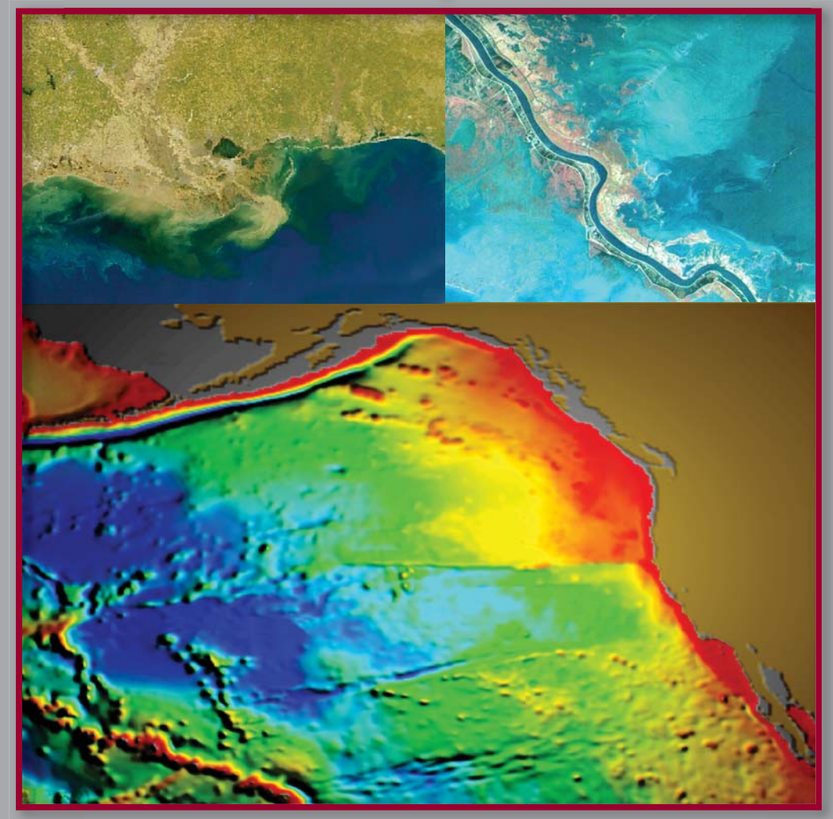
GeoResources Institute

Annual Report 2007



Mississippi State University

GeoResources Institute

From the Director

"2007 proved to be an incredible year for the GeoResources Institute. New initiatives and expanded programs occurred with almost every program we have, leading to a funding level of over $28M in this past fiscal year.

The NOAA-funded Northern Gulf Institute, newest in NOAA's cooperative institutes program, is a partnership of five academic institutions – MSU (as lead), University of Southern Mississippi, Louisiana State University, Florida State University, and Dauphin Island Sea Lab. It is in strong partnership with NOAA units at Stennis Space Center and nationally, as well as a number of other federal and state agencies, as well as industry and non-governmental organizations. The fundamental philosophy of operations for the NGI is integration—integration of the land-coastal-ocean-atmosphere continuum; integration of research to operations; integration of the collaborating institution's research and technical strengths; and cooperative integration with other entities.

GRI has also taken the lead in developing a NASA-funded Small Satellite program, the first of its kind in the U.S. In partnership with Surrey Space Technology, Ltd., as well as several other companies, this program is focused on bringing small satellite technology to Mississippi and the U.S. Thus, it will be a tremendous engine for economic development. It also has a strong element of education – a new concentration in Small Satellite Engineering at the Ph.D. level in the Bagley College of Engineering is being offered beginning Fall 2007.

The success that GRI has achieved comes through only one means – dedicated and innovative faculty, staff, and students. There are literally hundreds associated with the Institute, and teamwork and collaboration are the hallmarks of the many successful programs that have been built. GRI is committed to working closely with the departments and colleges at MSU, as well as researchers at other institutions and federal agencies, practitioners in the field, and policymakers in the federal and state government.

Through these new as well as our existing programs, GRI continues to demonstrate its commitment to high quality research and education/outreach that is relevant, visionary, and engaged. 2008 holds promise for even greater things! "

David R. Shaw
Director and William L. Giles Distinguished Professor

Mississippi State University

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GeoResources Institute

Our Vision is to be a world leader in advancing the state-of-the-art in spatial technologies and resource management.

