2018

Mississippi Water Resources Conference

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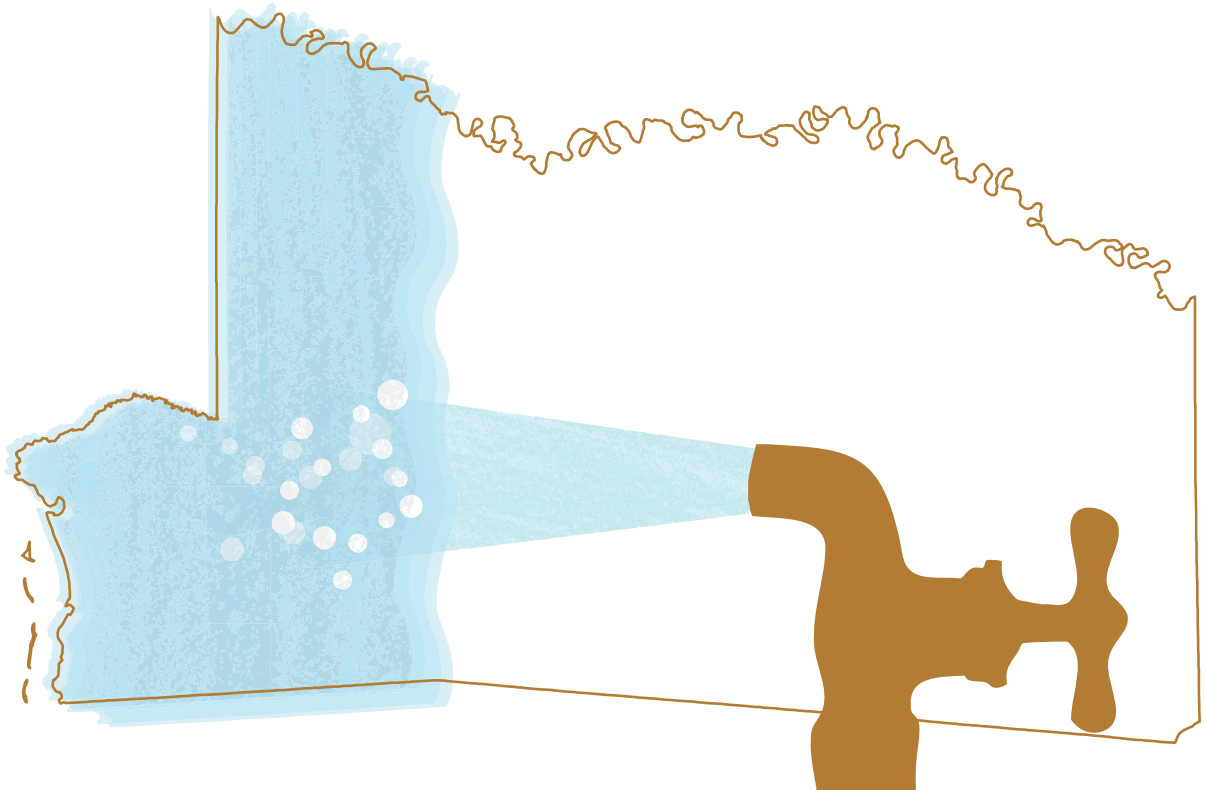

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Mississippi Water Resources Conference

Hilton Jackson Jackson, MS

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Poster Session

A Preliminary Investigation of Feral Hog Impacts on Water Quality

Chaney, B.; Brooks, J.; Aldridge, C.; Omer, A.; Street, G.; Baker, B.

Feral hogs (*Sus scrofa*) are world renowned for having disruptive behaviors that can negatively affect the environment around them. This study was conducted at Mississippi State University South Farm Research Facility. The objective of this preliminary investigation was to identify how water quality and nutrient distribution was affected by the presence of feral hogs. The experiment involved analyzing the nutrients along with the microbial organisms that were present before and after storm event runoff within in-ground sampling units that were located above and below the hog enclosure. Throughout sampling periods at field locations, samples were separated into two individual sampling containers; one set of samples were sent to the USDA lab for microbial testing and the remaining samples were filtered and preserved in the water quality lab at Mississippi State University for nutrient analysis testing. According to the sample analysis, nutrient concentrations and bacterial abundances fluctuated throughout the sampling period. However, nutrient concentrations and bacterial abundances seemed equally or less variable after January 2017 in the upstream and downstream locations. Despite limited sample size availability and detection effectiveness, findings such as these will help guide researchers in discussions pertaining to water quality viability and will allow for future analysis in similar studies involving the presence of feral hogs and their correlation to water quality.

Effects of Prescribed Burning on Canopy Structure and Water Partitioning in an Upland Oak Forest

Drotar, N.; Siegert, C.; Alexander, H.; Varner, J.

The distribution of rainwater by the forest canopy into stemflow (SF), throughfall (TF), and interception (IN) is determined by tree species characteristics, (canopy storage capacity, bark roughness, bark water storage, and bark thickness) as well as canopy position (midstory vs. overstory). In upland oak ecosystems, it is largely unknown how canopy water partitioning varies between co-occurring species, which has broad implications for water availability and forest flammability. Specifically these forests are undergoing a compositional shift from shade-intolerant, fire-tolerant oaks to shade-tolerant, fire-intolerant species (i.e., mesophytes) likely due to anthropogenic fire exclusion. To assess interspecific differences, we measured canopy and bark characteristics on 128 individuals of five different species of overstory and midstory trees (white oak, red oak, mockernut hickory, red maple, and winged elm). We compared these species with rates of stemflow, throughfall, and interception partitioning at monthly time scales.

Preliminary results show that overstory upland oaks partitioned 5.1% of rainfall into stemflow while mesophytic overstory species partitioned 7.2% into stemflow. In the midstory, mesophytes partitioned 1.5% to stemflow, while oak species only partitioned 0.9% to stemflow. These differences are likely manifested in soil moisture surrounding these trees. Results of this study will inform how trees move and store water and provide insights into the effectiveness of prescribed burning to restore and manage upland oak ecosystems.

Ecological Agriculture Application with Winter Flooding

Firth, A.; Baker, B.; Brooks, J.

Rice is the staple food for more than half of the world's population and has the ability to support more people per unit of land area than wheat or corn, as rice produces more food energy and protein per hectare than other grain crops. However, with the human population projected to reach 8.5 billion by 2030, there are major concerns about the sustainability of rice production practices because of its major contribution to water pollution and soil degradation. Thus, there is a need to identify sustainable production practices that minimize environmental damage, while also remain economically feasible. This study investigated a potentially sustainable rice production system in the Mississippi Alluvial Valley (MAV) that uses ecological principles to enhance environmental quality and economic gain at the field scale. It was hypothesized that the annual flooding of rice fields to create water bird habitat would benefit soil health, and in turn water runoff, providing agronomic benefits to the farmer. Two sites were selected that applied different management regimes during the winter: conventional fallow fields and winter flooding. Soil microbial diversity and nutrient content were quantified and compared for a measure of overall soil health. Results of the project will provide valuable data that identifies the relationships between biodiversity, soil health and water quality. Proof of concept at the field scale will provide a framework for other producers within the MAV to adopt similar management methods, ultimately improving the overall integrity of soil, water, and environmental quality as well as the farmer lifestyle.

Impact of Different Ratios of Surface Water and Groundwater for Row Crops Irrigation on Groundwater Level in Mississippi Delta

Gao, F.; Feng, G.; Dash, P.; Ouyang, Y.

Groundwater resources in Mississippi Delta have been overexploited for agricultural irrigation for a number of years. Over 700,000 hectares of row crops in this region was irrigated by using groundwater. As a result, groundwater level has declined > 6.5 m (20 ft) since 1970, which threaten the sustainability of irrigated agriculture in this region especially in Big Sunflower River Watershed. Surface water resources can be used as an alternative source for irrigation. Limited information was reported regarding groundwater level as affected by different ratios of surface water and groundwater for irrigation in this region. The objectives of this study were to employ a coupled SWAT-MODFLOW model and simulate the change in groundwater level and storage as affected by a) no irrigation scheme; b) conventional irrigation scheme; c) water-saving irrigation scheduling by using different percentages of surface and ground water. An analysis from 2000 to 2016 showed practically achievable reductions in weekly pumping (<22%) and replacement by surface water for irrigation would stabilize the groundwater levels in the Mississippi Delta. This study suggested that the conjunctive use of surface water in addition to groundwater can be a sustainable way for future to continuously grow major row crops soybean, corn, cotton and rice in the Mississippi Delta.

A Spatial Decision Support System for Choice and Placement of Nitrogen Source Reducing Best Management Practices in the Beasley Lake Watershed, Delta Region of Mississippi

Sinshaw, T.; Surbeck, C.; Shields, D.; Hossain, A.

Nutrient reduction efforts are planned based on spatially complex watershed information. These efforts encompass a series of activities, such as identifying sources, quantifying source yields, estimating exported load, and establishing source reducing best management practices (BMPs). The choice and placement of BMPs requires a decision on three conflicting objectives: performance, site suitability, and establishment cost.

The present study applied a spatial decision support system for the Beasley Lake Watershed to optimize a nitrogen (N) source reduction plan. The watershed information required to assess N pollution was stored as a database pool and served as an updatable data view. The nutrient movement on the landscape was tracked from sources to the receiving Beasley Lake using a distance-decay method. The critical N source locations and suitable sites for establishing buffer strips and wetlands were identified. This information served as a decision guide for choice and placement of BMPs within the watershed. Three BMP scenarios were identified through an iterative BMP placement process. With these BMP scenarios, it was possible to reduce up to 25% of the N load. The best BMP scenario was found at a cost to performance ratio of 168 $/kg. The approach presented in this study can be an alternative N assessment method when the availability of data and resources limit the use of existing watershed models for water quality assessment.

Controlling Mechanism of Chlorination on Emitter Bio-clogging for Drip Irrigation Using Reclaimed Water

Song, P.; Li, Y.; Feng, G.

Emitter clogging has been one of the bottlenecks restricting the drip irrigation application and promotion. Drip irrigation using reclaimed water or polluted surface water may causes the greater risk of bio-clogging, which is the most typical and complex clogging type. With the strong oxidizing effect, chlorination has been considered as the most effective method of controlling emitter bio-clogging. However, its mechanism is still unclear. Meanwhile, there were no unified standards established for chlorination to refer to. Field experiment using reclaimed water treated with Cyclic Activated Sludge System (CASS) process was carried out in the sewage treatment plant, in order to study the controlling mechanism and impacts on emitter bio-clogging with three types of chlorination modes. The results showed that the chemical chlorination could effectively regulate the microbial growth in the emitter clogging substances, with the microbial Phospholipid Fatty Acid (PLFAs) decreased by 8-36%, and the microbial types reduced by 2-3, and the microbial activity decreased by 3-23%, and the secretion of sticky Extracellular polymeric substances (EPS) decreased by 20-43%. The bio-clogging substances were well controlled, and the contents of solid particles (SD) decreased by 5-48%, while the discharge ratio variation (Dra) and Christiansen uniformity coefficient (CU) were improved by 15-23% and 7-20% respectively. However, the effects of different chlorination modes varied significantly, the chemical chlorination with low concentration and long contacting duration (2.5mg/L+2h) was recommended to control bio-clogging in the drip irrigation system using reclaimed water treated with CASS process.

Long-Term Effect of Cover Crop on Water Use Efficiency in Manured and Rainfed Soybean-Corn Rotations

Yang, W.; Feng, G.; Adeli, A.; Jenkins, J.

Planting winter wheat cover crops in corn and soybean rotations is an effective to improve the effective utilization of soil moisture and enhance water use efficiency. However, the longer-term impact of this practice needs to be further investigated. The hybrid RZWQM-DSSAT model calibrated with 5 yr (2013-2017) field data was used to simulate the effects of this practice on crop evapotranspiration, yield, and water use efficiency under a rainfed condition in no-till corn-soybean cropping system at Mississippi Agricultural and Forestry Experiment Station in Pontotoc Mississippi. The poultry litter (13.4 Mg ha^{-1}) was applied to corn field with cover crop (CC) and no cover crop (NCC) in May 2014 and 2016. The model was calibrated well in terms of crop yield and biomass, plant N uptake, and soil moisture with percent error (PE) was within ±15%, Nash-Sutcliffe model efficiency (EF) > 0.7, and relative root mean square error (RRSME) < 15%. Longer-term simulations showed that planting a winter wheat cover crop increased corn yield by on average 1,560 kg ha^{-1} (12%) and did not change soybean yield. The simulation also indicated that the practice increased annual evapotranspiration by 3.5 cm (9%) in corn years but did not affect evapotranspiration in soybean years. Simulated grain water use efficiency was increased by 17% for corn, and it was not changed in soybean. This study demonstrated that introducing winter wheat cover crops in a corn-soybean cropping system is a promising approach to increase corn water use efficiency in the subtropical agro-ecosystem.

Aquatic Vegetation Management to Enhance Multiple-User Benefits of Southeastern Wetlands

Ervin, G.; Turnage, G.

Resource managers of public lands, such as national wildlife refuges, are tasked with meeting multiple use needs of the fish and wildlife that reside on these lands, as well as the people who utilize those lands for recreational activities such as fishing, boating, and wildlife watching. Biologists at the Sam D. Hamilton Noxubee National Wildlife Refuge (NNWR) have identified the dominance of certain problematic aquatic plants as a key obstacle to achieving these multiple use needs in lakes and associated wetlands on this and other southeastern wildlife refuges. Few methods are currently known that allow the control of some of the problematic aquatic plant species that they encounter, while simultaneously enhancing the diversity of desirable species, maintaining water quality, and providing diverse aquatic habitats that are needed for many species of wildlife and for human users of these facilities.

The work we have initiated is aimed at determining optimally effective methods of managing invasive and problematic aquatic plants to enhance wetland plant diversity in a way that improves the quality of wetlands as wildlife habitat and sources of recreational use, while also minimizing potential negative impacts on water quality and desirable native plant species. This research will explore a variety of chemical control measures (herbicides) to reduce the abundance of key nuisance plant species, while maintaining diversity of desirable species and also minimizing any negative impacts on key water quality parameters (e.g., dissolved oxygen, nitrogen, and phosphorus).

Informing Environmental Health through Community-Engaged Research: Testing for Lead in Drinking Water in the Mississippi Delta

Green, J.; Fratesi, M.; Woo, L.; Willett, K.; Thornton, C.; Avula, B.; Khan, I.; Otts, S.; Janasie, C.

