sUAS Assist Agencies with Planning and Management

GRI and NGI have developed an extensive applied program that exploits small unmanned aerial systems or sUAS to collect timely and high spatial resolution data that is difficult, if not impossible, to collect any other way. Several recent examples include work with the Grand Bay National Estuarine Research Reserve (GBNERR) to utilize UAS for high resolution vegetation mapping, to monitor a simulated disaster response exercise, and to map the extent of and damage from two wildfires. One wildfire, a marsh wildfire, was initiated by a lightning strike and burned 1700 acres. The other wildfire, a forest wildfire, was human induced and burned almost 4300 acres.

Another project involved the analysis of coastal wetland created from hydraulically dredged material. As the dredged material de-waters in a confined area, it settles to a relatively flat, relatively homogeneous surface with minimal habitat diversity. To increase the habitat function, the barriers are removed and tidal channels are created. Typically, the location and specification of these additional habitat features are part of the initial project design and do not consider post-construction site conditions, which could be integrated to improve habitat function. Imagery collected with small UAS can be used to assess the habitat and to measure the surface topography, informing project managers how to connect existing depressions to maximize habitat function and minimize the cost of installation of functional features. Thus, this research supports advances in low-cost data acquisition and effective management of large-scale marsh reconstruction projects.

A third project addressed the analysis and promotion of the reconstruction and expansion of Deer Island, just off the Mississippi Gulf Coast. Collecting both RGB and multispectral imagery, using an array of UAS, researchers are able to analyze the habitat and monitor the island's morphological dynamics. As a result, a series of high resolution visible maps, high resolution vegetation maps, and 3D point clouds were created. In addition, several flyover videos of the island provided context for the mapping, as well as to help the State of Mississippi promote the restoration, preservation and use of the island.

Using UAS to Improve Understanding of Surface-Atmosphere Interactions

The Earth's surface plays a key role in weather processes by driving energy and moisture exchanges in the lower atmosphere. However, these processes occur over extremely small space and time scales, and are difficult to measure and predict using existing surface-based and satellite observations. Jamie Dyer, a researcher with the Northern Gulf Institute, is using real-time measurements from unmanned aerial systems to sample the lower atmospheric boundary layer to provide meteorologists with invaluable information for local-scale weather forecasting and analysis.

The scientific data collected by UAS is especially important for agricultural regions, coastal environments and urbanized areas. These diversified landscapes have varying surface conditions and related energy and moisture fluxes that can produce substantial changes in temperature, moisture patterns, wind speed/direction, and even precipitation.

Mississippi State leads the FAA's Center of Excellence for Unmanned Aerial Systems, and that notoriety gave Dyer and his colleagues the opportunity to test a variety of unmanned aerial vehicle platforms--including fixed and rotary wing--to collect data over different landscapes and locales while simultaneously validating atmospheric measurement strategies. This research not only increases the understanding about the role of surface conditions in the lower atmosphere, but also is crucial because scientists and agriculturalists alike can learn about how different crop types and irrigation can influence atmospheric characteristics, climate variability, as well as the justification of sustaining or changing agricultural practices. Further development of UAS platforms for meteorological applications, which offer a rapid and cost-effective means to observe weather patterns and features in the lower atmosphere, will allow for additional assessment of surface-atmosphere interactions and improvements in local-scale weather prediction.

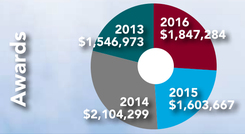
GIS Resources Are More Accessible to Residents Across the State

The Geospatial Education and Outreach (GEO) Project has expanded its offerings with new, Internet-based applications in geographic information systems (GIS). Now, GIS resources are available across Mississippi to anyone at any location.

