ridge National Laboratory. "We are transferring our technologies and capabilities to ICPF v.v.i. to help them improve their capabilities."

The collaboration will become official through funding from the Ministry of Education, Youth and Sport of the Czech Republic based on the recommendation of the American Science Information Center (AMVIS) to foster cooperation in all realms of science, research, and technology transfer between Czech and American scientists and research facilities. AMVIS is a nonprofit, nongovernmental organization, headquartered in Prague.

According to the terms of the grant, researchers from the Czech institute, ICPF v.v.i., will spend a few weeks per year at CEB, and researchers from CEB will travel to Prague.

The five-year project builds on Kuncova's expertise in fiber-optic technology and CEB's proven track record in sensor technologies using organisms genetically engineered to respond to specific contaminants. With this project, researchers will coat long fiber-optic

cables like those used in telecommunications with various types of reporter organisms that produce bioluminescence or fluorescence in the presence of contaminants.

“Lux reporters bioluminesce, and fluorescent reporters produce green, yellow, or cyan colors,” Ripp says. The optical fiber can be lowered into contaminated soil or water, and depending on what contaminant is present, the specific bioreporter responds.

The sensors will allow continuous monitoring of targeted contaminants in remote locations. “The sensors can be used to detect contamination near chemical factories, gas stations, oil pipelines, and reservoirs of drinking water,” says Kuncova.

These monitoring systems will be of interest to companies that produce, transport, or manipulate organic compounds and other potential contaminants.

#### WHOLE-CELL OPTICAL SENSORS

To produce the sensors, a core bundle of fiber-optic cables will be coated, or clad, with the reporter cells. While some sensors use only a part of a cell, this project uses the whole cell.


“We use the entire cell, so you see not only the response of part of a cell or an enzyme, but the response of the whole cell,” says Ripp. This makes the system more relevant to a potential real-life response by aquatic organisms and eventually human beings higher on the food chain.

A specific number of bioreporters will be spaced at intervals along the cable. “It’s a multiplex system that can detect heavy metals and potentially any sort of chemical,” Ripp says. As the cells respond, the information is transmitted through the fiber-optic cable back to a computer that identifies the contaminant by the color or intensity of light.

In addition, the specific location of

the contaminant can be determined by measuring the amount of light refracted back to the monitor. This is the same technology currently used by telecommunications companies to determine the location of breaks in fiber-optic cables transmitting signals across the ocean floor or deep underground.

Using commercially available instruments developed for measurement in optical telecommunications, Kuncova will be refining her technique to find more reliable ways to affix, or immobilize, the bioreporters along the cable and overcome challenges in the uncontrolled microenvironment.

Small companies are interested in commercial production of the sensors, and such efforts are strongly supported by the European Union. 

#### For More Information

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## CHEMBIOSNIFFER GIVES GLOWING REPORTS

(CONTINUED FROM PAGE 2)

continual basis to estimate the concentration in parts per billion at levels significantly lower than current standards set by the U.S. Environmental Protection Agency.

With a little training, the user can learn to place the sample contaminant in a small glass tube, snap on a Teflon® cap that holds the specific bioreporter organism, and attach the tube to the detection instrument. The information is transmitted to the computer either via a regular USB connection or wirelessly to a remote computer. This allows for a high degree of portability.

“You could attach the ChemBioSniffer to a long antenna and drop it down a well,” Ripp says. The results show up on the LED as a simple red light/green light readout signaling the presence or absence of the targeted contaminant.

New breakthroughs that make the ChemBioSniffer possible include miniaturization of the electronics so they can be applied directly onto the chip, reduction of battery size to that of a small watch battery, and advances in USB or wireless transmission. The

estimated price tag of the reusable system, including waterproof steel housing and the integrated circuit microluminometer encased in a protective plastic container, will be around \$150, and the disposable bioreporter disks should cost just a few dollars each.

The prototype will be tested in a portion of Chattanooga Creek, near the city of Chattanooga, which is a designated Superfund site due to coal-tar contamination.

After field testing of the naphthalene and mercury sensors, CEB hopes to fabricate inexpensive disposable disks using the dozens of biosensors already engineered and available to report contaminants from arsenic to zinc

“The ChemBioSniffer can sense target contaminants in a water column, soil sample, or in the air,” Ripp says. It can also be engineered to detect bacterial pathogens such as *E. coli* in food samples, drinking water, or beach water where people swim.