A variety of frameworks—including community based, participatory, action-oriented, and citizen science research—are being increasingly recognized as helping to engage community members with understanding and improving environmental health. Potential exposure to lead through drinking water is one among many important issues warranting this type of work. This poster will provide an introduction to community engaged research and then describe an interdisciplinary program connecting the University of Mississippi (UM) with community organizations in the Delta region of the state to test for lead. Working through an interdisciplinary collaborative consisting of the UM National Sea Grant Law Center, School of Pharmacy Division of Environmental Toxicology, and Center for Population Studies, researchers have partnered with nonprofit organization, community health centers, and Mississippi State University Extension to conduct outreach, education, and research with residents from across a nine-county region. This includes participants completing household surveys and submitting drinking water samples. Beyond providing results and recommendations back to individual households and populating a novel dataset, the data are being integrated with publicly available demographic, socioeconomic, and housing data to help inform recommended strategies for additional targeted water testing. Illustrative findings will be shared through the poster, emphasizing the associations between individual and aggregate housing characteristics, thereby demonstrating the importance of community engaged approaches to environmental health research.

A Confluence of Water and Interdisciplinary Education: The Mississippi Water Security Institute

Ochs, C.

Social-ecological systems (SES) are comprised of humans, human cultures and perspectives, human institutions, and multitudes of diverse non-human residents. Clean water is the solvent of social-ecological systems, a resource upon which the components of these complex systems are linked and dependent for their economic prosperity, heath, and sustainability. To meet and protect the resource requirements of SES, governance and management approaches are necessary that account for and promote the interests and needs of diverse stakeholders. The Mississippi Water Security Institute is an undergraduate program designed to provide interdisciplinary education in the methods and challenges of water use and management in Mississippi, and the opportunities for new approaches to best meet present and future needs in support of the state's economic development. Emphasizing the complex, interdisciplinary nature of the topic, students in MS WSI represent a university of majors, from business and the social science to the natural sciences, and are recruited from Honors College programs across the state. In its first year (2016), MS WSI focused on water use and management in the rural Mississippi Delta, and last year we examined these issues with respect to the well-being of urban communities such as Jackson. This coming year, we turn our attention to water resource issues affecting well-being, prosperity, and resilience along coastal Mississippi. The MS WSI program involves in-class presentations by expert guests, discussion, and extensive time in the field. In both years of the program, students composed a White Paper detailing their individual and group learning experiences. Student assessment indicates strong satisfaction with the MS WSI interdisciplinary approach, experiential design, and the practical application of the subject matter, with several students stating that the program had reinforced interests in some aspect of water security as a career.

Evapotranspiration Measurement Using Eddy Covariance Systems for Irrigation Scheduling

Sui, R.; Anapalli, S.; Baggard, J.; Murrell, C.

Irrigation plays a critical role in crop production. Irrigated crops produced more and stable yields than dryland crops. In the Mississippi Delta, acreage of irrigated land has increased rapidly in recent years. Uncertainty in the amount and timing of precipitation has become one of the most serious risks to crop production in this region. Crop producers have become increasingly reliant on irrigation to ensure adequate yields. Excessive withdrawal of the groundwater resulted in water level decline in the Mississippi River Valley Alluvial Aquifer. Ongoing depletion and stagnant recharging of the aquifer jeopardize the long-term availability of the aquifer and place irrigated agriculture in the region on an unsustainable path. Novel irrigation techniques and tools are needed for improving water use efficiency to maintain Mississippi water resource sustainability. Eddy covariance (EC) method is capable of measuring exchanges of water vapor between the surface of the earth and the atmosphere, and have been used for monitoring agroecosystems and measuring crop evapotranspiration (ET) for irrigation scheduling. Objectives of this project were to use EC systems to monitor the agroecosystem and measure evapotranspiration in Mississippi Delta for water management research and agroecosystem assessment. Five EC systems were set up in the Mississippi Delta for ET measurement and agroecosystem monitoring. Three of them are located in Stoneville, MS and two others in Arcola, MS. The EC system consisted of a CH_4 analyzer for measuring methane gas flux, CO_2/H_2O analyzer for measuring carbon dioxide and water vapor fluxes, three-dimensional sonic anemometer for determining wind speed in three dimensions, and biomet (biological & meteorological) sensors to collect ancillary data for filling measurement gaps and interpreting flux results. Installation and preliminary field tests of the EC systems have been completed in 2016. These systems are being used to collect data in 2017 season. This presentation will report the ET measurement results with corn, soybean, and cotton in different locations in Mississippi Delta.

NCCHE Modeling System for Water Resource Problems

Zhang, Y.; Jia, Y.; Chao, X.

This presentation gives a brief introduction of CCHE2D/3D model system and its capabilities. CCHE2D/3D is a state-of-the-art numerical modeling system developed at the National Center for Computational Hydro-science and Engineering (NCCHE) at the University of Mississippi. The model targets simulating water resource and environment related problems. It is capable of simulating free surface river flows, flooding/dam-break flows, sediment transport, morphological changes, chemical pollutant transport, environmental water quality, hurricane and coastal storm surge and wave processes. The model has been applied to simulate the city flooding of New Orleans, LA, caused by Hurricane Katrina the 2008 flood in the Mississippi River; sediment transport and water quality in the Lake Pontchartrain; pollutant transport and water quality in the Dan River, NC, caused by coal ash spill; flooding due to the storm surge of Hurricane Isaac 2012, Gustav 2008, Sandy 2012, etc. Since its initial development in the 1990s, it has been continuously developed and updated at the NCCHE and used by thousands of users in the US and worldwide. Many federal and state agencies have been CCHE2D users including USACE, USDA-ARS, NOAA, USGS, US Fish &Wildlife Service, USEPA, CA Dept. Water Res., Oak Ridge National Lab, North Alamo National Lab, US Navy Naval Oceanographic Office, US Marine Corps, Desert Res. Ins., National Disaster Preparedness Training Center, etc.

What Are the Precursors to Watershed Civic Engagement: Can Grass Roots Environmental Organizations Be Grown?

Ziogas, I.; Cossman, R.; Ingram, R.

If one is to create and partner with a grass roots organization where there is none, what are the precursors to civic engagement? This project identifies the necessary and sufficient conditions of civic engagement, particularly as it relates to environmental stewardship. Specifically, we are revealing the parameters surrounding the organic emergence of grassroots environmental groups. We are also interested in their financial viability and organizational longevity given conditions of minimal exogenous intervention and/or support by formal instruments of environmental governance. The set of hypotheses we introduce hinges on the appearance of an immediate perceived threat, coupled with the presence of high individual capacity for action in the context of a well-connected, quasi-informed, community. Our model incorporates insights from the wider civic engagement literature and is tested against new primary data. Our initial findings strongly support our claims. As we demonstrate, the likelihood of civilian involvement in regards to environmental action is contingent on the magnitude of the perceived source of degradation, the size of affected communities, and the socioeconomic capacity of those communities to engage the problem. However, it should be noted that even under those specified conditions, organizational success is not guaranteed and is not always correlated with organizational longevity; contradicting expectations, we find that when an environmental group rapidly manages to achieve its immediate goals, it tends to fade and decay, perhaps due to the lack of incentives for its continuing presence.

Coastal Issues

Alan Shiller *(University of Southern Mississippi)*	Hypoxia in the Mississippi Bight: Understanding Interactions of Circulation and Biogeochemistry in a Complex River-Dominated Coastal Ecosystem
George Ramseur *(MS DMR)*	The Louisiana, Mississippi, Alabama Coastal System (LMACS): Embracing Functional Boundaries to Drive Comprehensive Estuarine Restoration
Mohammadmmedhi Armandei *(Mississippi State University)*	The Development of a Hydrodynamic/Water Quality Model for Oyster Restoration in the Western Mississippi Sound
Catie Dillon *(Mississippi State University)*	Examining the Effects of Directional Wave Spectra on a Nearshore Wave Model

Hypoxia in the Mississippi Bight: Understanding Interactions of Circulation and Biogeochemistry in a Complex River-Dominated Coastal Ecosystem

Shiller, A.; Sanial, V.; Moore, W.

Coastal areas are key regions between the continent and the open ocean where land-derived chemical elements transported by rivers and groundwater mix with seawater. Coastal areas are very productive regions that are particularly vulnerable to human activities. The coastal waters to the east of the Mississippi River Delta, including the Mississippi Sound and Bight, are relatively understudied compared with the Louisiana Shelf to the west. Nonetheless, the Mississippi Sound and Bight contain productive fisheries, are subject to environmental issues such as oil spills, and experience seasonal hypoxia. The CONCORDE Consortium and other projects have recently been investigating this complex, river-dominated ecosystem. Because the Mississippi Sound and Bight receive fluvial inputs from various states and is comprised of both state and federal waters, potential management efforts are also complicated. In this presentation, we explore the interactions of different source waters with an emphasis on bottom water hypoxia in this system. With oxygen isotopes, we find that outflow from the Mississippi River is typically not the dominant freshwater source to the Mississippi Sound/Bight region. Furthermore, with naturally occurring radium isotopes, we observe a significant influence of submarine groundwater discharge (SGD) in bottom waters that is also correlated with hypoxic conditions. This relationship suggests that “bottom-up” influence of reduced substances on oxygen consumption can be an important contributor to hypoxia.

The Louisiana, Mississippi, Alabama Coastal System (Lmacs); Embracing Functional Boundaries to Drive Comprehensive Estuarine Restoration

Ramseur Jr., G.; Ferraro, C.; Pahl, J.

The LMACS is a restoration planning area that is based upon functional boundaries of the coastal estuary that spans from Lake Borgne to Mobile Bay and extends seaward to the Biloxi Marsh in LA and the barrier islands in MS and AL. The idea of using this area as a basis for multi-state restoration coordination recently grew out of long standing partnerships between the principal agencies (listed above) that developed in the Gulf of Mexico Alliance (GOMA). Many other agencies, nongovernmental organizations and institutions of higher learning are already engaged in work that may be synergistic with this concept. For example, efforts are ongoing to improve cross-border sharing of hypoxia and other water quality data. The networks and protocols that develop through these interactions will make it much easier to identify additional data needed to support a comprehensive assessment of the LMACS.

The primary goal of this partnership is to conduct comprehensive hydro- geophysical, biochemical and economic modeling of the LMACS which will be used to develop a restoration “master plan” for the estuary. This plan, the Restoration Framework for Sustainable Fisheries (RFSF), will assess geomorphic and other restoration approaches to support the long-term recovery and stability of traditional oyster, shrimp and fin fisheries. Aspects of the built environment and the human communities that depend directly on these resources will also be addressed. The intention is for the RFSF to guide restoration project development, prioritization, and implementation over a 50-year horizon to improve synergies with ongoing efforts such as the Louisiana Coastal Master Plan.

The geomorphic history and anticipated trajectory of the LMACS estuarine barrier is of significant interest for our team. Ongoing erosion and fragmentation of the Biloxi Marsh and barrier islands are causing the system to become increasingly marine. This geomorphic instability will likely drive a unique set of restoration priorities compared to similar class estuaries such as the Chesapeake Bay.

The Development of a Hydrodynamic/Water Quality Model for Oyster Restoration in the Western Mississippi Sound

Armandei, M.; Linhoss, A.

This study presents the development of a hydrodynamic and water quality model for the western Mississippi sound. The model was developed using the Visual EFDC program, which is an “advanced, 3D, time variable model” that links hydrodynamics with sediment transport and water quality modules. A computational grid has been generated consisting of 4 layers, each having 3000 cells. The cell size range is 1000m < DiameterCell < 3000m. The input data for the hydrodynamic model are water level, water temperature, salinity, and other meteorological data such as precipitation, and were mostly collected from the measurement stations of NOAA (National Oceanic and Atmospheric Administration) and USGS (United States Geological Survey). The hydrodynamic model was calibrated for the time period of Jan 1 to Dec 31, 2016. A sensitivity analysis is being performed in the light of which the parameters that most impact oysters in the western Mississippi sound will be identified. The model will be useful in identifying appropriate locations for oyster restoration in the western Mississippi Sound.

Examining the Effects of Directional Wave Spectra on a Nearshore Wave Model

Dillon, C.; Linhoss, A.; Jensen, R.; Smith, J.; Skarke, A.

Wave models are an integral part of coastal engineering due to their ability to quantitate information that is either unobtainable or unavailable. However, these models rely heavily on their inputs for accuracy. One critical input for nearshore models is the directional wave spectrum. The directional wave spectrum is the product of a frequency spectrum and a directional spreading function. There are many ways to compute the directional wave spectra depending on how either the frequency spectra or the spreading function is computed.

In this study, five methods for computing the directional wave spectrum were investigated. Using an offshore buoy, a Fast Fourier Transformation (FFT) of the time series of the buoy's heave generated a frequency spectra. Directional coefficients generated by the FFT were used to calculate three directional spreading functions: the maximum entropy method, the maximum likelihood method, and the Longuet-Higgins method. Using only the observed mean wave direction, the significant wave height, and the peak period from the offshore buoy, a frequency spectra was generated using the JONSWAP method, which applies a parametric shape based on the observed parameters. Since no FFT coefficients were created a cosine squared and a cosine 2s spreading function were used with the JONSWAP frequency spectra.

This study investigated how these five directional wave spectra perform within the nearshore spectral wave model, STWAVE. To accomplish this task, STWAVE was run five times in a half plane mode, meaning only wave propagation towards shore is retained. Each experimental run contained a different directional wave spectral computation, a bathymetry grid of 100 by 100 m resolution, a constant JONSWAP bottom friction value of 0.004, and spatially constant winds taken from the offshore buoy. No currents or changes in water level were included.

The results of the five experimental runs show that direction was the most affected parameter by the directional wave spectra input. Many differences observed between the five directional wave spectra occurred due to the differing placement of energy in the higher frequencies between the two frequency spectra methods, thus affecting where wave-bottom interaction begins. Another conclusion of this study, is that for the study's environment, which was shallow and low energy, the wave-bottom interactions dictate the spectra in the nearshore. Thus, no matter the complexity of the directional wave spectra used as the model input, the wave-bottom interactions will tend to converge all spectra according to the limits of the bathymetry.

Measurements and Mechanisms for Earthen Levee and Gully Erosion

Measurements and Mechanisms for Earthen Levee and Gully Erosion

Daniel Wren *(USDA/ARS)*	Field Measurements of Irrigation Reservoir Levee Erosion
Yavuz Ozeren *(University of Mississippi)*	Assessment of Slope and Mechanical Treatments for an Irrigation Reservoir Embankment
Will Andrews *(University of Mississippi)*	Measurements of Physical Characteristics of Earthen Levees for Small Lakes in Mississippi
Robert Wells *(USDA/ARS)*	Remotely Sensed Channel Emergence with Both Till and No-Till Management Systems

Field Measurements of Irrigation Reservoir Levee Erosion

Wren, D.; Ozeren, Y.; Reba, M.; Bowie, C.

