2011 Mississippi Water Resources Research Institute

Annual Report

Director's Update

Greetings from the Mississippi Water Resources Research Institute. As most of you know by now, the Institute has recently had a change in leadership. My name is Wayne Wilkerson, and I am the Institute's new Director. I am also an Associate Professor in the Department of Landscape Architecture here at MSU. Since taking on the role of Director back in the spring, I have traveled all over the state of Mississippi meeting with as many citizens and stakeholders as possible to get their impressions of how the Institute could best be addressing current and future water related issues. These include the traditional concerns of water quality and quantity, both urban and agricultural, as well as economic development.

I am sure everyone is aware of the impact that the Flood of 2011 had on the Mississippi Delta. The Flood set new record stages at Vicksburg and Natchez and approached record levels at Greenville and Memphis. Farm Bureau estimated that over 600,000 acres of Mississippi farmland were impacted. At the same time that the Mississippi River was experiencing record flood levels, on the other side of the levee farmers in the Delta were seeing decreasing levels in the alluvial aquifer available for irrigation.

Although the nation's economic growth has been somwhat unsure, Mississippi recently welcomed the opening of the new Toyota Plant at Blue Springs. When production is fully operational in 2012, over 2,000 new well paying jobs will be created on-site, with additional support industries providing many more.

What is the common denominator for these issues? Water. Our agricultural commodities require water to grow and flourish, and mega-sites such as Toyota and Nissan can use over a million gallons per day as part of the industrial process. I see the role of the Institute as a clearinghouse of resources to assist the citizens of Mississippi respond to water related issues in a positive manner.

The Institute's mission, as defined in its charter, is to provide a statewide center of expertise in water and associated land-use planning and to serve as a repository of knowledge for use in education, research, and community service. We will work hard to accomplish our stated mission, and improve the quality of life for all the citizens of Mississippi.

Wayne Wilkerson

Institute Mission Statement

Established by the U.S. Congress in 1964, the Mississippi Water Resources Research Institute (MWRRI) is one of 54 institutes (one in each state, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands) that form a network of research efforts coordinated to solve water problems of state, regional, or national significance. In 1983, the Mississippi Legislature formally designated the MWRRI as a state research institute. Federal legislation specifies that the institute consult with leading water officials in the state to develop a coordinated research technology transfer and training program that applies academic expertise to water and related land-use problems. These activities are funded in large part through an annual grant from the U.S. Geological Survey, Department of the Interior. The Institute's state authorization charges it with assisting state agencies in the development of a state water management plan, maintaining a technology transfer program, and serving as a liaison between Mississippi and funding agencies.

The MWRRI goals are to:
(1) Serve public and private interests in the conservation, development, and use of water resources.
(2) Provide training opportunities in higher education whereby skilled professionals become available to serve government and private sector alike.
(3) Assist planning and regulatory bodies at the local, state, regional, and federal levels.
(4) Communicate research findings to potential users in a form that encourages quick comprehension and direct application to water related problems.

Two Year Strategic Plan 2011-2013

Research

· Continued support for food/fiber/fuel mission.
· Develop a better understanding of the interactions between water systems, land use, the built environment, and climate change.

Education

· Develop a Certificate of Watershed Protection.
· Utilize demonstration projects as service learning.
· Expand the number of funded graduate students.

Engagement/Outreach

· Enhance working relationships with Mississippi universities and state agencies.
· Offer workshops for technology transfer.
· Return the annual conference to Jackson, MS.

MWRRI Research Impacts

- **Watershed Management –** The WRRI has been assisting interested stakeholders organize comprehensive watershed management organizations since the mid-'90s. Regardless of the geographic size of the watershed or the scope of interest, watershed management organizations are increasingly important nationally and in Mississippi because they can integrate and coordinate various federal and state environmental, agricultural, natural resource, emergency management, and economic development programs to develop and implement plans for environmentally sustainable economic development.

- **Water Quality** – Increasingly, good water quality is critical in attracting new industries to an area. As county and local governments begin to take a more active role in addressing nonpoint sources of water pollution, it is important to accurately and fully quantify the potential water quality benefits of various non-regulatory management alternatives. The WRRI is collaborating with local governments, the Environmental Protection Agency, the Mississippi Department of Environmental Quality and other state and regional agencies to design projects to meet these needs.