Our Mission is to understand Earth's natural and managed systems and provide comprehensive solutions for socioeconomic and environmental requirements, leading to an improved quality of life.

The GeoResources Institute serves as a partner and research resource for goverment agencies at the state, local, federal, and international level, as well as for commercial entities desiring to expand their current technical capabilties or to diversify into new market opportunities. Our programs are built upon the wide range of expertise and infrastructure available across the University, and through cooperative agreements with other academic and research groups.

During fiscal year 2007, over 100 students participated in the research projects administered by the GeoResources Institute, including 32 Masters, 34 PhDs, and 1 post doctoral candidate.

Using the infrastructure and expertise of one of the largest computing centers in the United States, the GRI provides capabilities in remote sensing computational technologies, visualization techniques, natural resource management, and the transition of these into operational agency research, planning, and decision-support programs.

GRI GPS GIS

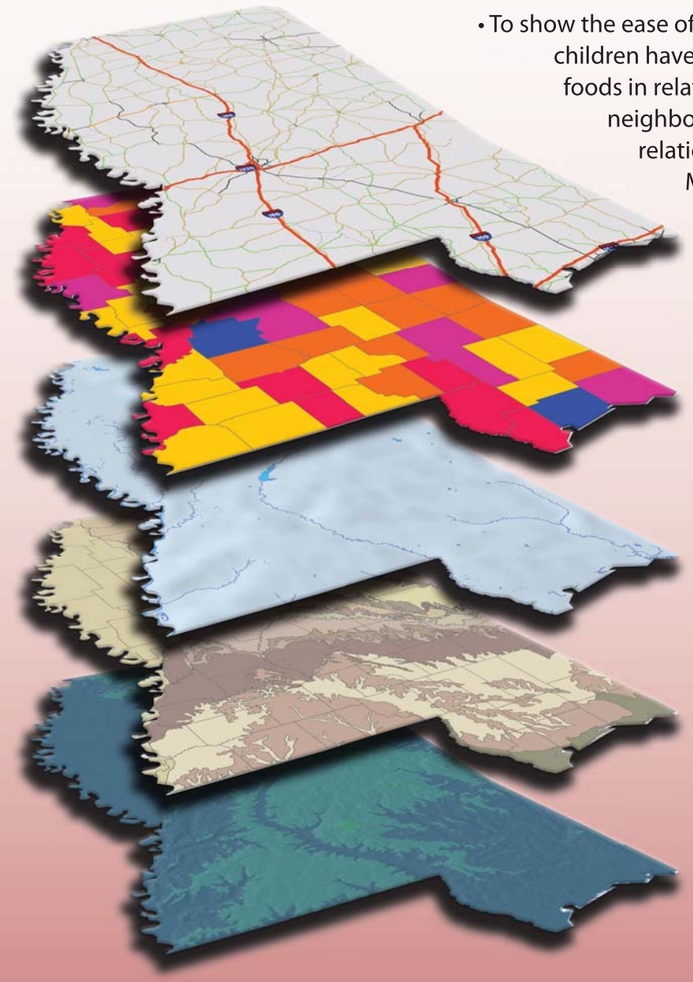
The Three G's

GeoResources Institute (GRI), Global Positioning System (GPS) and Geographic Information Systems (GIS) provide the data foundation for many of the projects at the GeoResources Institute. GPS gives pinpoint accuracy to geographical data, while GIS software allows easy analysis and clear visualization of spatial relationships.
GPS is a network of satellites orbiting the Earth and communicating with a receiver on the Earth's surface. The satellites can track the receiver in latitude and longitude as it moves across the surface. The receiver may also store points to which satellites can direct the receiver back. This allows GRI researchers to return points on an impacted lake or in a soybean field.

GIS is a way of showing geographic data, like GPS points. It helps researchers understand the spatial relationships of things on the Earth. For example, GIS can show where a sinkhole is in relation to utility lines to answer questions about the cause and effect of the sinkhole.

