31st Annual Alabama Water Resources Conference Proceedings

Orange Beach, AL 4-6 Sep 2019
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Alabama Section of the American Water Resources Association
Symposium Program

ALABAMA SECTION of the
AMERICAN WATER RESOURCES ASSOCIATION
Symposium
WEDNESDAY, SEPT. 4 - 1:00pm - 4:40pm

“The Power of Partnerships”

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<th>Time</th>
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<tr>
<td>10:00 am</td>
<td>Registration Opens (Lobby)</td>
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<tr>
<td>1:00 - 1:20 pm</td>
<td>Welcome &amp; Introductions</td>
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<td>1:20 - 2:00 pm</td>
<td>Slices of the Watershed PIES—Planning, Innovation, Engagement and Science</td>
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<td>Auburn University &amp; Alabama Cooperative Extension System</td>
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<td>2:00 - 2:40 pm</td>
<td>Collaborative Conservation from a Private Forest Landowner Perspective</td>
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<td>Forest Sustainability Resource Management Service, LLC</td>
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<td>3:10 - 3:50 pm</td>
<td>Learning to Love Ourselves</td>
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<td>3:50 - 4:30 pm</td>
<td>Building Better Conservation Through Partnerships</td>
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<td>Environmental Sustainability, Toyota Motor North America, Inc.</td>
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<td>4:30 - 4:40 pm</td>
<td>Announcements &amp; Adjourn</td>
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<td>5:30 pm</td>
<td>Social and Dinner</td>
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## AWRC Conference Program
### Session Topics and Presenters

### Concurrent Session 1
**THURSDAY, SEPT. 5 - 9:15am - 10:35am**

#### CLIMATE, DROUGHT, & FLOOD ISSUES I - SALON D
**MODERATOR:** GREG GUTHRIE, GEOLOGICAL SURVEY OF ALABAMA

1. **Drought Management Plans in Major Cities of Alabama v. California.** Philip Chaney, Auburn University
2. **Response of Fluvial Suspended Sediment Fluxes and River Discharge to Future Climate Change on a Global Scale.** Nishani Moragoda, The University of Alabama*
3. **Coastal Mapping Completion: A Look Back at the Decade Long Process to Update Alabama Coastal Flooding Hazards.** Jeff Zanotti, Wood Environment and Infrastructure Solutions, Inc.
4. **Predicting Pine Tree Growth and Evapotranspiration in Southeastern United States.** Henrique Haas, Auburn University*

#### MODELING IN WATER MANAGEMENT - SALON E
**MODERATOR:** BRIAN ATKINS, ALABAMA DEPARTMENT OF ECONOMIC & COMMUNITY AFFAIRS

2. **A Depth-Averaged Soil Moisture Model and Its Applications.** Junhao He, Auburn University*
3. **River Temperature Forecasting for Wheeler Reservoir, Alabama.** Daniel Saint, Tennessee Valley Authority
4. **Creation, Calibration and Validation of a Field-Scale SWAT Model in the Lower Flint River Basin.** Danielle Tadych, Auburn University*

#### AQUATIC ECOLOGY - SALON F-H
**MODERATOR:** TACONYA GOAR, ALABAMA DEPARTMENT OF CONSERVATION & NATURAL RESOURCES

1. **Partnering for Protection: How Aquatic Species and Water Quality Benefit from a Multidisciplinary Approach to Conservation.** Rebecca Bearden, Geological Survey of Alabama
2. **Physiological Effects of Temperature and Handling on Recovery of Largemouth Bass from Simulated Angling Stress.** Colin Dinken, Kleinschmidt Associates
3. **Comparison of Benthic Invertebrate Communities Upstream and Downstream of New Culvert Installations in Alabama.** Amy Gill, U.S. Geological Survey
4. **Marine Snow Facilitates a Novel Entry Pathway for Domoic Acid into the Marine Food Web.** Israel Marquez, University of South Alabama / Dauphin Island Sea Lab*
Concurrent Session 2
THURSDAY, SEPT. 5 - 10:45am - 12:05pm

CLIMATE, DROUGHT, & FLOOD ISSUES II - SALON D
MODERATOR: PATRICK O’NEIL, GEOLOGICAL SURVEY OF ALABAMA

1. Extreme Floods on the Middle Tennessee River. Lisa Davis, The University of Alabama
2. Investigating Soil Moisture and Streamflow Predictability in the National Water Model and in the Humid Alabama-Coosa-Tallapoosa River Basin. Yanan Duan, Auburn University

COASTAL ISSUES - SALON E
MODERATOR: SABRA SUTTON, ALABAMA ASSOCIATION OF CONSERVATION DISTRICTS

3. Flooding History of Mobile Bay and Weeks Bay: Building Long-Term Environmental Records to Help Future Predictions and Coastal Resiliency. Rebecca Totten Minzioni, The University of Alabama

STORMWATER - SALON E-H
MODERATOR: ASHLEY HENDERSON, ALABAMA SOIL AND WATER CONSERVATION COMMITTEE

1. Improving SWMM Hydraulic Accuracy Using Artificial Spatial Discretization. Daniel Allasia, Federal University of Santa Maria
3. Developing the Best CBMPP with Limited BMP’s. Perry Oakes, Alabama Soil and Water Conservation Committee
4. An Innovative Lining Strategy to Prevent Channel Erosion. Jose Vasconcelos, Auburn University

12:15 pm - 1:30 pm - Lunch (Grand Reef)
CONCURRENT SESSION 3
THURSDAY, SEPT. 5 - 1:40pm - 3:00pm

RESTORATION & REMEDIATION - SALON D
MODERATOR: TODD BOATMAN, U.S. ARMY CORPS OF ENGINEERS
1. Three Mile Creek Invasive Species Control Plan. Katie Dylewski, Mobile Bay National Estuary Program
3. Choccolocco Creek Watershed Conservancy District - 60 Years and Growing. Jennifer Yates, Choccolocco Creek Watershed Conservancy District
4. Documenting Changes to Streambank Condition and Habitat Suitability in the Coosa River Bypass. Brett Connell, Trutta Environmental Solutions

IRRIGATION - SALON E
MODERATOR: SHANNON WEAVER, U.S. DEPARTMENT OF AGRICULTURE
1. Using GIS Tools as Part of the Analysis and Assessment to Expand Irrigation in the Upper/Lower Choctawhatchee and Pea Watersheds. Jonathan Beeson, The University of Alabama in Huntsville*
2. Alabama Sustainable Irrigation Expansion Project Update. Eve Brantley, Auburn University / Alabama Cooperative Extension System - Water Program
3. Identifying Irrigated Agricultural Land Using Remote Sensing and Machine Learning. Ryann Firestone, Troy University; The University of Alabama in Huntsville Research Experience for Undergraduates*
4. Influence of Climate Variability on the Ecologically Sustainable Water Withdrawals from Streams for Irrigation. Laljeet Sangha, Auburn University*

CONNECTING AGENCIES, INDUSTRIES, & STAKEHOLDERS - SALON F-H
MODERATOR: BILLY TURNER, TROY UNIVERSITY
1. Managing Risks Related to Oil and Gas Development in Mississippi. Jason Barrett, Mississippi State University Extension
2. Estuary Program Implementation in Florida Panhandle. Darryl Boudreau, The Nature Conservancy
4. Working with Environmental Advocacy NGO’s and the “Public”. Cindy Lowry, Alabama Rivers Alliance

3:00 pm - 3:20 pm - Break
Concurrent Session 4
THURSDAY, SEPT. 5 - 3:30pm - 4:50pm

RESTORATION & REMEDIATION II - SALON D
MODERATOR: LYNN SISK, JACOBS

2. Testing the Mechanical and Hydrological Soil Strength Effects of Common Alabama Riparian Species when used as Live Stakes. Frances O’Donnell, Auburn University
4. An Interdisciplinary Collaboration Leads to an Assessment of Marsh Health in Fowl River, Alabama. Bret Webb, University of South Alabama

WASTEWATER SYSTEMS MANAGEMENT - SALON E
MODERATOR: CHRIS JOHNSON, ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

1. Reinventing Rural Wastewater Management: Challenges and Solutions for the Alabama Black Belt. Mark Elliott, The University of Alabama
2. Recent Developments in Real-Time Trace Metal Monitoring Technologies for In-Process Wastewater Applications. Tyler Sullens, Alabama Power Company
3. Communicating Rates with the Alabama Water and Wastewater Rates Dashboard. Annalee Harkins, UNC Chapel Hill - Environmental Finance Center

WATER LAW & POLICY - SALON F-H
MODERATOR: BARBARA GIBSON, CHOCTAW, PEA & YELLOW RIVERS WATERSHED MGMT. AUTHORITY

3. Panel Discussion: Navigating the Extremes - Past, Present and Future Southeastern US Streamflow and Implications for Policy. Glenn Tootle and Matthew Therrell, The University of Alabama

5:00pm - AWRA Business Meeting (Coral)
5:20pm - Poster Judges Meet at Registration Desk
**Concurrent Session 5**
FRIDAY, SEPT. 6 - 9:15am - 10:35am

**WATER QUALITY I - SALON D**
MODERATOR: JENNIFER RASPBERRY, ALABAMA POWER

4. Improving Water Quality Using an Adaptive Management Approach. Lynn Sisk, Jacobs and David Denard, Jefferson County Environmental Services Department

**GIS IN WATER MANAGEMENT - SALON E**
MODERATOR: ROY MCAULEY, MANUFACTURE ALABAMA

4. Using a Modified DRASTIC Model to Create an Aquifer Recharge Potential Map for Alabama. Mary Hastings Puckett, The University of Alabama*

**EDUCATION & STEWARDSHIP - SALON F-H**
MODERATOR: AMANDA FLEMING, KLEINSCHMIDT

2. Prichard Rain Barrel Program: Impacts and Education. Madison Blanchard, Mobile Bay National Estuary Program

10:35 am - 10:55 am - Break
Concurrent Session 6
FRIDAY, SEPT. 6 - 10:55am - 12:15pm

WATER QUALITY II - SALON D
MODERATOR: ASHLEY MCVICAR, ALABAMA POWER

2. Source Water Protection in Agricultural Watersheds. Shannon Weaver, US Department of Agriculture - Natural Resources Conservation Service
4. Water Turbidity Measurements for Rivers in Tombigbee River Basin and the Mobile Bay from Satellite Multispectral Imagery. Min Xu, The University of Alabama*

GROUNDWATER AVAILABILITY - SALON E
MODERATOR: BENNETT BEARDEN, ALABAMA STATE BAR - ENVIRONMENTAL SECTION

2. Impact of Groundwater Withdrawal for Irrigation on Surface and Groundwater Interactions in the Lower Apalachicola-Chattahoochee-Flint River Basin, USA. Ritesh Karki, Auburn University*
4. Time Series Hydrologic Monitoring within Karst Aquifers of Key Cave and Cathedral Caverns, Alabama, for the Protection of Sensitive Aquatic Biota. Gheorghe M. Ponta, Geological Survey of Alabama

WATER QUANTITY - SALON F-H
MODERATOR: TOM LITTLEPAGE, ALABAMA DEPARTMENT OF ECONOMIC & COMMUNITY AFFAIRS

1. Streamgage Network Analysis for Gulf States at Level-12 Hydrologic Unit Codes Based on GAM and SVM Difference Modeling. William Asquith, U.S. Geological Survey

Mohammad Al-Hamdan, Richard Smith, Anne Hoos, Gregory Schwarz & Richard Alexander
(United States Geological Survey) & William Crosson, Universities Space Research Association at NASA / MSFC

The USGS Spatially Referenced Regression on Watershed Attributes (SPARROW) surface water quality modeling system has been widely used for long term, steady state water quality analysis. However, users have increasingly requested a dynamic version of SPARROW that can provide seasonal estimates of nutrients and suspended sediment. The goal of this NASA-funded project is to develop a dynamic decision support system to enhance the southeast SPARROW model and finer-scale dynamic models for selected coastal watersheds through the use of remotely-sensed data and other NASA Land Information System (LIS) products. The spatial and temporal scale of satellite remote sensing products and LIS modeling data make these sources ideal for the purposes of development and operation of the dynamic SPARROW model. Remote sensing products including MODIS vegetation indices, SMAP surface soil moisture, and OMI atmospheric chemistry along with LIS–derived evapotranspiration (ET) and soil temperature and moisture products will be included in model development and operation. MODIS data will also be used to map annual land cover/land use and in conjunction with Landsat and Sentinel to identify disturbed areas that might be sources of sediment and increased phosphorus loading. These data and others constitute the independent variables in a regression analysis whose dependent variables are the water quality constituents total nitrogen, total phosphorus, and suspended sediment. Remotely-sensed variables such as vegetation indices and ET can be proxies for nutrient uptake by vegetation; MODIS Leaf Area Index can indicate sources of phosphorus from vegetation; soil moisture and temperature are known to control rates of denitrification; and bare soil areas serve as sources of enhanced nutrient and sediment production. The enhanced SPARROW dynamic models will provide improved tools for end users to manage water quality in near real time and for the formulation of future scenarios to inform strategic planning. Time-varying SPARROW outputs will aid water managers in decision making regarding resource allocation in protecting aquatic habitats, planning for harmful algal blooms, and restoration of degraded habitats, stream segments, or lakes.
Abstract No. 4. Improving SWMM hydraulic accuracy using artificial spatial discretization

Robson Pachaly (Auburn University), Daniel Allasia (Federal University of Santa Maria) & Jose Vasconcelos (Auburn University)

Rainfall regimes in Alabama are severe, particularly in the southern portions of the state. In such situations, urban stormwater collection systems undergo rapid filling and eventual pressurization, which in turn can lead to structural damage, manhole cover displacements, geysering and other issues. In order to perform design tasks or even diagnostics of existing drainage systems, numerical modeling tools such as the EPA’s Storm Water Management Model (SWMM) are applied, even in situations where severe inflow conditions are used. Efforts to improve SWMM hydrology modeling accuracy have been taken with better geospatial information, better characterization of land uses, and abstraction. Recent research has also been directed toward the ability of SWMM to improve the hydraulic characterization of closed conduit flows, particularly in intense inflow conditions. Such improvements have results in better predictions of rapid changes in hydraulic grade lines, surging episodes, and even closed conduits flow transients.

Among the techniques that have been used to improve SWMM hydraulic predictions, it is included the use of smaller computational time steps and use of artificial discretization. The latter is a departure of the original link-node approach used in SWMM, but a necessary change to represent dynamic inflows. This work presents results from ongoing investigations on the use of artificial spatial discretization in SWMM to improve hydraulic modeling accuracy. Results from link-node models representing a field data collection of a sudden discharge and the SWMM 5 QA Report are compared with a discretized alternative, showing much improved accuracy. A newly-developed tool to aid in the process of spatial discretization of SWMM will also be presented.
Abstract No. 6. *Groundwater Well Classification in Alabama*

**Ann Compton Arnold,** Geological Survey of Alabama

The Geological Survey of Alabama Groundwater Assessment Program (GSA-GAP) is currently evaluating wells in the real-time and periodic networks throughout the State to place them into subnetworks of background, suspected or documented changes in water-level elevations, using the USGS National Groundwater Monitoring Network (NGWMN) framework. This framework requires that wells have a minimum of five years of data to be included in the NGWMN. Five areas have tentatively been identified for the background subnetwork, which contains wells that are not affected by intensive groundwater withdrawal. Background areas are situated in low-yielding aquifers of the Cumberland Plateau or Piedmont region, with few major public supply or agricultural wells. Overall, the GSA-GAP approach is to identify areas in the State with clusters of high-volume pumping wells, which would be placed in either the suspected or documented changes subnetwork.

The Alabama Office of Water Resources (OWR) furnished current certificates of use data, providing locations for wells capable of extracting >100,000 gallons per day, chiefly for municipal, agricultural or industrial purposes. Existing GSA-GAP observation wells within areas of significant groundwater use, will be evaluated for potential aquifer drawdown. The primary areas being evaluated for the suspected changes subnetwork are located in the Gulf Coastal Plain, Valley and Ridge, and Highland Rim aquifers. Wells in the suspected changes subnetwork show some influence from groundwater withdrawal. To date, no areas have been classified as documented changes. Future studies will include analyses of available pump test data and delineation of water-level trends in major Alabama aquifers within these areas.
Abstract No. 7. Streamgage network analysis for Gulf States at level-12 hydrologic unit codes based on GAM and SVM difference modeling

Elena Crowley-Ornelas & R. Knight, U.S. Geological Survey

The majority of Gulf States, level-12, hydrologic unit codes (HUC12s) do not have historical or current streamflow monitoring. Statistically-based streamflow predictions at the pour point outlets of HUC12s are important drivers of subsequent scientific interpretations. To improve future statistical models, a need exists to analyze the USGS streamflow-gaging station (streamgage) network. To address this need, the U.S. Geological Survey (USGS), in cooperation with the Gulf Coast Ecosystem Restoration Council, is investigating statistical relations between streamflow and predictor variables in the greater Gulf State region (390,000 square miles).

For this presentation, various analyses of the streamgage network estimated the 10th (low flow), 50th (mid flow), and 90th percentiles (high flow) (quantiles) of streamflow at about 8,250 HUC12 outlets focused on the 2000 decade. The HUC12s outlets have a median accumulated (upstream) basin area of 75 square miles and an interquartile range of 250 square miles. Network analysis means, in part, that we seek to identify which of about 8,250 unmonitored HUC12s in the study area and simultaneously east of a statistical demarcation line (for elimination of semi-arid Texas zones) have the largest uncertainties in streamflow estimates relative to others. Streamflow quantiles were computed from observed daily-mean streamflow for about 850 stream gages and comprising about 2,400 decades (1950 through 2000; as many as six decades per streamgage). Attendant watershed properties (prediction variables) for the stream gages, HUC12s, and decades are based in part on the National Hydrography Dataset.

Two estimation approaches (generalized additive models [GAMs] and support vector machines [SVMs]) are studied to estimate for the low-, mid-, and high-flow quantiles. GAMs are a flexible semi-parametric form of multi-variate regression, whereas SVMs are a form of machine learning adaptable to multi-variate estimation. The mathematics of these approaches are very different, and each approach has a method-unique characteristic tendency as each is tasked in some HUC12s to extrapolate either away from or across information gaps within the multi-variate hull of prediction variables. Divergent estimates between the GAM and SVM (the differences between their respective HUC12 estimates) are used to identify shortlist of HUC12s that, in a manner of speaking, have been inadequately represented by the greater streamgage network. Within this shortlist, various stakeholders might consider continued sponsorship of active stream gages, reactivation of discontinued stream gages, or expansion of the streamgage network.
Abstract No. 8. Managing Risks Related to Oil and Gas Development in Mississippi

Jason Barrett, Mississippi State University Extension

Mississippi is a state with abundant natural resources, long known for its fishing and wildlife habitats, agricultural operations, and rural way of life. An increase in oil and gas drilling and development across the state has brought about new challenges and potential benefits that force policy makers and landowners to make decisions regarding how best to manage the potential growth of the oil and gas industry. This is a situation where the needs for energy development, such as access to water and minerals and the needs for agriculture, forestry and wildlife must all be met simultaneously. Mississippi State University Extension is committed to assisting residents and their communities to make educated decisions about energy growth while maintaining and preserving the state’s environmental and agricultural resources. This presentation consists of an overview of the project, information on challenges and strategies for meeting local needs, findings from stakeholder focus groups, and program post-session evaluation results. Finally, we will discuss implications, future research, and additional outreach to address mineral exploration in Mississippi.
Abstract No. 9.  

Significant Cases and Opinions in Alabama Water Law and Policy

Bennett Bearden, Geological Survey of Alabama

Most of the cases that are currently applicable to Alabama water law were decided in the 1800s. The passage of the 1993 Alabama Water Resources Act began the evolution of modern water law and policy in the state. This presentation briefly analyzes the significant court cases, selected Attorney General Opinions, laws, and policies applicable to the Alabama water resources spectrum. This collection of legal and policy instruments demonstrates the interfaces among science, policy, and law in water resources policymaking, promotes the goals of the state by illustrating the importance of continued water investigations, and informs the ongoing statewide surface water and groundwater assessments in Alabama. This presentation will brief and summarize these legal and policy instruments with emphasis on important concepts or topics utilized in Alabama water law.
Abstract No. 10. Partnering for Protection: How Aquatic Species and Water Quality Benefit from a Multidisciplinary Approach to Conservation

Stuart McGregor, Geological Survey of Alabama

Ongoing projects initiated by the Ecosystems Investigations Program at the Geological Survey of Alabama (GSA) continue to be successful for species and water conservation by employing a multidisciplinary approach with a host of partners. GSA’s partnerships with various federal and state agencies, nonprofit conservation organizations, and academic institutions have generated a variety of statewide watershed restoration efforts that include aquatic species assessments, water quality surveys, habitat evaluations, and species behavior studies. These projects are approached from a multidisciplinary perspective that encompasses aquatic biology, hydrology, water chemistry, restoration ecology, and outreach. From performing surveys of endangered Alabama Cave Shrimp in the Tennessee River system to assisting with eDNA analysis for threatened Trispot Darters in the Coosa River drainage to assessing the water quality of Locust Fork for habitat restoration in the Black Warrior River drainage, the ability to form partnerships and apply a working knowledge of system interactions has been key to producing measurable results for conservation in Alabama.
Abstract No. 11. Using GIS Tools as part of the analysis and assessment to expand irrigation in the Upper/Lower Choctawhatchee and Pea Watersheds

Jonathan Beeson & Cameron Handyside, The University of Alabama in Huntsville

While Alabama and the larger Southeastern United States does receive higher average annual rainfall than many more heavily agricultural areas of the United States including the Great Plains, uneven rainfall distribution throughout the year as well as periodic drought conditions leads to a larger climate pattern that is not necessarily ideal for rain-fed agriculture. Irrigation provides reliability that farmers need to be competitive and it can be sustainably conducted both economically and environmentally. During intra-year dry periods and periodic droughts when irrigation demand is high, a proper sensitivity and irrigation density analysis is at its highest importance. Despite only containing 133,335 irrigated acres (2.8% of all farm land) according to the 2017 agricultural census, irrigation is likely still the largest single consumer of water in the state of Alabama.