The use of surface water resources for irrigation has increased due to groundwater depletion. In order to reduce dependence on groundwater, irrigation reservoirs and tailwater recovery systems can be used to capture and store water for irrigation. Irrigation reservoir levees are typically constructed from local soils with low cohesion, resulting in levees that are susceptible to erosion by wind-driven waves, necessitating frequent repairs that are an added expense for producers. Motivated by the amount of erosion observed on the levees, a survey was conducted in 2013-2015 to assess the current condition of the levees and attempt to identify common factors for highly eroded sections. It was found that 79% of the 584 homogeneous levee segments contained within 148 surveyed reservoirs had block failures and near-vertical slopes. Despite regional winds with preferential southerly and northerly directions, levees of all orientations were damaged by waves. For the surveyed irrigation reservoir levees, soil type, vegetation, inner slope, and berm presence were found to be poor predictors of the state of impairment. The most important variable associated with levee failure was maximum effective fetch length; levee segments with longer fetches were more likely to have block failures and greater losses of top-width.

Assessment of Slope and Mechanical Treatments for an Irrigation Reservoir Embankment

Ozeren, Y.; Wren, D.

On-farm irrigation reservoirs are commonly used in the Mississippi River Valley alluvial floodplain to complement limited groundwater resources. The inner slopes of the earthen embankments of these reservoirs are subjected to continuous erosion due to wind-generated waves. Various methods were applied in the past to protect the levees but none of these methods were sustainable and cost effective. In order to compare their effectiveness against wave erosion, several treatment techniques were applied on the levees of an irrigation storage reservoir at the University of Arkansas Pine Bluff (UAPB) Lonoke Demonstration Reservoir in 2007. The treatment techniques included 17 different slope configurations along the east and west embankments, as well as 5 different mechanical treatments along the north and south embankments. In 2015 and 2017, USDA-ARS and The University of Mississippi carried out two comprehensive surveys along the embankments of the UAPB reservoir. The surveyed cross-sections were compared with the as-built cross-sections to quantify the loss of soil so that the effectiveness of the treatment methods could be evaluated. Almost all of the slope configurations significantly eroded over the past 10-years. In general, milder slopes performed better than the steeper slopes. Although having a berm did not reduce the total eroded volume significantly, in most cases it delayed the bank top retreat. For sections with identical slope configurations, the section with the longest maximum fetch, regardless of bearing, typically had the highest erosion and bank top retreat. The survey results showed that mechanical treatment methods were more resilient against wave action as compared to the slope treatment methods.

Measurements of Physical Characteristics of Earthen Levees for Small Lakes in Mississippi

Andrews, W.; Ozeren, Y.; Wren, D.

The state of Mississippi has many aging earthen levees, but the current status of the levee system is unknown. Many of the levees in Mississippi have exceeded their 50-year design life, and the possibility of a critical failure on one of the levees is increasing with time. The overall goal of this project is to create a computer model to simulate a critical failure of a levee and analyze how it would affect the surrounding area and the surrounding population. However, a computer model cannot be created without knowing the mechanical properties of each levee. Through a grant from MDEQ, the National Center of Computational Hydrological Engineering (NCCHE) was tasked with finding these mechanical properties by performing in-situ tests and to collect soil samples from fifteen levees throughout the state of Mississippi. The soil samples were taken at three different locations near the middle of each levee. At each location, one 6-in diameter sample was collected for jet erosion testing, and two 2-in diameter samples were collected for bulk density measurements and soil texture analysis. It was found that the range of the critical shear stress varied from 10 Pa to 130 Pa. The older dams had a higher critical stress due to longer amount of time for the soil to consolidate. The 2-in samples showed the soil texture of each levee. For example, the levee at Lake Druid in Meridian, MS, was composed of 30% clay, 41% silt, and 29% sand. With this information on the mechanical properties of each levee, more accurate simulations of levee breaches can be made, leading to better understanding of the aging levee system in the state of Mississippi.

Remotely Sensed Channel Emergence with Both Till and No-Till Management Systems

Wells, R.; Momm, H.; Vieira, D.; Bingner, R.

Ephemeral channels appear in agricultural fields under a host of conditions. The spatial emergence is primarily driven by topography, tending to increase or decrease the erosive forces of runoff, whereas the temporal component, represented by geomorphologic response over time, is much less understood. In this study, agricultural fields in Iowa were selected based upon potential for channel formation and management practices. Aerial topographic surveys were collected following planting in till and no-till managements, where localized climate measurements were obtained, then another aerial topographic survey was collected a month later. A novel surveying approach was designed by combining unmanned aerial vehicles (UAVs) with digital photogrammetry, differential global coordinate system (DGPS), and integration of on- and off-field ground control points. Each survey was anchored to a global coordinate system (GPS) via targets surveyed using GPS equipment and established static field monuments, ensuring that coordinate system solutions from the two aerial surveys of the same site were horizontally and vertically aligned. Custom algorithms were employed to process generated point clouds and produce geospatial datasets at centimeter spatial resolution. Difference mapping of the temporal topographic surveys combined with the climate measurements from each location provides guidance for temporal erosion components (i.e. the erodibility parameters) within erosion models such as RUSLE2. Conservation planning can be improved through time series of high resolution topography surveys that provides enhanced information on where problems are within agricultural fields and data to erosion management technology needed to evaluate conservation practices targeted to the existing problems.

Streamflow Alteration Assessments to Support Bay and Estuary Restoration in Gulf States

Streamflow Alteration Assessments to Support Bay and Estuary Restoration in Gulf States

Rodney Knight *(USGS)*	Streamflow Alteration Assessments to Support Bay and Estuary Restoration in Gulf States - Overview
Scott Mize *(USGS)*	Factors Controlling Salinity in Nearshore Waters of the Mississippi Sound, MS
Scott Worland *(Vanderbilt University)*	Predicting Daily Streamflow Using L-Moments and Neural Networks
Elena Crowley-Ornelas *(Texas Tech)*	Estimating Streamflow-Recession Indices Using Automated Methods with Application to Groundwater-Surface Water Interaction
Matt Moore *(USDA/ARS)*	Nutrient and Pesticide Mitigation by Common Aquatic Plants

Streamflow Alteration Assessments to Support Bay and Estuary Restoration in Gulf States—Overview

Knight, R.

Human alteration of waterways has affected the minimum and maximum streamflow in more than 86 percent of monitored streams nationally and may be the primary cause for ecological impairment in river and stream ecosystems. Restoration of freshwater inflows can positively affect shellfish, fisheries, habitat, and water quality in streams, rivers, and estuaries. Increasingly, state and local decision-makers and Federal agencies are turning attention to the restoration of freshwater flow as part of a holistic approach to restoring water quality and habitat in rivers and streams and to protecting and replenishing living coastal and marine resources and the livelihoods that depend on them.

In 2017, the U.S. Geological Survey, in collaboration with the U.S. Environmental Protection Agency, began a comprehensive, large-scale, state-of-the-science project to provide vital information on the timing and delivery of freshwater to streams, bays, estuaries, and wetlands of the Gulf Coast. Ecologically relevant streamflow metrics and measures of streamflow alteration will be developed for streams throughout the five Gulf States and made available via an online mapping tool. An assessment of trends in streamflow delivery to Gulf Coast estuaries will improve the understanding of potential drivers of change in estuarine health. A streamflow accounting model will be developed for one large watershed in the five Gulf States to evaluate and understand how streamflow alteration at locations in the upper basins may influence the magnitude, timing, duration, and frequency of freshwater flows to the Gulf. This model will provide local, state, and Federal officials the ability to evaluate how streamflow withdrawals and reservoir operations throughout the watershed may have altered streamflow metrics and affected freshwater inputs to the estuary.

Key questions this study will help address include:

Gulf-Wide Assessment

- Which streams in the Gulf States have the largest amounts of streamflow alteration?
- What are the gaps in streamflow data for assessing streamflow alteration in Gulf States?
- Are shifts in magnitude, timing, duration, and frequency of freshwater delivery to estuaries due to altered streamflow distinguishable from natural signals?

Large Watershed Assessment

- How far downstream from alteration points do substantial shifts in streamflow metrics occur?
- How sensitive are estuary freshwater inputs to upstream streamflow alterations?
- Is there a threshold of freshwater alteration below which no signal is detected in an estuary?

Factors Controlling Salinity in Nearshore Waters of the Mississippi Sound, MS

Swarzenski, C.; Mize, S.

Magnitude and variability of salinity of shallow waters shape estuarine living resources and habitat. The salinity gradient is widely recognized as foundational in maintaining biological diversity and productivity of estuaries. Thus, a clear understanding of the factors controlling salinity and variability of salinity in estuarine surface waters is essential for proper stewardship and for sustaining ecological structure and function. Salinity of estuaries is controlled by freshwater inflows, estuarine circulation and climate (storms, episodic droughts and trends in precipitation). To better understand the factors governing salinity and its variability in the Mississippi Sound, the U.S. Geological Survey is compiling all available current and historic salinity data. This effort will assist scientists in understanding the effects of current and future restoration projects on salinity and salinity variability in the Mississippi Sound. Such projects include the current efforts to rejoin Ship Island, which will affect water circulation patterns, and the implementation of massive river diversions into the Breton Sound basin in Louisiana, which will add considerable amounts of freshwater to the nearshore waters of the Mississippi Sound.

Predicting Daily Streamflow Using L-Moments and Neural Networks

Worland, S.; Knight, R.; Asquith, W.

Various statistical methods have been evaluated and applied to estimate daily mean streamflow and other streamflow statistics for ungaged streams and regional characterization. We elected to estimate daily streamflow in ungaged basins using flow duration curves (FDCs), L-moments, and machine-learning. The method is an extension of the Q1P1P2Q2 method that uses streamflow at gaged locations (Q1, streamflow at the gaged site) to calculate a time series of exceedance probabilities (P1, exceedance probabilities at gaged site) that are used streamflow at the ungaged site) at ungaged locations. The workflow requires estimating a FDC for an ungaged basin—a step achieved using L-moments to summarize the distributional geometry of FDCs and statistical regionalization models. We regionalize the first four L-moments computed from 10-year blocks of daily streamflow data from 1950–2010 for 1,030 gaged-basins that span from southern Texas to Florida. The decadal approach results in 3,027 L-moment ensembles available for regionalization. Out-of-sample predictions are used to simulate method performance at ungaged locations. The specific steps are (1) calculate decadal L-moments at gaged locations, (2) use multi-output neural networks and 34 basin descriptors to regionalize L-moments to ungaged catchments, (3) parameterize an analytical flow duration curve at the ungaged locations using the regionalized L-moments, (4) select donor sites using distance matrices in basin-descriptor space, and finally, (5) use the donated probabilities (P1P2) to generate daily streamflow values at ungaged locations. Additionally, compensation for no-flow conditions is made through logistic-regression like modeling. Uncertainty is incorporated into the predictions using stochastic neural-network dropout to approximate a posterior distribution of L-moments and streamflow estimates.

Estimating Streamflow-Recession Indices Using Automated Methods with Application to Groundwater-Surface Water Interaction

Crowley-Ornelas, E.; Knight, R.; Asquith, W.

Statistical properties of streamflow recession provide evidence of hydrologic processes such as groundwater and surface-water interactions. Bingham (1982, 1986) sought regional definition of generalized connectivity between surface water and groundwater by calculating a persistent streamflow recession slope during winter low flows and then relating the recession slopes to surficial geology. For our study, the recession slope value was referred to as the Bingham "geologic factor" or G factor.

The recession slope determined by Bingham's process was somewhat subjective because it was hand drawn based on the visual inspection of the stream hydrograph. The G factor was derived through a hands-on graphical method for selected peak flows over a 20-year time period from U.S. Geological Survey (USGS) streamgages in Tennessee and Alabama. A streamflow recession curve, plotted on semi-log graph paper, was created by starting at peak streamflow after a precipitation event until the line neared asymptotic with the x-axis. The number of days (x-axis) required for streamflow to decrease one log cycle (y-axis) was the index of streamflow recession for each station, or the G factor expressed in days per log cycle decline in flow. Boundaries for G factor regionalization were determined using streamflow hydrographs, surficial geology, and lithologic contacts. Although G factor values have been useful in statistical regionalization studies (Bingham, 1982, 1986; Knight and others, 2012), the subjectivity and time-consuming manual method of the approach has made it problematic to calculate G factors for newer records and different regions.

The USGS has developed an automated process that calculates G factors and has applied this method to more than 300 streamgages and more than 4 million days of streamflow at streams in or bordering Tennessee. Results from the automated process will be compared to the original G factor estimates to assess whether this new method is capturing the same hydrologic process information. Using the one-way layout statistical method, the relative impact of factors such as soil type, aquifer outcrop, and lithology on G factors will be assessed to create a regionalization of G factors across Tennessee.

Developing an automated process using existing data to calculate the G factor will make it possible to estimate the factor for larger areas as well as for discrete time periods. This new approach, if successful, will provide a tool to evaluate the extent of connectivity between surface water and groundwater in a basin; the influence of groundwater withdrawals on baseflow; and could be an early indicator of potential drought effects.

Nutrient and Pesticide Mitigation by Common Aquatic Plants

Moore, M.; Locke, M.

While some debate the severity, all agree that agriculture contributes to non-point source pollution issues. The challenge of feeding and providing fiber for a rapidly growing national and global population results in more marginal land being utilized for production acreage. As a result, conservation planners must look for innovative, cost-efficient practices to minimize impacts of agricultural runoff containing pesticides and nutrients. To that end, twelve experimental mesocosms (1.3 x 0.7 x 0.6 m) were established with a 16 cm of Lexington silt loam atop a base of sand (22 cm). Mesocosms were planted in monocultures of either *Myriophyllum aquaticum* (parrot feather), *Polygonum amphibium* (water knotweed), or *Typha latifolia* (common cattail). Three mesocosms were also left unvegetated to serve as controls. All mesocosms were amended with target concentrations of 10 mg L-1 (each) nitrate, ammonium, and orthophosphate; 20 µg L-1 (each) of the pesticides propanil and clomazone; and 10 µg L-1 of the pesticide cyfluthrin. After a 6 h amendment of simulated agricultural runoff, mesocosms sat idle for 48 h before flushing with unamended municipal water for another 6 h. Outflow water samples were routinely collected and analyzed for contaminant concentrations. No significant differences were noted between the control and any of the three different vegetation types regarding the percent contaminant retained within the hydraulic time retention time. Most significant differences between vegetated mesocosms and controls occurred when comparing mean contaminant breakdown rates post-amendment. *Typha* indicated significantly greater PO4, NH4+, TOC, TKN, TP, clomazone, propanil, and cyfluthrin breakdown percentages than controls during post-amendment (8–48 h). Likewise, *Myriophyllum* demonstrated significantly greater breakdown post-amendment for PO4, TOC, TKN, TP, clomazone, and propanil when compared to controls. *Polygonum* had greater NH4+, NO3-, TOC, TKN, TP, clomazone, propanil, and cyfluthrin breakdown percentages than controls during post-amendment. All three plant species had significantly greater percent propanil and cyfluthrin retention after the 6 h “clean” flush when compared to controls. These variable results indicate the importance of not only examining a variety of aquatic plants and their contaminant mitigation efficiency, but also determining potential downstream wash-off effects from multiple runoff events. Using natural systems, such as ditch vegetation, in the mitigation of agricultural runoff is a critical research area which must be further explored.