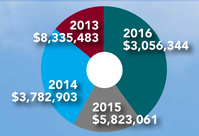
GeoDawg is a web-based, GIS application developed for the non-technical user community. While the learning curve is short, many of the typical functions of GIS are easily accessible. *GeoDawg* users may access installed data layers, query the Internet for GIS servers from around the world, upload data and create point, line and polygon data. Tools include: linear and areal measurements on aerial images, label user-created spatial features, obtain point elevation measurements for areas over Mississippi where recent LIDAR data has been collected, create thematic maps from assorted map layers, create screen capture images of user developed maps or send the maps to various social media outlets and generate cross section elevation transects. *GeoDawg* users with ESRI ArcGIS Online accounts may post their maps for world-wide public access. *GeoDawg* should prove to be an exceptional web-based GIS and one of the most advanced design applications in its class.

Another concern this technology addresses is sea level rise in coastal states. Where inundation may occur and what critical infrastructure will be affected by sea level rise should be addressed by all local and state planning agencies. The GEO Project introduces *GeoCoast*, an interactive simulation model for visualizing areas affected by sea level rise or surge inundation as well as the impact on routing traffic. *GeoCoast* allows users to select an elevation above the current sea level. Areas of potential inundation are displayed as well as points of critical infrastructure (e.g., hospitals, schools, chemical plants). The user also has the option to run a route over the local road system from an origin to a destination to assess the impact on sea level rise on travel distance and time.

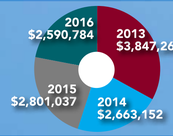
GRI



Awards

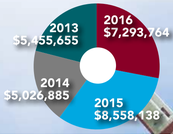


Proposals

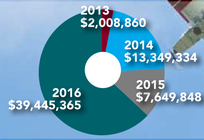


Expenditures

NGI



Awards



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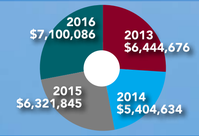

Expenditures

75 Projects
186 Publications

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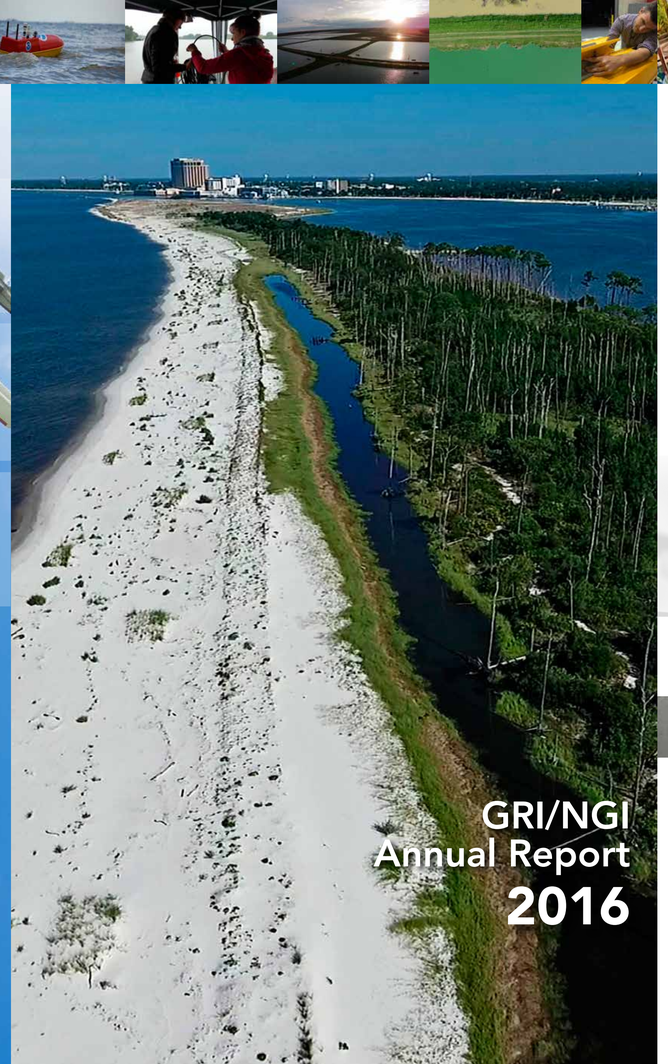

GRI/NGI Annual Report 2016

UAS at MSU

MSU is one of the nation's leading universities studying the many aspects of unmanned aerial systems, which include construction and operation, integrating payloads, analyzing the "how or if integration" of national airspace, navigation facilities and airports. GRI and NGI are researching how, and to what extent UAS are advantageous to agriculture and when addressing environmental issues.