As the National Resources Conservation Service (NRCS) Alabama office works with the Alabama Soil and Water Conservation Office to allocate funding to expand irrigation in the state of Alabama, a proper Sensitivity and Irrigation Analysis across selected HUC-8 watersheds is absolutely imperative moving forward. A basin that includes the Upper/Lower Choctawhatchee and Pea HUC-8 watersheds in Southeast Alabama is of particular interest. The Earth System Science Center at the University of Alabama in Huntsville is performing Sensitivity and Irrigation Density Analysis across these basins. Geographic Information Systems (GIS) tools are being used to compliment a larger Statewide Resource Assessment that is being developed in conjunction with Auburn University to support efforts by the NRCS and Alabama Soil and Water Conservation Office. The GIS tools are being used to identify critical environmental factors within the watershed that will be used to develop sensitivity analysis for wide-ranging criteria like water quantity and quality, threatened and endangered species, riparian agricultural land and economic benefit.

This analysis and presentation has been developed with guidance from faculty and staff at the University of Alabama in Huntsville, Auburn University, and additional guidance from diverse stakeholders including government agencies, non-governmental organizations, landowners, and other interested parties. This presentation will focus primarily on the usage of GIS tools to assist in Sensitivity and Irrigation Density Analysis in the basin, as well as ongoing plans to improve and ensure a high quality of data.
Abstract No. 12. *Juncus Isn’t Junky: How to Navigate Aesthetic Needs with Green Stormwater Implementation*

Laura Bell & Eve Brantley, Alabama Cooperative Extension System - Water Program

Understanding and acknowledging how local stakeholder perceptions impact the adoption of green stormwater infrastructure practices is a helpful step in integrating both green and grey stormwater management systems. As urban development continues and impervious surface cover expands, natural hydrology is interrupted. Natural drainage patterns are altered and water is channelized to quickly remove it from public spaces. This in turn increases the volume of water runoff, which can result in severe stream bank erosion and habitat alteration. Stormwater runoff poses a serious threat to water quality in urban settings, where the first flush of a storm can wash a large amount of sediments, plant nutrients, bacteria, chemicals, and other pollutants accumulated from impervious surfaces directly into receiving waterways. A growing number of U.S. municipalities are turning to a blend of gray and green infrastructure to adaptively manage stormwater runoff. However, the adoption of new stormwater management practices relies heavily on the willingness of municipalities, local planners, engineers, and other local government staff members accept changes in their aesthetic and maintenance expectations.

Perception influences not only maintenance strategies, but also the value placed on caring for and protecting green infrastructure as a practice. Community led water quality improvement often involves the recreation of ecological systems in urban areas, but these ‘natural’ systems require long term maintenance, care and investment from the community. Using the Moores Creek Project in Valley, Alabama as a case study, this talk will outline strategies for working with municipalities to gain public buy in and establish planting plans that meet ecological requirements while simultaneously signaling aesthetic maintenance and care.
Abstract No. 16. Prichard Rain Barrel Program: Impacts and Education

Madison Blanchard, Mobile Bay National Estuary Program

The Mobile Bay National Estuary Program is currently implementing a Low Impact Development (LID) stormwater management project with the installation of low-cost rainwater harvest systems, with a focus in the Toulmins Spring Branch Watershed (TSB), a sub-watershed in the greater Three Mile Creek Watershed. This sub-watershed is highly urbanized and was first placed on the State's impaired waters list for pathogens in 2004, with the primary source of impairment identified as stormwater runoff and failing sanitary sewer infrastructure. The Three Mile Creek Watershed Plan (2014) recommended implementation of LID practices to reduce stormwater impacts in the TSB area.

The Prichard Drainage Study, commissioned for Mobile County in 2016 to investigate issues related to urban flooding and nonpoint source pollution. Led by an Auburn University grad student hydrologist, the study surveyed the TSB drainage area and engaged homeowners to identify and map areas with recurrences of urban flooding, as well as sanitary sewer overflows. Identified hot spots became target areas for this Prichard Rain Barrel Program to reduce volumes and velocities of stormwater runoff. The purpose of this project is to improve the quality of the receiving waters in Toulmins Spring Branch. Goals include reducing volumes and velocities of stormwater runoff carrying nonpoint source pollution and causing sanitary sewer overflows impacting those receiving waters, and providing a free, alternate source of water to an under-served community that pays significantly higher rates for water than surrounding communities. Objectives include installing as many rainwater harvest systems in the headwaters of an urban area community draining to the impaired waterway as possible, and educating community members about the impacts of polluted stormwater runoff, inappropriate disposal of trash, and opportunities to become involved in activities to improve environmental conditions.

The program, initially implemented by Coastal Alabama Conservation Corps members in 2017, was officially reestablished in January of 2019 with private sector partners. Thirty-seven rainwater harvest systems have been installed for low-to-moderate-income homeowners, with 18 installed in 2017 and 19 installed so far in 2019. Each installation includes plumbing and spigots. Each system is capable of a 110-gallon reduction in stormwater runoff per rain event per residence.
Abstract No. 17. Estuary Program Implementation in FL Panhandle

Darryl Boudreau, The Nature Conservancy

Three Estuary Programs (EPs) based on EPA’s National Estuary Program (NEP) model are being implemented in the Florida Panhandle. Two of these programs have significant portions of the watershed in AL and are including AL entities in the program. This session will provide an overview of the EP implementation, an update on the progress for each EP and some of the key projects that have been implemented to date. The goal is to ensure AL stakeholders are aware of this work, understand some of the key initiatives, and leave with contact information for how to get involved.
Although the Southeast enjoys more annual rainfall than most of the U.S., it still experiences periodic droughts and the rainfall distribution throughout the year is not ideal for agriculture. In Alabama, agriculture is further impacted because of relatively poor water holding soils and lack of widespread irrigation. The need to pursue sustainable irrigation expansion and resource conservation in water rich states such as Alabama has been identified in farmer listening sessions. According to the irrigation status of harvested cropland in the 2017 agricultural census, Florida had about 1.3 million acres under irrigation, Georgia irrigated around 1.2 million acres, Mississippi had 1.8 million and Alabama had only 133,335 irrigated acres.

The Natural Resources Conservation Service (NRCS) Alabama office is working with the Alabama Soil and Water Conservation Committee to allocate financial assistance to sustainably expand irrigation in Alabama. Auburn University and the University of Alabama in Huntsville are supporting the effort through the development of a statewide resource assessment and follow up watershed plans for selected HUC-8 basins. The irrigation watershed plans examine alternatives for increasing acres of on-farm irrigation, identify natural and cultural resources that might be negatively impacted by expanded irrigated agriculture, estimate economic benefits, and evaluate environmental sensitivity concerns. Data at the HUC-12 level is provided where available to assist with the determination of sustainable expansion. Farmers selected for participation are prioritized using recommendations from the watershed plans and by categories including access to water and a record of stewardship practices.

The plans will be developed with coordination and guidance from diverse stakeholders including government agencies, non-government organizations, landowners, and others that are interested. This presentation will cover aspects of the overall project, provide updates on the recently completed draft Middle Tennessee River Basin watershed plan, and share future steps in planning for sustainable water use in Alabama’s agricultural industry.
Abstract No. 20. *Modeling Coastal watershed Erosion Potential with GIS and Expert Based Input for Improved Multi-Criteria Decision Analysis*

**John Cartwright**, Mississippi State University

Evaluating soil erosion is often assessed with traditional soil loss models like the Revised Universal Soil Loss Equation and similar models. These models are often integrated with Geographic Information Systems (GIS) to assist with execution and utilization. This project is focused on transitioning these types of models towards a Multi-Criteria Decision Analysis (MCDA) approach for improved decision support. The foundational effort of this phase of work is to add expert input to a previously developed conceptual GIS weighted linear combination (WLC) model for generalized watershed erosion potential. The Analytical Hierarchy Process (AHP) is used to value the importance of criteria based on expert input, providing a quantitative metric (weight) for qualitative data. The expert input increased the overall importance of topographic features, with topographic related criteria carrying half of the weight in the AHP model run. The results show that the AHP input to the conceptual model statistically changes to overall erosion potential. The AHP run of erosion potential was classified based on standard deviations for a comparison to the conceptual model. The AHP run changed classified cell counts most noticeably by decreasing counts in lower erosion potential classes and the moderate erosion potential class. The upper classes had increased cell counts, as did the base of cells around the mean erosion potential. The increase in the upper ranks was most evident in areas along the drainage areas of the rivers and streams of the watershed. The AHP weights were altered in 1% increments ranging from plus to minus 20% producing 41 runs per criteria or 201 unique runs. A quartile analysis was used to define areas of model agreement (or alignment) using a threshold of less than 25% outlier generation for each cell in the analysis. Allowing the application of an analysis mask to identify areas of increased erosion potential that could facilitate improved management related decisions.
Abstract No. 22. *Drought Management Plans in Major Cities of Alabama v. California*

**Meredith Moore, Philip Chaney, Eve Brantley & Christopher Burton, Auburn University**

The severe drought conditions impacting California and the Western U.S. over the last several years have led to greater awareness of the consequences of water scarcity and the need for effective drought policy. The Southeastern U.S. is not immune to this threat, as evidenced by the devastating droughts of 2007 and 2016. Without adequate management and effective planning, drought impacts and water scarcity issues are likely to become more severe. Few studies have critically analyzed local drought management plans and conceptualized the overall quality of the mitigation strategies. Characteristics of local management plans in California and Alabama were evaluated on three levels for key elements of sustainable policy (i.e., social, environment, and economic), the stages of drought management (i.e., pre-drought, during drought, and post-drought), and the level of detail and overall quality. This study presents a multi-state policy analysis for 7 key cities in Alabama (Auburn, Birmingham, Dothan, Huntsville, Mobile, Montgomery, and Tuscaloosa) and 8 key cities of comparable population size in California. The results confirm the assumption that drought management plans are more comprehensive in the western U.S. and they provide a roadmap for how cities in Alabama and the southeast can increase the level of preparedness. Recommendations for the development of successful local plans, particularly from the environmental pillar, pre-drought, and during-drought framework, are provided based on the higher scores of the California plans. These methods are a proactive approach to sustainably addressing water scarcity issues.
Abstract No. 23. *Comparison of Hydropeaking Metrics Utilizing Sub-Hourly Data Before and After Implementation of Flow Management*

**Kristie Coffman & Elise Irwin**, USGS Alabama Cooperative Fish and Wildlife Research Unit

Rivers and streams have natural variability in flow, also known as the natural flow regime. Components used to describe the natural flow regime of a river include the magnitude, frequency, timing, duration, and rate of change of flow events. These components can vary at annual, seasonal, daily, and even hourly time scales. Anthropogenic structures and activities, including hydroelectric dams and the production of electricity through hydropeaking, alter the natural flow regime. Because river hydrology is intrinsically linked to other features, such as habitat quality and geomorphology, changes to the natural flow regime can have widespread and profound impacts on the environment.

Understanding hydraulic alteration and its potential impacts is essential for predicting the consequences of restoration and management of flows. Analysis of flow regimes requires reliable long-term data. The US Geological Survey National Water Information System is a database providing real time and historical measurements of stream metrics, including discharge and gage height. Although many river gages take measurements at hourly or sub-hourly time scales, daily values are often the default choice for researchers and managers when it comes to comparison of temporal variation in flow regimes. Utilizing daily data to describe flow regimes in rivers with modified flows may often fail to capture flow alteration that can occur at sub-hourly time scale, especially in hydropeaking systems. Consideration of temporal scale when assessing impacts is needed for successful monitoring and restoration of river systems.

Data from gages below R.L. Harris Dam (Tallapoosa River, Alabama) were used to determine if sub-hourly discharge metrics varied as a function of hydropeaking management during long-term implementation of adaptive management below the dam (i.e., Green Plan). Since 2005, R.L. Harris Dam has operated by attempting to mimic upstream unregulated flows at the dam to achieve stakeholder and environmental objectives. Flow metrics analyzing the annual distribution of discharge, sub-daily flow fluctuation and flow-ramping rates were calculated for reaches of the Tallapoosa River variably regulated by R.L. Harris Dam. Results indicate that the Green Plan has reduced the sub-daily flow fluctuation and flow ramping rates, and shows a reduction of flow coinciding with the summer and fall months. Results from these analyses will be useful for determining impacts from the Green Plan and for suggesting future changes to the R.L. Harris Adaptive Management Project.
Abstract No. 106. Documenting changes to streambank condition and habitat suitability in the Coosa River Bypass

Brett Connell, Trutta Environmental Solutions

The 267-mile Coosa River begins near Rome, Georgia formed by the confluence of the Oostanaula and Etowah rivers and flows in a southerly direction where its meets with the Tallapoosa River to form the Alabama River. The Coosa River is a highly regulated river with nine hydropower reservoirs. In Cherokee County, Alabama, the Coosa River flows into Lake Weiss. Water released from Lake Weiss flows either through hydropower dam or through a spillway. Water released from the spillway flows into the Coosa River in the river segment known as the Coosa River Bypass. Water from hydropower generation flows into the Coosa River 19 miles downstream from the spillway. In the past, almost all the water at normal flow rates flowed into the Diversion Canal for electricity generation, leaving little water flowing in the Coosa River Bypass.

Beginning in 2014 under its new operations plan, Alabama Power Company (APC) has been providing environmental flows (consistent low flows) in the Coosa River Bypass in order to improve riverine habitats within the Bypass reach. To better understand changes from the four-year implementation of environmental flows in the Coosa River Bypass, APC contracted Trutta Environmental Solutions to complete a High Definition Stream Survey for a segment of the bypass reach. We collected longitudinal and cross-section transects which included high definition video of the streambanks and channel, sonar readings of water depth, and sidescan sonar imagery of the river bottom. The field data was classified to create continuous GIS layers for depth, left and right bank condition, habitat type (pool, shoal, run, riffle), surface water velocity, substrate type/bottom structure, substrate embeddedness, instream cover, and the presences of large woody debris. Habitat suitability analysis for the endangered mussel and snail species was created using a combination of depth, habitat type, surface water velocity and bottom structure data. Habitat suitability was compared with prior reintroduction areas to determine the quality of past sites and the possibility of additional reintroduction sites. The streambank condition was compared with a past survey completed in 2012 to document the change in bank condition over time. This project highlighted the ability of the High Definition Stream Survey method to rapidly document streambank condition and habitat for endangered mussels within the Coosa River Bypass.
Abstract No. 27. Extreme floods on the middle Tennessee River

Lisa Davis & Ray Lombardi (The University of Alabama), Christopher Stewart & Gary Stinchcomb (Murray State University) & Steve Forman, Baylor University

Paleoflood analyses use physical evidence of flooding, in this case sedimentary deposits, to reconstruct the timing and magnitude of floods that occurred prior to historical and instrumented records. We have developed a 2,200 year flood record for the middle Tennessee River in Alabama, spanning major climate transitions and pre-dating human occupation. The flood chronology provides unique insights into flooding not available from streamflow and precipitation records, which are too short to adequately characterize and understand rare and extreme floods. Our findings suggest that floods that occurred in the last 1000 years were moderate in size in comparison to floods that occurred in the 1000 years prior. This finding is based on the occurrence of medium to coarse sands in the sedimentary flood record that we interpret as a proxy for flood magnitude. Importantly, the sedimentary flood record contained several floods that exceeded the size of the flood of record on the Middle Tennessee River--the flood of 1867. The implications of these findings for flood frequency analyses, pertaining to new guidelines in USGS Bulletin 17C, will be addressed.
Abstract No. 29. New Alabama Watershed Steward Program

Nikki Dictson, Eve Brantley, Laura Bell & Alex James, Alabama Cooperative Extension System - Water Program

Alabama Watershed Stewards is a new statewide watershed stewardship educational program that is being piloted in the impaired Pepperell Branch Watershed located in Opelika. Alabama has abundant water resources and unique watersheds with high biodiversity. Watersheds are threatened by nonpoint sources (NPS) of pollution which are detrimental to these valuable resources. To help combat this threat, federal and state water resource management agencies have adopted a watershed-scale approach for managing water quality. One vital component of this approach involves engaging local stakeholders to become actively involved in planning and implementing water resource management and protection programs in their watershed. To support this need for stakeholder involvement in both planning and implementation, the Alabama Department of Environmental Management, Alabama Cooperative Extension System Water Program, and Alabama Water Watch partnered to develop the Alabama Watershed Steward (AWS) program. The new statewide program will be piloted in the impaired Pepperell Branch Watershed. The goal of these workshops are to increase citizen understanding of watershed processes and to foster increased local participation in watershed management and protection activities. It is critical to have informed stakeholders to be involved in the planning process and to support implementation of water resource management measures. The workshops will be conducted in communities that are working on watershed planning and TMDLs to increase understanding, stewardship, and adoption of management practices that will protect and restore watersheds in Alabama. The curriculum handbook and modules include: Program Introduction, Overview of Watershed Systems, Overview of Watershed Impairments (Pollution), Managing to Improve Watershed Function, and Community Driven Watershed Protection and Management. Workshop evaluations will be implemented to determine attendees: demographics, satisfaction with training, willingness to adopt best management practices to reduce nonpoint source pollution, intentions to participate in local planning or conservation, to take an active role in expanding watershed education efforts, and promoting watershed protection activities in their community. The information will also be available digitally to reach an even greater audience, as today’s information consumer utilizes mobile devices and other content delivery platforms. The digital approach ensures that all have access to science-based information that improves their quality of life and economic well-being in a way that connects and inspires communities. A digital toolbox for this program will be created that will include websites, social media, videos, digital publications, and e-newsletters to assure that the education program is accessible. A summary of this new program and the evaluation results from the pilot trainings will be presented.
Abstract No. 30. Physiological effects of temperature and handling on recovery of Largemouth Bass from simulated angling stress

Kevin Keretz, (Kleinschmidt Associates), Hal Schramm (USGS retired) & Peter Allen (Mississippi State University)

Post-release survival of angled black bass may vary due to cumulative physiological effects of multiple, sub-lethal stressors, notably ambient water temperature, live well water temperature, and handling. Although tournaments for Largemouth Bass, *Micropterus salmoides*, are common, connections between typical procedures, physiological stress, and mortality are not well established. Therefore, the objectives of this study were to examine the effects of acute temperature change (-4, 0, +4 °C) and handling stress over a range of acclimation temperatures (17, 25, 33 °C). Bass were initially reared in tanks and later in ponds, with a finishing diet of live forage 4-6 weeks prior to experimentation. Following acclimation to treatment conditions, fish were stressed by chasing to simulate angling, transferred to 4 replicate live wells where temperature and dissolved oxygen were manipulated for 8 hours, subjected to a simulated weigh-in procedure, and released into recovery tanks at acclimation conditions. At each stage, blood was sampled from a subset of fish and stress metrics were measured in blood (hematocrit, hemoglobin, pH, pO2, pCO2, Na+, K+, Ca2+, and Cl-) and plasma (cortisol, glucose, lactate, and osmolality). Fish acclimated to 17 °C showed the greatest cortisol response following the chasing stressor. However, higher levels of glucose, lactate, pCO2, and K+ were found at 33 °C, and blood pH and Cl- were lower at 33 °C than at 17 °C. When live well temperature was manipulated, cortisol levels were highest in fish subjected to the coldest conditions (acclimated to 17 °C and retained in 13 °C and 17 °C live wells) and the warmest conditions (acclimated to 33 °C and retained in ΔT = +4 °C live wells). However, all fish subjected to these colder extremes survived, whereas 100% mortality occurred in the warmest condition after 8 hours of live well retention. With the exception of cortisol, indicators of stress were less pronounced in colder temperatures. Glucose, lactate and K+ concentrations were highest in 37 °C live wells and blood pH, Ca2+, Na+, and Cl- were lowest. Mortality at high temperature may result from exhaustion of aerobic and anaerobic energy sources, failure to recover from metabolic acidosis, and an inability to regain ionic balance.
Abstract No. 31. Investigating Soil Moisture and Streamflow Predictability in the National Water Model and in the Humid Alabama-Coosa-Tallapoosa River Basin

Yanan Duan, Auburn University

Land surface states represented by soil moisture condition is a key source of climate and hydrological predictability. This study investigates effect of initial soil moisture conditions in state-of-the-art National Water Model (NWM) streamflow and soil moisture predictability. We have designed and implemented seasonal streamflow forecast experiment for the ACT River basin in the southeastern United States. We perform two set 220 ensemble seasonal streamflow forecast experiment: first set with realistic soil moisture initial conditions and second set with random soil moisture initial conditions. The realistic soil moisture states are generated from the last 7 days before forecast start date. The random states are selected from a different year but in the same date. We use observed climate forcing for 15 years: 5 El Niño, 5 La Niña, and 5 normal years and four seasons in the experiment. We found that the Streamflow predictability is significantly higher than soil moisture. The streamflow can be predicted for 30 days lead time with random forcing and for greater than 90 days with best (observed) climate forcing. ISMS tend to have higher impacts in dry seasons. There are 21%, and 41% contributions of pure ISMS, and climate forcing, respectively to streamflow forecast accuracy averaged across 4 seasons and 90 days of forecasts. This study provides a basis for developing sub-seasonal to seasonal streamflow forecast system and improve the forecast skill.
The Three Mile Creek Invasive Species control plan was funded through the Gulf Coast Ecosystem Restoration Council and the RESTORE Act to address recommendations of the 2014 Three Mile Creek Watershed Management Plan. The WMP identified abundances of invasive species and submerged aquatic vegetation as major ecological challenges to the health of the Creek and its drainage area. A team undertook extensive field sampling in May and September 2018, and delivered the completed Plan to the Mobile Bay National Estuary Program in April 2019. The scope of the Plan included:

- Describing existing watershed conditions, including a baseline inventory of target invasive plant and animal species, relative abundances and distributions, and a baseline map;
- Identifying control/management options for each, including biological, mechanical, and chemical treatments;
- Recommending preferred management alternatives;
- Providing a recommended calendar/schedule of control activities;
- Identifying required resources;
- Prescribing subsequent monitoring to assess success; and
- Determining total anticipated costs.

To quantitatively evaluate invasive species extent, the Team used a plot-based sampling design to document invasive and native species and their locations within major waterway corridors. They sampled over 369 plots: 266 in late spring and 102 in the fall. The Team provided matrices which included each of the 43 identified invasive species with distribution and cover data, invasiveness rankings, and species-specific schedules of recommended preferred and secondary treatment activities.