- **Water Quantity** – Industry experts say that the three things that we currently take for granted about the current state of water – quantity, quality, cost – will not be present in the decades ahead. Mississippi is currently blessed with adequate quantities of water. Availability of adequate water supplies was a major factor in the location of both the Nissan and the Toyota automobile manufacturing plants to Mississippi. But this may change in the future. Communities in Northeast Mississippi are experiencing drinking water shortages. The Mississippi Delta is also concerned with potential irrigation problems. The WRRI is working with these diverse economic and political groups to ensure that future generations of Mississippians will continue to have access to adequate supplies of water.

- **Small Public Water Systems –** The need to assist small (10,000 or fewer customers) and even the smallest (3,400 or fewer customers) public water systems in Mississippi and the Southeastern United State to develop financial, managerial, and technical capacity remains a WRRI priority. The Southeastern Regional Small Public Water Systems Technical Assistance Center (SETAC) was funded in 2000 to provide this assistance. SE-TAC projects have benefited hundreds of small systems in the region, providing technical assistance to more than 97 systems; training more than 2,000 water system personnel; and saving water associations more than $3 million in water loss and energy costs.

MWRRI Project Summaries

Watershed Assessment and Education

Maifan Silitonga, Mississippi River Research Center, Alcorn State University

The Coles Creek Watershed, located in the southwestern quadrant of the state of Mississippi, is listed under the US EPA impaired water section 303(d). Degradation of the ponds/lakes and streams/creeks in this watershed is caused mostly by biological impairment, followed by nutrients, organic enrichment or Low Dissolved Oxygen, sediment/siltation, pesticides, and pathogens (US EPA, 2007).

Research objectives were to:

1. Analyze the quality of water in the ponds
2. Analyze soil samples in the surrounding areas
3. Identify the cause of degradation
4. Find and select the best management practice(s) to restore the pond's conditions, and
5. Develop educational materials for the community

Water quality samples from Coles Creek Watershed were collected in 23 locations and monitored monthly for 13 months. Areas of concentrated research and analysis included such topics as: temperature, pH, turbidity, total dissolved solids, dissolved oxygen, nitrate, chlorophyll, total coliform, and *Escherichia coli.*

Watershed education and stewardship efforts were conducted to help promote water quality preservation quality in the Coles Creek Watershed. Activities included workshops, Non-Point Source Education Tour of the Mississippi River in collaboration with MDEQ, and Earth Day Recycling Competition whereby numerous student organizations and clubs collected approximately 1700 lbs of paper, 200 lbs of aluminum cans, and 200 lbs of plastic bottle during 2009.

In March 2010, the Small Farmers Conference was held for conducting educational presentations addressing non-point pollution and how it can directly and indirectly affect drinking water and human health. Summer Apprenticeship Programs sponsored by the Department of Agriculture, School of Agriculture, Research, Extension, and other sciences were conducted and administered by Alcorn State University Experiment Station personnel to introduce agriculture and relations sciences to students. At the end of the curriculum, students gave PowerPoint presentations to be shared with other students, staff, and parents. In 2010, two high school students are assigned to the environmental science program. They were trained to use Global Positioning Systems (GPS) to locate potential sources of contaminants and analyze data.

Assessing the Effectiveness of Measures to Reduce Sediment Loads in Surface Waters Using Pb Activity in Lacustrine Sediments

Gregg Davidson, Geology and Geological Engineering, University of Mississippi

Erosion control methods are difficult to measure on surface erosion which can vary widely over a specific area and hamper the development of management practices. Preventing accurate assessment of the value of erosion control structures over time is also hampered due to measurement practices. As a watershed drains into a lake, the accumulated sediments have the potential to provide information about historic rates of sedimentation that possibly will yield information about historic rates of sedimentation which can then be used to evaluate the effectiveness of previous erosion control measures.

During this study, sediments from five natural oxbow cutoff lakes in the Mississippi River alluvial floodplain were dated using Pb decay rates and bomb-pulse derived Cs with the possibility of relating trends in sedimentation rate to reductions in erosion due to management practices.