Here are just a few ways that GRI uses GPS and GIS:

- To create watershed maps for the National Resource Agency. They show many layers of information, from elevation to public or private ownership to locations of water pumps.
- To map the best routes for roads for the Department of Transportation, avoiding unique geological features and endangered species. By using GIS mapping instead of walking road routes, GRI can save years and millions of dollars off road projects.
- To monitor coastal habitats for growth, erosion and pollutants at the new Northern Gulf Institute.
- To create 8,000 virtual rain gauges across Mississippi based on the NexRad radar system. This gives forecasters more accurate data on rainfall.
- To take exact surveys of entire lakes for the US Geological Survey, finding the location and density of invasive species.
- To develop precision agriculture for USDA, that shows researchers exactly where pests or stress have occurred in a full field of crops, thereby saving farmers much time and money; to determine drift of airborne agents, whether bioterrorism agents, herbicide or even forest fire.



- To know whether crops have been affected by a biological agent. This could allow quick response in the event or threat of agri-terrorism. Agricultural security is a key part of studies for the Department of Homeland Security.
- To show the ease of access that school children have to less nutritional foods in relation to their schools and neighborhoods. This spatial relationship, examined with MSU's Kinesiology and Nutritional Science Departments, can help explain the increase in childhood obesity.
- To make a perfect 100-foot wide version of the 4-H symbol on MSU's Drill Field. Six hundred 4-H'ers celebrated the centennial of the Mississippi group by filling in the symbol and being photographed.

- To track utility lines on the campus of MSU. When the need arises, GRI can know whether events have impacted utilities and guide construction and maintenance activities.
- To teach city, county and state officials in the use of GIS. The classes now range from the basics to maintaining a database for tax or emergency response purposes.

REMOTE SENSING

Hyperspectral Imaging for Bio-Security

GRI researchers are working as a part of the Southeast Region Research Initiative to use hyperspectral imaging to detect and assess toxic airborne bio-chemical agents on agricultural food crops. This project meets the goals of the Mississippi State Homeland Security Strategy to ensure an adequate and safe food supply. The project is funded by the Department of Homeland Security.

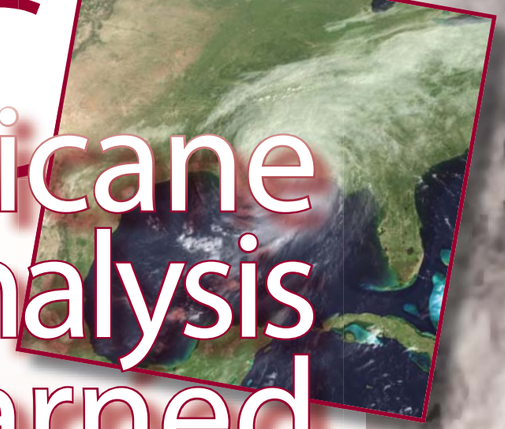
Agriterrorism is a real threat. U.S. troops in Afghanistan found plans made by al Qaeda to attack livestock and crops and food processing plants in the United States. The FBI has issued warnings about potential agricultural attacks. These acts, whether real or hoaxes, would cause economic devastation, especially in states, like Mississippi, where agriculture is a key industry.

Hyperspectral imaging has already proven successful in tracking invasive species populations, monitoring crop stress and finding weeds in crops to give targeted herbicide treatments. This project is testing new software for this technology to see if it can find certain herbicides or pathogens in common Mississippi crops. Analysis of hyperspectral imaging data is being evaluated to determine if it will be able to state the existence of an airborne biochemical agent, the rate of the agent's application and the degree of confidence in the data and analysis.

The researchers will be looking for commercial products with which to bundle the new software. This will allow the software to serve its purpose to detect acts of agriterrorism and determine occurrences of hoaxes.

RESEARCH

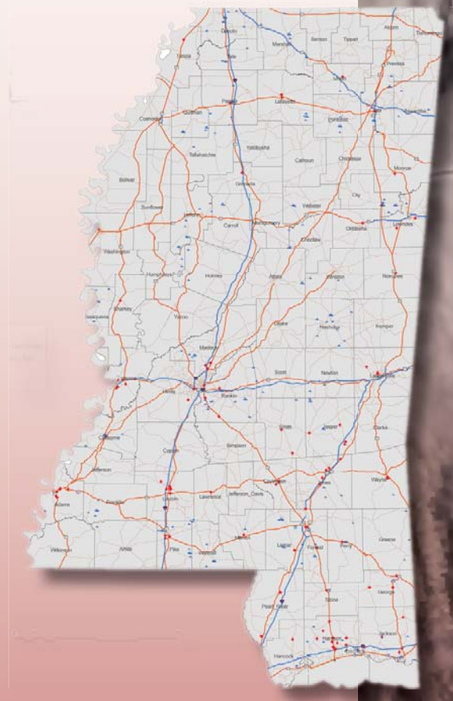
Capturing Hurricane Katrina Data for Analysis and Lessons-Learned