The Team developed a strategy to address Three Mile Creek’s iconic animal invader, the island apple snail, apparently inadvertently released from aquaria in the early 2000s to infest Langan Park’s lakes and spread downstream. A trip around the highly irregular banks of the lakes would reveal a jaw-dropping number of pink egg masses laid several inches above the water line on the surfaces of concrete infrastructure and emergent vegetation. Control of this species may require intensive, systematic manual removal of adults and eggs from along the lake’s shore before using a drip system with chelated copper to eliminate the snails from the main stem of the Creek downstream. The Plan represents the most prescriptive and comprehensive resource for invasive species control in coastal Alabama watersheds. It can be found on the MBNEP website at www.mobilebaynep.com/news/three_mile_creek_invasive_species_control_plan.
Abstract No. 33. Hurricanes and coastal response: Building a longer history of storms and associated ecosystem response for the Alabama and Mississippi coasts

Emily Elliott & Rebecca Minzoni (The University of Alabama); Davin Wallace (The University of Southern Mississippi); Lisa Davis (The University of Alabama); Matthew Waters (Auburn University) & Asmara Lehrman, The University of Alabama - Department of Geography

In recent years, the Southeastern United States (US) has experienced land-falling Hurricanes Harvey, Irma, Maria, Florence and Michael, which have been characterized as some of most damaging in the modern record. While these storms have been unprecedented in the instrumental period, placing them within a long-term (millennial), high-resolution record of tropical cyclone (TC) activity for the Southeast that can adequately capture long-term storm frequency and intensity is critical in understanding the drivers of extreme storms that track on the Alabama and Mississippi coastline. In addition to the physical damage TC activity can have along the coast, these high-energy events have long-lasting impacts on the ecosystems they disturb. From those leading to diasporas from Dauphin Island in 1717 to those in living memory—including Frederic, Ivan, and Katrina- TC activity has impacted Mobile Bay and led to short-and long-term shifts in the water properties, bay ecology, and barrier island morphology. Developing accurate, regionally representative records of TC activity along the northern Gulf of Mexico region is essential for placing recent TC activity within a long-term context and determining the long-lasting impacts of this sort of acute disturbance on overall ecosystem resiliency.

Through collaborative research efforts between the University of Alabama, Auburn University and the University of Southern Mississippi, this project seeks to not only add to and extend the record of TC activity for AL-MS, but further investigate the immediate effects of hurricanes on bay system ecology and barrier island dynamics. Working across the AL-MS coast in Mobile Bay and Mississippi Sound, this work will 1) test the relative influence of event scale disturbances like storms (inland floods and TC) to human activities (e.g., dams, shipping channels, agricultural, sewage and industrial inputs, etc.) on eutrophication, hypoxia, and salinity shifts and 2) identify baseline conditions of these stressors prior to European settlement. Preliminary data from central bay records from Mobile Bay, in addition to sediment records from Bon Secour Bay and Dauphin Island have been analyzed using grain-size analysis to detect storm associated marine sediment flux to the system, and will undergo pigment, phytoplankton assemblage and geochemical analysis to provide important constraints on ecological response to historic and pre-historic TC activity. The sediments contained in the study bays and adjoining river drainages are archives of the last ~9,000 years of environmental change—far exceeding the instrumented record— and capable of yielding new insights relating storms, human impacts and ecosystem health for the entire eastern seaboard. Our data will provide historic reference conditions and key controls on ecosystem stability through time, ultimately aiding in the development of long-term predictors of ecosystem resiliency and success for the entire Southeastern US.
Abstract No. 34. Reinventing Rural Wastewater Management: Challenges and Solutions for the Alabama Black Belt

Mark Elliott (The University of Alabama), Kevin White (University of South Alabama) & Mark Barnett, Auburn University

The historical Black Belt region in central Alabama is characterized by its population, rural character, poverty, lack of economic development, low educational attainment, poor access to health care, and a prevalence of clay soil conditions. These characteristics are shared by parts of Mississippi, Georgia and Appalachia. Rural poverty in the Black Belt has recently received national and international attention for its lack of access to appropriate sanitation. Most residents of this region do not have access to sewer, and thus, according to US law, are responsible for treating their wastewater onsite. However, impermeable shrink-swell clay soils in many areas prevent septic systems from infiltrating wastewater into the ground. These conditions have resulted in failure of septic systems and the use of “straight pipes” (direct discharge of raw sewage to the ground). Surveys reveal raw sewage on the ground surface in 50% or more of the rural homes in some Alabama counties. Troubling preliminary evidence of water quality and health effects has emerged; elevated concentrations of fecal microbes and evidence of parasitic helminth (worm) infections in Black Belt residents have been reported. The geological, technical, regulatory, social, financial and political challenges that have enabled this situation to develop and persist are diverse and complex. Our team is collaborating with state agencies, congressional offices and the Governor’s office to identify and develop five major approaches to address rural wastewater management in the Black Belt of Alabama.

1. Identify, cost, and prioritize specific wastewater needs for each Black Belt county;
2. Develop, test and catalog viable clustered and onsite wastewater technology options;
3. Explore and define viable funding mechanisms for both capital and O&M costs;
4. Develop alternative regulator strategies for onsite wastewater;
5. Develop a “How To” guide for local communities/counties to follow for obtaining funding and implementing sustainable wastewater infrastructure.
Abstract No. 35. Developing a tool for cost-optimal design of green infrastructure practices

Ross Ellis, Auburn University

Urban development projects typically increase the stormwater runoff of a site by increasing the amount of impervious area, which can also negatively impact the quality of the water leaving a site. Often, best management practices (BMP) such as detention basins are used to store runoff while it is slowly released from a site. Green infrastructure practices (GIP) make stormwater management more sustainable by reducing construction and operation costs associated with required detention, reducing environmental impacts of new construction, and improving the aesthetics of a project. A common barrier to sustainable stormwater management is the cost and wide range of GIPs available to designers, but this can be remedied by implementation of an algorithm to select a cost-optimal combination of GIPs. Cost optimization models have been developed for the design of individual BMPs such as infiltration and bio-retention basins. Models have also been developed to determine optimal location of BMPs and GIPs for stormwater management, but these concepts have not been adapted to provide detailed design configurations that will yield optimal cost reduction. The goal of this research is to develop a user-friendly tool that helps urban planners, designers, and engineers achieve sustainable stormwater management through cost optimization of green infrastructure practices. The user interface of this tool will be contained within Microsoft Excel to be accessible to any user. Preliminary efforts to develop an optimization model have employed the General Reduced Gradient (GRG) Nonlinear solver function in Excel to optimize the footprint area, excavated depth, and outlet structure design of a detention basin to minimize land use and earthwork costs while maintaining peak outflow below pre-development peak runoff. While the preliminary model generated optimal design solutions, this method had many limitations. The solutions were highly dependent on the initial conditions of the optimization input by the user, and the algorithm cannot perform calculations with discontinuous functions. To improve functionality and develop a more general optimization model, the General Algebraic Modeling System (GAMS) will be used to model the nonlinear optimization problem. GAMS has been used to solve a similar problem for infiltration basins, and can perform optimization using a mixed integer nonlinear programming model (MINLP) which can perform calculations with continuous and discontinuous nonlinear functions. GAMS models are executable from Excel, and the software is free and readily available. The hydrological parameters used to calculate a cost-optimal solution can be calculated in the Storm Water Management Model (SWMM) from user inputs. The Excel tool will execute SWMM calculations and export the relevant parameters to the GAMS model. This research will benefit municipalities and developers that wish to incorporate green infrastructure practices into their stormwater management plans.
Abstract No. 36. Studying Alabama’s water using the GRACE satellites

Johanna Engström, the University of Alabama - Department of Geography

Changing water quantities and location can be estimated using the Gravity Recovery and Climate Experiment (GRACE) satellites. By measuring differences in the Earth’s gravity, the satellites provide monthly data on regional changes in the Earth’s mass resulting from the movement of water.

Studying the Southeast U.S, using the full record of the GRACE satellites (2002-2016), a significant trend of declining water quantities appear in west-central Alabama. These findings confirm earlier research which indicate declining streamflow levels, but develops this research further as it also includes an estimate of the amount lost. The affected area extends into Mississippi and the total water loss adds up to over 10 km³ for the whole region and over 5 km³ in Alabama alone.
Abstract No. 37. Development of Low-Flow Frequency Equations for Ungaged Locations on Streams in Alabama

Toby Feaster, U.S. Geological Survey

Alabama water-resource managers need up-to-date low-flow frequency statistics for planning, management, and permitting decisions to help ensure adequate water availability for consumptive use, water-quality standards, recreation, and aquatic habitat protection. In 2017, the U.S. Geological Survey (USGS), in cooperation with other local and State agencies in Alabama, published selected annual low-flow frequency statistics at 210 continuous-record streamgaging stations in Alabama and 67 stations from basins that are shared by surrounding states (https://pubs.er.usgs.gov/publication/sir20175083). However, such low-flow statistics are also needed at ungaged locations. As such, the USGS began a second phase of the low-flow project to develop low-flow frequency regression equations for selected low-flow frequency statistics for ungaged stream sites in Alabama. The selected low-flow frequency statistics include annual minimum 7-day average flows with recurrence intervals of 2 and 10 years (7Q2 and 7Q10, respectively) and annual minimum 1-day flow with a recurrence interval of 10 years (1Q10). The stations included in the regression study are a subset of the stations published in the USGS 2017 report and were selected based on stations that are not substantially affected by regulation, diversions, or urbanization. This oral presentation will discuss the exploratory regression analyses and the preliminary findings from the second phase of this study. The USGS anticipates publishing these findings in a USGS Scientific Investigations Report in Federal fiscal year 2020.
Abstract No. 38. **Identifying Irrigated Agricultural Land using Machine Learning**

**Ryann Firestine & Cameron Handyside,** The University of Alabama in Huntsville REU

Over the last century, western states of the U.S. have taken the lead in agriculture. Despite their bountiful yields, their means of production continually drain the available water in the arid climate. However, across the country, Alabama receives more rainfall than nearly anywhere else in the continental U.S., but consistently falls short of the average yearly yield. Where is all of that moisture going? The heavy rainfall typical of the winter months in the southeast is the source for hundreds of streams and rivers that flow throughout the state; a very small percentage of that water finds its way into the fields due to the very limited irrigation.

An initiative started by academic institutions in the state, including the University of Alabama in Huntsville has worked to incentivize farmers to adopt irrigation as an economic and conservation measure. To understand how irrigation may expand, we first have to understand where irrigation currently exists to access the current use of water. To do that, we turn to the Moderate Resolution Imaging Spectroradiometer (MODIS) mounted on the Terra satellite. For this project we are particularly interested in the Enhanced Vegetation Index (EVI). The EVI is calculated using readings in the near infrared, red, and blue part of the electromagnetic spectrum. Healthy vegetation will have high EVI, whereas plants that are stressed or dying will have a lower EVI.

We use the USDA’s National Agricultural Imaging Program to first identify the agricultural crop land within Alabama’s Houston and Limestone counties. Using this crop mask, we extract all relevant EVI data within this agricultural land. Center pivots are the most prevalent form of irrigation in the state, so we assume that everywhere there is a center-pivot, it is most likely to be irrigated crop land. Thus, in addition to separating the crop land from non-agricultural land, we also use the in-house center pivot survey data to further classify this EVI data into irrigated land EVI values and rain fed land EVI values. This is where our machine learning model comes in.

Our Machine Learning model is first trained on all of irrigated and rain fed (not irrigated) crop land EVI data within Limestone County. Subsequently, this model is tested on the EVI data values from Houston County to predict the ground truth. Then, we use the actual ground truth data to evaluate how the model performed. The machine learning models we use are binary classification algorithms like logistic regression and the random forest. When we are relatively confident in the results of the current model and the measurements provided by the EVI, we plan on expanding our study to other vegetation indices and satellite products. The ultimate end goal is to produce a product that can identify the irrigated cropland across the state and then provide estimates of water usage. Once we understand current water use, we can begin considering how it can expand for irrigation in each region.
Abstract No. 39. Comparison of Benthic Invertebrate Communities Upstream and Downstream of New Culvert Installations in Alabama

Amy Gill, U.S. Geological Survey

Geomorphological and biological conditions in stream segments potentially affected by new culvert construction were investigated as part of a cooperative study between the Alabama Department of Transportation (ALDOT) and the U.S. Geological Survey (USGS). Five streams in the Coastal Plain of Alabama where new box culverts were proposed were selected for study. Biological conditions were assessed by comparing benthic invertebrate community structure upstream and downstream of proposed culvert installations before and after culvert construction. Invertebrate community samples were collected from 4 sites during the summer of 2011. The fifth site was not sampled because it was dry. Samples collected in 2011 were intended to be an assessment of pre-construction conditions, but the new culvert was already installed at the Tributary to Cahaba near Centreville. Post culvert construction invertebrate sampling for the 5 streams was carried out during summers of 2014, 2017, and 2018. Invertebrates were identified and enumerated by the USGS National Water Quality Laboratory using a 100-organism subsample method. Data were delivered in a spreadsheet format that could be easily used as input files to the USGS Invertebrate Data Analysis System (IDAS). The IDAS facilitated the calculation of multiple metrics of invertebrate communities for the 5 sites which remained in the study. Metrics were then compared between each culverts upstream and downstream reaches to look for significant differences.

The initial study hypothesis was that community composition (metrics) should be similar between upstream and downstream reaches before culvert construction but that communities would change in response to construction if there were related changes in hydrology, geomorphology, substrate stability, and other physical habitat characteristics. Changes to the composition of invertebrate community may also change the values of community metrics. Data from preconstruction samples indicated there was already variability between upstream and downstream reaches so the revised study hypothesis was the upstream-downstream variability prior to construction will be different from upstream-downstream variability measured post construction if culvert construction has changed stream conditions. The Wilcoxon rank sum non-parametric statistical test was used to evaluate differences between upstream and downstream metrics before and after culvert construction. Before-construction upstream to downstream differences for all sites were pooled and compared to pooled post-construction differences using an exact Wilcoxon rank sum test. Not all sites were sampled both before and after culvert construction. The pool of before construction samples contained 3 sample differences, and the pool of post-construction samples included 7 sample differences. All community metrics calculated by IDAS were tested by the Wilcoxon rank sum test for variation in the observed reach differences between pre and post construction. Total taxa richness, total abundance, EPT taxa richness and abundance, and average tolerance values did not have statistically significant differences, however, graphs of these metrics reveal some differences in reach characteristics. Statistically significant differences were found for richness of odonates and non-chironomid dipterans, abundance of odonates, and abundance of organisms in the climber behavioral group.

Gregory Guthrie, Geological Survey of Alabama

Sustained health and growth of communities in Alabama are dependent on freshwater supplied by an interconnected and diverse surface water-groundwater hydrologic system, which faces potential threats to availability and water quality in the coming decades due to increased demand and pollution due to population growth, land conversion and development, periodic drought, and coastal flooding related to sea level rise. This presentation will describe the groundwater monitoring and groundwater modeling initiatives at the Geological Survey of Alabama Groundwater Assessment Program. These initiatives are designed to provide state and local stakeholders with information that will enable them to make long-term science-based management decisions regarding groundwater-surface water responses to a dynamic hydrologic system influenced by these changing conditions to promote sustainable water resources in the state.
Abstract No. 41. *Predicting Pine Tree Growth and Evapotranspiration in Southeastern United States*

**Henrique Haas; Latif Kalin & Puneet Srivastava**, Auburn University

As a watershed scale hydrological model, the Soil and Water Assessment Tool (SWAT) can simulate processes such as surface runoff, infiltration, lateral flow, groundwater, return flow, canopy storage, and evapotranspiration (ET). ET usually represents the largest fraction of the water balance and, at a continental scale, can account for approximately 60% of the lost precipitation. However, ET is often overlooked by modelers and model parameters related to this variable are coarsely adjusted in order to approximate other simulated hydrological variables (e.g., streamflow and soil moisture) to observed values. ET is fundamental to land and water management because of its impact on soil moisture, baseflow, stormflow, and overall water availability for human and aquatic ecosystem use.

ET links hydrology, land processes, and climate interactions, and is affected by factors such as rainfall, temperature, solar radiation, wind speed, and phenology. Only a handful of hydrological modeling studies have assessed ET from pine plantation in southeastern US using actual measurements for model calibration and validation. In this study, we apply one of the most widely used watershed models, SWAT, in predicting ET and Leaf Area Index (LAI) at two Loblolly pine (*Pinus Taeda*) plantation fields in southeastern US. Loblolly pine represents over 50% of pine plantations in southeastern US and some studies predict that the planted area will increase by more than 70% by 2060. The study sites consist of a 5 hectare plot in Georgia (GA), where an average of 58 mm of water is lost to evaporation each year, and a 20 hectare plot in Alabama (AL), where an average of 72 mm of water is lost to evaporation each year. Model plausibility for LAI and ET was tested using remote sensing estimates derived from the NASA’s Moderate Resolution Imaging Spectroradiometer (MODIS) at 4 and 8 days intervals, respectively. Our model results show that SWAT can predict ET and LAI fairly well; Nash-Sutcliffe efficiency coefficient (NSE) of monthly LAI was 0.61 and 0.49 for the sites in GA and AL, respectively, whereas, for ET, it was 0.43 and 0.70.

Correlation analysis showed a strong and positive association between LAI and ET with a Spearman’s Rho coefficient of 0.89 and 0.77 for the sites in GA and AL, respectively. Despite model uncertainties, our findings suggest that SWAT is capable of predicting field-scale ET and that LAI development strongly affects ET rates.
Abstract No. 92. Communicating Rates with the Alabama Water and Wastewater Rates Dashboard

Austin Thompson, UNC Chapel Hill - Environmental Finance Center

To assess what water and wastewater utilities are charging customers across Alabama, ADEM and the Environmental Finance Center at UNC-Chapel Hill conducted a survey of water and wastewater rates, representing utilities across the state. These survey results are reflected in the Alabama Water and Wastewater Rates Dashboard, a tool designed for utility managers and decision-makers to evaluate their rates and conservation pricing signal, assess financial health, and measure affordability.

This presentation will introduce audience members to the Alabama Water and Wastewater Rates Dashboard, provide an explanation of how to use the tool, and describe the benefits of using the dashboard to communicate rates. At the conclusion of the presentation, audience members should have a thorough understanding of what the dashboard is and how to use it effectively.
Abstract No. 42. Water Use in Alabama - An Update

Michael Harper & Tom Littlepage, Alabama Office of Water Resources

In 2019, the Alabama Office of Water Resources (AOWR) released the latest update to the Water Use in Alabama series of reports. The report entitled “Estimated 2015 Water Use and Surface Water Availability in Alabama” is based on an analysis of 2015 data submitted under the Alabama Water Use Reporting Program and other data sources. It also includes significant enhancements to the report with the addition of consumptive water use summaries and an assessment of surface water availability. This will be the planned format for all future Water Use in Alabama reports. In this presentation, summaries of 2015 water withdrawals will be provided in eight primary water use sectors including:

- Public Water Supply
- Residential Water Use
- Industrial Water Use
- Thermoelectric Water Use
- Mining
- Irrigation Water Use (including nursery and sod use)
- Livestock Water Use
- Aquaculture Water Use

Summaries of the 2015 consumptive water use will also be provided in the following three sectors:

- Public Water Supply
- Agriculture
- Industrial, Thermoelectric, and Mining

The presentation will also provide comparisons to previous data and highlight how the Water Use in Alabama series fits into Alabama’s on-going water use assessment methodology as well as continue to be an integral aspect of the water resources management planning process.
Abstract No. 43. A depth-averaged soil moisture model and its applications

Junhao He & Latif Kalin (Auburn University), Mohamed Hantush (U.S. EPA National Risk Management Research Lab), Sabahattin Isik (Auburn University), & Mehdi Rezaeianzadeh, NOAA National Water Center

Modeling water movement in variably saturated porous medium is fundamental to environmental research and management. The Richards Equation (RE) has been widely studied and applied in soil physics and hydrologic studies due to its clear physical basis and applicability. However, solving RE numerically has always been challenging because it is a highly nonlinear, degenerate elliptic-parabolic partial differential equation which makes the design and analysis of numerical scheme very difficult. In this study, Depth-Averaged approximation of RE (DARE) was obtained for one-dimensional vertical unsaturated flow in the root zone and the vadose soil below. Essentially, the partial differential equation was replaced by two, coupled ordinary differential equations describing depth-averaged soil moisture dynamics in the two soil zones subject to a deep or shallow water table and variable soil moisture flux and pressure conditions at the surface. DARE was assessed for three uniform soil textures having high, medium and low permeability subject to different fluxes and prescribed pressure conditions at the soil surface combined with water-table and free-drainage bottom boundary conditions. The numerical results were compared with HYDRUS-1D model as a benchmark. In addition, DARE was tested against site level soil moisture data gathered from several sites from Soil Climate Analysis Network (SCAN). Results showed that DARE simulated results matched well with that from HYDRUS-1D. DARE predicted average soil moisture contents under real weather scenarios showed good consistency with site level soil moisture data. For large scale applications or in field-scale models where only average moisture content of few soil layers are needed, DARE can be a robust methodology for simulating soil moisture dynamics.
Abstract No. 45. *Flood Mitigation Successes in Huntsville*

Byron Hinchey, S&ME, Inc.

Huntsville was the cotton trading center of the Tennessee Valley during the 1840s and ‘50s. Flash forward 150 years, Huntsville is a thriving, high-tech, metropolitan area. The City has experienced a population growth of 14% in the last decade, and is projected to be the largest city in Alabama by 2025. Increased flood risk is often an unintended consequence of community growth and Huntsville is not immune to urban flooding.

Severe flooding in the Aldridge Creek valley inundated hundreds of homes in the late 1990’s prompting the City to initiate a flood mitigation program to identify flood risks, develop and design flood mitigation projects, and seek funding opportunities to implement projects. Following successful implementation of a flood mitigation project along Aldridge Creek that removed 99 homes from the Floodway and hundreds of homes from the floodplain, the community turned its focus to flooding along Pinhook Creek in downtown Huntsville.