Results from the research conducted found that Pb and Cs dating methods were better quantifiers when working with known dates for implementation of management practices. Sedimentation rate changes over time frames as short as 12 years were detectable and larger lakes indicated smaller changes in sedimentation rate relative to smaller lakes.

Successful application requires that lake sediments that have not been significantly reworked since deposition and erosion control measures which were implemented at least 10 years prior result in measures that will remain in effect after the implementation.

Influences of Land Surface / Land Use Characteristics on Precipitation Patterns over the Lower Mississippi Alluvial Plain

Jamie Dyer, Department of Geosciences, Mississippi State University

The lower Mississippi River alluvial valley in southeast Arkansas, northeast Louisiana, and northwest Mississippi is often characterized as few urban areas but widespread agriculture. Land use is cultivated cropland with little variation in topographic variation; however, the eastern edge of the alluvial valley is described as having small rapid changes in elevation which then moves to heavily forested landscape. This change in land use / land cover has known to enhance precipitation through generation of a weak mesoscale convective boundary. This research project seeks to define the causes and influences of the land surface on corresponding precipitation processes by simulating a convective rainfall event which is influenced by regional surface features. Using a high-resolution simulated dataset generated by the Weather Research and Forecasting (WRF) model, results show that the strongest uplift coincides with an abrupt low-level thermal boundary which primarily is developed by a rapid change from sensible to latent flux relative to the agricultural and forested areas, respectively. This information can then be used to define and predict surface-influenced convective precipitation along agricultural boundaries in other regions where the synoptic environment is weak.

One important finding from the research identified and described the influences of land cover properties, including soil and vegetation conditions, on atmospheric processes of the Mississippi Delta. Analysis confirmed that variations in the energy and moisture fluxes during the warm season along with the eastern boundary of the Mississippi Delta were responsible for the generation of a mesoscale convective boundary through processes similar to that found in an urban heat island. This is a direct indication of regional climate change resulting from agricultural practices. Another finding was the development of a convective circulation in the area was responsible for the generation of localized precipitation to the east of the Mississippi Delta. While convection was initiated along the boundary of the land cover, prevailing westerly flow cause the cloud cover to move around to the east where it eventually rained. The result of this finding concludes that the atmosphere is acting as a source of interbasin water transport but the exact volume of moisture removed from the study region has yet to be quantified.

These findings indicate that more research ideas should include quantification of the volume of moisture that could be transported through the atmospheric due to surface-influenced convective circulation. Findings would then assist not only in the development and understanding of the sources and releases of moisture over the Mississippi Delta but water resource management as well.

Water Quality and Other Ecosystem Services Performed in Wetlands Managed for Waterfowl in Mississippi

Richard M. Kaminski and Amy S. Spencer, Department of Wildlife, Fisheries and Aquaculture, Mississippi State University

Wetlands are ecologically, environmentally, and economically valuable worldwide. Natural moist-soil emergent vegetated wetlands, abundant in the Lower Mississippi Alluvial Valley (MAV), are generally flooded during fall-winter and then dewatered naturally by evaporation or by managers during spring-summer to promote growth of annual grasses and sedges.

The life-history strategies of these plants are adapted for production of abundant seeds or tubers that are used by a wide diversity of waterfowl and other wetland wildlife. Within agricultural landscapes, such as in the MAV, strategic location of moist-soil wetlands amid farmed lands can reduce dispersal of sediments and other nutrients into surrounding watersheds and thus enhance water and environmental qualities. Additionally, seasonal decay of native vegetation in wetlands sustains nutrient cycling and is the foundation of detrital based food webs in these systems. Crayfish (*Procambarus* spp.) and other aquatic invertebrates inhabiting moist-soil wetlands are bio-indicators of quality freshwater wetlands. Crayfish can also provide additional economic gain and food for landowners.

Research in the MAV will: (1) generate baseline water quality data for describing potential watershed quality improvements provided by moist-soil management, (2) model factors contributing to the formation of a detrital-based food web of crayfish and other invertebrates within these managed wetlands, and (3) estimate population size, survival, and recruitment of crayfish populations to assess economic potential for sustainable harvest of this resource from natural wetlands for human consumption.