Unmanned aerial systems are a disruptive technology that is referenced by many names. Those involved in the area prefer terms like Unmanned Aerial Systems (UAS) or Remotely Piloted Aircraft (RPA). However, the term drone – short for "target drone" – is much easier to say and often used to refer to, well, a UAS.

GRI/NGI focuses on applications of small UAS in agriculture and natural resources, as they are able to obtain information that is difficult to obtain by any other means, whereas the MSU Raspet Flight Research Lab (RFRL), in general, focuses on the design, development, and use of larger UAS for longer missions. Together they are studying how UAS that can stay aloft 10-24 hours are best configured to support international issues such as beach erosion, marine pollution, oil spill detection and tracking, marine mammal detection and tracking, and other coastal and marine environmental issues. GRI and RFRL are part of MSU's team in the FAA's Center of Excellence for UAS called ASSURE. ASSURE is a coalition of twenty-two universities, led by MSU, who perform research to assist and support the FAA in forming UAS policies and rules.

GRI FLY

GEOSYSTEMS RESEARCH INSTITUTE

GRI develops and advances geospatial technologies to better understand and predict Earth and Mother Nature's systems that promote stewardship, sustainability and increases prosperity.

GRI

MISSISSIPPI STATE UNIVERSITY
GEOSYSTEMS RESEARCH INSTITUTE
NORTHERN GULF INSTITUTE

NORTHERN GULF INSTITUTE

NGI is a regional leader providing integrative research and education to improve the resiliency and conservation of the Northern Gulf of Mexico.

NGI

EMILY Uses Sonar to Capture Hi Res Images of Seafloor

The EMergency Integrated Lifesaving LanYard (EMILY) is an unmanned surface vessel (USV) originally designed to assist lifeguards in the rescue of distressed swimmers in turbulent and choppy coastal waters. Two years ago, researchers reimagined the 65-inch-long boat as an advanced oceangoing marine research vessel, outfitting five EMILY USVs with advanced oceanographic and atmospheric observing sensors. In order to improve storm intensity forecasts, initial research focused on the collection of wind, wave and barometric pressure data from within hurricanes and tropical storms in the Gulf. Field deployments and laboratory testing were conducted to validate onboard environmental sensors and evaluate the capacity of the EMILY USVs for offshore data collection. These efforts yielded a number of design improvements and systems upgrades that will make them more robust ocean and atmosphere research platforms.

Adam Skarke, a GRI scientist, leads the effort to expand the observational capacity of the EMILY USVs. The addition of mapping sonars will enable the vehicles to collect high-resolution images and three-dimensional maps of the seafloor in coastal waters. For instance, EMILY USVs will have the capacity to map coastal habitats and seafloor features with a high degree of resolution, while conducting pre-programed survey missions. This capability has the potential to result in greater seafloor survey efficiency relative to traditional crewed vessels, as well as access to shallow waters that were previously inaccessible to larger manned vessels. What's more, these EMILYS USVs can be rapidly deployed to the location of natural disasters such as a hurricane landfall, in order to survey coastal waters for morphological change and the presence of submerged debris including channel obstructions, which are navigational hazards.

USVs hold the potential to revolutionize the way researchers study and understand marine environments. The innovative development of the EMILY USVs at GRI is resulting in faster, more efficient, and more cost effective means of answering many important scientific questions related to our coastal and ocean environment.