Again using a FEMA HMGP grant, the community is currently improving conveyance along 3 streams, and correcting a century-old inadvertent stream diversion, that will shrink floodplains and floodways and reduce flood risk for hundreds of properties. The flood mitigation project includes channel improvements, bridge/culvert improvements, home relocation, regional detention, and stream diversion. Design and construction required extensive coordination with ALDOT and Norfolk Southern Corporation with both have transportation systems in the project corridor. Grant funding was approved in 2018 and construction is imminent.
Abstract No. 46. **GIS Use and Benefits of Watershed Master Plan Development and Evaluation – Double Hammock Creek Watershed**

**Heather Hyde** (Jacobs), **Jezabel Pagan-Garcia & Joella Schultz** (Southwest Florida Water Management) & **George Thomas**, Pasco County

As part of the Southwest Florida Water Management District’s Watershed Management Program, Jacobs developed the Watershed Evaluation and Management Plan (WEMP) for Double Hammock Creek Watershed located in Pasco County. The watershed is approximately 13 square miles, relatively flat, highly urbanized, tidally influenced, and features some closed-basin systems with an aging infrastructure. The WEMP efforts included identifying data gaps and evaluating the Digital Elevation Model for elevation discrepancies either from LiDAR post-processing or subsequent development. In addition to the general watershed feature data regarding land use, soils, potentiometric surfaces, and topography, many as-built construction plans were reconciled into the watershed geodatabase representing both inventory features and those features identified to be modeled. Using the HydroNetwork dataset stormwater features, initial catchments were developed through GIS processing for ArcHydro and were subsequently grouped into processed subbasins based on preferential flow paths. Survey was conducted to supplement stormwater inventory and other data sources. The model ready geodatabase developed during evaluation was used to build a robust watershed scale hydrologic and hydraulic model. Using the Green-Ampt method for runoff estimation, the model could account for varying groundwater conditions. The model was verified for 2012 Tropical Storm Debby known flooding information and was subsequently used to develop 100yr floodplain delineations. In addition to the 100yr floodplain development, smaller storm events were evaluated for a level of service (LOS) analysis. The LOS analysis was conducted for both roadway features and building structures. Critical features such as evacuation routes or hospitals were given priority within the ranking system. The benefit of a large scale WEMP for LOS analysis includes the ability to identify an extensive coverage of both flood impacts and flood duration.

Additionally, a cost evaluation was performed to calculate flood damage estimates for the different storm events. A LOS analysis can also help identify at risk emergency response routes. Conceptual BMPs were evaluated for both the 100yr and smaller storm events. With a WEMP, BMPs can be analyzed to assess either risk aversion or resiliency reliance. Risk aversion removes flood impact risks and a resiliency evaluation allows for a structure to be reasonably flooded, sometimes exemplifying a more cost-effective flood management approach. With the LOS analysis, a BMP cost benefit evaluation was performed to promote an implementable prioritized projects list to improve LOS rankings. Completing a WEMP allows for both individual or combined regional scale conceptual BMPs to be evaluated for benefits. The evaluation also allows for pre-planning benefits to permitting, regulatory consideration, and funding prioritization. The BMPs evaluated can also cover studying water quality credit options.
Abstract No. 48. *Nutrient Management in Alabama, "A Regulatory Update"*

**Chris Johnson**, Alabama Department of Environmental Management (ADEM)

Nutrients are essential building blocks for a healthy aquatic community. However, overabundance of nutrients, such as phosphorus and nitrogen, to a waterbody can create undesirable affects such as algal blooms, oxygen deficits, flora and fauna imbalances, and fish kills. Nutrient over enrichment of surface waters in Alabama has been a primary focus of ADEM’s water protection programs over the past two decades.

An overview of ADEM’s overall nutrient management strategy for Alabama’s surface waters will be presented to the audience. The Department’s past, present and future efforts to address cultural eutrophication will be provided to include an overview of ADEM’s adopted numeric nutrient criteria for Alabama’s lakes and reservoirs, 303(d) assessment and listing results, nutrient total maximum daily loads (TMDLs) development and water quality monitoring. An emphasis of the presentation will focus on ADEM’s analysis of water quality monitoring trends in phosphorus, nitrogen and algal (chlorophyll-a) levels throughout the State of Alabama over the past several years.
Abstract No. 50. Impact of Groundwater Withdrawal for Irrigation on Surface and Groundwater Interactions in the lower Apalachicola-Chattahoochee-Flint River Basin, USA

Ritesh Karki, Puneet Srivastava & Jasmeet Lamb, Auburn University

The Upper Floridan Aquifer (UFA) is one of the most productive aquifers in the United States and is the principal water source for irrigation as well as industrial and domestic water uses in the lower Apalachicola-Chattahoochee-Flint (ACF) River Basin in Alabama, Georgia, and Florida. With nearly 500,000 acres irrigated from about 4,000 wells, UFA is a major source of water for agricultural irrigation in the lower ACF River Basin. In recent years, stress on the UFA has increased with increasing agricultural acreage, population, industry, and more frequent drought conditions. This has become a major concern in the region and has led to increasing conflict for water allocation between Georgia, Florida, and Alabama as well as for habitat destruction of the federally endangered mussel species in the region. An increasing trend in water withdrawals from the UFA for crop production in the lower ACF is projected by the Georgia State-wide Water Management Plan, which will likely cause further decreases in groundwater levels and increased stress on the UFA. The objective of this study was to evaluate the effects of current and projected irrigation water withdrawals from the UFA on groundwater levels, groundwater budget, and stream-aquifer fluxes in the lower ACF. A three-dimensional groundwater flow model of the UFA over an area of 4,632 mi2 in the lower ACF was developed using the USGS Modular Three-Dimensional Finite-Difference Ground-Water Flow Model (MODFLOW). The model was calibrated and validated for transient conditions for the period 2008 to 2013 for groundwater levels and stream-aquifer flux, which included both wet and dry climate periods. The model was then used to simulate projected irrigation scenarios and quantify the effects of the projected water withdrawals on the UFA. Preliminary results show that the UFA contributes, on average, more than 1000 Million gallons per Day (MGD) of water to the perennial and ephemeral streams in the lower ACF, which shows the importance of contribution from UFA to streamflow in the lower ACF. Evaluation of the projected irrigation scenario in a drought year showed that groundwater level may decrease by as much as 15 ft when compared to current groundwater levels. Groundwater contribution to streams could decrease by as much as 100 MGD during the growing season as a result of increase in water withdrawals.
Abstract No. 51. Streamflow Alteration Assessments Supporting Bay and Estuary Restoration in Gulf States – Update

Rodney Knight, U.S. Geological Survey

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?
Abstract No. 52. Implementing a Comprehensive Strategy to Create Trash-Free Waters in the Three Mile Creek Watershed, AL

Jason Kudulis (Mobile Bay National Estuary Program) & Don Bates, Osprey Initiative

In November 2016, the first Litter Gitter was installed on the Maple Street Tributary to One Mile Creek, one of the most trash-impacted and infested urban waters in the Three Mile Creek (TMC) Watershed. Following the success of this pilot project, the Mobile Bay National Estuary Program received a grant from the USEPA Gulf of Mexico Program to install Litter Gitters at 10 strategically-located stormwater outfalls in the TMC Watershed to reduce the amount of stormwater-borne trash and litter. The “Litter Gitter,” is a small-stream litter collection device used to intercept floating litter from stormwater runoff. Partnering with Osprey Initiative, the brains and muscle behind the device, additional goals of this project include piloting the USEPA’s Escaped Trash Assessment Protocol (ETAP), conducting tactical single pass cleanups, developing a web tool to report and collect litter data, and implementing an alternative packaging program targeting businesses in TMC.
Abstract No. 56. *Working with Environmental Advocacy NGO’s and the “Public”*

**Cindy Lowry**, Alabama Rivers Alliance

The environmental headlines in Alabama in recent years have been full of public health crises, political corruption, and lawsuits. If your agency or company interacts with environmental advocacy organizations and/or has been a subject of any of these headlines, you are at best, frustrated, and more likely, ready to join the fight to do away with public participation completely.

Leaving consumers and taxpayers and those who are often most impacted by government decisions and industry operations out of the conversation is not a productive pathway, so how do we shift the paradigm from adversarial, costly strategies to collaborative problem solving? It starts with gaining a better understanding of stakeholder perspectives. This session is your chance to gain an inside perspective of a longtime environmental advocacy leader. This will be an interactive session. We will analyze case studies, hear tips on communicating and building relationships with advocates, and participants will have a chance to ask questions (even uncomfortable ones if done in a civil manner).
Abstract No. 58. *Marine snow facilitates a novel entry pathway for domoic acid into the marine food web*

**Ann Abraham** (U.S. Food and Drug Administration Gulf Coast Seafood Laboratory) & **Jeffrey Krause**, University of South Alabama / Dauphin Island Sea Lab

Domoic acid (DA) is a known neurotoxin produced by diatoms from the cosmopolitan genus *Pseudo-nitzschia*. DA is responsible for amnesic shellfish poisoning and its transfer through the marine food web may pose a threat to human health. Copepods (e.g. *Acartia tonsa*), benthic infauna, shellfish, cephalopods, and fish can act as vectors for DA, which appears to rapidly accumulate in the food web despite loss variables that favor quick degradation in the water column and depuration from animal tissue. The observation that DA can be detected in higher trophic level organisms when *Pseudo-nitzschia* abundance and toxicity are low, suggests the scientific community may have overlooked a pathway(s) for how this toxin enters the food web. Using particle-free seawater spiked with a purified DA standard, two laboratory experiments (L1, L2) tested—and confirmed—that organic polymers could be formed and adsorb dissolved DA (dDA) from the ambient water. Experiment L2 included copepods in the bottles to test for DA accumulation via consumption of organic polymers bound with DA. In triplicate measurements, copepods accumulated 24.8 ± 4.7 pg DA copepod-1 in particle-free seawater treatments, confirming that copepods can accumulate a measurable amount of DA via this mechanism.

Five separate experiments using field-collected seawater were conducted to assess if this mechanism operated similarly with naturally present DA concentrations. In one experiment, triplicate measurements found accumulated DA in copepod tissue (14.4 ± 3.8 pg DA copepod-1). These data suggest ~34% of the assimilated DA entered via a dDA pathway. This experiment also had the highest *Pseudo-nitzschia* spp. abundance (2.3 x 10^5 ± 0.4 x 10^5 cells L^-1) and cellular toxicity (0.54 ± 0.07 pg DA cell^-1). Our results robustly demonstrate, through laboratory controlled and field-manipulation experiments, that DA can be assimilated through consumption of organic polymers (e.g. transparent exopolymers, marine snow) which scavenge DA—a pathway which does not require direct ingestion of the toxic DA-producing diatoms. Additionally, resuspended sedimentary organic matter which has sequestered the DA can be consumed, suggesting that DA can enter the food web during periods when no *Pseudo-nitzschia* spp. are present. This has crucial implications to how we monitor DA and the potential vectors for entry into the food web (e.g., filter feeding bivalves such as oysters) and whether other marine toxins can enter the food web through similar mechanisms.
Abstract No. 60. A Watershed Approach to Coastal Restoration

Christian Miller, Mobile Bay National Estuary Program

In 2013, the Mobile Bay National Estuary Program (MBNEP) embarked upon a holistic, watershed-based approach to guide coastal ecosystem restoration and protection measures recommended through watershed management planning. The MBNEP’s five-year Ecosystem Restoration and Protection strategy initiated this novel approach which prescribes development of watershed management plans (WMPs) to ensure that restoration projects are based in science and fit into an overall management program.

A watershed approach is a shift from traditional land use planning, where geopolitical boundaries limit what can be done to address problems. Conversely, a WMP is concerned with areas, independent of political boundaries, which drain to common receiving waters. This planning process, guided by the MBNEP’s Project Implementation Committee and watershed stakeholders, charts a conceptual course for improving and protecting the things people most value about living along the Alabama coast. In addition to meeting requirements for watershed planning specified by EPA’s Nine Key Elements, these plans also encompass issues related to environmental health and resiliency, culture and heritage, public access, and critical coastal habitats identified by the MBNEP’s Science Advisory Committee as most threatened by anthropogenic stressors.

To date, with funding secured through the National Fish and Wildlife Foundation’s Gulf Environmental Benefit Fund and the Federal RESTORE Act through the State of Alabama, WMPs have been completed for Dog River, Fowl River, Weeks Bay, Bon Secour River, Bayou La Batre, and West Fowl River. WMPs are also under development for Wolf Bay, the Western Shore of Mobile Bay, Little Lagoon-Gulf Frontal, and the Mobile Tensaw Apalachee Delta. Key projects identified by the WMPs will feed into the upcoming Coastal Alabama Restoration Plan. This effort is focused on improving the quality of the water entering Mobile Bay, as well as the Gulf of Mexico, and increasing the amount of nursery habitat necessary for sustaining healthy fisheries. This plan will include an inventory of restoration and conservation opportunities guiding future funding requests.

Improving water quality and maintaining healthy populations of fish and shellfish are at the base of ensuring what is most important to people living along the Gulf coast: access to Gulf waters; abundant fish and shellfish; protection of heritage; environmental health and resilience; and water that is fishable, drinkable, and swimmable.
Flooding history of Mobile Bay and Weeks Bay: Building long-term environmental records to help future predictions and coastal resiliency

Rebecca Totten Minzoni; Lauren Parker & Asmara Lehrmann (The University of Alabama), Davin J. Wallace (University of Southern Mississippi); Emily Elliott & M. Lisa Davis, The University of Alabama

Sea level rise has accelerated in Mobile Bay, with an average rate of 3.74 +/- 0.58 mm per year from 1966 to today. The long-term impacts of sea level and climate on coastal estuaries remain uncertain, while the majority of the world population lives and relies upon the coast. In a collaborative effort to improve coastal resiliency for Alabama, we investigate 9,000-year records of floods and algal blooms in relation to different sea level rise rates and past climate in Weeks Bay and Mobile Bay, AL, which is the fourth largest estuary in the US and hosts valuable aquaculture industry and commercial infrastructure upon which the state and the country rely. Sediment cores were targeted in the central bay stratigraphy, where they record the last ~9,000 years of environmental change in the linked bay systems.

Piston cores WB-18-02 and MB-18-01 recovered 6 m and 9 m of undisturbed sediment from Weeks Bay and Mobile Bay, respectively. Age models are constructed using Pb-210 and C-14 AMS dating and integrated with published studies. Multiple proxies are used to reconstruct environmental change and to elucidate relationships of extreme weather and algal bloom events with climate and sea level conditions. Elemental composition indicates trends of increasing marine influence at the base of the cores following formation of the bays ~8,200 and 7,000 years ago, respectively. Carbon and nitrogen isotopes record phytoplankton as the main source for organics, with trends of increasing TOC, decreasing δ13C, and increasing terrestrial flux ~3,000 years ago. Peaks in sand content and detrital elements record discrete riverine flood events with terrestrial influx.

Ongoing diatom phytoplankton analysis will help identify algal blooms that may have been triggered by nutrient loading after floods. Long records of floods and algal blooms during key intervals of the Holocene, especially ~7,000 to 10,000 years ago when sea level rise in the Gulf of Mexico was similar to today, can help us better understand what to expect from extreme weather events under projected climate and sea level scenarios. Improved predictions can help improve sustainability planning, policy, and restoration efforts for Mobile and Weeks Bays. Further, a pre-European settlement record of bay conditions will help us evaluate human impacts on these estuaries, including coupled human and natural flood influences on bay ecology and evolution.
Abstract No. 62. Response of Fluvial Suspended Sediment Fluxes and River Discharge to Future Climate Change on a Global Scale

Nishani Moragoda & Sagy Cohen, The University of Alabama

Anthropogenic climate change, particularly through increased greenhouse gas (GHG) emissions, is projected to considerably impact 21st-century precipitation distribution, altering fluvial processes such as sediment dynamics and riverine water discharge, worldwide. Changes in the magnitude of fluvial water and sediment fluxes can have profound impacts on the functioning and connectivity of earth’s natural systems. This study is focused on isolating the impacts of GHG-induced future climate change on riverine water discharge and suspended sediment fluxes in the 21st century at a global scale. A global-scale hydro-geomorphic model (WBMsed) was forced with precipitation and temperature projections generated from five General Circulation Models (GCMs), each driven by four Representative Concentration Pathways (RCPs). The results, based on an ensemble of model outputs, revealed that global river discharge and sediment dynamics are considerably impacted by anthropogenic climate change in the 21st century. Despite substantial regional heterogeneity, a global net increase is projected for both river discharge and sediment flux in the 21st century under all RCP scenarios. Increases are larger and more variable with increasing levels of GHG concentrations in the atmosphere.

At the end of this century, climate change under RCP 2.6 is projected to cause approximately 1% increase in global river discharge and 5% increase in global suspended sediment flux. Under the RCP 4.5 emission scenario, climate change will lead to a 5.6% increase in river discharge and a 7% increase in sediment flux at a global scale. Approximately 5% and 9% increases are projected under RCP 6.0 in global river discharge and sediment flux respectively. Climate changes projected under RCP 8.5 will lead to the largest increases in river discharge and sediment flux (7.3% and 14.7% respectively) at the end of the 21st century. With increased warming, more extreme changes (increasing or decreasing) can be expected in both discharge and sediment flux. Also, the number of rivers with statistically significant trends in either direction increases with warming. In addition to magnitudes, inter-annual variability in both global river discharge and sediment fluxes also increase with increasing RCPs. Changes in sediment flux closely follow the patterns predicted for discharge and are mostly driven by climate warming induced spatial and temporal variation in precipitation. However, the relationship between discharge and sediment flux was found to be non-linear both in space and time, demonstrating the utility of explicit modeling of both hydrology and geomorphology.
Abstract No. 63. *A Decision Making Framework for High Resolution Flood Resiliency Assessment of Coastal Communities*

Ross Nazari, The University of Alabama at Birmingham

The Coastal and inland flooding has been a problematic occurrence, specifically over the past century. Global warming has caused an eight-inch sea level rise since 1990, which made the coastal flood zone wider, deeper and more damaging. Additionally, riverine flooding is extremely damaging to the coastal communities’ substructure and the economy as well which causes river banks to overflow, inundating low-lying areas. Low-lying coastal areas at severe risk for flood hazard, sea level rise, land depletion, economic loss, property damage, destroy habitat destruction and also threaten human health and safety which are the main study area of this work.

A decision making framework is being built to help mitigate the impacts of the environmental and economic dangers of storm surges, sea level rise, flashfloods and inland flooding. With vigorous research and the use of innovative hydrologic modeling, this tool can be utilized to help with resiliency planning for coastal communities. This will allow the individuals living in a coastal community to understand the details of climatic hazards in their area and risks associated to their communities. This tool also suggest the best solution for the problem each community faces. The damage assessment results for a particular type of storm has been mapped to illustrated damage levels for individual properties.

This holistic approach of structural damage assessment due to flooding at a large spatial scale is unprecedented and could be a very useful system for accurate damage assessment of buildings due to extreme storm events. The results and benefits from this work will allow coastal communities to choose the most appropriate method for building a long lasting and sustainable community in the future.
Abstract No. 65. *Developing the Best CBMPP with Limited BMP’s*

**Perry Oakes & Earl Norton,** Alabama Soil and Water Conservation Committee

Improper Erosion Control, Sediment Control, and Stormwater Management are often discovered during and after construction of a project site resulting in additional remediation costs and potential fines. To minimize these issues, proper planning must occur to ensure the project has minimal effect on the environment. This presentation will involve the discussion of a potential development site where the presenter will lead an audience discussion looking at the site features to help develop the best CBMPP plan. Discussion items will include:

- Minimizing the area disturbed.
- Limiting the time of exposure to rainfall.
- How to control stormwater.
- The sequence of construction.
Abstract No. 66. *Installation of Dissolved Oxygen Enhancement Equipment on the Upper Coosa Hydroelectric Plants*

**Kenneth Odom**, Alabama Power Company

In June of 2016, Alabama Power Company (APC) began the engineering and design to install dissolved oxygen (DO) enhancement facilities on the Upper Coosa hydroelectric plants (Weiss, Neely-Henry, and Logan-Martin) and be operational by May 2018. The first step in the process was to submit a preliminary design to the Federal Energy Regulatory Commission (FERC) for approval before final engineering and design could begin—APC received approval of the preliminary design in December of 2016.

What was to follow would be a major commitment to begin construction by July 2017. Based on the amount of work and the timing, construction needed to be underway no later than this date for the project to be operational by May 2018. The effort required APC, engineering consultants, and the contractor to work closely on a strict schedule expediting engineering decisions on materials, adjusting project scheduling, and resolving electrical and piping layout issues. On May 2018, centrifugal blower facilities were installed and operational at all three Upper Coosa plants as well as a forebay diffuser system at Logan-Martin Dam.

This presentation focuses on the engineering of the mechanical and electrical components of the project and the construction to meet the May 2018 FERC deadline. Many of the obstacles will be discussed including critical engineering and construction decisions and safety. Safety was a major focal point throughout the project because of the amount of overlapping work. Many interesting photographs of the construction, from project beginning to finish, will be presented and explained in order to give the audience a sense of the magnitude of the project and the short timeframe in which it was completed.
Abstract No. 67. Testing the mechanical and hydrological soil strength effects of common Alabama riparian species when used as live stakes

Victoria Niedzinski, Jessica Calhoun & Jack Montgomery, Auburn University

Riparian vegetation restoration and enhancement is an important strategy for improving stream health and water quality in the southeastern U.S. Live staking cuttings of native hardwood species is the most common method for planting woody species along stream banks. Woody species promote streambank stability mechanically increasing soil cohesion and hydrologically by removing soil water through transpiration. Previous work has demonstrated differences between southeastern riparian species in the quality of bank stabilization provided by mature trees and in root growth rates. Ideally, the species or group of species planted will provide both rapid stabilization to prevent costly project setbacks or failures and long-term stabilization to withstand large storm events. We will present the preliminary results of a test of the effect of two riparian species that are commonly used in live staking on soil strength through both mechanical and hydrologic mechanisms at four months after planting.