It is hoped that by increasing awareness of multiple ecological, environmental, and economic benefits of moist-soil management the potential to enhance water quality, wetland conservation, biodiversity, and economic values of public and private lands in Mississippi and the MAV will provide numerous advantages.

Water-Conserving Irrigation Systems for Furrow and Flood Irrigated Crops in the Mississippi Delta

Joseph Massey, Plant & Soil Sciences, Mississippi State University

Significant declines in the Mississippi River Valley Alluvial Aquifer have occurred over the past 20 years. As a result of this decline, improved crop irrigation practices are even more of an important issue. This project's goal is to improve water use efficiency for one of the most economically important crossing rotations which is practiced in the Mississippi Delta – soybean-rice rotation. Past planting history has typically been two years of soybean are followed by one year of rice. Rice and soybean together are grown on approximately 100 million acres and represented about $500 million (soybean) and $100 million (rice) in economic activity for the Mississippi Delta in 2007.

This project research will include: **economic** – using a systems approach to calculate water-saving irrigation techniques for the soybean-rice rotation; **regulatory** – assist MDEQ and YMD by providing practical, field-tested irrigation practices; **environmental** – reduction of non-point source runoff of agrichemicals into nearby surface waters while reducing carbon emissions related to energy use; and **educational** – results will be used for reports, seminars, and videos for educating producers on more water-efficient cropping systems.

A Climate-driven model to serve as a predictive tool for management of groundwater use from the Mississippi Delta Shallow Alluvial Aquifer

Charles L. Wax, Geosciences and Jonathan W. Pote, Agricultural and Bioengineering, Mississippi State University

Research to develop a model that could be used as a management tool to find ways to meet the need for water use while conserving groundwater was needed to assist water management personnel as well as stakeholders in the Mississippi Delta. In phase one, growing season precipitation was used to develop a relationship estimating irrigation use which became the driving mechanism of the model that simulated water use though the year 2056. Phase two added the use of surface water when growing season precipitation was 30% or more above normal. During the third phase, new climatological input was added to the model – irrigation demand. This was calculated using daily precipitation, evaporation, and crop coefficient to estimate daily water needs by crop type. Daily values were then summed to one week segments which were added to derive the total growing season irrigation demand. Weekly summations increased temporal resolution thereby improving the model's efficiency in accounting for excess daily rainfall.

Findings from the research were:

- The amount of water withdrawn from the aquifer each year for irrigation is directly related to climate inputs: specifically precipitation, evaporation, and resulting plant water demand.
- The aquifer volume responds positively and quickly to changes in management strategies and land use changes.
- Use of surface water in lieu of groundwater for irrigation in years when growing season precipitation is 30% or more above average can significantly reduce aquifer drawdown in the particular year resulting in a faster recovery of folume in the aquifer during the recharge period.

Data analysis concludes that climate could provide the entire water need of the plants in 70% of the years for corn, 65% of the years for soybeans and cotton, and even 5% of the years for rice. Analysis also demonstrates that extra water delivered by the climate could be a possible source of water that could be used often in place of pumped groundwater. Positive economic benefits include a savings in energy, save producers money, and enhance the sustainability of the aquifer.

Sources, sinks, and yield of organic constituents in managed headwaters of the Upper Gulf Coastal Plain of Mississippi

Jeff A. Hatten, Janet C. Dewey, and Andrew W. Ezell, Forestry, Mississippi State University

Forest management activities can potentially affect as much as 20 million acres in Mississippi, much of which is in headwater catchments. Headwater streams are important in-terms of their contribution of water and nutrients to downstream fluvial environments, however headwater-derived sediment, organic matter, and nutrients (particularly nitrogen) are constituents that most often lead to the impaired designation for rivers in Mississippi. Many studies of non-mountainous systems have focused on the quantity of particulate or dissolved forms of material (e.g. suspended solids, organic matter, and nitrogen); few have examined the source of this material. This proposal addresses the transport and source/sink behavior of sediment and dissolved and particulate forms of organic matter in the form of nitrogen (N) and organic carbon (OC), over a range of hydrographic conditions and scales. Our objective is to quantify the yield, source, and transport processes of OC and nutrients within managed, forested watersheds in Webster County, Mississippi.

Results from this research will be of value to forested-watershed managers as they weight the environmental cost vs. nutrient cycling benefit of organic inputs resulting from silvicultural activities.