NGI and NOAA Develop Innovative Methods to Improve Marine EcoSystems

MSU researcher Valerie Samedy, with the Northern Gulf Institute, is working with NOAA's National Marine Fisheries Service to develop innovative methods for accurately estimating fish populations in the Gulf of Mexico. These ocean fisheries have a nearly $6 billion economic impact. Conducting research that ensures the long-term health of marine life in federal waters becomes of interest to everyone on some level. Research includes the use of acoustic systems from shipboard surveys which complements more established, but invasive and labor-intensive, methods of biological sampling such as netting. Hydro acoustics provide efficient tools to collect high-quality continuous measurements of organism densities at a wide range of spatio-temporal resolutions. It is a very robust method to estimate fish densities, size and spatial distribution in the detection beam in aquatic ecosystems. The use of acoustics requires highly specialized data processing that utilizes a technique called echo-integration, which integrates the return-echo strength (backscattering) from the echo sounder's sampled volume. Recent analysis of the data indicated that food web components such as zooplankton can also be measured with this method. Analytical results were also compared to a fisheries model being applied in the Gulf of Mexico for stock assessments and fisheries management decisions. Consequently, improved measurements of food web components can be incorporated into the model for better estimates of fish stock and information for management decisions.

GoMRI Team Publishes Over 300 Original Articles

The Northern Gulf Institute is a member of the GoMRI management team, providing support for program administration, communications and outreach. To date the program has funded $353 million in research (236 projects) at 280 institutions in 42 states, DC, Puerto Rico and 17 countries. This research has generated ~750 publications, ~2,870 conference presentations, and supported over 1050 graduate students. To date, the NGI team has published over 300 original articles highlighting research, publications, and the people involved with GoMRI.

GULF OF MEXICO RESEARCH INITIATIVE

Gulf of Mexico Research Initiative is a 10-year, $500-million independent research program established by an agreement between BP and the Gulf of Mexico Alliance to study the effects of the Deepwater Horizon incident and the potential associated impact of this and similar incidents on the environment and public health.

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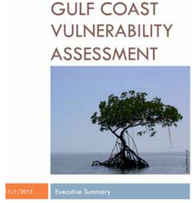
Smart Strategies for Connecting Conservation

Mississippi's success in managing public and private lands for conservation starts with people who are deeply rooted in the land, and all the natural and cultural resources it provides. However, there is increasing recognition that these resources are at risk from factors such as land use change, invasion of exotic pest species, and climate change. The urban footprint is growing, feral hogs are spreading, and not only are sea levels rising, but forests across the state are changing in response to variations in temperature and precipitation. There has never been a more important time to address the tremendous challenges ahead in a more strategic and intentional manner. The time is now for conservation professionals and landowners in Mississippi and neighboring states to come together in a unified voice to set a new paradigm for conservation land management over the next century.

The Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative (LCC) provides a collaborative partnership-based forum for state and federal conservation agencies, non-profit organizations, universities, and private landowners to unify and identify common conservation priorities that transcend individual organizations across a large 180 million acre landscape. Under this unified framework, the LCC addresses conservation priorities by producing robust and defensible science that will help the partnership design and deliver a sustainable conservation network into the future. The Geosystems Research Institute at Mississippi State University is a leading partner in LCC collaborative conservation efforts, and provides the LCC with necessary institutional and operational support. Thus far the LCC has supported $5.4 million in research funds through a cooperative agreement between the U.S. Fish and Wildlife Service (USFWS) and GRI, which includes support for research activities within GRI and the Northern Gulf Institute, in MSU Departments of Geosciences, Forestry, Wildlife, Fisheries and Aquaculture, and at the MSU Coastal Research and Extension Center. The funds have also supported 24 other research projects at 18 different universities and non-profit organizations seeking to address LCC science priorities.