BMP Effectiveness

Austin Omer *(Mississippi State University)*	Water Quality Improvements from Implementation of Tailwater Recovery Systems
Dave Spencer *(Mississippi State University)*	The Effects of Cover Crops on Runoff, Erosion, and Off-Site N and P Transport
Laura Wilson *(Mississippi State University)*	Predicting the Effects of Conservation Practices in Tropical Soils
Phong Ly *(Mississippi State University)*	Hydrologic and Nutrient Removal Performance of Rain Gardens: A Review

BMP Effectiveness

Water Quality Improvements from Implementation of Tailwater Recovery Systems

Omer, A.; Baker, B.

Impacts of nutrient loading from agricultural landscapes have gained widespread attention and led to the implementation of conservation practices aimed at mitigating nutrient loss to downstream systems. Tailwater recovery (TWR) systems, have been considered as a potential mitigation strategy. The objective of this study was to compare concentrations and loads between effluent of TWR systems (TE) and effluent of similar catchments without TWR systems (CE), under the same agronomic management. Tailwater recovery systems, CE, and paired differences between TE and CE were compared over seasons. Nutrient concentrations and hydrologic discharge were monitored at five TWR system outflow and control catchment outflow locations on a flow event basis. Results revealed that of all experimental analytes, including total suspended solids, total phosphorus, total Kjeldahl nitrogen, nitrate-nitrite, and ammonium, only total phosphorus concentrations were greater ($F_{1,97} = 8.58$, $p < 0.005$) at CE locations than TE locations. The difference between loads of TE and CE showed reduced loads per hectare leaving TWR systems. This included loads of total phosphorus, total nitrogen, organic nitrogen, total inorganic nitrogen, and nitrate-nitrite. Analyses revealed no differences across seasons for TE and paired differences between TE and CE. However, CE concentrations and loads were seasonally different, where ammonium was greater in the summer than in the winter and spring but not different than fall. Additionally, only loads of total nitrogen were different across seasons, where winter was greater than spring but not different than summer and fall. This study provides evidence that TWR systems are a positive contribution to reducing nutrient loads compared to control locations.

The Effects of Cover Crops on Runoff, Erosion, and Off-Site N and P Transport

Spencer, D.; Krutz, J.; Locke, M.; Henry, B.; Golden, B.

There has been increasing interest in incorporating cover crops into production systems in the Midsouthern United States. Studies were established in Stoneville, MS to determine the effects of four cover crops on water use efficiency, runoff, erosion, and off-site N and P transport in a continuous corn production system. Treatments consisted of a reduced till/no cover (RTNC) as a control, reduced tillage with cereal rye (CR) (Secale cereal L.), reduced tillage with Austrian winter pea (AP) (Pisum sativum L.), reduced tillage with tillage radish (TR) (Raphanus sativus L.), reduced tillage with crimson clover (CC) (Trifolium incarnatum L.), and no till/no cover (NTNC). A portable rainfall simulator was used to simulate precipitation and the resulting runoff was captured from each plot to determine flow, sediment load, and N and P transport. Austrian pea increased infiltration by 24.7% relative to the RTNC plots. CR resulted in higher amounts of PO4 and total Kjeldahl nitrogen (TKN) in the runoff water than the control and higher amounts of NH4 than all other treatments except the RTNC. Also, furrows which received equipment tire traffic had lower amounts of NH4 and TKN than furrows not receiving tire traffic. Lastly, corn grain yield was 40 and 45% lower in the AP and CR plots, respectively, than the RTNC control. These results indicate that there is potential for some cover crops to improve infiltration in the Mid-south, however, more research is required to understand the effects on corn grain yield and nutrient transport.

Predicting the Effects of Conservation Practices in Tropical Soils

Wilson, L.; Ramirez-Avila, J.; Almansa-Manrique, E.

Understanding the implications of conservation management practices on runoff and erosion from agricultural fields is important to determine subsequent impacts on soil health, crops productivity, and the overall environment in a watershed. By establishing better practices to improve soil health, the crops will also be more productive, while keeping the impact on the environment to a minimum. In the Eastern Savannahs of Colombia, agricultural production became a very important part of the national economy. However, soils in the region are prone to high erosion and loss of soil fertility if adequate conservation management practices are not established. Fields in the area growing soybean, corn, and rice on rotation under conventional tillage, reduced tillage, and direct planting were studied at the Experimental Station La Libertad (CORPOICA) in Villavicencio, Colombia. The ability of APEX (Agricultural Policy/Environmental eXtender) to predict runoff, sedimentation, and nutrients present in the eroded material is evaluated using observed climate, runoff, sediment, nutrients, and crop yield data. Using the calibrated models, a better understanding of short and long term effects of implemented management practices is achieved, and the best management practice with regards to the economy and environment health can be identified.

Hydrologic and Nutrient Removal Performance of Rain Gardens: A Review

Ly, P.; Ramirez-Avila, J.

As the intensity of hydrologic events and concerns of pollutants in stormwater runoff increase, it is critical to recognize the importance of stormwater management. Thus, best management practices (BMPs) have been developed as control measures against the potentially detrimental effects caused by excess runoff. Structural or institutional BMPs have been proven to successfully manage stormwater runoff, improve runoff quality, and mitigate effects of erosion. Rain gardens or bioretention facilities have been used as a structural BMP to filter pollutants from runoff and mitigate erosion by slowing runoff volume and velocity. However, because of the great variability in soil type, vegetation, rainfall conditions, and many other parameters, it is difficult to assess the hydrologic efficiency of a given rain garden. Past research has quantified rain garden's performance in terms of volume of the system's inflow, outflow, and removal of nutrients and heavy metals. Because a good understanding of design configurations, climate conditions, and temporal relationships are crucial for the efficient performance of a rain garden, a study aimed to compare and contrast results on previous rain garden research, in order to determine correlations between design configurations and their potential to both, flow and pollutant loads. From these compiled studies, it was found that hydraulic conductivity is a major design parameter to be considered as high infiltration leads to greater hydraulic performance, but poor nutrient removal. Inherent soil properties such as the soil test phosphorus are also indicative of how well the rain garden will perform in terms of water quality.

Challenges to Establishing Targets and Practices for Managing Nutrients in Delta Waterbodies I

Kim Caviness *(MDEQ)*	Developing Nutrient Criteria for Delta Waters: Expectations and Challenges
Richard Lizotte *(USDA/ARS)*	Sources of Hypoxia in Mississippi Streams
Matt Hicks *(USGS)*	Can Diatom Assemblages Identify Important Stressor-Response Relationships Necessary to Establish Nutrient Management Goals for Mississippi Alluvial Plain Streams?
Jason Taylor *(USDA/ARS)*	Can Controlled Experiments Play a Role in Informing Nutrient Management Goals for Mississippi Alluvial Plain Waterbodies?
Martin Locke *(USDA/ARS)*	Can Cover Crops and Reduced Tillage Improve Surface Water Runoff Quality and Soil Health in the Mississippi Delta Alluvial Plain?
Rachel Nifong *(USDA/ARS)*	Hydrologic and Vegetation Management Influence Oxygen Dynamics and Nitrogen Processing in Experimental Ditches
Gary Ervin *(Mississippi State University)*	Despite Their Differences, Managed and Non-Managed Wetlands in the Mississippi Delta Achieve Similar Functional Outcomes
Jennifer Murphy *(USGS)*	Assessing Water-Quality Changes in Two Oxbow Lake Tributaries of the Mississippi Delta
Beth Baker *(Mississippi State University)*	Effects of Varying Suites of Agriculture Conservation Practices on Water Quality in the Mississippi Delta

Developing Nutrient Criteria for Delta Waters: Expectations and Challenges

Caviness, K.

The Clean Water Act (CWA) requires each State to establish and maintain water quality standards (WQS) to meet the two objectives expressed in Section 101(a), which are as follows: (1) restore and maintain the chemical, physical, and biological integrity of the Nation's waters and (2) wherever attainable, achieve a level of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. Consequently, WQS serve as the foundation for a wide range of water quality management programs under the CWA. WQS serve multiple purposes that include defining the water quality goals for a specific waterbody and providing the regulatory basis for establishing water quality-based effluent limits (WQBELs) beyond the technology-based levels of treatment required by CWA Sections 301(b) and 306. WQS also serve as a target for CWA restoration activities such as total maximum daily loads (TMDLs).

The CWA also states that WQS must include the following three elements including (1) designated use(s) for each water body, (2) water quality criteria necessary to protect these designated uses, and (3) antidegradation requirements. Since WQS establish the environmental baselines used for measuring the success of CWA programs, protection of the designated uses (aquatic life, recreation, sources of drinking water, etc.) depends on States developing and adopting well-crafted WQS.

In Mississippi, like many other states, excessive amounts of nitrogen and phosphorus are a major cause of surface water impairments. Since 2001, the Mississippi Department of Environmental Quality (MDEQ) has been working diligently to develop appropriate and protective numeric nutrient criteria (NNC) for Mississippi's waters. Nitrogen and phosphorus are natural parts of aquatic ecosystems and they are essential to supporting the growth of algae and aquatic plants, which provide food and habitat for fish, shellfish, and smaller organisms that live in aquatic ecosystems. However, when too much nitrogen and phosphorus enter the environment, streams, rivers, lakes, estuaries, and coastal waters may be impacted.

Developing NNC is extremely complex at every step of the process from selecting the appropriate endpoint that demonstrates support of the designated use to ultimately determining the concentration of nitrogen and phosphorus that will achieve that desired endpoint. Additional complexity is added by the numerous other confounding factors that occur within aquatic environments and their biological communities that are also affected by habitat, sunlight, flow, and numerous other variables that are different for every water body. Establishing NNC becomes even more complicated in the MS Delta region of the State due to the extent of historical stream and channel alteration as well as other physical and chemical characteristics that are unique to this region of the state.

Designated uses are a critical component of WQS because the use of the water body is used to define the appropriate water quality goals to protect that use. Mississippi currently has a very simple water body classification structure. One aspect of the current classification structure that has been criticized is how the State classifies waters within the MS Delta. Even though there are numerous water body types present in the MS Delta, from large rivers to bayous, every water body currently has the same designated use and thus the same expectations. MDEQ is examining the current water body classification structure and investigating further refinement of this structure. Further refinement of water use classifications will allow MDEQ to provide a more accurate distinction between water bodies around the state and allow for more appropriate criteria (or goals), including the development of nutrient criteria, to be established for those various water bodies.

Sources of Hypoxia in Mississippi Delta Streams

Lizotte, R.

Rivers and streams in watersheds with intensive row-crop agriculture are vulnerable to ecological impairment associated with non-point source runoff. Agricultural watersheds impacted by elevated nutrients can exhibit eutrophication, producing periods of severe oxygen stress or hypoxia (dissolved oxygen concentrations<2 mg/L). Additional factors such as hydrology and channel morphology as well as sporadic influxes of dissolved organic matter (sometimes referred to as blackwater) can exacerbate oxygen stress. From 2011-2017, we monitored biweekly summer and fall nutrients (total nitrogen and total phosphorus), chlorophyll α, dissolved organic carbon, and daily dissolved oxygen (one-week deployments) within three low-gradient, low-flow stream bayous in the Mississippi Delta. Eutrophication-induced hypoxia exhibited diel dissolved oxygen patterns with hypoxia primarily occurring during late night to early morning hours throughout the summer months. Periods of eutrophication-induced hypoxia lasted an average of 29 h or 17% of a 168 h (one-week) deployment period. In contrast, blackwater-induced hypoxia occurred sporadically following intense rainfall events typically >25.4 mm falling on dry row-crops prior to harvest (late summer to early fall) producing dissolved organic matter-laden runoff and dissolved oxygen sags. Periods of blackwater-induced hypoxia lasted an average of 84 h or 50% of a one-week deployment period. Classification and Regression Tree (CART) analysis of eutrophication-induced hypoxia produced a model indicating that stream morphology as channel width and elevated nutrients and total nitrogen worsened hypoxic conditions. CART analysis of blackwater-induced hypoxia produced a model indicating that elevated dissolved organic matter, decreased water depth and inhibition of photosynthesis worsened hypoxic conditions. Monitoring results indicate that reduction of both nutrients and sporadic dissolved organic matter pulsed inputs to low-flow Mississippi Delta streams is necessary to help mitigate hypoxic conditions and improve summer to fall dissolved oxygen concentrations in agricultural streams.

Can Diatom Assemblages Identify Important Stressor-Response Relationships Necessary to Establish Nutrient Management Goals for Mississippi Alluvial Plain Streams?

Hicks, M.; Taylor, J.

Anthropogenic alterations to large river floodplains like the Mississippi Delta disrupt natural disturbance regimes that typically maintain the ecological integrity of lowland stream ecosystems. Anthropogenic activities can also cause shifts in water quality, such as conversion of forested floodplains to intensive agriculture that leads to potential excess nitrogen and phosphorus in runoff to streams. As a result, streams within the Delta are generally habitat limited, exposed to alterations of natural temporal and acute geomorphological and hydrologic regimes, and often experience widespread nutrient enrichment. All of these factors limit development of field-derived stressor-response relationships to establish nutrient reduction goals as one mitigation effort to improve ecological integrity. To address this limitation, in 2015, the U.S. Geological Survey sampled diatom assemblages from 25 streams that were located within the Mississippi Alluvial Plain (MAP) ecoregion in Mississippi but drained portions of upstream ecoregions with greater variation in land management and represented a measurable gradient in total phosphorus (TP) and total nitrogen (TN). We collected epidendric diatom assemblage samples from instream woody debris as this was the primary stable habitat for diatom colonization found within our study systems. Ordination analysis identified a gradient in species composition associated with increasing TP and decreasing dissolved oxygen. Additional variation in assemblage structure was correlated with increasing alkalinity. Our results indicate that diatom assemblages are responsive to phosphorus enrichment and show promise for deriving stressor-response relationships and identifying nutrient reduction targets within Delta streams. However, additional work is needed to better quantify stressor-response relationships. Specifically, using standardized artificial substrates for diatom collection could improve precision, increasing the range of field gradients by adding more sites at low and high nutrient concentrations, and conducting controlled experiments to verify field-derived results will improve future efforts to establish defensible stressor-response relationships for nutrients within Delta streams.

Can Controlled Experiments Play a Role in Informing Nutrient Management Goals for Mississippi Alluvial Plain Water Bodies?

Taylor, J.; Lizotte, R.