Southeastern Regional Small Public Water Systems Technical Assistance Center (SE-TAC)

Mary Love Tagert, Mississippi Water Resources Research Institute; Jonathan Pote, Department of Agricultural and Biological Engineering,
Mississippi State University

The Southeastern Regional Small Public Water Systems Technical Assistance Center (SE-TAC), funded by the Environmental Protection Agency, was established in 2000 as part of EPA's Technical Assistance Center Network authorized by the Safe Drinking Water Act (SDWA) amendments of 1996 and has been administered by Mississippi State University since its inception. SETAC's mission is to build partnerships among water utility organizations, state primacy agencies, technical assistance providers, and universities throughout the Southeastern Region of the United States to protect public health by enhancing small water systems' capacity to protect and provide safe drinking water. SE-TAC works closely with state and regional organizations and agencies to assist small public water systems in acquiring and maintaining the technical, financial, and managerial capacity to provide safe drinking water and meet the SDWA's public health protection goals. SE-TAC's efforts are focused on eleven states in the Southeastern United States: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee and Texas. A multi-state, fifteen member, external Advisory Board helps SE-TAC avoid duplication of effort and focus the program's resources on issues inadequately addressed by existing programs. SE-TAC provides a forum to create partnerships that can identify gaps in existing capacity development programs. Since its establishment, SE-TAC has provided a competitive grants program to develop novel pilot projects to fill those gaps and directly assist small drinking water systems in protecting human health and complying with the SDWA's increased technical, monitoring, and reporting requirements. Competitively-funded projects currently underway include:

- Asset Management, Board Training, and Capacity Development for Small Drinking Water Systems, Florida Rural Water Association
- Developing Workforce Strategies to Meet Utility Employment Needs, Alabama Rural Water Association.

More recently, SE-TAC has also incorporated an applied approach to directly and meaningfully provide asset management and mapping assistance for small public water systems in the region, with efforts in the current funding cycle focused on Northeast Mississippi. Hundreds of small public water systems have received training and assistance with technical, financial and managerial issues through SE-TAC projects, as all projects and outputs have the goal of transferability to other small systems.

2010 Water Resources Conference

The 40th Annual Mississippi Water Resources Research Conference was held November 3-5, 2010 at Hollywood Casino in Bay St. Louis. More than 200 individuals attended the two and one half day conference, which included 20 student presenters. The conference included 12 keynote speakers and offered 11 technical tracts including Sedimentation, Weather/Climate, Coastal Resources, Surface Water Management, Wetlands, Education, Management/Planning, Delta Groundwater, Nutrients, Delta Water Resources, and Ports.