We planted black willow (Salix nigra) and silky dogwood (Cornus imomum) from live stakes in streambank microcosms in early March 2019 and made a fallow control microcosm without vegetation. The microcosms simulate the hydrologic conditions of a streambank while allowing the plants to be grown under controlled, greenhouse conditions. Our hypothesis is that soil strength will be greater in the microcosm planted with silky dogwood at four months after planting, because this species has been shown to grow root biomass most rapidly. We also hypothesize that the soil strength in the microcosm planted with black willow will be higher in later tests, because the species is known to be good for long-term bank stabilization. In early July 2019, we will test the hydrologic effect of the plants on soil strength by watering the microcosms to saturation and monitoring the rate of drying with time domain reflectometry soil moisture probes. We will test the mechanical effects of the roots through two tests. An Iowa borehole shear test will give the shear strength of the soil across a range of moisture content values. We will use a pullout test and root counts from a trench cut through the microcosm to determine the increase in soil cohesion provided by roots. These tests provide the parameters required to determine soil strength using simple physics-based calculations and determine if soil strength is higher in the black willow or silky dogwood microcosm. Additional tests will be performed at eight months after planting (early November 2019) to determine if the species converge or diverge in soil strength effects.

Project results will inform the selection of species for live stake planting on stream banks in Alabama.
Abstract No. 68. Groundwater quality in karst hydrogeologic systems of Redstone Arsenal, Alabama: long-term variability and implications for groundwater quality management to the endangered Alabama Cave Shrimp, *Palaemonias alabamae*, in regions of increasing land development

Patrick O’Neil & Stuart McGregor, Geological Survey of Alabama

The Alabama Cave Shrimp, *Palaemonias alabamae*, is a federally-listed endangered species known to inhabit cave environments in karst regions of north Alabama. The Geological Survey of Alabama (GSA), working in conjunction with the U. S. Department of Defense, Redstone Arsenal (RSA) and the U. S. Fish and Wildlife Service (USFWS), have for many years cooperatively monitored population variability of the Alabama Cave Shrimp and environmental conditions in Bobcat Cave and surrounding environments on the RSA complex near Huntsville, AL. Beginning in 1990, water samples were collected from Bobcat and Matthews caves on a quarterly basis until 1995, then on a monthly basis from 1995 to the present. The hydrology in Matthews Cave (urban nonpoint runoff influenced) is more characteristic of surface channel hydrology whereas the hydrology of Bobcat Cave (deeper groundwater source) more closely mimics traditional groundwater patterns typical of karst systems. Concentrations of major water-quality constituents such as total dissolved solids, chloride, sulfate, and bicarbonate have distinct seasonal patterns of variability and unique inter-cave differences in water quality related to the source(s) of groundwater. Physical parameters, such as temperature and pH, vary with respect to groundwater source while dissolved oxygen is more conservative with less variability between the cave systems. Seasonal patterns and inter-cave variability are less well defined for concentrations of selected metals. The RSA groundwater quality data set offers a unique perspective into patterns of long-term variability, relationships of groundwater quality to land development, and perhaps some insight into long-term climate patterns in the region.
Abstract No. 70. Protecting Alabama’s Forests and Waterways through Forestry Best Management Practices Monitoring

Ryan Peek, Alabama Forestry Commission

Alabama is blessed with abundant forest resources having 23.1 million acres of forests covering approximately 70% of the land in the state. Additionally, Alabama boasts more than 132,000 miles of rivers and streams flowing through its boundaries. There is a strong connection between the quality of the state’s waters and the surrounding land use. The biodiversity contained within Alabama’s waterways is in part a reflection of the protection afforded these waters by the abundant forests which serve to filter water entering these rivers and streams. These same waterways also provide drinking water for three-quarters of the citizens of the state, thus elevating the importance of forests in this state. The Alabama Forestry Commission is charged with protecting, conserving and increasing the timber and forest resources of the state and administering all laws relating to timber and forestry and the protection, conservation and increase of such resources. This charge includes protecting the water quality of the state through implementation and monitoring of Best Management Practices (BMPs) for Forestry program on silvicultural operations in the state. This presentation will provide an overview of AFC’s commitment to protect Alabama’s water quality through its BMP program.

Alabama’s forestry BMPs are non-regulatory, voluntary guidelines intended to help Alabama’s forestry community maintain and protect the physical, chemical and biological integrity of waters of the state. The program is comprised of three elements: implementation monitoring, education and complaint resolution and conforms to the Southern Group of State Foresters (SGSF) BMP framework. Through its monitoring efforts, the AFC observes a high rate of implementation of the following six BMP practice categories on harvested forest stands: stream side management zones, stream crossings, forest roads, timber harvesting, reforestation/stand management, and forested wetlands. In fiscal year 2018, the AFC conducted 349 BMP implementation monitoring inspections, 24 educational events reaching more than 1,600 individuals and responded to 39 complaints. This information is reported in the AFC annual report with implementation data aggregated into the SGSF’s Southern Regional BMP implementation report.

In these efforts, the AFC coordinates with the Alabama Department of Environmental Management and the U.S. Army Corps of Engineers to protect the quality of water and forested wetlands under their respective jurisdiction. Additionally, the AFC works closely with the Sustainable Forestry Initiative (SFI) forest certification program and also serves on the SFI state implementation committee (SIC). The SIC is comprised of industry representatives whose companies participate in SFI. Participation in SFI mandates that fiber sources entering a participating mill are harvested from sites that utilize forestry BMPs to protect water quality.

Mary Wallace-Pitts, The University of Alabama

Water management, perhaps the most critical natural resource issue of the 21st century is considered by many to be a “wicked” problem, one that is not only complicated and complex, but often poorly defined. This complexity arises due to the interaction of natural, societal and political drivers superimposed on a background of laws and regulations. Population growth, weather extremes (drought and flooding), conflicts over shared resources, and global demands for equity in the apportionment of water have resulted in widespread adoption of comprehensive management strategies on local, state, national and international levels.

The need for an integrated water policy in Alabama has long been recognized and although considerable progress has been made to this end much remains to be accomplished. This research, through analysis of State entity mandates with respect to water management, identifies the most appropriate institutional framework within which to implement the developing water policy. The concept of subsidiarity as an organizing principle for water policy is widely accepted, and when applied to the existing spatial patterns of the political, legal and institutional structures in the State, mandated and funded to manage water, the most appropriate framework is readily apparent.
Abstract No. 73. *Time series hydrologic monitoring within karst aquifers of Key Cave and Cathedral Caverns, Alabama, for the protection of sensitive aquatic biota*

Stuart W. McGregor (Geological Survey of Alabama) & Randall Blackwood, Cathedral Caverns State Park Ranger

Key Cave, located in the Tennessee River drainage in south-central Lauderdale County Alabama about 8 km southwest of Florence, is in an area underlain by the Mississippian-aged Tuscumbia Limestone and Fort Payne Chert. Key Cave and the immediate vicinity comprise the Key Cave National Wildlife Refuge, a satellite of Wheeler National Wildlife Refuge, and is designated for protection of an assortment of federally-protected and state conservation priority species, with no public access and stringently restricted access to professional researchers. Cathedral Caverns, also located in the Tennessee River drainage, is located approximately 8.0 km northeast of Grant in Marshall County, Alabama, an area underlain by the Mississippian-aged Bangor and Monteagle limestones. Cathedral Caverns and the immediate vicinity comprise a state park open to the public and as a result the area has been modified for public access. Karst features in both areas include sinkholes, springs, and caves, and sinking streams are common. Cave ecosystems in north Alabama provide vital habitat for numerous conservation concern species, including the federally endangered Alabama Cavefish (*Speoplatyrhinus poulsoni*), Alabama Cave Shrimp (*Palaemonias alabamae*), and Gray Bat (*Myotis grisescens*), as well as other conservation priority species such as Southern Cavefish (*Typhlichthys subterraneus*), Alabama Cave Crayfish (*Cambarus jonesi*), and Phantom Cave Crayfish (*Cambarus pecki*), among others. Furthermore, Key Cave has been designated as critical habitat for the Alabama Cavefish, which is known only from pools within the cave.

While Cathedral Caverns also has a diverse aquatic fauna, none of its members are currently afforded protection. To that end, time series data were collected using data loggers on an hourly/daily schedule in 2018 to evaluate and document flow conditions and seasonal variability of flow, to establish a water quality baseline, and to determine aquifer characteristics (water level, specific conductance, and temperature patterns) in the area within and around Key Cave National Wildlife Refuge and Cathedral Caverns State Park. Sites were visited monthly to download data and perform routine maintenance. A rain gauge at each site was installed to collect data to evaluate water-level response to precipitation events. Reservoir pool level of Pickwick Lake of the Tennessee River, adjacent and hydraulically connected to Key Cave, was provided by the Tennessee Valley Authority. Streamflow was measured at Cathedral Caverns in the cave and at a spring outflow. Realtime dataloggers established during these projects continue to record data and are available via the Geological Survey of Alabama Groundwater Assessment webpage. The purpose of these studies was to delineate the recharge area and aquifer characteristics of each cave to enable local, state, and federal agencies and interested citizens to develop, manage, and protect the water resources that support these species.
Abstract No. 75. *The Beckoning Phosphorus: The Status of Phosphorus in Alabama Soils*

**Rishi Prasad,** Auburn University

Alabama poultry operations generate litter that contains approximately 19,350 tons of recoverable phosphorus. Much of this litter is applied to pasture, hay and row croplands. A repeated annual application of litter over time results in P buildup in soil, which can potentially enter the water system via runoff or erosion. The P transported to water bodies increase biological productivity causing eutrophication and degradation of water quality. It is important to understand the P loss risk potential of Alabama soils that have received litter over several years. The objective of this study was to quantify the soil test P (STP) levels of Alabama soils across five major soil types and estimate their potential to act as P source or sink to the environment. Soil samples were collected from commercial row crop, pasture, and hay fields across several locations in Alabama.

Relationship between commonly used STP in the southeast region (such as Mehlich-1 (M1) and Mehlich-3 (M3)) and water-soluble P (WSP) was studied. Preliminary data suggest that 58%, 23% and 6% of 0-15, 15-30 and 30-60 cm soil samples, respectively, exceeded the agronomic threshold or critical P concentration of 25 ppm. The relationship between the WSP and STP was non-linear. Additionally, when M1< 50 mg kg-1, 50-100 mg kg-1 and >100 mg kg-1, the WSP ranged between 0-5 mg kg-1, 0-25 mg kg-1 and 2 to 35 mg kg-1, respectively. Preliminary data also indicate that the P loss risk is highly variable over soil types and soil depths.
Abstract No. 76. Using a Modified DRASTIC Model to Create an Aquifer Recharge Potential Map for Alabama

Mary Hastings Puckett (The University of Alabama), Greg Guthrie & Gary Hastert, Geological Survey of Alabama

The DRASTIC Model was first introduced by the Environmental Protection Agency (EPA) in 1985 to model the potential for contaminants to enter groundwater. The DRASTIC acronym is made up of the factors which affect groundwater pollution potential: Depth to water table, Recharge (net), Aquifer media, Soil media, Topography, Impact of vadose zone, and Conductivity (hydraulic). Using a system of weights, ranges, and ratings, a numerical value known as the DRASTIC Index is produced which prioritizes areas vulnerable to groundwater contamination. Each DRASTIC factor is evaluated separately to establish rating ranges, between 1 and 10, with 1 being the least significant and 10 being the most significant. Each DRASTIC factor is assigned a relative weight from 1 to 5 with 5 being the most significant and evaluated with respect to the others to determine the relative importance of each factor. We propose a modified DRASTIC approach to produce an Aquifer Recharge Potential map for Alabama. The intent of the map is to show areas with the most, and the least, potential for aquifer recharge. We have used an algorithm that combines recharge (precipitation – evapotranspiration), soils (% sand + % organic composition + hydraulic conductivity), land use, slope, depth to water table, and aquifer hydraulic conductivity to create a Recharge Potential Index (RPI) map. Slope, soils, and aquifer conductivity are relatively unchanging and are used to produce an intrinsic properties base map. The remaining factors (land use, recharge and depth to water table) vary with time and can be added to address specific questions, such as what will be the potential for recharge in an area given a set of land use and climatic conditions. Using statistical techniques, such as Single Parameter Sensitivity Analysis (SPSA) to modify the weights and the Wilcoxon rank sum nonparametric statistical test to modify the ratings creates a more accurate RPI for Alabama. The RPI is found by multiplying the modified weights by the modified ratings for each factor and then adding them together within the ArcGIS platform to create the final map products. The map is intended to provide managers and stakeholders a tool for evaluating the potential effects of drought and flooding for water availability in Alabama.

Kirk Rodgers, Victor Roland, Anne Hoos & Rodney Knight, USGS Lower Mississippi-Gulf Water Science Center

The U.S. Geological Survey and U.S. EPA are collaborating to assess the climatic, physiographic, and anthropogenic factors driving spatial variability and temporal trends in the freshwater delivery to the Gulf of Mexico. The timing and magnitude of fresh water delivery influences terrestrial and aquatic communities, changing community composition and altering habitats necessary to support indigenous life. Streamflow at 139 stream gaging stations in the southeastern United States were analyzed from 1950 to 2015 to determine if climatic oscillation, spatial correlation, and variability in the streamflow indicated significant increases or decrease for the period of record. This study examined spatial and temporal patterns in seasonal and monthly mean daily streamflow and for quantiles of streamflow. Three primary methods were used to analyze streamflow trends including: 1) the non-parametric Mann-Kendall trends test to identify monotonic change, 2) cluster analysis to determine if trends in streamflow were regional in nature, and 3) Quantile-Kendall analysis to identify trends over the period of record. Results from our analysis have identified significant trends in monthly and seasonal streamflow values as well as significant trends over the entire flow regime.
Abstract No. 81. River Temperature Forecasting for Wheeler Reservoir, Alabama

Daniel Saint & T. Matthew Boyington, Tennessee Valley Authority

As part of the ongoing effort to maintain the aquatic habitats of the Tennessee River, the Tennessee Valley Authority (TVA) actively monitors and manages the thermal discharge from its power plants. A key element in the management of reservoir temperatures has been the development and application of numerical river models. These tools assist in the optimization of cooling equipment, operation of power plants, and scheduling the river in order to maintain downstream thermal compliance. As part of a multi-year project, TVA River Management has transitioned from an internally developed, one-dimensional hydraulic model to a coupled model framework that includes a three-dimensional hydrodynamic model (Delft3D). This presentation will describe the new system along with the benefits of using a three-dimensional river model in the management of river temperatures for Wheeler Reservoir, Alabama.
Abstract No. 54. Influence of climate variability on the ecologically sustainable water withdrawals from streams for irrigation

Laljeet Sangha, Jasmeet Lamba, Hemendra Kumar, Puneet Srivastava, Mark Dougherty & Rishi Prasad, Auburn University

Alabama (AL) receives a large amount (1270-1727 mm) of rainfall annually. However, much of the rainfall occurs in the non-growing season (winter months), and recurring, severe droughts during the crop growing season lead to losses in crop production. In AL, in addition to using groundwater for irrigation, farmers withdraw water from streams to irrigate crops. However, if water withdrawal from streams is not done in an ecologically-sustainable manner, it can potentially harm stream ecology and reduce the dilution capacity of streams, impacting water quality and aquatic biota. In the southeast United States (U.S.), the quantity of water that can be ecologically-sustainably withdrawn for irrigation and other uses depends on El Niño Southern Oscillation (ENSO), a seasonal-to-interannual (SI) climate-variability phenomena.

The objectives of this study were to: (a) quantify the relationship between ENSO and precipitation, ENSO and temperature, and ENSO and streamflow; (b) develop surface water withdrawal prescriptions for irrigation without disturbing the ecological integrity of streamflow; (c) quantify the area of a watershed that can be irrigated via surface water withdrawals from different order streams; and (d) determine optimum pond size for the storage of withdrawn water from streams for irrigation. The study was conducted in the Swan Creek watershed located in Limestone County of north AL, U.S. The Soil and Water Assessment Tool (SWAT) model was used to simulate streamflows and develop water withdrawal prescriptions.

The results of this study indicate that percentage area irrigated upstream of withdrawal point was not the function of stream order. During a La Niña phase 14% to 55% more water can be sustainably withdrawn from streams than the El Niño phase from January to March. Furthermore, irrespective of the ENSO phase, about 8% more water could be withdrawn during the non-crop growing months than the crop growing months. Based on the water withdrawal criteria, about 16% of the watershed cropland area can be irrigated if the withdrawals were made throughout the year, 9% if stream water was withdrawn in non-crop growing season months and 5% if stream water was withdrawn in the growing season. If farmers plan water withdrawal in accordance with the ENSO phase, it would not only provide them ample volume of water for irrigation during the growing season but would also help to maintain stream water quality and aquatic biota.
Abstract No. 86. Improving Water Quality Using an Adaptive Management Approach

Lynn Sisk (Jacobs) & David Denard, Jefferson County Commission

Addressing complex surface water quality problems requires a systematic approach which can incorporate lessons learned during implementation of corrective actions. Adaptive management can be used to improve water quality while also making wise use of limited resources. The process is illustrated in Alabama’s phased implementation of total maximum daily loads (TMDLs) for nutrients. Planning, construction, and maintenance and operation of treatment processes to comply with low-level total phosphorus limits in municipal wastewater facility permits has proven to be costly and user fees and/or public funds are limited. In addition, uncertainty surrounding the establishment of nutrient targets in receiving streams and the achievable nutrient concentrations in a particular wastewater effluent require an implementation process that builds on information obtained during each phase of a multi-phase schedule. Faced with new mandates to achieve lower total phosphorus concentrations in wastewater treatment facility discharges, adaptive management provides utility managers with a process that accounts for uncertainty, achieves water quality improvement, and makes the most efficient and effective use of limited public resources. This presentation will discuss two examples where adaptive management is being used in Alabama to achieve water quality improvement goals.
Abstract No. 88. Recent Developments in Real-time Trace Metal Monitoring Technologies for In-Process Wastewater Applications

Tyler Sullens & Jonathan Ponstein, Alabama Power Company

Continuous on-line water quality monitoring is used in many municipal water and industrial wastewater applications. Commercially available technologies have been useful as operational parameters such as turbidity, pH, dissolved oxygen, and others to monitor effluent quality, such as nitrates, and arsenic. New federal regulations (EPA Effluent Limit Guidelines, ELG) imposed on the electric utility industry will require more stringent technology-based limits on certain power plant wastewaters. These water quality limits include the parameters: nitrates, arsenic, mercury, and selenium. Wastewater treatment systems installed to meet the ELG rule will face challenges due to very dynamic influent water chemistry, complex wastewater matrices, and low limits for mercury and selenium; real-time continuous measurement would provide operators with another tool to troubleshoot system performance. The emergence of online monitor technology promises to reduce turnaround of analytical results to minutes. Water quality monitors have been used to measure trace metals in other industries; however, they have not been successfully tested for accuracy and reliability with power plant wastewaters. Alabama Power’s Compliance Studies Field Group and General Test Laboratory partnered with multiple equipment vendors over the past 5 years to test and develop the best technologies to meet the needs of the electric utility industry for mercury and selenium monitoring. Research and development of these monitors were conducted in the laboratory and under extended field conditions. Testing these trace metals monitors on various wastewaters were performed. Results indicate these monitors are not as accurate as laboratory EPA methodology. However, the mercury and selenium monitors show promise for real-time, in-process trending measurement for electric utility wastewaters.
Abstract No. 90. Creation, Calibration and Validation of a Field-scale SWAT model in the Lower Flint River Basin

Ritesh Karki & Puneet Srivastava (Auburn University), Arianna Toffanin & George Vellidis, University of Georgia

The Apalachicola – Chattahoochee – Flint (ACF) region has been the subject of much legislature and research regarding water allocation over the past forty years. The state of Georgia’s heavy reliance on the ACF’s water resources for agricultural production has been a partial cause of this conflict between Alabama, Georgia, and Florida. Regional, watershed, and field scale models have been employed by researchers to better understand the hydrology of this area; however, few studies exist focusing on the effects of weather and soil parameters on the hydrology and crop production at the field scale. The objective of this study is to create, calibrate, and validate a field scale model using the Soil and Water Assessment Tool (SWAT) of a research station in the Lower Flint River Basin.

The research station modelled is the Stripling Irrigation Research Park (SIRP) located in Camilla, Georgia and run by the University of Georgia (UGA). UGA provided all management information needed to create the model, including crop type, fertilizer rates, irrigation amounts, planting dates, harvest dates, and crop yields. Three fields were modelled, which grew corn, peanut, and cotton, respectively, after a winter cover crop of Rye and strip tilling. Each field had two plots with berms surrounding the plots to isolate surface flow. Plot specific soil nutrients, soil texture, as well as surface runoff flow and nutrient data were obtained for 2018. Since only 2018 data was available, one plot was used for calibration and one plot for validation in each field. Other soil parameters were obtained from the Soil Survey Geographic Database (SSURGO) and all weather data (precipitation, temperature, solar radiation, and wind speed) was provided by the Georgia Weather Network (GWN) from a station at the SIRP. Land use maps were obtained from the National Land Cover Database (NLCD) and modified to accurately reflect the crops grown on each field.