Field-derived stressor-response models are useful for establishing nutrient management goals that protect ecological integrity of regional water resources. However, these studies can be difficult to implement in large river floodplain regions with intensive agricultural for a variety of reasons including: general habitat limitation of lowland stream ecosystems; significant alteration of geomorphological and hydrologic regimes; and a lack of clearly defined nutrient gradients among sites due to widespread enrichment. Given the diverse potential confounding factors and challenges to deriving nutrient stressor– ecological response models within the Mississippi Delta, conducting field mesocosm experiments may provide additional empirical evidence to evaluate field observations and inform nutrient reduction goals. We will explore this option by first, briefly presenting examples from a nutrient stressor-response study conducted in Texas that demonstrates how controlled stream mesocosm studies can 1) confirm field-derived stressor-response relationships and 2) identify relationships difficult to see with field data due to confounding factors. Secondly, we will present results from field mesocosm studies that demonstrate heterotrophic and autotrophic responses to nutrient enrichment within Delta habitats. We will conclude by discussing how experimental mesocosm studies can be expanded and conducted to inform identification of nutrient management goals for water bodies within the region.

Can Cover Crops and Reduced Tillage Improve Surface Water Runoff Quality and Soil Health in the Mississippi Delta Alluvial Plain?

Locke, M.

Cover crops and reduced tillage are in the toolbox of conservation management practices that need to be assessed in the alluvial plain of the Lower Mississippi River Basin to balance goals for production goals with natural resource concerns. Results from a series of USDA-ARS studies in the Mississippi Delta assessing effects of cover crops on water and soil quality in row crops are reviewed here. Synthesis of results from these studies showed that: (a) Cover crop and reduced tillage resulted in moderate increases in soil organic carbon and soil nitrogen at the soil surface; (b) Biological activity in surface soils was enhanced by cover crops (e.g., enzymes, mycorrhizae), but effects diminished with soil depth; (c) Total runoff sediment loss was reduced by no-tillage and cover crop; (d) Nitrogen and phosphorus associated with runoff sediment were reduced in no-tillage and cover crop; (e) Soluble nitrogen and phosphorus in runoff was variable, and was sometimes higher in no-tillage and cover crop areas.

Hydrologic and Vegetation Management Influence Oxygen Dynamics and Nitrogen Processing in Experimental Ditches

Nifong, R.; Taylor, J.; Yasarer, L.

With increasing consumer demand for sustainable agricultural production and continued concern for coastal economies, excess nitrogen (N) runoff from agricultural areas remains a major challenge to reducing the environmental footprint of high intensity agriculture. To address this challenge, producers need simple and innovative approaches that reduce runoff from agricultural fields while maintaining high productivity. Agricultural ditches act as the primary water-soil interface on farms and are a pivotal, but currently underutilized, location to implement low-cost management practices to increase both on-farm and landscape-scale mitigation of excess N runoff. Previous small scale experiments have demonstrated good potential for rice cutgrass (*Leersia oryzoides*) to enhance both N uptake and denitrification in ditch sediments. However, it is unclear how small-scale mesocosm studies and core based methods translate to larger scale observations that incorporate diel patterns in light and temperature, both of which can influence primary production, O2 dynamics, and related N processing. To inform how ditch management may influence N dynamics at larger spatial and temporal scales, we examined how hydrologic and vegetation management practices interact to influence diel nitrogen and oxygen dynamics by experimentally manipulating hydrologic residence time and the presence of rice cutgrass (*L. oryzoides*) in six experimental ditches. We measured plant nutrient uptake, denitrification fluxes, and metabolism using in situ dissolved solute and gas sampling techniques over three 24 hour diel experimental runs. Results indicate that ditches with vegetation promote N retention and have more pronounced oxygen dynamics which can alter expected N removal pathways. We will discuss the complexities in outcomes of these management practices within the context of whole system measurements that incorporate diel cycles.

Despite their differences, managed and non-managed wetlands in the Mississippi Delta achieve similar functional outcomes

Ervin, G.; Shoemaker, C.

This project aimed to evaluate abiotic and biotic characteristics of restored and non-managed wetlands in the Mississippi Delta, in an effort to determine whether restored wetlands are achieving desirable ecological functions in this predominantly agricultural landscape. With the assistance of USDA-NRCS, we identified 24 Wetland Reserve Program (WRP) wetlands and 6 non-restored, non-managed wetlands (NMW) for this work. These wetlands were assessed during 2014 and 2015 for water quality, hydrology, plant species composition, and landscape setting, as metrics of ecological condition and function.

Hydroperiods differed between NMWs and WRP sites, with longer, more intense flooding observed in NMWs; these differences were correlated with lower levels of plant species diversity, richness, and evenness in the NMWs, compared to WRP sites. We also found significant differences in soil organic matter content between wetland types, with NMWs having higher soil organic matter content, also likely correlated with the differences in hydroperiod between groups. In contrast to our observations of plant species and soils in these wetlands, few differences were found in water quality parameters between the two groups of wetlands.

At a broader scale, we found that WRP sites tended to be surrounded by higher levels of agriculture and conservation land, at distances from 100 to 500 m from the wetland edge, while NMWs tended to be surrounded by greater amounts of forested wetland cover. Additionally, we found that the conservation status of plant species in NMWs tended to be higher than that for WRP wetlands, which typically are situated in former marginal agricultural lands. Nevertheless, the lack of any substantial differences in water quality between NMWs and WRPs suggests that removal of excess nutrients associated with agricultural practices can be accomplished by wetlands across the agricultural landscape, even in moderately to heavily disturbed systems, such as the moist-soil managed wetlands typically created under the WRP efforts.

Assessing Water-Quality Changes in Two Oxbow Lake Tributaries of the Mississippi Delta

Murphy, J.; Hicks, M.; Stocks, S.

Many best management practices (BMPs) have been implemented across the Mississippi Delta in an effort to reduce the amount of nutrients and sediment leaving agricultural fields. However, it has been difficult to assess the influence of BMPs because there is often a lack of monitoring of downstream water quality. To this end, the U.S. Geological Survey collected approximately 8-9 years of water-quality and hydrology data at two agricultural ditches that drain row-crop fields and have a variety of BMPs in place in the ditches or fields. These sites discharge into separate oxbow lakes in the Mississippi Delta and previously had been identified as having excessive nutrient and sediment runoff. Using an event-based dataset and bootstrapping techniques, we tested for differences in flow-weighted mean concentrations of nutrients and sediment between an early and late period at each site. Most of the major BMP implementations occurred during in the early period whereas the late period had some additional implementations but typically at a lower intensity. We tested for differences and equivalences in median early and late concentrations and also for differences in the concentration-streamflow relationship between periods. We found several statistically significant decreases in nutrients and sediment at one site but none for the other. Nutrients and sediment were also not found to be equivalent between the early and late periods at either site. This means, while one site had substantial decreases in event concentrations for some constituents, results at the other site were generally inconclusive. These mixed results are likely due to differences in BMP implementation, farming practices, and the data characteristics at these sites.

Effects of Varying Suites of Agriculture Conservation Practices on Water Quality in the Mississippi Delta

Baker, B.; Prince Czarnecki, J.; Omer, A.; Aldridge, C.; Kroger, R.; Prevost, J.

Increasing concern regarding environmental degradation and annual hypoxic zones has led to the need for mitigation of nutrient laden runoff from inland landscapes. An annual occurrence of a hypoxic zone in the Gulf of Mexico has led to the development and implementation of nutrient reduction strategies at the state level throughout the Mississippi River Basin (MRB). With federal, state, and private financial and technical assisstance, landowners have implemented best management practices (BMPs) to reduce nutrient and sediment loading; however, the effectiveness of these BMPs to improve water quality, alone or utilized together, has not been widely documented. This research includes a field-scale, paired watershed approach in two watersheds in the Mississippi Alluvial Valley to test for differences in sed¬iment and nutrient runoff concentrations between four management systems. Baseflow and stormflow samples were collected from 2011 to 2015 and analyzed for nutrient and sediment concentrations. Median baseflow concentrations across all sites were 52 mg L–1 for total suspended solids (TSS), 0.38 mg L–1 for total phosphorus (TP), 0.09 mg L–1 for nitrate-nitrite (NO3--NO2-), and 0.81 mg L–1 for ammonium (NH4+). Median sediment and nutrient concentrations from stormflow samples across all sites within the study were greater than baseflow concentrations, where median stormflow concentrations were 985 mg L–1 for TSS, 1.21 mg L–1 for TP, 0.32 mg L–1 for NO3--NO2–, and 1.04 mg L–1 for NH4+. Results showed no strong improvements in water quality from agricultural landscapes where suites of BMPs had been implemented. Rather, the data presented variability in runoff concentrations indicative of strong influences from environmental and management variables. Study outcomes highlight opportunities to better capture nutrient dynamics at the field scale through adaptive management of BMPs and the importance of in-field practices for improved water quality to improve nonpoint source pollution reduction.

Streamflow and Sedimentation

James Grafe *(Mississippi State University)*	Understanding Relations Between Streamflow, Turbidity, and Suspended-Sediment Concentration in an Impaired Mississippi Stream
Michael Runner *(USGS)*	Estimates of Suspended-Sediment Yields for Select Streams in Mississippi
Dave Johnson *(USACE)*	The Use of Normalized Duration to Evaluate Low Flow in Mississippi Streams
Kirk Rodgers *(USGS)*	Trend Analysis of Streamflow to Support Bay and Estuary Restoration in Gulf States

Streamflow & Sedimentation

Understanding Relations Between Streamflow, Turbidity, and Suspended-Sediment Concentration in an Impaired Mississippian Stream

Grafe, J.; Ramirez-Avila, J.; Schauwecker, T.; Ortega-Achury, S.; Czarnecki, J.; Langendoen, E.

Sediment is listed as the most common pollutant in rivers, streams, lakes and reservoirs in Mississippi and the USA. Understanding the relations between suspended sediment concentration and measurements of turbidity and their temporal and spatial variability can be used as tools for assessing the effectiveness of programs for reduction of nonpoint source pollution. The Red Bud-Catalpa Creek watershed in Mississippi is currently listed by the Mississippi Department of Environmental Quality (MDEQ) as impaired by sedimentation and a Total Maximum Daily Load (TMDL) has been developed that sets challenging targets for sediment load reductions. Water quality parameters including flow velocity and depth, turbidity, suspended sediment concentration (SSC), specific conductivity, salinity, temperature and pH have been weekly monitored in 40 stations along the main stream and three headwater tributaries of the Catalpa Creek in Mississippi. The study is part of a research oriented to determine spatial and temporal variations of SSC and suspended sediment loads and to determine the relations among streamflow, SSC and turbidity in the evaluated streams. Positive correlations were initially observed between turbidity and SSC for most of the monitoring sites, but initial results have evidenced that a single relation may not be used to determine SSC for the entire watershed. Results have also evidenced key locations along the stream where erosion is a main concern, and highlights areas where erosion control actions are imperative and for which further research should be conducted.

Estimates of Suspended-Sediment Yields for Select Streams in Mississippi

Runner, M.

Stream quality can be impaired by changes in the quantity and quality of suspended sediment and stream paths and flows can be altered by erosion and deposition. Thus, it is important to monitor suspended-sediment loads and yields of stream basins to establish reference or background sediment- transport characteristics for streams in a given region or basin, as well as to help determine where potential sediment-related impairments may exist.

Reference suspended-sediment transport rates at an effective discharge equal to the 1.5-year recurrence intervals have been developed for various ecoregions of the United States and include several stream basins in Mississippi. Preliminary analysis of historical USGS sediment and flow data for sites in these select basins indicate that there is a correlation between sediment yield at the effective discharge and certain basin characteristics, including basin slope and drainage area, and these relationships may improve the ability of water-resource managers to identify potentially impaired streams and set target sediment yields at more attainable levels.

The Use of Normalized Duration to Evaluate Low Flow in Mississippi Streams

Johnson, D.

Currently the Mississippi Department of Environmental Quality uses the lowest observed flow in seven consecutive days occurring in ten year period (7Q10) to establish minimum flows for streams. The 7Q10 is a minimum flow established for wastewater discharges, but it does not address the needs of aquatic organisms. The period of record flows from 128 streams in Mississippi were analyzed for annual duration. An index was developed based on the mean annual duration distribution. The index was compared to several methods that are commonly used to establish minimum environmental flows.

Trend Analysis of Streamflow to Support Bay and Estuary Restoration in Gulf States

Rodgers, K.

The discharge of freshwater from rivers and streams to estuaries is important for biological and economic endpoints. The estuaries of the Gulf of Mexico represent one of the most diverse and important ecosystems in the United States. These systems are also heavily influenced by anthropogenic effects within upstream watersheds. Understanding systematic changes in streamflow can provide decision-support for water resources managers to help ensure that estuaries of the Gulf of Mexico receive the critical supply of freshwater needed. In 2016, the U.S. Geological Survey began an effort to characterize freshwater discharge in U.S. tributaries to the Gulf in support of the initiatives prioritized by the Gulf Coast Ecosystem Restoration Council. As part of this effort, daily mean streamflow data were aggregated to monthly, seasonal and annual means at 1,389 gaging stations for streams that drain to the Gulf of Mexico. These values were used to test for monotonic trends in streamflow using the non-parametric Mann-Kendall Trend test. Streamflow trends were synthesized by watersheds representing four-digit hydrologic-unit codes (HUC4). Initial analysis of monthly mean discharge at 28 gaging stations (the most downstream station in each of the 28 HUCs draining to the Gulf) indicate increasing trends at 14 percent (4 sites) of the sites and decreasing trends at 32 percent (9 sites) of the sites. Fifty-five percent of the sites indicated no trend in streamflow. A calculation of area based on land use in the 28 HUC4s does not indicate a dominant land use classification associated with increasing or decreasing streamflow trends. Future work will also evaluate trends in low and high flows, relate streamflow trends to changes in land use or other causal influences, and examine the relationship between streamflow trends and biological or economic endpoint within the Gulf of Mexico.

Irrigation Efficiency & Conservation

Saseendran Anapalli *(USDA/ARS)*	Quantifying Crop Coefficients for Corn Irrigation Scheduling in the Lower Mississippi Delta Using an Eddy Covariance Method
Hazel Buka *(Mississippi State University)*	Improving the Corn Crop Coefficient Method in the Mississippi Irrigation Scheduling Tool (MIST)
Fei Gao *(Beijing Normal University)*	Impacts of Different Ratios of Surface Water and Groundwater for Row Crops Irrigation on Groundwater Level in the Mississippi Delta
Meredith Brock *(Mississippi State University)*	Salinity Effects from Treated Effluent as Irrigation
Gary Bell *(USACE)*	Lidar in Scaled Physical Modeling: Applications, Advantages, and Development

Quantifying Crop Coefficients for Corn Irrigation Scheduling in the Lower MS Delta Using an Eddy Covariance Method

Anapalli, S.; Reddy, K.; Fisher, D.; Sui, R.