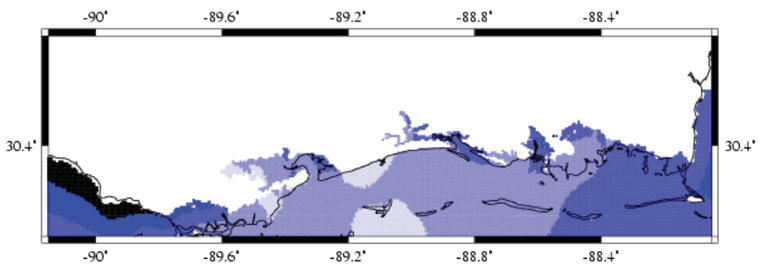


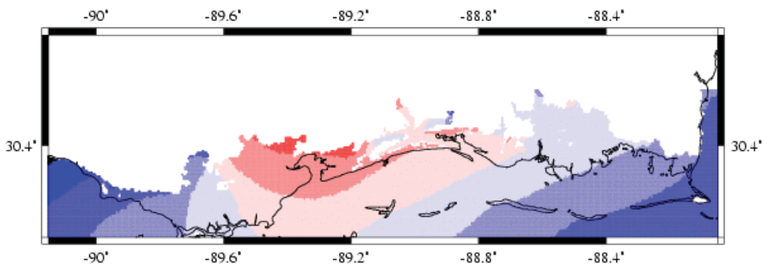
GRI researchers are working with the Oak Ridge National Laboratory as a part of the Southeast Region Research Initiative to collect data about the disaster management and aftermath of Hurricane Katrina. They are compiling geospatial data, data analysis procedures and cartographic products generated in central and southern Mississippi in the weeks after the hurricane.

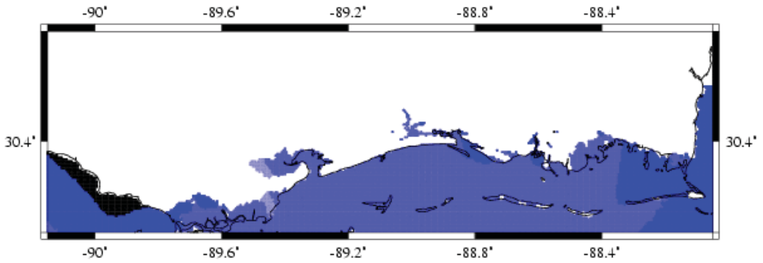
The researchers are reviewing and analyzing the compiled data. They are assessing the methodologies the emergency operation centers used to generate geospatial information. They will then concentrate on the data and procedures that proved successful in generating the required information to first responders. The researchers are surveying first responders in Mississippi who used spatial products in response to Hurricane Katrina. The researchers are focusing on how much those products were used, what worked or didn't work, and recommendations for future disasters. The researchers will see if any steps can be taken to improve obtaining information and managing the data efficiently. Their findings and cartographic data will be available through a web site.

Finally, the researchers will collect social, economic and health data needed for disaster preparedness in a central source. The focus will consist of critical humanitarian agencies and needed community information, such as: hospitals, schools, fire stations, law enforcement offices, banks, per capita income and special populations. Using GIS software, the researchers will map the Gulf Coast region before Hurricane Katrina. This will allow agencies to figure out where needs are after Katrina.