—Elise LeQuire

## TIES with the PAST

The buildings dotting the University of Tennessee's (UT) campus provide examples of numerous styles of architecture and design. Although none has, as yet, been placed on the National Register of Historic Places, many of them would qualify, says Tim Ezzell, director of the Community Partnership Center, a subunit of UT's Institute for a Secure and Sustainable Environment.

One definite contender is South College, which was constructed in 1872 and is the oldest building on the Hill. "It's the only surviving structure from the 19th century that was part of the built campus," says Carroll Van West, director of the Center for Historic Preservation at Middle Tennessee State University.

Built in the vernacular style as one of a trio of buildings on the Hill, South College housed students back when the university was largely a military academy, according to Ezzell.

With a Getty Campus Heritage Grant, Ezzell and Van West are working to get South College and a number of other campus buildings designated as historic places on the National Register. Such a listing, Ezzell says, "would help protect them and provide added prestige to the university as a whole."

—Kris Christen



# STORIES TOLD *in* BRICK *and* MORTAR

*A Getty campus heritage grant is helping the University of Tennessee inventory its wealth of historic buildings and sites scattered throughout its campus.*

ARTICLE BY: KRIS CHRISTEN

A Native American settlement. A Civil War battle. Civil rights protests. A World's Fair. These are just some of the events and goings-on that have occurred on the University of Tennessee's (UT) Knoxville campus. The campus, situated along the downtown riverfront, has been a cultural nexus for more than 200 years. Over that time period, numerous buildings have come and gone, but more than a third of the surviving structures on UT's campus today are potentially eligible for placement on the National Register of Historic Places.

"In many ways, this is one of the most historically significant campus sites in the nation," says Tim Ezzell, director of the Community Partnership Center (CPC), a subunit of UT's Institute for a Secure and Sustainable Environment. "We've got some

great architecture representing a number of different styles and periods, as well as so many sites on campus that reflect much about the history of the university and the history of Knoxville."

A \$150,000 Campus Heritage Grant is now allowing the university to take full stock of these markers of the past. The J. Paul Getty Foundation, an international cultural and philanthropic institution, awarded the grant in 2006. Key goals include conducting a comprehensive review of historic structures and sites on campus and developing plans for preserving and enhancing them. The idea is to protect and maintain buildings that unite generations of students and alumni, faculty, and staff, says Ezzell, who is overseeing the project.

Indeed, that's why Getty created this program. "American college and university campuses are often museums of great architecture and design. They provide students, faculty, and visitors with both inspiration and a vital link to the past," says Joan Weinstein, interim director of the Getty Foundation. "Our grants have assisted these institutions as they make plans to care for, maintain, and preserve their important historic resources."

This is a vital step, agrees UT Chancellor Loren Crabtree. "The university is a treasure for the state and its people, and its physical assets must always be preserved as a reminder of the importance of higher



*South College, constructed in 1872, is the only surviving structure from the 19th century that was part of UT's built campus.*

ERIC OGLE

education to the state's citizenry," he says. "We're grateful to Getty for providing this grant to facilitate our efforts."

### SCHOOL ON 'THE HILL'

Founded in 1794, UT was the nation's first non-sectarian institution of higher learning and is the 28th oldest college in the country. Relocated to a prominent nearby hill in 1826, the university overlooked downtown Knoxville and the Tennessee River. The original core campus makes up only a small part of today's campus, but it remains at the heart of UT academic life and is known to students and alumni simply as The Hill.

Some 220 structures now dot UT's 550-acre campus, and 35 percent of them are potentially eligible for placement on the National Register, according to Ezzell.