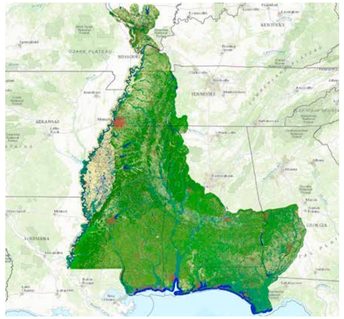
A National Spotlight for the GRI-LCC Partnership

The LCC works across geopolitical and organizational boundaries to define, design and deliver landscapes capable of sustaining natural and cultural resources in the face of climate change and other stressors. The concept is simple – work together to define common conservation priorities and design and deliver a network of lands and waters that will address those priorities. The conservation community is already reaping the benefits of this collaborative conservation approach. The award-winning Gulf Coast Vulnerability Assessment (GCVA) used an expert-driven assessment tool to determine the vulnerability of priority Gulf Coast ecosystems and species to compounding stressors of climate change and coastal urbanization. This unprecedented collaborative work, coordinated by NGI, determined where vulnerability levels were extremely high for priority Gulf species and ecosystems, which resulted in the project being awarded the first ever Sam D. Hamilton Award for Transformational Conservation Science by the USFWS.



The Science Behind the Strategy

Over the past two years LCC science teams have worked on behalf of the partnership to identify a set of common-thread conservation priorities within the LCC geography. The teams identified nine high priority ecosystems for conservation, and developed an initial set of desired conditions that would reflect a healthy and intact ecosystem. LCC staff assessed those conditions across the landscape, determining where intact patches of each target system exist, as well as areas where the conservation community can work together to improve those conditions. This information combined with spatial priorities of partner organizations, species distributions, and information on landscape stressors have informed a first draft of a holistic vision of the conservation landscape now and into the future, set to be released as one component of the initial Southeast Conservation Adaptation Strategy in October 2016.



The LCC has funded additional science projects that continue to provide high-impact science to inform landscape-level conservation planning and delivery efforts. A recently-completed project led by researchers in the MSU Department of Geosciences uses 2011 Landsat satellite imagery and multiple other data sources to create 30m resolution maps of land cover detailing specific ecological systems on the landscape and providing critical and highly-anticipated baseline information upon which conservation planning and management efforts can be based. Two other recently-completed MSU projects in the College of Forest Resources directly address the need for private landowner engagement by examining the capacity for industrial timberlands to provide open pine structural conditions, as well as the willingness of private landowners to participate in conservation programs targeting LCC priority systems. These and several other projects slated for completion in 2016 provide the means to address critical information gaps and allow for incorporation of robust science into the landscape-level strategy of connecting conservation lands.

Improving Agriculture Efficiency with Precision Technologies

"But what can I use it for," is a question agriculture producers and owners of UAVs, ask Joby Czarnecki and Louis Wasson, GRI employees focused on precision agriculture. And it is the question they hear the most when on-site to demonstrate the use and benefits of UAVs. Wasson and Czarnecki are capitalizing on farmers' curiosity and enthusiasm to help them introduce Unmanned Aerial Systems technologies into agribusiness. The Precision Agriculture Research and Extension program relies on agriculturists' inquisitiveness and scientists' applied and tested analyses to ensure that UAS technology transitions from research to large-scale adoption.

As the State's Land Grant University, the role of MSU is to provide scientific validation and extension support for how UAVs and other precision technologies can be used appropriately in our Mississippi production systems. This year, MSU is researching use of these technologies in all of the State's major field crops, including corn, cotton, soybean, rice and peanuts. This information will be used to start answering the question of what UAVs can be used for, and perhaps more importantly, what they cannot be used for.

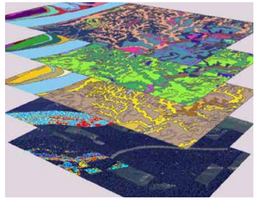
According to Czarnecki, "In past years, we've seen waxing and waning enthusiasm for new technologies and the last thing any of us wants to see is frustrated producers; that will be the end of the fascination with UAVs in Mississippi. Margins are too tight for producers to mess around with technologies that don't deliver and that is why producers want to know how it can be used and what the benefit will be to their farming operation."