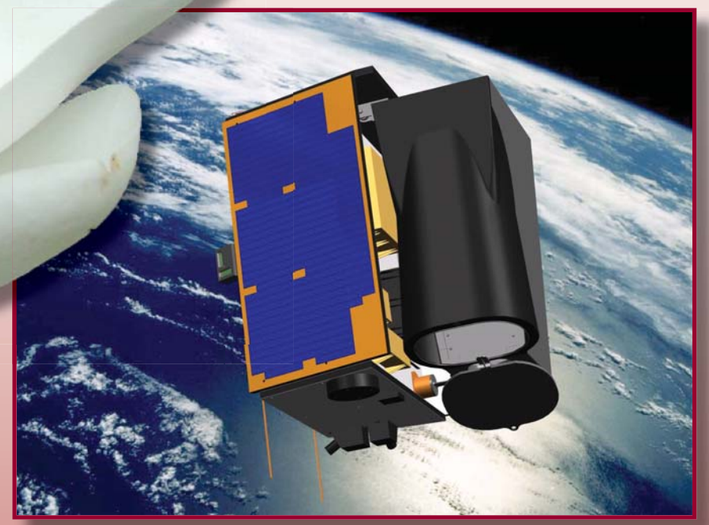




MAGNOLIA SmallSatelliteProgram

NASA needs advanced, low-cost spacecraft technology and is working with the GeoResources Institute to develop a research, education, training, and applications program leading to a comprehensive low-cost space capability for NASA and other U.S. customers. The small spacecraft capability emerging at MSU will offer a more compact and less expensive space capability feeding applications ranging from navigation and communication services, to mapping, agriculture, and disaster response.

NASA has contracted with the GeoResources Institute to develop a lunar navigation and communications system pathfinder mission dubbed "Magnolia". GRI and NASA researchers are receiving training from Surrey Space Technology, Ltd. (SSTL), in the U.K. on small spacecraft design, manufacturing, testing, and operations. With a 20-year history of remarable innovations, SSTL has helped more than a dozen countries develop their own satellites and has notched over 25 successful launches. MSU plans to extend that remarkable track record to the U.S., and significantly advance the technology and applications of small spacecraft systems along the way.



With a successful pathfinder launch, MSU will be positioned as the leading U.S. center for small, low-cost space system research, training and development. This unique knowledge and research will be provided across the full range of federal agencies, like the Department of Defense and the National Oceanic and Atmospheric Administration, to allow them to build and use smaller, more economical satellites. For some agencies, the MSU collaboration with NASA and SSTL will dramatically lower the high-cost barriers to space and provide many federal customers and commercial companies with their first real chance to have assets in orbit.

CREATED
New Northern Gulf Institute

Leadership in the GeoResources Institute was instrumental in establishing a new cooperative institute for developing research at academic institutions in the Northern Gulf of Mexico Region. The Northern Gulf Institute (NGI) at Stennis Space Center, Mississippi, was established in October 2006, and is the newest of 23 NOAA Cooperative Institutes across the United States.

The NGI is a consortium of universities led by Mississippi State University, in partnership with the University of Southern Mississippi, Louisiana State University, Florida State University, and Dauphin Island Sea Lab. The fundamental philosophy of the NGI is integration - integration of the land-coast-ocean-atmosphere continuum; integration of research to operations; and integration of individual academic institutional strengths into a holistic research and educational program specifically geared to the needs of Northern Gulf of Mexico users.

The NGI conducts collaborative research with NOAA researchers and other NOAA partners under four scientific themes, focusing on the northern Gulf of Mexico: (1) Ecosystem Management – Characterize Northern Gulf of Mexico Coastal Wetland and Fisheries Habitats, including Restoration Strategies; (2) Geospatial Data Integration and Visualization in Environmental Science - Develop significant results at the intersection of inland/watershed-coastal waters and resources, with a particular focus on the research, development, prototype testing and transition of scientifically-based geospatial observations, integration and improved access to data, and increased use of effective visualization technology; (3) Climate Change and Climate Variability Effects on Regional Ecosystems - Contribute to Northern Gulf of Mexico Climate Assessment and Impact Models; and (4) Coastal Hazards - Strengthen the Integration of Watershed, Estuarine and Coastal Models in the Northern Gulf of Mexico.

NGI research supports all five of NOAA's Mission Goals: (1) Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management; (2) Understand climate variability and change to enhance society's ability to plan and respond; (3) Serve society's needs for weather and water information; (4) Support the nation's commerce with information for safe, efficient, and environmentally sound transportation; and (5) Provide critical support for NOAA's mission.

RESEARCH

RapidPrototypingCabability

GRI researchers are helping NASA develop a stronger and more accessible Earth science research database for use by a wide variety of U.S. governmental agencies. Armed with the funding from NASA's Applied Sciences Directorate, the GeoResources Institute is marshaling its geospatial technology expertise to help build a computerized, one-stop data resource that could have global research impacts on such diverse issues as climate change, bioterrorism, transportation and population trends.