The water levels in the Mississippi river valley alluvial aquifer is falling fast due to water withdrawals for crop irrigations that are not replenished with rainfall recharge. Irrigation applications based on the exact crop evapotranspiration demands—consumptive water requirements—can be the way forward for preserving this aquifer-water resources for its sustainable use for irrigations in the region. In this direction, in a pioneering study, we quantified ETc from corn using an eddy covariance (EC) approach (ETe). In the EC system, vertical velocity of eddy transport and sonic temperature were measured using a Gill New Wind Master sonic anemometer (Gill Instruments), and water vapor density in the eddies was measured using the LI-7500-RS open-path infrared gas analyzer (LI-COR Inc.). All instruments were calibrated once in a year before moving to the field for measurements. The sensors were mounted on a telescopic, height adjustable tower, and the sensor height was maintained at twice the canopy height. Recognizing the unresolved problems in balancing energy fluxes in the EC approach, we also monitored ETc by computing latent heat energy flux (LE) from the system following a residual energy balance (EB) approach (ETb) using added instrumentation and compared the fluxes. The unclosed energy fluxes in the EC was post-analysis corrected using the Bowen ratio (BR) and LE methods. The measurements were conducted in a 31 ha clay soil field planted to irrigated corn in the lower Mississippi Delta, USA, in 2017. Further, for scheduling irrigations in corn, based on grass and alfalfa reference crop ET calculated from weather data, averages of the ETb, ETebr, and ETele daily estimates were used in deriving corn crop coefficients (Kc).

Improving the Corn Crop Coefficient Method in the Mississippi Irrigation Scheduling Tool (MIST)

Buka, H.; Linhoss, A.; Tagert, M.; Pote, J.; Wax, C.

This study examines the value of improving the crop coefficient method being used in the Mississippi Irrigation Scheduling Tool (MIST). Due to an overall increase in irrigated acreage, irregular distribution of rainfall during the summer growing season and continual decline of the Mississippi Alluvial River Valley Aquifer (MARVA), it is important to implement irrigation management practices that minimize water use without compromising crop production, yield, and quality through use of scientific models and soil monitoring devices. The objectives of this study were to 1) adjust and examine the Food and Agriculture Organization (FAO) crop coefficient method and the adjusted "SCS polynomial crop coefficient" method adapted and digitized from the former Soil Conservation Service (SCS, 1970) using a growing season of 120 and 150 days, 2) determine corn emergence and physiological maturity using 50 Growing Degree Days (GDD50) for use in adjusting the length of the growing season, 3) examine the importance of initiating the model at planting and emergence date, and 4) compare MIST modeled results to measured soil moisture data from Watermark soil moisture sensors for the 2014, 2016 and 2017 growing seasons. Currently, MIST uses a FAO crop coefficient with a growing season of 150 days, while the adjusted SCS method allows the growing season to be adjusted based on crop, variety, and maturity stages. Results showed that even though the adjusted SCS method called for irrigation earlier in the season, irrigation water was applied during the critical growth stages and did not trigger irrigation events after the crop reached physiological maturity. Results also showed that by using the adjusted SCS method and GDD50 to determine the growing season, fewer irrigation events and less total crop water use were indicated when irrigation was terminated at 2,700 and 2,900 GDD physiological maturity, depending on the variety used, as compared to the FAO crop coefficient. In addition, changing the timing of model initiation (planting vs emergence) was not important on the total crop water use, but it may have other benefits. Lastly, even though Watermark soil moisture sensors installed in the study field generally did not report similar results, especially around the mid-season, shallower sensor depth somewhat matched and showed similar trends with the MIST modeled results.

Impact of Different Ratios of Surface Water and Groundwater for Row Crops Irrigation on Groundwater Level in Mississippi Delta

Gao, F.; Feng, G.; Dash, P.; Ouyang, Y.

Groundwater resources in Mississippi Delta have been overexploited for agricultural irrigation for a number of years. Over 700,000 hectares of row crops in this region was irrigated by using groundwater. As a result, groundwater level has declined > 6.5 m (20 ft) since 1970, which threaten the sustainability of irrigated agriculture in this region especially in Big Sunflower River Watershed. Surface water resources can be used as an alternative source for irrigation. Limited information was reported regarding groundwater level as affected by different ratios of surface water and groundwater for irrigation in this region. The objectives of this study were to employ a coupled SWAT-MODFLOW model and simulate the change in groundwater level and storage as affected by a) no irrigation scheme; b) conventional irrigation scheme; c) water-saving irrigation scheduling by using different percentages of surface and ground water. An analysis from 2000 to 2016 showed practically achievable reductions in weekly pumping (<22%) and replacement by surface water for irrigation would stabilize the groundwater levels in the Mississippi Delta. This study suggested that the conjunctive use of surface water in addition to groundwater can be a sustainable way for future to continuously grow major row crops soybean, corn, cotton and rice in the Mississippi Delta.

Salinity Effects from Treated Effluent as Irrigation

Brock, M.; Tagert, M.

Around the world, increasing and sometimes competing demands on water for irrigation, industrial processes, aquifer recharge, drinking and other systems require investigation into additional viable water sources. Effluent from industrial and municipal wastewater treatment systems is gaining more attention as a potential source to meet these demands. By receiving further treatment beyond these systems, reclaimed or recycled water has been developed as a means to use this effluent as a viable source. Southwest Florida has proven its successful use on a large scale for more than 40 years with 62 treatment facilities and widespread applications without harmful impacts on local water and soil quality (Reclaimed Water, 2014). Risk factors that must be addressed include pathogens, nutrients, and salinity. While standard treatment facilities meet established limits for these components, reclaimed water requires extra treatment in potential applications that have more direct contact with humans. Salinity is considered one of the greatest risk factors associated with irrigation applications as it affects hydraulic conductivity of soils and water uptake of plants. This study assesses salinity in wastewater effluent and examines its potential for irrigation. A potential solution combines effluent with other water sources to reduce salinity risks to soil. Using samples from Starkville Wastewater Plant, electrical conductivity and total dissolved solids of the effluent are tested and compared to values established by the Food and Agriculture Organization as water quality restrictions to irrigation (US EPA, 2012). Using these restrictions, effluent is diluted using a predetermined ratio with controls set as undiluted effluent and freshwater. Results will provide a basis for potential application of treated water for irrigation in Mississippi or demonstrate a need for additional treatment of wastewater to meet standards adopted by current reclaimed water facilities.

Lidar in Scaled Physical Modeling: Applications, Advantages, and Development

Bell, G.

Nearly every physical model done is scaled (1:1 scaled models are rare in that they require vast amounts of space and resources). The larger the scale, the larger the error is amplified from measurements at the model scale. Thus the need for a very high degree of accuracy in physical model data collection is of the highest importance.

When doing moveable bed modeling, it is advantageous to have data with high resolution and accuracy to evaluate bathymetric changes from hydraulic processes. Use of a lidar (light detection and ranging) system provides an accuracy of millimeters, minimizing measurement error that is magnified when scaled to prototype dimensions. Unlike the challenges of traditional bathymetric data collection methods, the high resolution of terrestrial scanning provides complete coverage of the domain.

Lidar scanning is a process that collects high resolution geometric, bathymetric, and topographic data. Lidar uses lasers to make measurements based on time of flight returns. The scanners used in this study each have a wavelength of ~ 1550 nm (or near infrared). These lasers cannot travel through the water medium (their energy is absorbed by the water). When the bathymetry is being scanned, the model must be drained of water (and if this is after testing, then the draining process can be long due to slow drainage in order to preserve post-test bathymetric results). These methods of collecting physical model bathymetric data have been proven to be accurate and efficient.

Lidar was also used in a coastal application in which a dune's response to collision and over-wash erosional events was tracked. The focus of the study whether, and to what degree, vegetation alters the dune response to those erosional events. In addition to pre and post test lidar scanning, line-scanning was performed during the testing to track the dune configuration changes during the testing. Line-scan lidar continuously scans to provide instantaneous water levels and dune evolution during each wave burst. A MATLAB code was written to filter the returns of the lidar data, thus the position of the wave (water) could be pin pointed and continuous dune topography could be collected during the model testing.

I am undertaking a research study which involves using lidar scanning to measure water surface elevations in scaled physical models. Currently, water surface elevation measurements are typically made using some variation of stilling gage/ pipes or a variety of piezometer boards. Measurements can be made via point gage, surveyed elevation, or some other point of control. Accuracy of these measurements is on the order of 0.5 mm. The biggest constraint of using this method is the lack of measurement locations that can be utilized. The pipes will cause flow disturbance, take up space, require routing, etc. The work that I have done up to this point has proven that by scanning materials floating on the water surface, it is possible to collect accurate (below 10 mm) measurements of the water surface elevation during live physical model testing.

The following points summarize what will be presented in this topic.

Explain where lidar stands now in laboratory physical modeling.
What improvements have been done, are being done, and will be done to this data collection tool.
Where possibilities in the future lie.

Surface Water-Groundwater Interaction

Ying Ouyang *(USDA/ARS)*	Assessing Groundwater Interactions between Forest and Crop Lands and the Potential to Increase Groundwater Availability through Afforestation in Mississippi
Michael Gratzer *(University of Mississippi)*	Oxbow Lake-Wetlands Systems as a Source of Recharge to the Mississippi River Valley Alluvial Aquifer

Assessing Groundwater Interactions between Forest and Crop Lands and the Potential to Increase Groundwater Availability through Afforestation in Mississippi

Ouyang, Y.; Jin, W.; Feng, G.; Leininger, T.

Groundwater depletion due to agricultural pumpage in Mississippi has been an issue of increasing water resource concern. Currently, little to no effort has been devoted to estimating the impacts and potential benefits of afforestation on marginal agricultural lands for increasing groundwater availability. In this study, we modified the USGS's MERAS (Mississippi Embayment Regional Aquifer Study) model to estimate such impacts and benefits in two different land uses at the Upper Yazoo River Watershed (UYRW) in Mississippi, one from crop land with groundwater pumpage and the other from forest land adjacent to the crop land. Three simulation scenarios were then developed for a simulation period of 147 years in this study. The first scenario was a base scenario for agricultural pumping conditions commonly used as well as natural forest conditions occurring in Mississippi. The second scenario was the same as the first scenario except that the model was iterated three times, respectively, at the increasing agricultural pumping rates of 5%, 10%, and 15% in crop land. The third scenario was the same as the first scenario except that the marginal crop land was converted to forest land a result of afforestation. These scenarios would ascertain: (1) the interactions of groundwater between the two land uses; (2) if groundwater from forest land is a source or is irrelevant to groundwater from crop land in Mississippi; and (3) the potential benefits of afforestation in marginal agricultural lands for increasing groundwater availability. Simulation results show that afforestation increased groundwater level by 3.3 ft after 27 years from 1980 to 2007 at the UYRW as a result of no groundwater pumpage in the afforested land. Our simulation further revealed that contribution of increasing groundwater recharge rate due to afforestation on groundwater availability at the UYRW was trivial. Further study is therefore warrant to estimate how afforestation of marginal crop land would enhance groundwater availability in the Lower Mississippi River Alluvial Valley.

Oxbow Lake-Wetland Systems as a Source of Recharge to the Mississippi River Valley Alluvial Aquifer

Gratzer, M.; Davidson, G.; O'Reilly, A.; Rigby, J.

This project investigates whether the Sky Lake oxbow lake-wetland system contributes significant recharge to the Mississippi River Valley Alluvial Aquifer through preferential flow pathways created by tree limbs and roots embedded in the wetland bottom sediment. The problem is being investigated by monitoring water levels in 11 wells in and around the Sky Lake oxbow lake-wetland system. These data are being used to determine the shape of the potentiometric surface and how the aquifer responds to precipitation and surface water level changes (changes in surface-water/groundwater head difference) at different locations. Temperatures at various depths in these wells are also being monitored to see how subsurface temperatures respond to air and surface-water temperature changes at different locations, thereby potentially allowing inference of different recharge sources. Soil temperatures are being measured at two locations in the wetland at 30 and 60 cm belowground and analyzed for evidence of spatial heterogeneity. Generally, the potentiometric surface is relatively flat upgradient (eastward) of the oxbow and steeper downgradient (westward) of the oxbow. It is also curved, forming a possible groundwater ridge. Hydrographs of four wells are consistent with vertical recharge beneath the lake raising the groundwater level beneath the lake. Consequently, groundwater backs up, causing a decrease in the hydraulic gradient inside and upgradient of the meander loop and an increase in the hydraulic gradient outside and downgradient of the meander loop. The hypothesis that preferential flow paths convey wetland surface water into the subsurface is supported by the temperatures recorded at 30 and 60 cm belowground, because the trends shown by these soil thermistors vary spatially.

Water Treatment

Jason Barrett *(Mississippi State University)*	Mississippi Private Well Characteristics and Well Owner Demographics
Stephanie Otts *(University of Mississippi)*	An Analysis of the Lead Contamination Risks of Public Water Supplies in the Mississippi Delta
Gray Turnage *(Mississippi State University)*	Chemical Control of the Floating Aquatic Plant Common Duckweed (Lemna minor L.) and Watermeal (Wolffia spp.)

Water Treatment

Mississippi Private Well Characteristics and Well Owner Demographics

Barrett, J.

Mississippi citizens who acquire their drinking water from private wells do not have the luxury of knowing the quality of their drinking water on a regular basis unless they are making the effort to have their water screened and tested. Without knowing and understanding the safety of drinking water, private well owners do not know if and when treatment is needed. Approximately 90% of Mississippi citizens are served by one of the 1,200(+/-) public water systems which provide safe reliable water under the regulatory guidance of the Mississippi State Department of Health-Bureau of Public Water Supply. Private well owners are free to own, operate, and maintain their wells because there is no regulatory oversight. For some private well owners, this freedom is welcome but others want to know the quality of their drinking water and best practices for proper maintenance.

No demographic data about private well owners has been compiled since the 1990 census. Since the inception of Mississippi State University Extension's Mississippi Well Owner Network (MWON), demographic data has been collected. The MWON workshops have allowed private well owners the opportunity to have their well water screened for bacteria. This presentation will compare demographic data of current private well owners with those from the 1990 census as well as compare to overall Mississippi demographic data. Private well characteristics are also gathered when a well owner has their water screened for bacteria. Characteristics may prove beneficial when analyzed against the presence of bacteria to assist well owners in making improved decisions on the treatment or introduction of treatment to their well water. The concluding data can be utilized to better understand and serve Mississippi private well owners.

This study should be of interest to representatives of local municipal water systems, local communities, and rural water associations for potential expansion of their water systems. The expansion of a public water system may achieve multiple goals. Additional customers generate more revenue for the public water system, as well as provide a larger customer base in which to spread costs. The regulatory oversight of public water systems should promote and produce a safer drinking water supply for Mississippi residents. The study should also be of interest to private well owners as they navigate life obtaining their drinking water from an unregulated source.