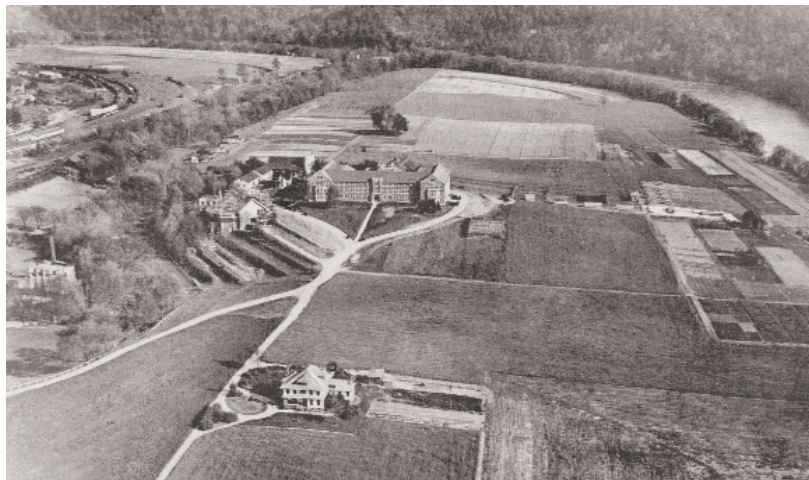
Eighty-three of the buildings are more than 50 years old, 19 more than 75 years old, and five more than 100 years old.

Architectural styles run the range from the vernacular or traditional architecture of the 19th century to the modern movement of the mid-20th century, but in the middle is where most of it falls, says Carroll Van West, director of the Center for Historic Preservation (CHP) at Middle Tennessee State University and a UT alumnus. CHP is providing technical assistance for the project.

"Most of the campus is what we'd call Collegiate Gothic, a Gothic revival style that became popular for American universities starting in the 1860s and

remaining popular through the 1940s," Van West points out. "It was a real dominant trend, with different architects giving each building its own feel."

The Hill by itself hosts quite a collection of Collegiate Gothic buildings erected from 1928–1935, with Ayers Hall being the most impressive example. "Its tower has really been the defining trait of the university," Van West says, "standing as an icon for everyone who's been on this campus for the past 80 years." Morgan Hall, which was constructed in 1921 as the centerpiece of UT's agricultural campus, is another



*The UT campus in the early 20th century, when open fields, working farms, and quiet two-lane highways defined the landscape.*

stunning example of Collegiate Gothic.

Following this period, post-war modern style came into vogue and is showcased by the downtown UT Conference Center, Ezzell says. Then, during the early 1960s, a major campus expansion was undertaken under the auspices of urban renewal. A substantial portion of the main campus, including most residence halls and recreational facilities, was constructed during this period, Ezzell notes. The skyscraper-like McClung Plaza and Tower built in 1967 and the stair-step look of Hodges Library built in 1987 depict this style.

Elsewhere, vestiges of the Victorian era that once dominated Kingston Pike,

a major thoroughfare running through the campus, can be found in several former carriage houses and outbuildings that date back to that building style.

"The overall design of the campus has a nice cohesiveness to it, but at the same time, there are interesting little bits of diversity between the buildings that make it fun," Van West says.

As it moves, building by building, Ezzell and Van West's team is also digging through the archives to track down the stories behind the people who gave these buildings their promi-

nence, as well as the events that took place around them.

"So many things have happened here, and a lot of people have come off this campus who are significant both regionally and nationally," Ezzell explains. "It's a rich legacy, and yet very little has been done to date to preserve that heritage."

### PRIORITIZING PRESERVATION

Inventory work began last fall. In evaluating and prioritizing what to preserve, Ezzell and Van West's team will rely heavily on criteria used by the National Register. These include architectural significance in terms of design; historical significance in terms of events that took place there; and connections to important people locally, regionally, and nationally. Building age and condition will also factor into the assessments.

Additionally, they're also considering other criteria such as "campus signifi-

*(continued on page 7)*

# ISSE CO-SPONSORS CONFERENCE ON QUALITY GROWTH



Tennessee Governor Phil Bredesen will welcome attendees to the “Plain Talk on Quality Growth” conference at the Knoxville Convention Center on March 29-30. The conference, chaired by Rep. John J. Duncan Jr. (R-TN), will provide perspective on how growth has changed the region, as well as on the consequences of current development practices.

Daniel Williams, a fellow of the American Institute of Architects and the author of *Sustainable Design: Ecology/Architecture/Planning*, will serve as the event’s keynote speaker.

The conference will benefit anyone interested in growth and development decisions. A small registration fee includes comprehensive conference materials, breakfast, lunch, and refreshments. Limited scholarships are available.