Researchers are using high performance computing, remote sensing, rapid prototyping, geographic information systems, global positioning systems, and 3-D landscaping visualization capabilities that will come together in a very complementary way. Also providing support for the National Aeronautics and Space Administration project are the University of Mississippi's Geoinformatics Center, and a team from the Stennis Space Center comprised of the Institute for Technology Development and Science Systems and Applications, Inc.

This will position not only Mississippi State, but the state of Mississippi to be more competitive by providing a significant contribution to the base system from which the next generation of research will be determined. GRI experts in rapid prototyping technology are producing working models from computer-aided designs or animation modeling software.

Earth system science is the study of how the Earth works as a system of continents, oceans, atmosphere, ice, and life. It is based on the ability to measure key parameters and integrate that knowledge into Earth system models.

AWARDS AND RECOGNITIONS

Ball, J. E., L. M. Bruce. January. 2007. Digital Mammogram Spiculated Mass Detection and Spicule Segmentation Using Level Sets. MSU graduate student association research symposium, physical sciences oral competition.

Ball, J. E. May. 2007. MSU Geoscience Certificate.

Cheshier, J. C. February. 2007. Mid-West Aquatic Plant Management Society Scholarship for 2007.

Doshi, R. A. May. 2007. Geospatial and Remote Sensing Engineering Certificate. James Worth Bagley College of Engineering, Mississippi State University.

Ervin, G. N. May. 2007. GeoResources Institute Academic Professor of the Year.

Madsen, J. D. May. 2007. Associate Editor, Invasive Plant Science and Management, Weed Science Society of America.

Madsen, J. D. May. 2007. Research Professor of the Year. GeoResources Institute, Mississippi State University.

Reddy, K. R. November. 2006. Award of Excellence for Outstanding Work in the Mississippi Agricultural and Forestry Experiment Station (MAFES). Mississippi State University, Mississippi.

Reddy, K. R. December. 2006. Fellow. Crop Science Society of America, USA.

Reddy, K. R. March. 2007. College of Agriculture and Life Sciences and MAFES Faculty Research Award. Mississippi State University, Mississippi State, Mississippi.

Shah, V. P. May. 2007. Geospatial and Remote Sensing Engineering Certificate. James Worth Bagley College of Engineering, Mississippi State University.

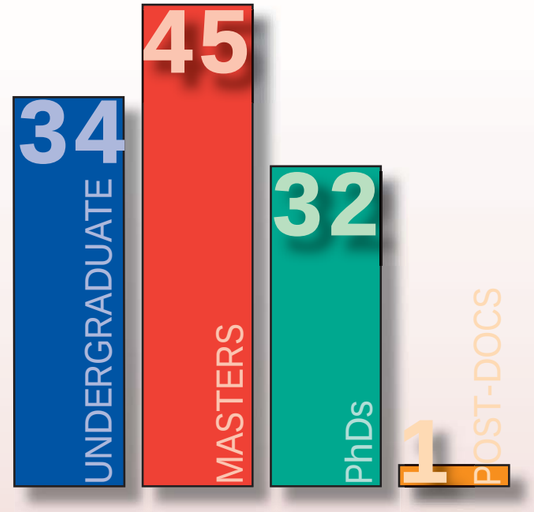
Wasson, L. L. May. 2007. Presidential Citation, Association of Environmental & Engineering Geologist, GIS Volunteer for Hurricane Katrina Relief Efforts.

Wersal, R. M. October. 2006. Midsouth Aquatic Plant Management Society 2006 Scholarship. Midsouth Aquatic Plant Management Society.

Wersal, R. M. April. 2007. Awarded 2nd Place, Student Presentation Contest. 37th Annual Mississippi Water Resources Conference.

PATENTS AND LICENSES

Lawrence, G. W., R. L. King, A. J. Kelley, J. J. Vickery. 2006. Method for Detecting and Managing Nematode Population.



112 Students involved in GRI Research

In addition to the many publications listed in this report, GRI researchers submitted 73 abstracts and manuscripts to non-refereed conferences and workshops. Approximately 165 professional presentations were given at various venues such as symposiums, council meetings, forums, and instructional meetings. The presentations included a vast and diverse range of topics, including invasive species monitoring and management techniques, increasing agricultural crop yields, managing soil erosion, improving hurricane forecasting and tracking, watershed protection, remote sensing and satellites, highway/corridor planning, global environment change, natural resource management and high performance computing. In addition, there were 26 in-house or technical reports written and submitted to sponsors and collaborators.