An Analysis of the Lead Contamination Risks of Public Water Supplies in the Mississippi Delta

Otts, S.; Janasie, C.

Childhood lead poisoning is a challenging social issue that requires the coordination of health, housing, and environmental law and policy. Little is known about the contribution of lead pipes and water treatment to lead poisoning in Mississippi. In 2017, the National Sea Grant Law Center at the University of Mississippi analyzed the lead monitoring data of public water systems in nine counties as part of a Mississippi Water Resources Research Institute-funded interdisciplinary project to assess the effectiveness of community-based research strategies to analyze risk of lead contamination in public water supplies in the Mississippi Delta. The distribution system for drinking water in Mississippi is incredibly fragmented. The majority of public water systems in the region serve less than 500 customers. Due to their small size, the samples sizes required under state and federal law are quite small—usually just five or ten samples every three years. For many public water systems, this means that less than 1% of the homes within the service area are tested for lead. A review of lead monitoring data can help identify public water systems that may be experiencing problems with their corrosion control or other aspects of their systems that can increase the risk of lead contamination. However, the lead risks of individual homes throughout the community cannot be known without further testing. This presentation will present an overview of the legal framework governing the provision of public water supplies in Mississippi, followed by a summary of the research results for each county. Four public water systems reported sampling results for the current monitoring period that exceed the federal action level for lead (15 ppb). Five additional public water systems reported exceedances within the past five years. This presentation will conclude with a discussion of the challenges of addressing lead exposure from drinking water supplies and actions that policy-makers, water supply systems, community organizations, and other interested stakeholders might take to protect public health.

Chemical control of the floating aquatic plants common duckweed (*Lemna minor* L.) and watermeal (*Wolffia* spp.)

Turnage, G.

Floating plants are increasingly becoming widespread problems in waterways in the southern United States. Nuisance problems are often exacerbated with increased nutrient inputs into waterbodies from point and non-point sources. Common duckweed (*Lemna minor* L.) and watermeal (*Wolffia* spp.) are both floating aquatic plant species that can be problematic in southeastern waterbodies. Infestations of these species can reduce the use and aesthetics of waterbodies and can shade out submersed aquatic plants potentially causing oxygen depletions in which may result in fish kills. Duckweed and watermeal are some of the most difficult aquatic species to control due to their high rate of reproduction. Most management options utilizing chemical control methods produce inconsistent results when used on these species. This work analyzed the effects of the contact herbicide diquat and a new liquid formulation of the contact herbicide flumioxazin when used to control duckweed and watermeal. Each species was established in 20 40L aquaria in a greenhouse and were allowed to grow for one month prior to herbicide applications. Diquat was applied to each species at the maximum label rate while flumioxazin was applied to each species at low, medium, and high rates. All herbicides and rates reduced duckweed by four weeks after treatment (WAT) when compared to an untreated control. Diquat and the high and medium rates of flumioxazin reduced watermeal when compared to the untreated control at four WAT, however the low rate of flumioxazin did not.

Groundwater Availability in the Mississippi River Alluvial Plain I

Wade Kress *(U.S. Geological Survey)*	Coupling Groundwater Flow Modeling with Hydrologic Monitoring to Assess Water Availability in the Mississippi Alluvial Plain
Burke Minsley *(U.S. Geological Survey)*	Evaluating the Hydrogeologic Framework of the Mississippi Alluvial Plain Using Geophysical Methods
Steve Westenbroek *(U.S. Geological Survey)*	Improving Estimates of Recharge in the Mississippi Alluvial Plain Using the Soil-Water- Balance (SWB) Model
Courtney Killian *(Mississippi State University)*	Evaluation of Methods for Relating Continuous Streambed Resistivity Data and Hydraulic Conductivity in the Mississippi Delta
Andrew Leaf *(U.S. Geological Survey)*	Improving Numerical Simulation of Streams and Shallow Groundwater in the Mississippi Alluvial Plain
Drew Westerman *(U.S. Geological Survey)*	Reducing Uncertainty in Estimates of Irrigation Water Use
Steve Peterson *(U.S. Geological Survey)*	Updates to a Groundwater Flow Model to Facilitate Decision Support and Uncertainty Analysis for the Mississippi Alluvial Plain
James R. Rigby *(USDA/ARS)*	Riverbank Filtration, Transfer, and Injection Pilot Project Along the Tallahatchie River for Enhanced Aquifer Recharge: Progress and Plans

Coupling Groundwater Flow Modeling with Geophysical Mapping and Hydrologic Monitoring to Assess Water Availability in the Mississippi Alluvial Plain

Kress, W.; Barlow, J.; Hunt, R.; Pindilli, E.

The Mississippi Alluvial Plain water availability project is in it its third year of data collection and model development in support of a water availability and valuation decision support tool for the region. Years 1 and 2 of the project focused on assessing existing datasets and groundwater- flow models to help increase efficiency of geophysical mapping efforts and hydrologic monitoring networks. These field data, in turn, will help improve the next generation groundwater- flow model. This third year focuses on the development of a series of supporting models and automated data services designed to update the groundwater-flow model on regular intervals. A range of approaches is targeted, including water budget models to estimate recharge, surface-water model to supply baseflow estimates, irrigation water-use model to provide estimated pumping rates, and a geophysical model to inform the hydrogeologic framework. Stakeholder forecasts from the updated groundwater-flow model are improved as uncertainty decreases. By coupling the modeling, mapping, and monitoring within an iterative framework, an improved representation of alluvial aquifer water resources will be developed. The final outcome of this work is an encompassing economic-physical system approach that allows stakeholders to assess societal and system costs and benefits associated with water use from the MAP aquifer. The economic analysis will incorporate both supply (e.g., how a reduction in groundwater availability might affect agricultural revenue) and demand-side effects (i.e., how people's behavior, such as crop switching, might influence the other parts of the system).The economic-physical system approach forms the basis of a decision support system, where economic and physical system analyses will provide the basis for informed cost-benefit trade-offs in the region.

Evaluating the Hydrogeologic Framework of the Mississippi Alluvial Plain Using Geophysical Methods

Minsley, B.; Kress, W.; Johnson, C.; Lane, J.; Bloss, B.; Thayer, D.

A geophysical framework model of the Mississippi Alluvial Plain is being developed using a diverse suite of geophysical methods applied over multiple scales. Measurement techniques include terrestrial and waterborne continuous resistivity profiling (CRP), electrical resistivity tomography (ERT), time-domain electromagnetics (TDEM), and surface and borehole nuclear magnetic resonance (NMR). CRP methods have been used to map approximately 68 km over land and 1,200 km of streams within the study area to characterize the near-surface (<15 m) lithology of major geomorphologic units that control recharge and groundwater/surface-water exchange to the alluvial aquifer. CRP surveys have identified the boundaries of individual geomorphic features and indicate that these features have distinct ranges of resistivities. The deeper subsurface structure in the region (5-200 m) is being measured using ground-based TDEM measurements, which are capable of measuring the electrical resistivity variations within the alluvial aquifer and can be used to identify subcropping hydrogeologic units. Six east-west regional-scale profiles of time-domain electromagnetic (TDEM) measurements, each comprising 10-20 TDEM soundings and spanning 100-200 km, were conducted in the MAP study area. These profiles are approximately traverse to the synclinal axis of the Mississippi embayment. The profiles were spaced north to south at about 100 km intervals and represent a total area of nearly 100,000 sq. km. These regional-scale profiles are being used to refine the 3D aquifer structure the MAP study area and will be used to guide the survey design and planning of a large airborne electromagnetic survey of the MAP region that will begin in 2018. Borehole and surface NMR data were collected to estimate hydraulic properties and characterize subsurface hydrostratigraphy. NMR methods are used to measure hydraulic properties in the formation including total-, mobile-, and bound-water content, estimates of pore-size distribution, and hydraulic conductivity with depth. The interpreted hydrostratigraphic layers from the surface NMR measurements were consistent with the presence and thickness of a confining unit overlying a more coarse-grained aquifer and were validated by observations from nearby boreholes and TEM surveys. The goal of the comparison is to establish a relation between resistivity and NMR results and facilitate development of a petrophysical relationship between the resistivity and hydraulic conductivity. Resistivity values may then be used as a cost-effective way approximate aquifer hydraulic conductivity distributions that will be input into regional groundwater models.

Improving Estimates of Recharge in the Mississippi Alluvial Plain Using the Soil-Water-Balance (SWB) Model

Westenbroek, S.; Ladd, D.

Independently derived estimates of recharge calculated from spatially explicit inputs can significantly improve evaluations of groundwater movement. The U.S. Geological Survey's Soil-Water-Balance (SWB) code is a tool to estimate distribution and timing of net infiltration (recharge) out of the root zone using readily available data, such as gridded climate, land-use, and soils. Calculations are completed on a daily time step and gridded results are summarized on monthly and annual time scales. In addition, irrigation water requirements (crop water demand) are optionally estimated to evaluate the effects of agricultural water use on the water budget. Version 2.0 of the SWB code was recently released and is being applied to the Mississippi Alluvial Plain (MAP) study area. Current work combines historical and recent land use, agricultural, and daily weather data to produce estimates of crop water demand and net infiltration at a 1-km grid resolution. Previous modeling in the study area assumed some fraction of precipitation (on the order of 1.0E-4 to 7.0E-2) becomes recharge, supplied to the model through 19 zones of similar soil type and geomorphology. The SWB approach allows recharge to be estimated with greater spatial resolution than the original zone method, but the limited knowledge of crop patterns from the early 20th century introduces uncertainty to SWB estimates from that time period. SWB recharge estimates will be constrained by other complementary datasets generated for this project, such as the Empirical Water Budget model. Our initial work generates recharge values up to an order of magnitude greater than the previous model estimates in some locations, particularly relative to the initial estimates based on data from early in the 20th century.

Evaluation of Methods for Relating Continuous Streambed Resistivity Data and Hydraulic Conductivity in the Mississippi Delta

Killian, C.; Rigby, J.; Barlow, J.; Kress, W.; Schmitz, D.

Data worth and uncertainty analyses of an existing regional groundwater-flow model that includes portions of the Mississippi Alluvial Plain (MAP) identified streambed hydraulic conductivity as a notable parameter that affected model uncertainty, influencing the model's ability to evaluate groundwater and surface-water interactions. The streambed hydraulic conductivity of each stream reach is currently represented by one value in the existing model due to the paucity of existing data, resulting in high uncertainty in model outputs. Waterborne continuous resistivity profiling (CRP) data was collected by the U.S. Geological Survey in 2016 and 2017 along selected streams within the Mississippi Delta to: (1) characterize near-surface lithology of the Mississippi River Valley alluvial aquifer for improved understanding of groundwater and surface-water interactions; and, (2) allow for increased variability of streambed hydraulic conductivity within the existing model. Multiple methods to translate resistivity values to estimates of streambed hydraulic conductivity were evaluated. Two-dimensional profiles of estimated streambed hydraulic conductivity data were aggregated vertically to develop one-dimensional streambed hydraulic conductivity values and horizontally to the scale of the existing model. Estimated streambed hydraulic conductivity values from the methods were incorporated into the existing model and model estimates of predicted streamflow and groundwater levels were compared to measured values to evaluate model performance for each translation method. This exercise to improve streambed hydraulic conductivity values will allow for reduction in model uncertainty by allowing the model to better estimate groundwater/surface-water interaction and improve tools to make informed decisions when creating and implementing best water-use management practices.

Improving Numerical Simulation of Streams and Shallow Groundwater in the Mississippi Alluvial Plain

Leaf, A.; Breaker, B.; Adams, R.; Dietsch, B.

In humid regions such as the Mississippi Alluvial Plain (MAP), surface water typically exerts a fundamental control on both the water levels and flow directions of shallow groundwater. Groundwater pumping ultimately diverts water that would otherwise go to streams or lakes, and can have dramatically alter surface water features, even when only a small portion of the overall regional water budget is removed compared to recharge. The stream network in the MAP is an important source of water to wells thus serves as an important consideration for sustainable management of groundwater.

Representation of streams in groundwater models has historically been arduous and error-prone, requiring many GIS operations or even hand-digitizing of features. Software support for automation of stream network creation and visualization has been limited. Automated stream network generation in the MAP region is challenging in that it encompasses a large number of streams, many of which originate far from the area of interest, has a complex history landscape alteration, and highly variable surficial lithology. In the MAP area, three new approaches are being performed to improve the simulation of this important surface water network.

1) Automation, machine learning and additional field data collection are being used to improve the representation of streams in the Mississippi Embayment Regional Aquifer System (MERAS) model. Python code was developed to automatically translate information from the NHDPlus version 2 database into finite-difference stream networks. The revised networks include most streams that have base flow for at least part of the year, increasing the number of streams represented in the MERAS model from 43 to more than 5,000. The automated processes of generating the stream networks facilitates adaptation to different computational grids or inset areas within the larger Mississippi Embayment.

2) A random forest (RF) statistical model was developed to estimate streamflows originating outside of the MERAS study area as well as ungaged flows in both space and time within the model domain. The RF model considers drainage area, climate statistics, and other factors to estimate stream flows at monthly intervals, providing valuable information on stream inflows to the model because continuous flow observations that can be compared to output from the physics-based finite difference model.

3) Waterborne geophysical electrical resistivity surveys were conducted on more than 700 miles of streams, to identify areas of relatively high and low permeability in the streambed sediments, and inform the representation of streambed conductance in the model. Simulated streamflows will be compared to existing and newly collected measurements of base

Reducing Uncertainty in Estimates of Irrigation Water-Use

Westerman, D.; Wilson, J.; Painter, J.; Torak, L.

The Mississippi Alluvial Plain (MAP) is one of the most important agricultural regions in the United States, and the MAP region has seen substantial declines in groundwater levels and reductions in stream base flow that have led to concerns about sustainability and future availability of the water resources. One of the tools used to understand groundwater responses in the MAP region to current and future water-use demands is groundwater modeling; however, one of the largest sources of uncertainty in groundwater modeling of the MAP region is irrigation water-use estimates. The U.S. Geological Survey (USGS) is working closely with local and state cooperators to help improve estimates of water-use demand within the MAP region. A publicly available water-use network is being established that includes 46 real-time monitoring flow meters installed on irrigation wells. In addition to the real-time data, existing State programs will be leveraged to obtain water-use measurements from hundreds of additional metered sites within the MAP region. The metered water-use data will be essential in providing authoritative datasets for estimating water-use demands based on crop types, climatic variables, and the variety of soil types present within the MAP region. Using the water-use metered data as the main driver, the USGS is developing a national water-use model with the goal of estimating monthly groundwater use for irrigation at a spatial resolution of 1 kilometer. The initial version of the water-use model will be aimed at quantifying irrigated acres, estimating irrigation rates developed from current water-use metered data, and developing estimates of water use for the entire MAP region. Future, more sophisticated versions of the water-use model will aim to incorporate additional site-specific water-use data, develop irrigation rates as a function of climate variation based on the metered data, use remote-sensing data to estimate irrigated acres, and implement geostatistical and machine-learning approaches to spatially and temporally estimate groundwater use for irrigation. The real-time flow meter data collected as part of this project, when coupled with real-time remote sensing data, will allow for real-time prediction of water use. Estimates from the water-use model will be used directly as input into the current groundwater-flow model, which will help guide future refinement of both the water-use and groundwater models, capture uncertainties in the data, and identify data gaps.