Multivariable calibration and validation for soil moisture, surface runoff, nutrients, and crop yields were conducted in this study. The calibrated and validated field scale model produced in this study will be used in future soil and crop yield studies to quantify soil and weather parameter uncertainties in SWAT. It will also be used to further understand the soil’s effect on crop yields in the state of Georgia and help legislators make appropriate water allocation decisions.
Abstract No. 91. Tree-Ring Reconstructions of Chattahoochee River Streamflow

Matthew Therrell & Glenn Tootle, The University of Alabama

Increasing community resilience to the hazards such as drought/reduced streamflow requires understanding the full range of long-term natural variability as well as the frequency and magnitude of extreme hydrologic events in relevant river systems. The Apalachicola–Chattahoochee–Flint (ACF) River Basin forms the border between Alabama and Georgia and has been the subject of intense litigation between AL, FL and GA. Unlike many river systems in the western U.S. no reconstructions of past streamflow have been developed for this system. In this presentation we report on the development of a 1,000-year streamflow reconstruction for the ACF, which indicates multiple historic low-flow years since 2000, are unprecedented within the context of the last millennium. Given the current lack of a comprehensive water policy in Alabama as well as the ongoing litigation over interstate water resources, it is imperative that the paleo record be thoroughly studied and the results used to inform water policy and statewide water management plans in Alabama.
Abstract No. 93. *Fishing While Black: Threats to Gullah/Geechee Fishing Practices*

**Ryan Thomson**, Auburn University - Agricultural Economics and Rural Sociology

This study provides an interpretive context to understand Afro-Indigenous Gullah/Geechee fishing practices as a livelihood activity and as a means of constituting Gullah/Geechee identity. I then turn to qualitative data from my archival work, participant observation and key informant interviews and focus groups. I analyze Gullah/Geechee perspectives on different types of outsider attempts to deny Gullah/Geechee access to their traditional fishing grounds. This is followed by a discussion of Gullah/Geechee experiences of harassment by government agents seeking to impose state-based environmental regulations on the Gullah/Geechee. The study concludes with an overview of Gullah/Geechee views on growing competition from outsiders for fishing grounds and difficulties in marketing their catch.
Abstract No. 94. Watershed Assessment and Restoration: A Model for a Holistic Approach

Jason Throneberry, The Nature Conservancy

Aquatic biodiversity of the Southeastern United States is higher than any other place in North America. The diversity of aquatic species can be attributed to many factors, including but not limited to, the vast amount and sizes of stream systems, highly diverse macrohabitats and microhabitats, geological variation, and seasonal variation. Of all states in the Southeastern United States, Alabama is the foremost in aquatic biodiversity, number of imperiled species, rate of endemism, and species decline. To address the ever-growing threats faced by the stream systems of Alabama, it is necessary to use a watershed-scale approach. Over the past 20 years, The Nature Conservancy (TNC) has worked to develop, implement, and demonstrate a watershed-scale protection and restoration methodology. The case study watershed used for Alabama was, and continues to be, the Paint Rock River in Jackson County. The watershed protection and restoration focused on sediment abatement, longitudinal connectivity, and headwater protection. Over the lifespan of this project TNC and partners have implemented over 40 restoration projects and successfully protected over 40,000 acres of headwater forests within the watershed. Threat abatement for water quality, aquatic species, and habitat alteration has resulted in a healthy, functioning aquatic ecosystem that has been deemed worthy for re-introductions of federally protected species and continues to support other native species. Given the success in the Paint Rock watershed, TNC now uses this as a model for assessment, prioritization, and implementation of restoration in other focal watersheds in Alabama. Current focal watersheds in Alabama are Paint Rock River, Locust Fork of the Black Warrior River, Cahaba River, and Big Canoe Creek. Within these watersheds, TNC and partners will assess current conditions regarding streambank stability, instream habitat quality, water quality, hydrologic alteration, barriers to aquatic organism passage, rare species occurrence, instream flow, and sediment regime. Once these data have been collected and analyzed, project opportunities and priorities will be established for restoration and protection efforts. Using the prioritized targets to focus restoration and protection activities, TNC will target landowners for relationship cultivation, increase knowledge of the resource, and identification of potential funding sources. Existing federal and state conservation programs will be at the forefront of options presented to the landowners. TNC has had great success utilizing these funding sources for restoration and protection implementation, and for aiding other state and federal entities with enrollment in their conservation programs. This collaborative, watershed-scale approach to protection, conservation, and restoration of key areas of biodiversity will continue to drive the activities of TNC and partners into the future, and under the persistent threat of climate change,
Abstract No. 96. *Transitioning From Rain-fed to Irrigation-fed Agriculture in Alabama*

Hamid Moradkhani, Mukesh Kumar, Hamed Moftakhari, Nicholas Magliocca & Glenn Tootle (The University of Alabama) & Denis Nadolnyak, Auburn University

The Deep South states, including Alabama, Georgia, and Mississippi, continue to experience one of the highest poverty rates in the nation. As agriculture plays a significant role in the economies of these states, one potential option for their economic resurgence is through a drastic increase in agricultural productivity. The National Science Foundation (NSF) recently awarded The University of Alabama an NSF: Innovations at the Nexus of Food, Energy and Water Systems (INFEWS) four-year research grant that considers a scenario of transition from rain-fed to irrigation-fed (RFtoIF) agriculture. The study will be conducted in the Mobile River Basin encompassing portions of Alabama, Georgia and Mississippi.

Given that food, energy and water (FEW) resources are intricately linked within the basin, the study will evaluate the impacts of RFtoIF agriculture transition on the distribution-of and interactions-between these three resources. The overarching goal of this proposal is to develop a refined assessment of the feasibility of transition from rain-fed to irrigation-fed agriculture and the potential ensuing impacts on food-water-energy nexus in regions of the Deep South. The proposed presentation will outline the four-year research plan and provide opportunities for engagement and participation from federal, state and local water agencies; agricultural and farming industry; energy sector; special interest groups and stakeholders.
Abstract No. 97. An innovative lining strategy to prevent erosion channel erosion.

Jose Vasconcelos (Auburn University), Leigh Terry (The University of Alabama), Jalil Jamily & Ross Ellis (Auburn University), Alysa Evans & Katharine Conaway, The University of Alabama

The possibility of erosion in channels due to high velocity flows is an important issue to be considered both in the context of post-construction stormwater management as well in construction sites drainage facilities. The proper selection of channel lining will avoid such issues by reducing shear stresses between water flows and the natural grade. A commonly adopted strategy is the use of riprap, which will create a complex flow pattern and significant energy dissipation, thus preventing erosion. However, in some locations that are far from quarries, the unit cost of riprap is high, and a lower-cost alternative that could yield protection to the original channel grade would be desirable.

This research has evaluated an innovative application of cellular confinement systems (CCS), also known as geocells, as a channel lining strategy to prevent erosion. While CCS have been traditionally used as means to control erosion, in these earlier deployments CCS cells were filled with materials that included crushed rock and concrete. Instead, in this present investigation, CCS were deployed empty and only partially opened. The idea evolved from laboratory-based experiments on similar geometries. The rationale was that empty CCS cells create obstacles that will generate significant roughness and create energy loss, thus decreasing shear stresses.

A 9-month long deployment of the empty CCS strategy was promoted at a site near Auburn, AL at a roadway drainage ditch site. Significant rain events were recorded during the deployment period at the research site, resulting in large channel flows. Yet, no observable signs of erosion were detected at the channel section where the CCS was used as a lining alternative. Moreover, various water quality tests were performed upstream and downstream from the location where CCS was deployed.

These tests have shown that the CCS do not create deleterious impacts to water quality parameters, and even improved some of these parameters. While more tests in a wider range of conditions are warranted, this points to a low-cost alternative for channel lining that could be particularly attractive to regions in Southern Alabama, which are more distant from sources of riprap.
Abstract No. 99, *Source Water Protection in Agricultural Watersheds*

Shannon Weaver, USDA Natural Resources Conservation Service

This paper will outline USDA’s approach to target source water protection in agricultural watersheds. The Conservation Title of the 2018 Farm Bill specifically mandated that at least $4 billion of program funds over the next 10 years be directed to source water protection. We will look at past efforts and future efforts to plan and implement conservation practices that help protect drinking water sources.
Abstract No. 100. An Interdisciplinary Collaboration Leads to an Assessment of Marsh Health in Fowl River, Alabama

Bret Webb, University of South Alabama

Leveraging its collective expertise within the Science Advisory Committee (SAC), the Mobile Bay National Estuary Program (MBNEP) endeavored to comprehensively assess the health of priority restoration areas within the Fowl River Watershed. An updated watershed management plan for Fowl River, completed in 2016, recommended restoration and conservation opportunities to enhance and preserve tidal marsh habitat, which play an important role in watershed and estuarine function. MBNEP secured funding from the National Fish and Wildlife Foundation Gulf Environmental Benefit Fund to pay for engineering design and regulatory permitting associated with four priority marsh-covered spits within Fowl River. MBNEP used a portion of those funds to assess the characteristics of those marsh areas as part of the Fowl River Marsh Health and Recovery Study. The interdisciplinary study team included geologists, ecologists, oceanographers, environmental and wetland scientists, and coastal engineers from academia and the private sector. The study team addressed three areas: vegetation, sedimentation, and hydrology and hydrodynamics. The vegetation study quantified marsh plant species diversity and abundance, indices of wetland community health, and associations between marsh elevation, porewater salinity, and wetland characteristics. The sedimentation study evaluated sources and sinks of sediment materials within the study area. The hydrologic and hydrodynamic studies observed processes controlling water surface elevation, currents, temperature, salinity, and nutrients within the estuary; and characterized wave conditions within the study area. The vegetation study team found that while the priority marsh spits obtained hydrogeomorphic model (HGM) scores consistent with natural tidal marshes in Alabama, the spits are undergoing a continuous transition from forested wetland to marsh as a result of recent sea level rise. As mean sea level continues to rise, the corresponding increases of tidal inundation and salinity will change the quality and composition of the marshes while diminishing in size as they migrate to higher elevations on the spits. The sedimentation study found that erosion rates within the Fowl River watershed were well below geological baselines, and that marsh and channel areas within the study area were just as likely to receive sediment from Mobile Bay as compared to fluvial sources. However, neither source of sediment is sufficient to allow the marshes to keep pace with sea level rise. Analysis of marsh sediment cores reveals that the marshes are only accreting at a rate of one-third that of relative sea level rise in this area of coastal Alabama. The hydrologic and hydrodynamic studies determined that the marshes are experiencing almost constant inundation during some parts of the year, higher salinities within the bottom waters, higher porewater salinities, and eutrophication. The higher water levels and bottom water salinities could be the result...

Daniel West, Geological Survey of Alabama

The U.S. Fish & Wildlife Service (USFWS), Geological Survey of Alabama (GSA), Alabama Department of Conservation and Natural Resources (ADCNR), and Cawaco RC&D are among a number of agencies, utilities, industries, and NGOs working collectively under the Alabama Rivers & Streams Network (ARSN). Alabama’s water needs are major priorities for the protection and conservation of water resources, as well as the preservation of sustainable habitat for fish and wildlife. A primary impact to water quality in Alabama is excessive sedimentation from non-point sources including, agricultural fields, eroding banks, poorly maintained ditches, and stream crossings. Due to the stability of stream crossings being of interest to the Alabama Department of Transportation, a partnership was formed with USFWS in 2015 to begin assessing the condition of state maintained highway crossings throughout Alabama by means of a Sediment Risk Index (SRI). To assist with field assessments, USFWS provided funds to Cawaco RC&D to provide stipends for two qualified university students per year. The success of the initial program led to a growth in scope of the project with the addition of more interns, a focus towards Strategic Habitat Units (SHU), and a limited amount of funding to continue support for the program.

USFWS prioritizes SHU locations for surveys to be completed by interns under the supervision of a project manager. Surveys are performed using the SRI Manual for Stream Crossing Assessments developed by ARSN and completed evaluations are uploaded to the SHU Mapper, where results are made public after quality assurance and control (QA/QC) performed by USFWS. The mapper is hosted by the U.S. Geological Survey at https://nwrcwebapps2.cr.usgs.gov/AL/Map. To date, SRI interns have completed 3764 surveys, with 3006 surveys being QC’d and available for public viewing. SRI assessments have been completed across the state, encompassing 10 SHUs and 19 counties. Assessments have returned data usable by various agencies, utilities, industries, NGOs, and citizens. SRI assessments have identified issues to be addressed with infrastructure, including physical stability of road crossings, habitat fragmentation from elevated culverts, sediment inputs from roadside surfaces, and derelict utility services. Environmental issues identified through SRI assessments include, blockages of flow, livestock access to streams, illegal dumping, eroding stream banks, and other channel alterations.

The SRI project has not only returned valuable data on stream interference and NPS pollutants, it has also helped in the preservation of habitat and provided introductory educational experiences in natural resource careers to young adults. To date, 17 interns (9-University of Alabama, 2-Alabama A&M University, 4-University of West Alabama, 1-University of West Florida, 1-USFWS personnel) have gained valuable in-field experience in data collection and analysis.
Abstract No. 103. Water Turbidity Measurements for Rivers in Tombigbee River Basin and the Mobile Bay from Satellite Multispectral Imagery

Hongxing Liu, David Mitchell, Yang Liu, Yuehan Lu, Richard Beck & Shuo Chen, The University of Alabama

Timely monitoring water turbidity of rivers is critical for making informed water resources management decisions. Satellite based remote sensing is a cost-effective way to gather information needed for water quality assessment, especially at a basin or regional scale. In previous studies, empirical models have been widely used to derive water quality parameters from remotely sensed images. A single empirical model was normally used to map turbidity for the entire water body under study, whereas its performance is often limited due to the complex optical properties of inland waters. Moreover, traditional empirical models are often one-time applications that cannot be extended to other water bodies for regional water quality mapping. To overcome the limitations, this study adopts a multi-predictor ensemble model, which synergistically exploits a set of empirical models to obtain optimal estimation of turbidity in different water conditions. In this study, we processed four spatially consecutive Landsat 8 multispectral image scenes acquired on May 2nd, 2019, which were combined to cover the rivers of the Tombigbee River Basin, the Mobile River and the Mobile Bay. During the Landsat 8 overpass, in situ water-truth data at 20 sites were collected. The sampling sites are distributed in the Tombigbee River, the Black Warrior River, and their confluence area including Lake Demopolis. After atmospheric correction, a set of empirical turbidity models are calibrated by associating single spectral bands, band ratios, or band differences of Landsat-8 images with the in situ turbidity measurements. Based on the training data set, we identified that B4/B1 explained the most proportion of the variation in turbidity with R² of 0.85. Four heterogeneous empirical models are selected as the candidate component models in the ensemble model base. To establish the ensemble model, we first optimized the component empirical models with an iterative approach and then combined their predictions through a selection strategy based on the spectral space partition. Evaluated by the independent testing set, the ensemble model (RMSE=1.64 NTU) has remarkably improved the turbidity prediction accuracy by 39% compared with the best traditional empirical model (RMSE= 2.69 NTU). Then, the ensemble model was applied to rivers in the entire Tombigbee River Basin, Mobile River and Mobile Bay. Our analysis shows that Tombigbee River have significantly higher turbidity level than the Black Warrior River near Demopolis where they converge. Within the Tombigbee River Basin, the lower Tombigbee is more turbid than the upper Tombigbee. We also observed that the Mobile River and Mobile Bay has very high turbidity levels. This study demonstrates that our multi-predictor ensemble model possesses an improved prediction ability and stronger spatial extensibility than traditional empirical models and hence is critical for basin and regional scale river water quality monitoring and assessment.
Abstract No. 104. Choccolocco Creek Watershed Conservancy District - 60 Years and Growing

Jennifer Yates, (Choccolocco Creek Watershed Conservancy District), Carol A. Kirk, (Eastman manufacturer), John R. Loper & Thomas B. Loper, (The Loper Group) & Alan S. Fowler, Geosyntec Consultants

The Choccolocco Creek Watershed Conservancy District (CCWCD) implements programs and practices to protect the waters and riparian corridor of Choccolocco Creek located in northeast Alabama. Choccolocco Creek flows for approximately 65 miles from its head waters in the Talladega National Forest southeast to its confluence with the Coosa River and receives inputs from a surrounding drainage basin that is approximately 500 square miles in size.

The CCWCD was initially formed in 1959 to help establish watershed dams that prevented flooding and the erosion of agricultural lands. Since that time, its mission has grown to now include flood protection for homes and critical infrastructure, implementation of best management practices for riparian corridor and urban areas, adequate and safe drinking water supplies, and a range of recreational opportunities. This presentation provides an overview of the CCWCD’s past, present and future regarding activities to address protection and utilization of the watershed. Historically, the CCWCD was tasked with erosion minimization and flood prevention resulting in the construction of seven dams within the watershed. As land use in many areas has transitioned from agricultural to suburban and urban based on population growth and development expansion, the mission of the CCWCD has also grown.

This is demonstrated through recent actions by the CCWCD to fortify an existing dam structure to enhance flood protection for an area with homes and a publicly-owned drinking water treatment plant. The CCWCD has also worked jointly with ADEM to enhance this watershed through the reduction of nonpoint source discharges. Efforts to enhance the watershed have allowed the CCWCD to implement activities (e.g., kayaking program) to encourage recreation within the watershed. These actions have and will continue to result in a watershed that is both resilient and flexible for existing and future land uses recognizing the increased challenges and vulnerabilities associated with climate change.
Abstract No. 105. Coastal Mapping Completion: A Look Back at the Decade Long Process to Update Alabama Coastal Flooding Hazards

Jeff Zanotti, Wood Environment and Infrastructure Solutions, Inc.

It has been over 10 years since the federal grants were issued to perform coastal modeling and Digital Flood Insurance Rate Map (DFIRM) production in coastal Alabama and Northwest Florida. The Baldwin County maps went effective earlier this year with Mobile County going through one last revised preliminary stage before going effective. This presentation will look back across the steps in the process to explain what was achieved, why it took so long, and why it was so important to update.

The project began as a two phase approach that involved numerous entities from academia, state government, federal government, and private sector contractors. The last surge elevations in Baldwin and Mobile Counties had not been revised since 1983. The base flood elevations at the Mississippi state line were lower by 4 to 6 feet in Mobile County than the post Katrina modeled Jackson County in Mississippi. It was obvious that these coastal maps in Alabama were outdated significantly. The first phase involved utilizing a NOAA Advanced 3D Circulation model that computed storm surge heights from historic and synthetic storm events. This was done to create still water elevations and wave setup for various return period intervals. The second phase, led by State of Alabama’s Office of Water Resources, involved the overland wave and transect modeling, as well as the DFIRM mapping. With technologic advances in topographic data and modeling software, GIS was leaned on heavily for inputs and outputs throughout both phases.

As the project began there were frequent updates and buzz around the water resources community as well as in local media. As the project went on through its starts and stops work was still being done behind the scenes to keep up communication. Great effort was spent on keeping local stakeholders up to date with what to expect at various points across the project so that they could be prepared for the results of the final maps without causing hysteria across the communities’ private citizens. Outreach efforts were executed to make the changes as painless as could possible with local open houses to show preliminary results and explain what was causing the changes.

Like with any project that runs this long there were many lessons learned, hardships endured, and lucky breaks along the way. We found out that there is no such thing as infallible input data when ADCIRC corrections had to be made in overland areas causing a lengthy delay. The 10 year project length also meant turnover at numerous entities even at the managerial levels to not just the project team but also the federal level reviewers. There were also some unexpected benefits from delays as the Mobile County coastal flooding would have been plotted on older LiDAR had the original date for production been meant. Due to the unexpected delay a more accurate map was produced thanks to newly delivered LiDAR right before the mapping production.
## Poster Presentations

**Poster Session**

**SALONS E-H**

**THURSDAY, SEPT. 5 - 5:30pm - 7:00pm**

Refreshments are courtesy of corporate sponsors

### STUDENT POSTERS

| 2. | Identifying Controls on and Potential Solutions to Storm Water Flooding in Urban Area - A Case Study of the UA Campus. Afrin Hossain Arni, The University of Alabama |
| 3. | Effects of PFOS on Gene Expression and Bioaccumulation in Freshwater Unionid Mussels. Amanda Strozier, Auburn University |
| 4. | Applications of Algal Turf Scrubbers for Water Remediation in Brazil. Ana Gabriela Itokazu, Auburn University |
| 9. | Comparison of Pollutant Removal Capabilities of Three Representative Bioretention Mixes of the United States. Caitlin Sweeney, Auburn University |
| 10. | Morphological Evolution of Global River Deltas During the Satellite Era. Dinuke Munasinghe, The University of Alabama |
| 11. | Associations Between Changes in River Morphology and Mussel Assemblages. Gregory Shafer, The University of Alabama |
| 14. | Using Paleoflood Hydrology to Extend Flood Records and Understand Large Floods in South Sauty Creek (Buck's Pocket State Park, AL). Joni Corbin, The University of Alabama |
| 15. | Oil-Derived Trace Metal Signature in Crassostrea virginica Shell May Provide Historical Record of Oil Exposure. Kimberly Peter, Dauphin Island Sea Lab |
| 16. | Water Quality Analysis of the Choctawhatchee, Pea and Yellow Rivers Watershed Through the Use of SPARROW Modeling. Lucia Alonso Guzman, The University of Alabama in Huntsville |
17. Effects of Vegetation and Time on Soil Stability at Stream Restoration Sites. Madison Wichmann, Auburn University
18. Effects of Toxicity and Structural Alterations Caused by Perfluorinated Alkyl Acid on the Microalgae Scenedesmus obliquus UTEX 393. Meizhu Liu, Auburn University
21. Satellite Data Assimilation with the WRF-Hydro Model: An Effective Approach to Improve Hurricane-Induced Flood Prediction. Peyman Abbaszadeh, The University of Alabama
22. Phosphorus Release Characteristics of Poultry Litter and Its Implications for Water Quality. Poulomi Dey, Auburn University

30. 1,4-Dioxane Cosolvency Impacts on Trichloroethene Dissolution in Groundwater and Sorption to Aquifer Materials. Geoffrey Tick, The University of Alabama
32. Carbon Dynamics at the Terrestrial-Aquatic Interface of Mobile River Basin: A Modeling Study. Shufen Pan, Auburn University
33. Perceptions of Drought and Flooding in Two Cities in Alabama. Wanyun Shao, The University of Alabama
Visualizing Wastewater Issues in Rural Alabama

Approximately 60% of rural US households are not connected to a sewer system, leaving them to rely on conventional septic systems that require subsurface discharge. However, there are many reports that raw sewage discharges to the ground surface (via so-called straight pipes) are common in some poor rural areas of Appalachia and the Southern US. Stakeholders report that straight pipes are especially common in the impermeable clay soils and shallow chalk of central Alabama. A 2005 survey in Bibb County found that 15% of unsewered homes had a straight pipe (White and Jones, 2006). Surveys of Wilcox County indicate that >60% of unsewered homes had straight pipes and in our Hale County sample, 6% of households had straight pipes (Elliott, 2017). These discharges are estimated to result in over 500,000 gallons of raw sewage discharged to the ground every day. Estimating the number and location of straight pipes and the volume discharged will enable legislators and stakeholders to prioritize wastewater projects and justify spending based on clearly defined benefits. While there are many areas in rural Alabama suffering from impermeable soil and rural poverty, the prevalence and location of straight pipes are unknown; site-by-site surveys are too expensive and unreliable to conduct.