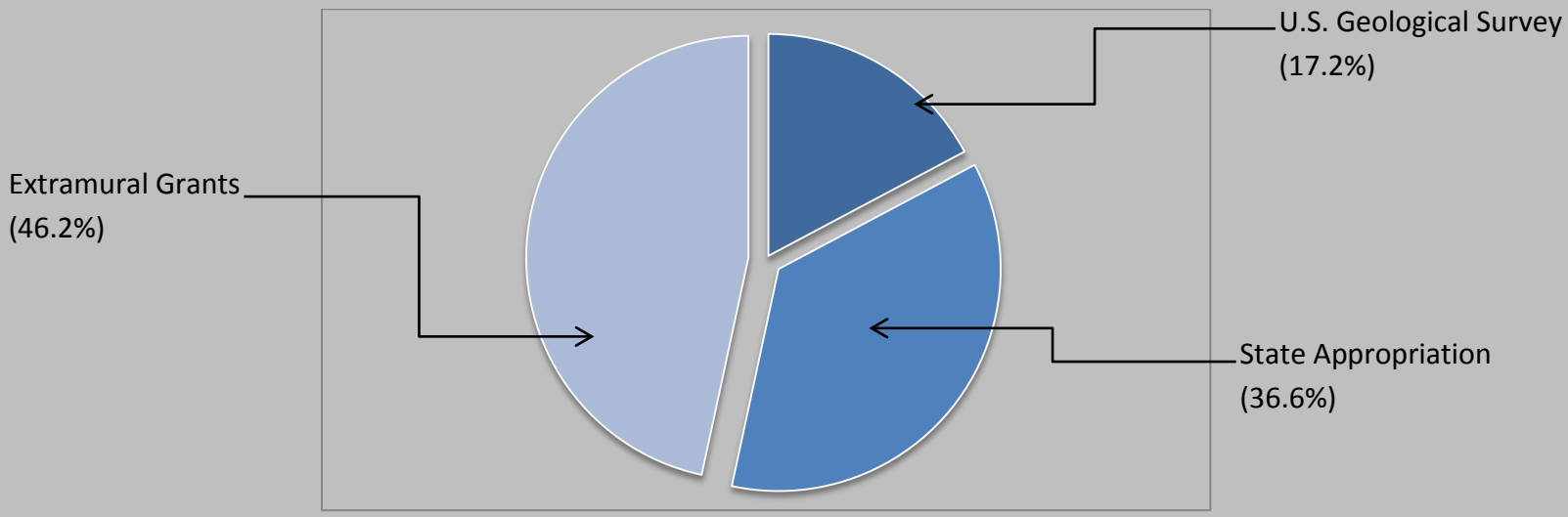
A student competition was offered for both oral and poster presentations. Eight student posters were presented with **Garry Brown, Jr.,** a graduate student at University of Mississippi, garnering the top prize. The presentation was on *Concentration of Methylmercury in Natural Waters from Mississippi Using a New Automated Analysis System*. Thirteen students made oral presentations during the conference. **Mary Catherine Mills**, a graduate student at Mississippi State University received third place for her presentation on *Evaluating Physiological and Growth Responses of Arundinaria spp. To Inundation.* **C. Elizabeth Stokes**, a PhD candidate from Mississippi State University garnered second place for her presentation on *Identification of Pentachlorophenol (PCP) Tolerant Bacterial Communities in Contaminated Groundwater after Air-Sparging Remediation.*

The first place winner was **Amy Spencer**, a Mississippi State University PhD candidate, whose presentation was on *Ecosystem Services from Moist-Soil Wetland Management*. All of the students did an exemplary job and it was difficult to choose three winners from the group of presentations. Special thanks go to Mississippi Water Resources Research Institute, Mississippi Water Resources Association, and Weyerhaeuser Company for sponsoring the student competition awards.

The conference was planned by Mississippi Department of Environmental Quality, Mississippi Water Resources Association, Mississippi Water Resources Research Institute, and U.S. Geological Survey. Sponsors included Florence and Hutcheson, Neel Schaeffer, Rosedale-Bolivar Port, Waggoner Engineering and Yazoo-Mississippi Delta Levee Board. Exhibitors present at the conference included Mississippi Department of Environmental Quality, Natchez Convention Center, Northern Gulf Institute, Pickering Firm, Inc., Pierce Pacific, Taylor Machine Works, U.S. Army Corps of Engineers, and U.S. Geological Survey.

Financial Summary

Program Component	Federal	Non-Federal	Total
U.S. Geological Survey Grant	$92,335		$92,335
State Appropriations		$193,868	$193,868
Extramural grants and contracts		$250,000	$250,000
TOTAL	$92,335	$443,868	$536,203



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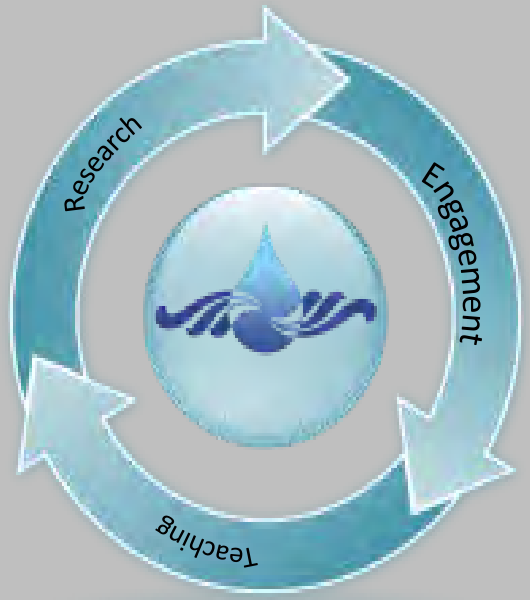

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