## FOR MORE INFORMATION:

Call 865-524-0270, visit the website at [www.ETQG.org](http://www.ETQG.org), email: [info@ETQG.org](mailto:info@ETQG.org), or view the conference brochure here: [isse.utk.edu/pdf/QualityGrowthBrochure.pdf](http://isse.utk.edu/pdf/QualityGrowthBrochure.pdf).

# NATURAL CAPITAL

*Can economic development and population growth coexist with natural resource stewardship in the southern Appalachians?*

ARTICLE BY: ELISE LEQUIRE

The take-home message that emerged from the 17th annual Southern Appalachian Man and the Biosphere (SAMAB) conference was a cautiously optimistic yes.

“Development is inevitable,” says Susan Schexnayder, SAMAB’s program manager and a researcher with the University of Tennessee’s Institute for a Secure and Sustainable Environment. “That’s why conference planners decided to focus the 2006 program on the theme “Natural Resources and the Economy: Hand in Hand.”

A common thread in the program held November 28-30, 2006, in Gatlinburg, Tennessee, was finding ways to guide development while providing for environmental protection and land conservation. A case in point is the Lake James project in Burke County, North Carolina, a rural area adjacent to Pisgah National Forest and the Linville Gorge Wilderness area that has been used for recreation for more than 100 years but has recently been threatened by ecologically destructive development.

Through a partnership among federal, state, and local representatives, a land trust, a private developer, and property owners, planners were able to devise a model of development that meets recreational, conservation, and scenic needs while allowing compatible economic development. “An economic impact statement of Lake James shows there has been an infusion of millions of dollars, in addition to enhanced recreational and economic opportunities,” says panel moderator Judy Francis, community partnerships

and economic development liaison for the North Carolina Department of Environment and Natural Resources.

## A SENSE OF PLACE

While immigration of people and businesses infuses new energy—and money—into the southern Appalachians, the image of a remote, rustic, and even backward region belies its rich heritage. In his keynote address, Jeff Biggers, author of *The United States of Appalachia: How Southern Mountaineers Brought Independence, Culture and Enlightenment to America*, notes that political, cultural, and literary forces sprang from its people and spread to have profound influences on the nation as a whole.

“Appalachia has been on the frontline of change in America; it’s a burning ground of clash and conflict,” Biggers says. “The vanguard of the ecology and social justice movements has come out of Appalachia, and writers from Willa Cather to Thomas Wolfe have looked to the land as part of their cultural heritage.” Biggers encourages park rangers, scientists, and environmentalists to peel back the layers and see the diversity of cultures and histories attached to this land.

“Jeff Biggers really brought home the sense of place for this year’s participants,” says Rick Durbrow, chairperson for the 2006 conference, vice-chairperson of the SAMAB Executive Committee, and program analyst for the U.S. Environmental Protection Agency, Region 4. “I thought this year’s conference was one of the more effective and well received in the more than

10 years I have been involved with SAMAB.”

### HAND IN HAND

The SAMAB Cooperative is a consortium of 11 federal and three state natural resource agencies with the stated mission to promote the environmental health and stewardship of natural, economic, and cultural resources in the Southern Appalachians. “The role of SAMAB is to identify how the agencies involved can support the community to harness economic activities in a sustainable way,” Durbrow says.

Conference organizers encourage attendance by key players from the non-profit, private, and local government sector. “Since the late 1980s, SAMAB has shown real leadership in elevating conservation issues to a regional level,” says Hugh Irwin, a conservation planner with the nonprofit Southern Appalachian Forest Coalition (SAFC).

Sessions on the production and availability of biofuels in the southern

Appalachians were of interest to Jesse Pope, park naturalist for Grandfather Mountain, a 5,000-acre privately owned nature park in the Blue Ridge Mountains of North Carolina. “We are looking to


*The SAMAB Cooperative is a consortium of 11 federal and three state natural resource agencies with the stated mission to promote the environmental health and stewardship of natural, economic, and cultural resources in the Southern Appalachians.*

switch our vehicles to biodiesels here in the park, so this year’s information was important, and the networking with folks from other states was great,” says Pope.

Pope also gained good information from the sessions on invasive species. “I learned several things new to me, like the threat of the emerald ash borer, a tiny insect that is making its way south now by people who bring their own firewood from up north.” Pope plans to raise awareness of the problem with local campgrounds near Grandfather Mountain, which is the only privately

owned nature preserve declared by UNESCO as one of an international network of Biosphere Reserves.