The prevalence of straight pipes varies across counties and communities. Our preliminary analysis indicates that these differences are likely based on two main factors: soil characteristics and rural poverty. We have developed a GIS model that will map the risk of straight pipes in rural areas of Alabama. The model was built using available data including USDA soil surveys, digital elevation models, and property information from county tax assessors. We are currently working on methods to validate the model in spite of the data gap for this problem. We are also working on novel methods of visualizing the model output to better contextualize the problem, including estimating the number of people directly impacted and the accumulation of raw sewage into local streams.

References:
Abstract No. P03. *Effects of PFOS on Gene Expression and Bioaccumulation in Freshwater Unionid Mussels*

**Amanda Strozier, Dean Schwartz, Vanisree Mulabagal, Joel Hayworth & Jim Stoeckel**, Auburn University

Per- and polyfluoroalkyl substances (PFAS) are persistent organic chemicals that are resistant to metabolic breakdown and degradation in the environment. PFAS are found in fire prevention agents, weatherproof clothing and other everyday household items. They also are now found in many Alabama waterways including the Tennessee River downstream of Decatur Alabama, the Coosa River, the Tensaw River, and Mobile Bay.

Alabama has the highest diversity of unionid mussels in the world but populations of the majority of species are threatened and/or declining. As benthic filter feeders, they perform important ecosystem functions but are exposed to contaminants present in the water column, sediments, and food. Because of their high filtration rate (up to 38 L/day), this exposure can be substantial. In this study we examine the potential for a common type of PFAS – PFOS – to bioaccumulate in filter-feeding unionids. We also examine effects of PFOS exposure on gene expression and how this differs between males and gravid females.

Ten males and nine brooding females (i.e. females brooding glochidia larvae in their gills) were collected from an unpolluted pond and half were sacrificed for initial analysis. The remaining five males and four gravid female were exposed to 200 ng PFOS/liter in the laboratory for 7 days and then sacrificed. For all mussels, a portion of the mantle tissue was frozen and RNA isolated using RNeasy. Changes in gene expression was measured using QPCR with beta actin as the housekeeping gene. The remaining tissues were freeze dried for analysis of PFOS concentrations in the visceral mass, mantle, and gills.

Prior to exposure, males exhibited significantly higher gene expression of the chaperone molecule heat shock protein beta-1 (HSP 27) than did brooding females. After exposure, expression did not change for males, but was significantly elevated in brooding females. Tissue samples are still being analyzed to determine whether PFOS bioaccumulation differed between males and females.

Results this far suggest that induction of gene expression by PFOS differs between sexes and is likely related to reproductive state. Chaperone molecules are typically induced in response to stressors affecting stability of various proteins. The induction of chaperone molecules in gravid females supports previous studies showing relatively high sensitivity of glochidia to PFOS with multiple effects including decreased duration of brood viability and reduced metamorphosis success of exposed glochidia. Effects of PFOS on reproductive success of unionids are of particular concern and deserve additional study.

Anjan Bhatta, Rishi Prasad, Debolina Chakraborty, Joey Shaw, Eve Brantley & Jasmeet Lamba, Auburn University

Repeated annual application of phosphorus (P) fertilizers and manure in excess of plant requirement leads to buildup of P in soil. Excess soil P is susceptible to loss and promote eutrophication of water bodies. Soil test phosphorus (STP) originally developed for agronomic purpose is used as an indicator of environmental P loss risk. However, STP is not a true indicator of P loss risk. Degree of phosphorus saturation calculated from acid ammonium oxalate (DPSox) is another tool used for assessment of P loss risk. However, oxalate extraction is not a routine soil test due to the length of time and reaction conditions required. There is a need to follow a standard rapid soil testing protocol to determine the environmental P loss risk from Alabama soils. Phosphorus saturation ratio (PSR) calculated using Mehlich-1 (PSRM1) and Mehlich-3 (PSRM3) defined as the molar ratio of extractable P to extractable Fe +Al, can be potentially used for predicting P loss risk for Alabama soils. The objective of this study was to determine and compare the environmental risk of P loss for Alabama soils under different management practices using the concept of PSRM1, PSRM3, and DPSox. Soil samples were collected to a depth of 0-60 cm across different manure application history, and soil types from different farms (row crop, hay or pasture) in Alabama. Water soluble phosphorus (WSP), Mehlich-1, Mehlich-3 and Oxalate extractions were carried using standard procedures and DPS and PSR were calculated. For most of the surface soils (0-5 cm), PSR and DPS values were greater than the threshold limit (a critical point beyond which WSP increases abruptly) and the magnitude differed between soil types, manure history and farm types. Results showed that the WSP increased abruptly beyond 0.8 PSR for Mehlich-1, 0.1 PSR for Mehlich-3 and 0.15 PSR for Oxalate. Comparing PSRM1 and PSRM3 with DPSox (%), the linear regression showed higher coefficient of determination for M-3 (r²=0.83). Preliminary results indicated that PSRM3 values were closely related to DPSox and can be used for predicting environmental P loss risk for Alabama soils.
Abstract No. P06. *Long-term drivers of hydrological changes in southeastern United States*

**Arshdeep Singh & Sanjiv Kumar**, Auburn University - School of Forestry & Wildlife Sciences

Climate and vegetation are two key drivers of the hydrological changes that also perturb carbon and energy cycles. The study aimed at investigating the effect of long-term climate and vegetation changes on water availability in the southeastern United States. Approach of this study includes: analysis of historical climate, vegetation, and streamflow data, and climate modeling studies for future projections. We have analyzed high-resolution PRISM (Parameter elevation Regression on Independent Slopes Model) data for precipitation and temperature, NDVI (Normalized Difference Vegetation Index) for vegetation, and SMERGE (SoilMERGE) for soil moisture from 1981 to present. We found statistically significant increase in NDVI, whereas the precipitation, and soil moisture have decreased in the winter and spring seasons in the southeastern United States. A decreasing vegetation trend is found in the summer and fall seasons, which was also accompanied by decreasing soil moisture trend. We have formulated two hypothesis for the observed vegetation: (1) increasing NDVI can be related to increasing CO2 concentration in the atmosphere, and (2) a shift in the Pacific Decadal Oscillation (PDO) have resulted in decrease in precipitation, and cloud cover and thereby increasing net radiation at the surface that can drive vegetation growth. We are developing a high-resolution Community Terrestrial System Model (CTSM) model configurations to test these hypothesis, as well as to investigate future water availability change. Results from modeling study will also be presented.
Abstract No. P07. *Spinach Growth Using Vertical Garden Techniques and Local Water Sources for Urban Gardens*

**Ashly Manzella & Robert Peters**, The University of Alabama at Birmingham

This project seeks to identify guidelines for producing high-nutrient valued spinach using sustainable vertical farming techniques in Jefferson County, Alabama and across the United States to improve access to fresh fruits and vegetables for individuals living in food insecure areas. Based on the non-thesis report of University of Alabama at Birmingham graduate student (J. Ashly Manzella) using the 2010 census data, approximately 70% of Birmingham, Alabama, ZIP codes are located in low-income, low-access areas (food deserts). Over 289,000 Birmingham residents are impacted by these conditions, and the area’s racial breakdown is 65% African-American, 30% white, and 5% other.

Encouraging healthier eating habits and providing better access to fresh fruits and vegetables, such as through community gardens and farm stands, is an important way to reduce risks of chronic diseases due to poor diets in low-access areas. It is postulated that if local water sources, such as lake water, can be used with limited addition of fertilizers and pre-treatment chemicals, nutritious fruits and vegetables can be grown sustainably. This research activity seeks to reduce soil, water, and energy requirements for healthy food growth and to demonstrate that vertical gardening techniques using surface waters can produce as many quantitatively nutrient-equivalent plants per square foot as traditional gardening techniques.

The research design analyzes water quality and usage volume, vertical gardening techniques (Tower Gardens®, pyramid, and pallet gardens), yield, biomass, and plant health via chlorophyll analysis. Both lake and city collected waters have been analyzed for alkalinity, conductance, pH, and turbidity for the viability of the water sources using bench top chemistry methods. The soil has been analyzed using commercially available pH and soil moisture meters. In the first growing season, of the 200 spinach planted in late September of 2018, only 26 plants survived until harvesting. Of those 26 plants, only 11 plants were healthy enough for harvesting. Of the 11 plants, the average wet weight of a single leave was 0.58 mg and dry weight of 0.04 mg. The average percent moisture content was found to be 94.13%. The chlorophyll fluorescent measurement average was 0.752, and anything greater than 0.7 is indicative of a healthy plant. In early April 2019, 154 spinach plants were planted to be analyzed similarly to the fall of 2018 planting. Due to space requirements, fewer spinach plants were planted to allow for root growth. Eighty plants are located in Tower Gardens®, thirty-eight plants are located in pallets, and thirty-six plants are located in the pyramid gardens. A secondary site in the greater Birmingham metropolitan area was selected to grow spinach which includes twenty plants in a Tower Garden® and twenty plants located in planters. The testing is currently on-going.
Abstract No. P08. *Flash Flood Damage Prediction in the Southeast US via Machine Learning*

Atieh Alipour, Ali Ahmadalipour & Hamid Moradkhani, The University of Alabama

Due to frequent torrential rainfall caused by tropical storms, thunderstorms, and hurricanes, flash flood is a common danger across the Southeast U.S. Flash floods are generally costly natural hazards, primarily due to their rapid onset. Therefore, predicting potential property damages of flash floods is essential for achieving proactive disaster management. However, the majority of previous flood damage prediction assessments were conducted at small-scales, explicitly applicable to the region of interest. To fill this gap, in this study, we present a framework that considers a variety of features explaining different components of risk (i.e., hazard, vulnerability, and exposure), and multiple Machine Learning (ML) models to predict flash flood damages. A large database of flash flood events consisting of more than 14,000 events are assessed for training and testing the methodology, and multitude of data sources are utilized to acquire reliable information related to each event. A variable selection approach was employed to alleviate the complexity of the dataset and facilitate the model development process. The ML model is implemented in two modes: first, as a binary classifier to estimate whether a region of interest is damaged in any particular flood event, and then as a regression model to predict the amount of damage associated with each event. The results indicated effectiveness of the proposed methodology in predicting flash flood damages across the SEUS.
Abstract No. P09. Comparison of pollutant removal capabilities of three representative bioretention mixes of the United States

Caitlin Sweeney, Eve Brantley, Thorsten Knappberger & Joey Shaw, Auburn University

The conversion of land use to urban areas in the United States creates concern for stormwater toxicity impacts on water resources. Typical pollutants found in stormwater include heavy metals, nutrients, and polycyclic aromatic hydrocarbons. The introduction of these pollutants degrades water quality, impairs habitat, and reduces aquatic diversity. Stormwater toxicity may be addressed with the use of green infrastructure stormwater control measures such as bioretention cells. Bioretention cells are structures designed to filter the first flush of stormwater through a media before it enters surface or groundwater, reducing the amount of runoff, peak discharge rate, and concentration of pollutants. However, the recommended media for pollutant removal in bioretention cells differs by state. State bioretention media recommendations (or a major city if state information did not exist) were collected with information including media depth, sand percentage, fines percentage, topsoil percentage, and organic matter percentage. Three mixes representative of those used across the United States were then identified by performing a factor analysis of mixed data. The resulting compositions were (1) 81% sand, 11% fines, 3% topsoil, and 5% organic matter; (2) 53% sand, 38% fines, 2% topsoil, and 7% organic matter; and (3) 54% sand, 5% fines, 18% topsoil, and 23% organic matter. A fourth mix was included to evaluate the potential use of zeolites, a group of natural or manufactured aluminosilicate minerals that can increase the soil’s cation exchange capacity and saturated hydraulic conductivity, in bioretention media. Synthetic stormwater with known pollutant concentrations will be evaluated in column studies with the four media types and a control of 100% sand. Measurements will include residence time, hydraulic conductivity, cation exchange capacity, bulk density, and pollutant load reduction. Results of the summer 2019 project will be presented at the conference.
Abstract No. P10. Morphological Evolution of Global River deltas during the Satellite Era

Dinuke Munasinghe, The University of Alabama

River deltas are important coastal depositional systems that are home to almost half a billion people worldwide, including several megacities. River deltaic landforms act as central locations for agricultural production, livestock farming, and hydrocarbon extraction. Understanding river-delta morphology changes in response to environmental and anthropogenic drivers is important in identifying vulnerabilities to natural disasters and to improve sustainable planning and management. During the past four decades satellite remote sensing technologies have emerged as a viable alternative to in-situ observations of river deltas and associated deltaplain morphology changes owing largely to its capability to provide spatially continuous observations.

The overarching goal of the study is to elucidate the interconnectivity between fluvial fluxes and associated landform changes in large global deltas. Forty Global River deltas are analyzed and the following research questions are investigated: (1) Are changes in fluvial sediment flux to the delta directly linked to changes in delta morphology? (2) What are the magnitudes and trends of riverine sediment fluxes that can be expected throughout the 21st century? A multifaceted research approach combining (a) satellite remote sensing analysis of delta morphology changes (progradation/degradation), and (b) numerical modeling of riverine water and sediment fluxes, is used on selected large river deltas globally.

Major outcomes of the study indicate that the synoptic capability of remote sensing provides a useful reconnaissance tool to infer on the rates at which the deltas change. We found that the performance of Remote Sensing Techniques used in the analysis varied based on the complexity of the deltaic environment. An overview of global delta change is presented with special focus on case studies with severe degradation and interesting flux estimates. The outcomes of the study yields a number of novel insights into fluvial fluxes of the 21st century and transforms our analytical capabilities for studying delta morphology change and sediment flux dynamics in large rivers, globally.
Abstract No. P11.  Associations between Changes in River Morphology and Mussel Assemblages

Gregory Shafer, Lisa Davis & Carla Atkinson, The University of Alabama

Mussels are burrowing, filter feeders and are abundant and widespread in many of Alabama rivers. Few studies have examined whether mussel modification of their abiotic surroundings (ecosystem engineering) creates spatio-temporal changes in river morphology. In this study, conducted on the Sipsey River of Alabama, aerial photo and satellite image analyses (spanning 1965-2018) were used to determine if channel migration had occurred to a greater extent in three reaches with high mussel densities than in other reaches located within a 48 km segment. A total of 444 individual areas of migration were analyzed, representing 25.5% of the total river channel banks analyzed. Annual migration rates for the entire study segment ranged from <0.01 m yr-1 to 0.68 m yr-1 and averaged 0.12 m yr-1. A minimum estimate of total erosional area for the study segment was approximately 228,958 m2. Annual channel migration rates in high density mussel reaches were approximately twice the average annual migration rate (0.22 m yr-1) measured for the total study segment. Most of the migration activity in these reaches occurred as a result of mid-channel bars, located downstream of mussel communities, creating two channel thalwegs that eroded river banks. This study suggests that mussel communities may facilitate bank erosion and channel migration by contributing to mid-channel bar formation. Future work will focus on determining the relationship between the mid-channel bars and mussel communities.
Abstract No. P12. Water Dynamics in Cropland Fields under Rain-fed and Different Types of irrigation Practices

Hemendra Kumar, Puneet Srivastava, Laljeet Sangha, Jasmeet Lamba, Guilherme Morata & Luca Bondesan, Auburn University

In Alabama, only 15% of cropland is available for irrigation. In comparison, 40% and 61% of cropland is irrigated in Georgia and Mississippi respectively. Irrigation practices affect nutrient transportation and dynamics within the soil profiles. This study explored the soil nutrient dynamics such as N and P with irrigation and precipitation in the Tennessee Valley region of North Alabama. Different irrigation zones were delineated based on historical records of crop yield maps including measured topography and electrical conductivity data. Multiple locations were selected for soil sampling in each zone at 0-15, 15-30, and 30-61 cm depth increments before and after the growing season. The selected locations were investigated if they are significantly different for nutrient concentrations. The soil water tension was measured for respective depths of each locations and precipitations was recorded by installed weather station. The soil tension data was used to reflect the effect of irrigation on nutrient transportation using van Genuchten single porosity model. The PWP was measured using WP4 and remaining soil hydraulic properties were measured using HYPROP instrument required in VG model. The soil samples were analyzed using AQ2 discrete analyzer for nutrient concentrations.
Abstract No. P13. Mediating the Impacts of Local Flooding in the Mississippi-Alabama Coastal Region through Green Infrastructure Plan Evaluation

Joe Nisbett & Megan Heim-LaFrombois, Auburn University

Urban ecosystems are increasingly at risk of being devastated by an ever-expanding city. The rapid expansion of urban areas in coastal communities, in particular, will likely lead to the conversion of undeveloped land into impervious surfaces, which degrades ecosystems, exacerbates flooding, and increases the amount and velocity of stormwater runoff. In order to minimize these negative impacts, some local governments have adopted “green infrastructure” plans and strategies in order to conserve and protect their natural resources, such as greenways, wetlands, and open spaces. This research: 1) identifies communities that have engaged in green infrastructure planning in the Mississippi-Alabama coastal region; 2) identifies best practices among those communities; and 3) identifies landscape patterns that should be protected with the goal of transferring this knowledge to other coastal communities. This research specifically focuses on the cities of Mobile, Gulf Shores, Orange Beach, and Dauphin Island in Alabama; and Biloxi, Gulfport, Oceans Springs, D’Iberville, and Pascagoula in Mississippi. This research uses both quantitative and qualitative methods in order to examine current green infrastructure planning practices and their outcomes in the Mississippi-Alabama coastal region. Specifically, the comprehensive plans of the nine cities are analyzed in order to assess if and the degree to which they have incorporated green infrastructure planning strategies.

This assessment is based a plan quality scorecard of key indicators related to green infrastructure planning. An online survey and interviews with planners in these nine cities were conducted in order to understand planners’ experiences and identify which specific factors encourage municipalities to integrate green infrastructure concepts into planning practice, specifically examining the planning organizations in which these planners work and their capacity in terms of leadership and collaboration, comprehensive planning authority and oversight, and availability of resources. Finally, actual stormwater runoff attenuation is examined, looking at the spatial configuration (e.g., size, shape, isolation, and connectivity) of open and green spaces. This research seeks to improve the quality of coastal communities’ plans, and the communities’ quality of life, by incorporating key concepts of green infrastructure planning in to their planning process and reducing flooding events. It also promotes awareness of and provisions for green infrastructure plans in rapidly growing jurisdictions as to avoid excessive stormwater damage. This research additionally provides practical tools for governmental leaders and planners to assess their current green infrastructure, determine future needs, and develop strategies for closing this gap.
Abstract No. P14. Using paleoflood hydrology to extend flood records and understand large floods in South Sauty Creek (Buck’s Pocket State Park, AL)

Joni Corbin, Lisa Davis & Matthew Therrell, The University of Alabama

In this study, we used paleoflood hydrologic techniques to develop a chronology of flood events that pre-date stream gauge data for South Sauty Creek, a tributary of the Tennessee River in north Alabama. Paleoflood hydrology uses physical evidence of flooding to reconstruct the timing and magnitude of floods that occurred prior to historical and instrumental data. South Sauty Creek’s gorge setting makes the stream highly prone to large floods, which as recently as 2019 resulted in loss of life. Streamflow data only begins in 2011, providing limited data for understanding the large floods generated by this stream. Tree core samples were collected from oak (Quercus) trees with flood impact scars in the riparian zone and were counted and dated using standard dendrochronology techniques. The earliest dated flood in the tree ring cores occurred in 1758 C.E.

Preliminary findings suggest that all of the tree scar heights correspond to stages associated with the 2-year flood event, including those scars dated to the 25-year event that occurred in 2015. In the channel adjacent to the tree core sampling site, the 10 largest particles within an imbricated cobble field were measured along their principal axes. Sediment entrainment equations based on the Shield’s parameter were used to determine the minimum water height necessary to move the imbricated cobbles located in channel. We used HEC-RAS 5.0.6 to determine the discharge and flow recurrence interval associated with the flow stage that transported the imbricated boulders. Transportation of 70% of the measured cobbles is associated with flows from a 25-year event or smaller. The largest cobble could be mobilized by a discharge associated with a 500-year flood event. Future work will expand the data set to include higher tree scars to isolate the dates of larger flood events based on inundation mapping of the floodplain.
Abstract No. P15. *Oil-derived trace metal signature in Crassostrea virginica shell may provide historical record of oil exposure*

**Kimberly Peter & Ruth Carmichael**, Dauphin Island Sea Lab and University of South Alabama

Bivalves are useful biomonitors because they assimilate particles from their environment into their tissues, with shells recording changes throughout the oyster’s life, while soft tissues reflect the most recently assimilated elements. To determine if bivalves incorporate oil-derived elements, we exposed juvenile oysters to various oil types (fresh crude, weathered, and controlled spiked oil forms) and concentrations under controlled laboratory conditions during a 4-month period and determined the resulting chemical signatures in their shells and soft tissues. To incorporate the effects of multiple stressors, oysters were exposed to regionally relevant estuarine salinities (14 or 25). Trace element profiles of Ba, Cd, Co, Cr, Cu, Ni, Pb, Sr, V, and Zn were determined using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). Preliminary data showed that the oysters were able to assimilate oil-derived elements into their shells. Zinc was the most efficiently assimilated element among most treatment types. Oysters exposed to Macondo 252 source oil assimilated multiple oil-derived elements including Cr, Cu, Ni, and Zn. We also detected high background levels of trace metals in Mobile Bay, which has potential to interfere with detection of oil contamination. This study demonstrates the potential for using oyster shells to study longer-term contaminant exposure and enhance existing environmental monitoring programs, which currently are largely based on short-term contaminant exposure reflected in soft tissues.
Abstract No. P16. *Water Quality Analysis of the Choctawhatchee, Pea and Yellow Rivers Watershed through the use of SPARROW modeling*

Lucia Alonso Guzman, Maury Estes, Cameron Handyside & James Cruise, The University of Alabama in Huntsville

The agriculture sector in Alabama is not as productive as the other surrounding states in the Southeast US. This is potentially due to lack of irrigation in Alabama, where less than 120,000 acres of farmland are irrigated, according to a USDA 2012 Census. The University of Alabama in Huntsville is working with Auburn University and government organizations to develop watershed plans related to selected scenarios for expansion of irrigation on existing agricultural lands. We are using the SPARROW model (SPAtially Referenced Regression on Watershed attributes) to evaluate the impact that expanded irrigation would have on water quality of the selected watersheds and its subsequent relationship to overall environmental concerns. This model, developed by the USGS, is based upon a non-linear regression equation to describe the loading and transportation of contaminants from land to water resources. The contaminant that we are observing with this model is Total Nitrogen annual load. The sources taken into account are atmospheric deposition, fertilizer applied to farmland, livestock manure, wastewater discharge and urban land, and fertilizer loads, which are manually changed to fit each scenario evaluated. Transport variables are also accounted for within the model. Based on the results of scenarios run with the model, this study can then develop possible plans and parameters within which to expand irrigation and improve economic conditions for farmers across the state of Alabama without negatively impacting the environment in any significant way. The plans will be developed with and guided by many stakeholders, e.g. government agencies, non-government organizations, landowners, etc. The specific watershed that will be elaborated upon is the one currently being studied, the Choctawhatchee, Pea and Yellow rivers watershed. Thus far, the scenarios we have run for said watershed have produced promising results: an expansion in irrigation would not have an impact of high significance on the water quality of the majority of the Choctawhatchee, Pea and Yellow Rivers reaches.
Abstract No. P17. Effects of Vegetation and Time on Soil Stability at Stream Restoration Sites

Madison Wichmann, Thorsten Knappenberger & Eve Brantley, Auburn University

Stream restoration and mitigation projects have become increasingly necessary in today’s rapidly developing society due to the past and current negative impacts of urbanization, agriculture, mining and other land uses. Stream enhancement and restoration projects may be championed by local grassroots groups, invested in by communities seeking to improve natural infrastructure and protect gray infrastructure, required by federal and state regulations, or a combination of these motivations.