GRI PROPOSALS

Federal
$44,619,281

Non-federal
$782,666

Total
$45,401,947

GRI ACTIVE PROJECTS

Federal
$27,485,193

Non-federal
$582,765

Total
$28,067,958

BOOKANDBOOKCHAPTERS

Du, Q. December. 2006. Noise-adjusted Principal Component Transform and its Applications to Hyperspectral Image Analysis. Recent Advances in Hyperspectral Signal and Image Processing (ISBN: 8178952181). 241-262.

Fowler, J. E., J. T. Rucker. 2007. 3D Wavelet-Based Compression of Hyperspectral Imagery. Hyperspectral Data Exploitation: Theory and Applications. 379-407. Bried, J. T., G. N. Ervin.

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2006. Abundance Patterns of Dragonflies along a Wetland Buffer Gradient. Wetlands. Vol. 26. 878-883.

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Cooke, W. H., K. Grala, R.C. Wallis. August. 2006. Avian GIS models signal human risk for West Nile virus in Mississippi. International Journal of Health Geographics. Vol. 5:36. 1-19.

Cui, S., Y. Wang, J. E. Fowler. August. 2006. Motion Estimation and Compensation in the Redundant-Wavelet Domain Using Triangle Meshes. Signal Processing: Image Communication. Vol. 21. 586-598.

Du, Q., J. E. Fowler. April. 2007. Hyperspectral Image Compression Using JPEG2000 and Principal Component Analysis. IEEE Geoscience and Remote Sensing Letters. Vol. 4. 201-205.

Du, Q. May. 2007. Unsupervised real-time constrained linear discriminant analysis to hyperspectral image classification. Pattern Recognition. Vol. 40. 1510-1519.

Durbha, S. S., R. L. King, N. H. Younan. March. 2007. Support vector machines regression for retrieval of leaf area index from multiangle imaging spectroradiometer. Remote Sensing of Environment. Vol. 107. 348-361.

Ervin, G. N., M. Smothers, C. Holly, C. Anderson, J. Linville. September. 2006. Relative importance of wetland type vs. anthropogenic activities in determining site invasibility. Biological Invasions. Vol. 8. 1425-1432.

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Ervin, G. N., L. C. Majure, J. T. Bried. December. 2006. Influence of long-term GTR impoundment on stand structure, species composition, and hydrophytic indicators. Journal of the Torrey Botanical Society. Vol. 113. 468-481.

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Fowler, J. E., S. Cui, Y. Wang. October. 2006. Motion Compensation Via Redundant-Wavelet Multihypothesis. IEEE Transactions on Image Processing. Vol. 15. 3102-3113.

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Fujisaki, I., D. L. Evans, M. J. Mohammadi-Aragh, R. J. Moorhead, D. W. Irby, S. D. Roberts, S. C. Grado, E.B. Schultz. January. 2007. Comparing forest assessment based on computer visualization versus videography. Landscape and Urban Planning. Vol. 81. 146-154.

Gray, C. J., D. R. Shaw, J. A. Bond, D. O. Stephenson, IV, L. R. Oliver. January. 2007. Assessing the Reflective Characteristics of Palmer Amaranth (Amaranthus palmeri) and Pitted Morningglory (Ipomoea lacunosa) Accessions. Weed Science. Vol. 55. 293-298.

Gray, C. J., J. D. Madsen, R. M. Wersal, K. D. Getsinger. January. 2007. Eurasian Watermilfoil and Parrotfeather Control Using Carfentrazone-ethyl. Journal of Aquatic Plant Management. Vol. 45. 43-46.

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Reddy, K. R., H. F. Hodges. October. 2006. Exploring the Limitations for Cotton Growth and Yield. Journal of News Seeds. Vol. 8. 1-22.

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Salem, M. A., V. G. Kakani, S. Koti, K. R. Reddy. January. 2007. Screening Soybean Genotypes for High Temperatures by in vitro Pollen Germination and Pollen Tube Length. Crop Science. Vol. 47. 219-231.

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