At the end of the conference, participants took home compact fluorescent

light bulbs, but even more important, the sense that economic development can proceed in the southern Appalachians hand in hand with conservation of green space for public use, recreation, ecological services, and aesthetic values, says SAMAB program manager Schexnayder. 

#### For More Information

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## STORIES TOLD IN BRICK AND MORTAR (CONTINUED FROM PAGE 5)

cance,” as there may be sites or structures that are important to the campus or alumni that might not fall under the other traditional criteria, according to Ezzell. The famous campus rock that’s splashed with paint before big games and other events is one example. “It’s not a building and not much of a site, but when they talked about moving it last year, the campus community reacted very strongly because it’s an important part of the culture and history of this place,” Ezzell notes.

As the two-year project runs its course, “we’ll be placing all of these properties into their architectural and

historical significance,” Van West says. To go with the inventory will be a listing of the buildings, dates, and basic descriptions and photographs. “We’ll also be putting together a narrative explaining what we see as significant patterns and events associated with the campus and how the campus changed over time,” Van West adds.

Members of the UT community, including students, faculty, staff, alumni, and the public at large, will play an important role in the preservation planning process. A series of public meetings will kick off later this year at which “we’ll talk to them about the

campus and its history, tell them some of the things we’ve learned, and see where they want to go with this,” Ezzell says. Final recommendations for bringing UT’s history alive could include the creation of a campus historic district, interpretive signage, and a self-guided walking tour with details of the different architectural styles and significant past events. 

#### For More Information

Contact: Tim Ezzell, 865-974-9036, or email: tezzell@utk.edu.

# ISSE Staff Citings

**Catherine Wilt** (senior research associate, ISSE Environmental Sustainability) accepted an award for Outstanding Community Leadership in Tennessee on behalf of the Tennessee Valley Earth Partnership (TVEP). The award was given in recognition of Knoxville's Earth Fest, an annual celebration of Earth Day, which draws more than 10,000 attendees every year. **Wilt** has served as co-chair of the Earth Fest Steering Committee for the past five years, and helped create TVEP to promote environmental education and outreach in East Tennessee. The award was given by Keep Tennessee Beautiful and the Tennessee Department of Transportation, and presented by TDOT Commissioner Gerald Nicely at the Keep Tennessee Beautiful biennial conference.

**Randall Gentry** (ISSE interim director) is working with graduate students to study shallow near-stream hyporheic zones in the Greenbrier Valley of the Great Smoky Mountains. The team is testing the hypothesis

that these hyporheic zones play an important role in water-quality issues in local hydrologic systems. Hyporheic zones are areas near or under streams where groundwater and surface water mix. **Bruce Robinson** and **John Schwartz** (Department of Civil and Environmental Engineering) are examining the effects of low-pH storm events on fish habitat within the same area. These studies will allow researchers to develop models addressing the behavior of hydrologic systems and the environment.

**Robert Shelton** (ISSE Energy and Environmental Policy Research) hosted Eisenhower Fellow Masahito Hiratake. Hiratake, senior operations officer for the World Bank's Carbon Finance Unit, offered a presentation to ISSE staff titled "The Challenge of Sustainable Development in the Experience of the Kyoto Protocol" before meeting with UT and ORNL research staffs. The Eisenhower Fellowships program "engages emerging leaders from around the world to enhance their professional capabilities, broaden their con-

tacts, deepen their perspectives, and unite them in a diverse, global community."

**Maggie Stevens** (ISSE research assistant and student in the Department of Geography), will serve as an intern during the spring of 2007 with Iricambi, a nonprofit conservation and research organization located in the Atlantic Rainforest of Brazil. **Stevens'** responsibilities include fundraising and assisting with proposal development. Additionally, **Stevens** will complete an independent study for the Department of Geography on Brazil's transition to an ethanol-based transportation infrastructure and the resultant environmental and economic effects on communities surrounding this section of the rainforest. Iricambi is located five hours north of Rio de Janeiro where development pressure along the Atlantic section of the rainforest continues to rise. The organization works to identify sustainable livelihoods for Brazilians, which allow them to earn income from the land while preserving the biodiversity of the forest.

QUARTERLY NEWSLETTER FROM UT'S INSTITUTE FOR A SECURE AND SUSTAINABLE ENVIRONMENT

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