Updates to a Groundwater Flow Model to Facilitate Decision Support and Uncertainty Analysis for the Mississippi Alluvial Plain

Peterson, S.; Fienen, M.; Clark, B.; White, J.

A recently-updated groundwater model of the Mississippi Embayment has previously provided key information and decision support for stakeholders and serves as the foundation for the Mississippi Alluvial Plain project for continued decision support tool development. The MODFLOW-2005 groundwater model was updated to use the Newton-Raphson solver, which provided an improved ability to simulate the nonlinear unconfined aquifer. The streamflow routing network was updated with a more detailed and comprehensive representation of surface water features. Recharge was updated using outputs from a Soil-Water-Balance model generated through a companion study. The MODFLOW-2005 model also was converted to MODFLOW-6 to take advantage of the most-current (2018) software improvements available and to facilitate future refinement. Existing calibration targets were retained with the exception of stream base flow, which also was updated through a companion study. Forecast uncertainty for stakeholder-identified scenarios is being evaluated through history matching and uncertainty analysis using PEST and a newly developed iterative ensemble smoother.

In addition, the value of potential future data is assessed through using the updated model to quantify their role in reducing uncertainty of stakeholder-identified forecasts. This type of analysis, known as “data worth” analysis, is being used to prioritize geophysical mapping and hydrogeologic monitoring efforts so that the data collected is most valuable to model-simulated future conditions. Such analyses can be repeated as necessary as new societal concerns arise and as new understanding of the MAP system is gained.

Riverbank Filtration, Transfer, and Injection Pilot Project along the Tallahatchie River for Enhanced Aquifer Recharge: Progress and Plans

Rigby, J.; Ozeren, Y.; Holt, B.; Pophet, N.

The USDA-ARS is conducting a pilot study to investigate the potential for using aquifer storage and recovery technology to augment recharge to the Mississippi River Valley Alluvial Aquifer (MRVAA). This study proposes to use riverbank filtration to capture water from the Tallahatchie River for direct injection in the aquifer. Preliminary investigations of interaction between the river and the aquifer were conducted near Money, MS including continuous resistivity profiling of the subsurface, bathymetric characterization of the river channel and a pumping test to analyze drawdown and recovery of groundwater levels at fifteen observation wells up to 300 meters from the river. The pilot study will combine an extraction well along the Tallahatchie River with a transfer pipeline approximately 2 miles long to a set of injection wells west of the river. Locations have been chosen for the pilot study and a design is being developed. This presentation will review the conceptual model of the pilot study, results from investigations at Money, MS, and the timeline for the pilot study construction and operation.

Reservoirs & Streams

John Ramirez-Avila *(Mississippi State University)*	Impacts of Riparian Buffer Zones on Stream Water Quality: A Quantitative Assessment in the Catalpa Creek Watershed
Xiaobo Chao *(University of Mississippi)*	Study of Sediment and Nutrients in Pelahatchie Bay and Upland Mill-Pelahatchie Creek Watershed
John Ramirez-Avila *(Mississippi State University)*	A Project-Based Learning Study Oriented to Develop a Natural Stream Restoration Design
Jae-Young Ko *(Jackson State University)*	Adopting Ecosystem Services for Enhanced Sustainable Communities by Wetlands Assimilation of Wastewater and Water Quality Credit Trading

Impacts of Riparian Buffer Zones on Stream Water Quality: A Quantitative Assessment in the Catalpa Creek Watershed

Ramirez-Avila, J.; Grafe, J.; Schauwecker, T.; Ortega-Achury, S.; Martin, J.; Noble, T.; Czarnecki, J.

Riparian buffer zones importantly affect stream water quality and its ecosystem's structure and function. A study was conducted to determine if there is a measurable difference in water quality conditions between forested or grassed riparian zones along tributaries of the Catalpa Creek Watershed. The study considered field data and laboratory analysis. Weekly monitoring was performed at 18 stations along the tributaries during fall 2017. The study reaches consisted of an upstream segment covered by a forested riparian zone and a downstream segment in which grass grew and was mowed along both sides of the stream. Stream water temperature along the forested riparian segments were lower (13.9°C to 27°C) than those along the grassed riparian zones (15.0°C to 31.5°C). The differences in water temperature between forested and grassed riparian zones were smaller as the air temperature decreased during the late fall season. Overall, the instantaneous concentration of dissolved oxygen (DO) along the reaches was always higher than 6 mg l-1, a higher concentration than the standard proposed by MDEQ (5.0 mg l-1). The DO concentration along the stream was sometimes higher for grassed riparian zones, which can be attributed to reaeration caused by an abrupt change in slope, depth and flow velocity downstream of the forested riparian zone. However, DO concentrations at the end of the grassed riparian segments reached similar or lower values than those observed along the forested riparian segment. No adverse impacts on water quality were caused on the monitored reaches due to levels and temporal or spatial variability of pH in the stream water. The spatial variability of pH appears to be consistent with the spatial variability of DO concentrations for all the studied reaches. Forested riparian zones can reduce stream water temperatures and maintain favorable DO concentrations and pH, with a biological significance for living organisms in the stream. Consequently, establishment and maintenance of forested riparian zones might provide benefits in mitigating adverse impacts on stream ecology and water quality.

Study of Sediment and Nutrients in Pelahatchie Bay and Upland Mill-Pelahatchie Creek-Watershed

Chao, X.; Bingner, R.; Zhang, Y.; Yasarer, L.; Jia, Y.

Ross Barnett Reservoir is the largest drinking water source in the state of Mississippi. Pelahatchie Bay is a part of Ross Barnett Reservoir, and located in the southeast corner of the reservoir. The upland watershed of Pelahatchie Bay contains a high percentage of construction sites and developed area, causing a lot of sediment and associated pollutants to discharge into the bay through runoff. In addition, sediment, nutrients, and other pollutants may also flow into Pelahatchie Bay from the upstream Pelahatchie Creek.

The major water quality problem in Pelahatchie Bay is sedimentation, which causes high turbidity and limits boat navigation in the bay. The levels of nitrogen and phosphorus in the bay are relatively high and cause excessive growth of aquatic plants.

In this study, the AnnAGNPS watershed management model, developed at the USDA ARS, National Sedimentation Laboratory (NSL), are applied to simulate the loads of runoff, sediment and nutrients from the upland watershed. The simulated results are used as boundary conditions for CCHE, a free surface flow, sediment and water quality model developed at the National Center for Computational Hydroscience and Engineering (NCCHE), to simulate the flow, sediment transport and water quality processes in the Pelahatchie Bay. The concentration distributions of sediment and nutrients, and their variations in time due to the influence of loading, wind, and the operation of the Ross Barnett Reservoir are simulated.

This study provides a useful tool to evaluate the effectiveness of watershed BMPs on water quality in Pelahatchie Bay. Information obtained from the research can be used by decision makers to develop improved watershed management plans to achieve maximum water quality benefits to Pelahatchie Bay.

A Project Based Learning Study Oriented to Develop a Natural Stream Restoration Design

Ramirez-Avila, J.; Delgado, T.; Buie, T.; Schauwecker, T.; Martin, J.; Ortega-Achury, S.; Czarnecki, J.

The Natural Channel Design (NCD) approach to stream restoration was developed to reproduce the function of natural streams. Headwater tributaries of Catalpa Creek in Mississippi are on an urban fringe and have been experiencing impacts of progressive development over the last decade. The runoff depth and peak flows from stormflow events have increased, inducing incision and streambank erosion. A project-based learning study involving senior and graduate Civil and Environmental Engineering students was developed to determine the hydrologic, hydraulic and geomorphologic functions of different reaches along three tributaries of Catalpa Creek and propose a stream restoration design following the NCD approach. The design considered restoring floodplain connectivity, increasing sinuosity and reducing active erosion. The goal and specific objectives of the study were addressed combining field reconnaissance and detailed data collection, laboratory analysis and computational modeling techniques. Hydraulic, hydrologic and geomorphologic data were collected and analyzed including channel and floodplain survey, flow depth and velocity at different stages, sediment loads, and streambank material. Hydrologic assessments were completed using GIS applications and the HEC-HMS model. The HEC-RAS model was used to assess existing stream conditions and to test the effectiveness of the proposed restoration design, which will include in-stream structures to decrease potential effects of near bank shear. The presentation will detail the characteristics of the proposed restoration design and the learning outcomes from the based learning project.

Adopting Ecosystem Services for Enhanced Sustainable Communities by Wetlands Assimilation of Wastewater and Water Quality Credit Trading

Ko, J.

Adopting ecosystem services as policy tools in achiving sustainable communities have been advocated by academicians and government officials. Adopting natural ecosystem services increases local community's capacity to comply with environmental regulations (e.g., Clean Water Act) without significant financial burden, while keeping ecological integrity of natural ecosystem surrounding human community. For example, more than half of communities in State of Mississippi has been failing in compliance of wastewater treatment permit, because they are in economically depressed region, causing harms to the human health, and the aquatic ecosystems. Natural wetland assimilation of municipal wastewater increases water quality of wastewater, contributing to increased compliance of wastewater permit with highly reduced engineering and operating costs, and increased vegetative productivity. Water quality credit trading - another policy tool of adopting ecosystem services – is an EPA approved policy which allows credit trading between polluters and local stakeholders of unimpaired watershed on nutrients (e.g., total nitrogen) and sediments. After considering that State of Mississippi is economically poor and a rural state, adopting ecosystem services has significant potentials of increasing compliances of environmental regulation with less financial burden, and generating additional financial revenues to local communities. However, currently the two policy tools are not available in the State of Mississippi, even though the EPA endorses them. The presentation discusses the opportunities of introducing the two ideas to Mississippi.

Management of Water Resources in Mississippi

Patricia Phillips *(MDEQ)*	Water Resources Data Availability
Chris Hawkins *(MDEQ)*	Water Resources Data Management
Casey Fitzgerald *(MDEQ)*	Water Use in Mississippi
Andrew Cummings *(MDEQ)*	Safety of Flood Control Dams in Mississippi

Water Resources Data Availability

Phillips, P.; Watts, J.

A primary objective of the Mississippi Department of Environmental Quality (MDEQ), Office of Land and Water Resources (OLWR) is to research and manage the water resources of the state to assure adequate supplies for the future, which requires a significant amount of data and information, much of which is easily available to the public. OLWR maintains geographical information system (GIS) data sets, attribute data, and links to related data. GIS data sets include groundwater wells, surface water diversions, public water supply wells and their protection areas, and dams across the state with the associated data for each record. The Water Resources Information System (WRIMS) includes data such as the owner, well construction information, beneficial use, water levels, water quality information, groundwater and surface water permit information, and surface water discharge measurements. Selected data from WRIMS is the source of attribute data for some of our GIS data sets. OLWR also tracks water use for selected wells. Public water supply wells in the Source Water Assessment Program can be viewed online via a web map. This web map includes data about potential contaminants provided by OLWR as well as other sources such as MDEQ's Office of Pollution Control and the Environmental Protection Agency. OLWR's Dam Safety Division also maintains a web map that allows viewing of dams, inundation areas from simple breach analyses, and these data's associated attributes. Along with data, OLWR provides information on its various programs, forms, permit applications, well completion reports, and water well drillers' licensing. OLWR also provides links to outside source data such as the Office of Geology's geophysical logs, the Yazoo Mississippi Delta Joint Water Management District's water permit data, and water compendium that includes GIS data from MDEQ's various water related programs.

Water Resources Data Management

Hawkins, C.

The Office of Land and Water Resources (OLWR) is responsible for the management of the water resources in Mississippi. In order to accomplish this, the OLWR collects and maintains a significant amount of data. This data includes groundwater and surface water withdrawal permit information, such as landowner and permittee contact information, groundwater well construction data, beneficial uses, permitted volumes, locations, etc. It also includes water quantity data, water quality data, compliance and enforcement actions, and other pertinent information associated with the states aquifer systems and streams. Most of this information has been maintained in the OLWR's current database the Water Resources Information Management System (WRIMS) for over 15 years, while other data either existed on spreadsheets or paper files. OLWR is developing a new database that not only will house all the information being maintained in WRIMS but would also incorporate other datasets needed to manage the state's water resources. The new database will also serve as a tool for processing surface water and groundwater withdrawal permit applications. The first phase of this web-based database will be in production this spring with other phases to follow over the next two years. This upgrade will be a vast improvement over the aging WRIMS database and help in making informed decisions associated with Mississippi's water resources.

Water Use in Mississippi

Fitzgerald, C.

The Office of Land and Water Resources (OLWR) is responsible for the management of the water resources in Mississippi. Mississippi code requires that "...the water resources of the state be put to beneficial use to the fullest extent of which they are capable, that the waste or unreasonable use, or unreasonable method of use, of water be prevented, that the conservation of such water be exercised ..." This is achieved through the water withdrawal permitting process which is informed by the inventorying and assessment of the availability of water associated with fresh water aquifers and major fresh water streams in Mississippi and through the evaluation of water use as reported to MDEQ. Programs for reporting how much of the State's water is used and how it is used are in place for agriculture, industry, public supply, private and commercial areas. These programs provide the OLWR with information needed to assess future permitted water use parameters, whether current conservation methods are effective, as well as allow the OLWR to develop plans to better manage the State of Mississippi's water use for future generations.

Safety of Flood Control Dams in Mississippi

Cummings, A.

In the 1960's and 1970's, the USDA Soil Conservation Service (now the Natural Resource Conservation Service [NRCS]) constructed hundreds of earthen dams throughout the State. These dams were constructed primarily for flood control purposes under the directives of PL-534 and PL-566. They were designed and built using federal funding and were locally sponsored by county or local drainage districts. As part of the agreement the drainage districts accepted the responsibility for the maintenance and operation of the dams. Unfortunately, many of the drainage districts are no longer functioning, or are not functioning as intended. Nearly all of these dams have maintenance issues (some serious), but without a functioning drainage district to hold accountable, correcting these issues is a challenge. The MDEQ Dam Safety Division has been working with the NRCS, the Mississippi Soil and Water Conservation Commission (MSWCC), local governments, and landowners to try to bring these dams into compliance with State regulations and prevent dam failures. This presentation will discuss the status of these dams as well as previous and future efforts planned to try and improve the condition and safety of these dams.

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