Mississippi State's GRI, MAFES, and Extension Service are working together to address this concern by working with agriculture crop specialists to find ways to integrate UAVs into established research programs to collect data on common problems related to crop production. Beyond demonstrating usability and applicability for research and production, Wasson also interacts directly with producers to find how they hope to use UAVs.

"Many producers have a UAV. They flew it a few times and then put it back on the shelf because they didn't know how to get the information out of the imagery. It's like a puzzle. The pieces have to fit to get the benefit of the technology. And that is what we are here for – to help them see how they can use UAVs to make better decisions for their farming operation," Wasson said.

It is unclear at this time how Mississippi will cash in on the projected $82 billion UAS industry; however, as long as producers continue to ask questions about UAVs and need assistance putting the pieces together, MSU will have a crucial role to fill by performing end user-driven research and providing needed answers.

Reinforcing Levees Across the Globe



An international partnership featuring researchers from Mississippi State University, the Colorado School of Mines, University of Delft and Twente University, both out of the Netherlands, are examining earth, dam and levees' (EDLs) critical infrastructure that provides flood protection, fresh water storage and renewable energy to society.

For four years, Jim Aantoos, GRI associate professor, has been leading a team of researchers to collaborate and conduct research on multiscale monitoring science to enable a sustainable future for the vast worldwide array of EDLs. EDLs are prone to a costly cause of failure in the form of internal erosion of soils within the structure. This progressive failure occurs at areas of weakness in EDLs due to inferior construction and/or aging.

Currently, the dam and levee inspections are performed infrequently and the problem areas are invisible to current methods of inspection. There is a critical need to advance the science of levee and dam monitoring to enable the implementation of a cost effective multiscale system that can identify the internal weakness at an early stage, which can prevent catastrophic damage. Sensing the condition of levees remotely provides extensive and inexpensive monitoring.

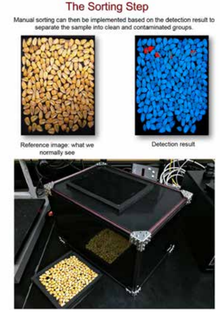
Of primary interest to the researchers are analyzing the internal conditions of the EDLs, their interaction with the natural environment and how they will perform with climate change. In general, EDLs are evaluated for overtopping, macro-instability (e.g., slope failure), and internal instability (e.g., erosion). Using polarimetric and interferometric synthetic aperture radar (SAR), earth deformations and slump slide detection can be detected at a very small scale. Advanced capabilities from airborne and space-borne SAR are used to characterize numerous levee and dam condition indicators, including surface deformation, surface soil moisture/dielectric properties, soil density, surface roughness and vegetation. The research findings from the remote sensing based approach help levee managers to focus and prioritize EDL inspection and maintenance activities.

Researcher Develops Technology to Help Fight World Hunger

An associate research professor with the Geosystems Research Institute and the Mississippi Agricultural Forestry Experiment Station has captured worldwide attention because of his work in developing user friendly, inexpensive technology that will help screen a fungal metabolite in corn. Aflatoxin is a known carcinogen associated with liver and lung cancer in humans. The maize fungus is a threat to food security, human health and trade in developing countries. The current identification method is expensive, has low detection rates and is not accessible to farmers in these countries.

Haibo Yao's most recent development is a handheld device similar to the size of a shoebox. This demonstration device uses UV-LEDs to excite the contaminated corn kernels to fluoresce. A tablet is used to detect and display the contaminated kernels. Comparing with the existing analytical methods for aflatoxin detection, the approach could provide a rapid, low-cost detection method that may be used in developing countries.

The GATES Foundation, the USDA and the United States Agency for International Development has partnered with Yao to provide funding to develop portable technology to help fight world hunger and poverty by improving nutrition through early detection and elimination of aflatoxin from staple commodities.



GRI MISSISSIPPI STATE UNIVERSITY NGI Northern Gulf Institute a NOAA cooperative institute

GRI and NGI are member institutes of the High Performance Computing Collaboratory at Mississippi State University.
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