Riparian vegetation may be cleared to provide construction space and vehicle site access. Due to this disruption, the soils that comprise these floodplains and streambanks become highly unstable and unconsolidated, therefore leading to a high risk of erosion and structural failure in the cases of flooding or extreme weather events, such as drought or other minor natural disasters, especially right after construction. Soils typically become more stable as the project site matures. Increased soil stability might be due to vegetation and root growth or could also be largely a soil physical effect driven by wetting and drying cycles. The objectives of this study are to determine how time affects the stabilization of these soils and how rooted vegetation contributes to soil aggregation. We hypothesize that soil shear strength increases as the ages increase, due to root growth, and soil aggregation.

Stream restoration sites of different age ranging from months to a decade since restoration were identified. At each stream restoration site, disturbed and undisturbed soil samples were taken. The disturbed samples were analyzed for total soil carbon content, aggregate stability, root mass, soil texture, pH, and color. The undisturbed samples were analyzed for saturated hydraulic conductivity, shear stress under saturation and at field capacity (~-30kPa), bulk density, and water retention characteristics. Results from 8-10 stream restoration sites in the Piedmont and Coastal Plain regions of Alabama will be presented and discussed. Findings from this study inform stream restoration professionals to improve restoration site risk assessment and ameliorate stream restoration channel design.
Abstract No. P19. *Nutrient recovery from aquaponics wastewater using algal turf scrubber and the utilization of filamentous algae for lactic acid fermentation*

Nicholas Burgess, Suan Shi & David Blersch, Auburn University

Aquaponics systems help to recover the nutrients in the wastewater from fish farming tanks, but the waste stream after recirculation in vegetable greenhouses still contains very high amounts of nitrogen and phosphorus. These nutrients can result in eutrophication in receiving water bodies. The algal turf scrubber (ATS) is an effective way to further reduce and recover the nutrients in these waste streams. In this study, the effect of using ATS to further treat the wastewater and the production of lactic acid from the algae biomass was investigated. Algae cultured in an indoor four lane ATS system using the aquaponics wastewater were harvested, dried, and collected from February to May 2019. The growth conditions of filamentous algae in the ATS such as pH and temperature were studied and optimized which produced six to eight grams of algae biomass for each ATS lane per weekly harvest. The harvested algae samples were ground and mixed to form a composite sample and analyzed to determine carbohydrates and ash contents. These algae samples were compared to cucumber residues cultivated within the aquaponics system. Due to the less recalcitrant structure, algae does not require complicated pretreatment step as lignocellulosic materials do. Also, the fermentation process could be done in about 48 hours, which is half of that from lignocellulosic materials. However, the final lactic acid concentration is low because of the low carbohydrates content in the predominantly blue-green algae. We are now trying to adjust the growing conditions to facilitate the growth of green algae which contains high carbohydrates.
Abstract No. P21. *Satellite Data assimilation with the WRF-Hydro model: An effective approach to improve hurricane-induced flood prediction*

Peyman Abbaszadeh, Keyhan Gavahi & Hamid Moradkhani, The University of Alabama

Despite recent advances in hydrologic data assimilation systems and remote sensing technologies, their utilization has become limited in hydrologic applications due to rising extreme events such as heavy rainfall and severe floods caused by thunderstorms and hurricanes. This is the main concern particularly in Southeast US because of the prevailing extreme weather conditions. The idea of assimilating high-resolution satellite soil moisture data into fully distributed hydrologic models, such as WRF-Hydro (Weather Research and Forecasting Hydrological model), is still at infancy due to its complexity and sophistication. It is therefore important to examine the benefit of assimilating independently and jointly high-resolution satellite soil moisture data and streamflow observations into a hyper-resolution hydrological model (here WRF-Hydro) and to understand the extent to which these observations can contribute to improving the model predictions, particularly during the extreme events. Therefore, we conducted our study over a region in Southeast Texas where heavy rainfall from Hurricane Harvey caused flooding. We assimilate SMAP (Soil Moisture Active Passive) soil moisture observations (ascending and descending overpasses) at different resolutions (36 km- native footprint; 9 km- Backus-Gilbert interpolated and 3 km-SMAP/Sentinel-1) along with the recently downscaled SMAP soil moisture product at 1 km into the WRF-Hydro model with the aim to improve the accuracy and reliability of WRF-Hydro model predictions.
Abstract No. P22. *Phosphorus release characteristics of poultry litter and its implications for water quality*

**Poulomi Dey, Rishi Prasad & Debolina Chakraborty**, Auburn University

The quality and integrity of rivers and lakes in Alabama is important as it touches several spheres of human day-to-day needs. Phosphorus (P) transported from point or non-point sources is often associated with impairment of water quality and environmental problems such as eutrophication and algal blooms. Approximately 1.5 million tons of Poultry Litter (PL) is applied widely across the farms of Alabama. It is important to understand the true potential of PL to release P during sequential rainfall events. This research aims to evaluate the P release characteristics from poultry litter of various ages (flock cycles) and composition (bedding materials). The objectives of our experiments were 1) to characterize the total P released from PL of different ages by repeated washing with de-ionized water; 2) quantify proportions of organic verses inorganic P forms in the labile phase during repeated wash cycles. Poultry litter of varying age and composition were collected from several poultry houses across Alabama. The PL was washed with de-ionized water (PL: DI of 1:100 and 1 hour shaking time) repeatedly to mimic P release during sequential rainfall events. The PL was washed with DI repeatedly until the molybdate reactive P fall below the method detection limit. The wash solution was analyzed for molybdate reactive P, organic P and total P. It took seven wash cycles for molybdate reactive P to fall below the method detection limit. The residue P left at the end of 7th cycle was 21703±6537 mg of P per kg of PL and represented 58 ±7 % of the total P present in litter.

The wash samples were also analyzed for As, Cr, Cd, and Pb. The P released from PL followed an exponential decay trend. The 1st wash cycle extracted 50 ±4 % of the total water soluble P, followed by 24±2 %, 7±1 %, 4±1%, 3 ±1% and 1% in 2nd ,3rd , 4th ,5th , 6th and 7th wash cycles, respectively. Molybdate reactive P extracted in labile phase during all seven extractions, accounted 32±4 % of the total P present in PL, the organic P fraction in labile phase was only 9±5 % of the total P. On an average, DI can solubilize 41±9 % of the total P present in the PL. Heavy metal concentrations of As, Cr, Cd, and Pb was found below the method detection limit in the wash cycles. This research can aid in developing management strategies that can help minimize P runoff from PL applications.

Rajveer Singh & Rishi Prasad, Auburn University

Quantification of nitrogen (N) losses from row crop production via leaching, denitrification, runoff or volatilization loss pathways is challenging and subjected to measurement errors. It is critical to understand N losses in crop production systems so that best management practices (BMPs) can be developed to reduce such losses. In Alabama, poultry industry generates an estimated 1.4 billion kg of poultry litter (PL) annually which is used as a nutrient source for row crops especially corn (Zea mays L.). However, estimates of N losses associated with PL application are scanty for Alabama soils. We evaluated the components of N budget for dry land corn fertilized with poultry litter and urea using a calibrated crop model, CERES-Maize in Decision Support System for Agrotechnology Transfer (DSSAT). A two-year (2018-2019) field plot study was conducted at Auburn University’s E. V. Smith Research Center in a completely randomized block design. The treatments included two N sources (PL and urea), two rates (168 and 336 kg N/ha), two application timings (pre-plant and split) and a control. Plant and soil samples were collected at three growth stages of corn (V6, R1 and R6) and aerial dry matter was determined. Tissue samples were further analyzed for total N whereas soil samples were analyzed for total N, nitrate (NO3) and ammonium (NH4) N. The calibrated model was validated for nitrogen mass balance components against the observed data and estimates of environmental N losses were compared. Preliminary data will be presented.

**Rebecca Russell, Maury Estes & James Cruise**, The University of Alabama in Huntsville

Nutrient pollution, caused by excess nitrogen and phosphorus, causes harm to the environment by contaminating the groundwater and other waterways. Surplus nitrogen overloads the ecosystems and can result in algal blooms or other harmful bacteria that can damage water quality, destroy natural resources and habitats, and kill aquatic life. Excessive nitrogen pollution is known to result from agricultural production and other human activities such as urban development and wastewater discharge. The distribution, sequestration, and transportation of nitrogen are also affected by the watershed properties and other environmental characteristics. Land cover land uses (LCLU) and other contributing factors are integral when estimating the nitrogen concentration in downstream waterways. The Spatially Referenced Regressions on Watershed attributes (SPARROW) model is able to use LCLU data and associated variables to predict Nitrogen fluxes and concentrations as the contaminant moves through the hydrologic system to the ocean. SPARROW uses a nonlinear regression equation to calculate the predicted nitrogen loads and to evaluate the influence of select nutrient sources and watershed properties that affect the transportation of the nutrient as it moves downstream. In this way, the modeling of predicted nitrogen concentrations over stream networks can be used as an important tool when determining the impacts of human development and activities. To develop a tool useful for end users in coastal regions the SPARROW model is being used in conjunction with different future land cover land use scenarios in order to determine the effects of LCLU change on water quality. To project future changes, USGS developed future LCLU data out to the year 2100. We are using future LCLU data for 2030 and 2050 years and will select the LCLU coverages from four scenarios developed by the International Panel on Climate Change (IPCC) based on varying development and environmental assumptions. Substituting these future land use areas and associated variables into the SPARROW model, the new resulting nitrogen concentrations for each watershed area can be calculated. End users in coastal communities plan to use this tool when evaluating future agriculture or urbanization expansion to determine the best course for both development and environmental conservation. In order to provide results that are more accurate for these communities, model calibration is ongoing to focus the model on coastal watersheds such as Weeks Bay-Alabama, Tampa Bay-Florida, and Winyah Bay-South Carolina.

Ritesh Karki & Puneet Srivastava (Auburn University), David Bosch (USDA-ARS Southeast Watershed Research Lab), Latif Kalin & Jasmeet Lamba, Auburn University

Multi-variable calibration of a field scale Soil and Water Assessment (SWAT) model is critical for understanding the true impacts of irrigation and nutrient best management practices on hydrology, water quality, and agricultural productivity, and for building stakeholder trust for its eventual implementation at the watershed scale. This study evaluated the ability of the SWAT model to simulate runoff, soil moisture, cotton and peanut yield, and nitrate in conventionally- and strip-tilled plots while also evaluating the differences in hydrological and nutrient simulation parameters in the two tillage practices. Modeling results showed that SWAT can adequately simulate runoff, soil moisture, cotton and peanut yield, and nitrate at the field scale and that calibrated values for the Curve Number of Operation (CNOP) were different for the conventionally- and strip-tilled plots and critical to runoff calibration. We found that it was also important to change the routing method from Variable Storage to Muskingum and adjust DIS_STREAM for runoff simulation, if the fields were to be simulated as a watershed rather than as an HRU. Sequential calibration of surface runoff, crop yield, soil moisture, and nitrate showed that crop yield can be an important consideration for improving SWAT model robustness in nutrient transport simulations, although soil moisture calibration did not have a significant effect on runoff simulations. We also evaluated the impacts of different management scenarios on crop yield, irrigation water use, and nutrient loss, and demonstrated to stakeholders that the SWAT model can successfully quantify the impacts of different management scenarios on their farm fields.

Kelley Rich, Wood Environment and Infrastructure Solutions, Inc.

Wood Environment & Infrastructure Solutions, Inc. (Wood E&IS) installed radio telemetry systems to remotely monitor groundwater elevations at two sites in separate counties in Alabama. The systems were deployed at the sites simultaneously and are currently being maintained by Wood E&IS, but each site has presented its own set of challenges, requiring creative and sometimes spontaneous adjustments to be made by Wood E&IS personnel. Such systems require preparatory actions, installation strategies, and equipment upkeep that can vary from site to site depending on factors including vegetation, topography, site use, geology, and wildlife, among others. Wood E&IS would like to share our experience with this type of groundwater monitoring system and offer insight into the installation and utilization of these systems. In addition to discussing the challenges and advantages of groundwater-elevation telemetry systems, the basic concepts and technical aspects of the system’s equipment and software utilized by Wood E&IS will be discussed to assist others considering the implementation of similar systems at sites in Alabama.

Allyson Shabel, Karnita Garner & Paul Okweye, Alabama Cooperative Extension System

According to the Associated Press, concentrations of pharmaceuticals have been found in the drinking water supply of nearly forty-one million Americans. The potential toxicity of these chemicals remains unknown, and that uncertainty poses an immense threat to human, animal and environmental health worldwide. The pandemic use, misuse, and abuse of prescription and opioid drugs only perplexes the problem, in both urban and rural communities. The Synergistic Efforts to Reduce Pharmaceuticals in the Environment (SerPIE) program was developed to advance knowledge and emphasize the benefits of using safe, effective methods to dispose of expired, unused, and unwanted pharmaceuticals and personal care products (PPCPs). Applying a ‘One Health’ approach, it has reached over 8,959 traceable and 662,998 non-traceable contacts and partnered to host forty-five drug take-back programs; collecting over 24,600 pounds of PPCPs. SerPIE’s measurable outcomes include increased knowledge gained on PPCP issues based on pre/post-test measures, increased adoption of pharmaceutical best management practices (BMPs), a decrease in the medicine stockpiled in homes and fated for the environment, a decrease in drug overdoses resulting from unguarded medicine, decreased costs associated with drug-related health issues, and improved environmental sustainability. Overall, SerPIE offers a novel approach, incorporating the human, animal and environmental aspect into its education and outreach efforts.
Abstract No. P29. Understanding the Phosphorus Retention Capacity and Phosphorus Forms in Poultry Litter Impacted Soils of Lake Wedowee Watershed in Alabama

Debolina Chakraborty & Rishi Prasad, Auburn University

Poultry is the second-largest agricultural industry in Alabama with an economic impact of $15.1 billion in revenue. Poultry operations generate 1.4 billion kg of poultry litter (PL) annually. Poultry litter (PL) is bulky which limits their economical long distance transportation. Repeated land application of PL results in buildup of P in soil leading to creation of “P hotspots” near the poultry operations. This accumulated P in soil is susceptible to P loss via runoff and can promote eutrophication of surface water. Lake Wedowee watershed in Alabama is of prime importance mainly due to expansion of poultry operations in the area. Tools such as P index or soil test P (STP) are used to indicate the potential for P loss risk to environment; however, the effectiveness of these tools to estimate P loss risk is not clear for Alabama soils. Additionally, no work has been done to understand the P retentive capacity of soils in the Wedowee watershed. Phosphorus saturation ratio (PSR), which is the molar ratio of P to [Fe + Al], is often used as an environmental indicator of P loss from soils. Neither STP nor PSR provides information on how much P can be added to a certain volume or mass of soil before the soil begins to release P. The latter information is provided by the soil phosphorus storage capacity (SPSC). Additionally, P in litter-impacted soils can exist in several forms and can differ in their relative ability to become bioavailable. Identification and quantification of P forms in the PL impacted soils will provide information on major P forms that can be potentially transported to waterbodies in runoff events. The objectives of this study were to 1) identify and quantify the dominant P forms in the PL impacted soils of Lake Wedowee watershed under pasture, row crops, and hay operations using sequential chemical extraction; 2) estimate the soil P storage capacity (SPSC) of poultry-litter impacted soils of Wedowee watershed under pasture, row crops, and hay operations. Soil samples up to a depth of 60 cm were collected at multiple locations in row crop, hay and pasture operations in the Wedowee watershed. Water soluble phosphorus (WSP), Mehlich 1(M1), Mehlich 3 (M3) and Oxalate (Ox) extractions were performed on these soil samples using the standard procedures. Soil P fractions of selected samples were also evaluated to quantify different forms of P and to relate that to the stability of P in the watershed. Soils were characterized for labile P (1 M NH4Cl), iron-aluminum bound P (0.1 M NaOH) and calcium-magnesium bound P (0.5 M HCl). Preliminary data of soil P fractions and the P release potential of PL impacted soils of Lake Wedowee watershed will be presented.
Abstract No. P30. 1,4-Dioxane Cosolvency Impacts on Trichloroethene Dissolution in Groundwater and Sorption to Aquifer Materials

Geoffrey R. Tick (The University of Alabama), Justin Milavec & Kenneth C. Carroll (New Mexico State University) & Mark L. Brusseau, The University of Arizona

Solvent stabilizer 1,4-dioxane, an emerging recalcitrant groundwater contaminant, was commonly added to chlorinated solvents such as trichloroethene (TCE), and the impact of co-disposal on contaminant transport processes remains uncertain. A series of batch equilibrium experiments was conducted with variations of 1,4-dioxane and TCE composition to evaluate aqueous dissolution of the two components and their sorption to aquifer sediments. The solubility of TCE increased with increasing amounts of 1,4-dioxane, indicating that 1,4-dioxane acts as a cosolvent causing solubility enhancement of co-contaminants. The solubilization results compared favorably with predictions using the log-linear cosolvency model. Equilibrium sorption coefficients (Kd and Kf) were also measured for different 1,4-dioxane and TCE compositions, and the findings indicate that both contaminants adsorb to aquifer sediments and TCE Kd values increased with increasing organic matter content. However, the Kd for TCE decreased with increases in 1,4-dioxane concentration, which was attributed to cosolvency impacts on TCE solubility. These findings further advance our understanding of the mass-transfer processes controlling groundwater plumes containing 1,4-dioxane, and also have implications for the remediation of 1,4-dioxane contamination.
Abstract No. P31. *GIS Methods Used as Groundwater Tools at Sites in Alabama*

Kendall Rich, Wood Environment and Infrastructure Solutions, Inc.

As groundwater availability and quality are progressively impacted with Alabama’s increasing population, innovative and efficient tools that characterize and manage groundwater issues are of increasing importance. Site characterization, conceptual site modeling, and contaminant remediation are among the numerous groundwater-related disciplines that benefit directly from the use of GIS. Wood Environment and Infrastructure Solutions, Inc. (Wood) has managed and continues to manage numerous projects related to groundwater both directly and indirectly. Examples of GIS tools and processes utilized in groundwater data collection, conceptual site modeling, groundwater monitoring, and contaminant remediation are provided in this presentation.

One specific example includes the use of internet tools and database queries to map borehole-log data from USGS online databases for site conceptual modeling. Another example involves the use of GIS plug-ins to create subsurface geologic cross sections for aquifer characterization. Another significant GIS tool set utilized interpolation calculations with kriging and other tools in GIS to map groundwater-elevation contours and contaminant-concentration contours at remediation sites.

Additionally, these contours, paired with additional spatial data, were used to design parameters and dimensions of an air-sparging and high-vacuum extraction corrective-action system at another underground storage tank remediation site.
Abstract No. P32. Carbon dynamics at the terrestrial-aquatic interface of Mobile River Basin: A modeling study

Shufen Pan, Zihao Bian, Yuanzhi Yao & Hanqin Tian, Auburn University

Although terrestrial carbon pools and fluxes have been widely investigated in previous assessments, there is a lack of investigation integrating terrestrial and aquatic ecosystems over a large basin. Especially at the coastal terrestrial-aquatic interface, the inland water carbon cycling is acknowledged to be a major component of the carbon cycle and budget. In this study, we use the Dynamic Land Ecosystem Model (DLEM) to quantify magnitude, spatial and temporal patterns of carbon fluxes in both terrestrial and aquatic ecosystems across the Mobile River Basin during 1900-2018, and further attribute relative contribution of climate, land conversion, atmospheric CO2, and nitrogen deposition to carbon fluxes in the basin. Our modeling study shows substantial year-to-year variations in land-atmospheric carbon exchange due to inter annual climate variability. Climate extreme events such as hurricanes result in substantial seasonal variations in the riverine export of carbon (dissolved organic carbon, dissolved inorganic carbon, and particulate organic carbon). Land use and land cover change controls decadal and century-scale patterns of carbon fluxes in both terrestrial and aquatic systems. Our study indicates that it is clearly needed to integrate terrestrial and aquatic systems for accurately assessing the carbon budget over a large region.

Wanyun Shao, The University of Alabama

Drought poses serious risks and causes damages to the human society. Many efforts have been exerted to understand the physical characteristics and mechanisms of this hazard. Still, not much is known about how the society reacts to drought. Particularly, how do people perceive drought? Using a two-city survey data that was collected in two cities -Mobile and Huntsville in Alabama in the spring of 2016, we attempt to examine how the objective condition along with socio-economic characteristics and perceptions of related hazards (i.e., precipitation, extreme heat) affect residents' perceptions of this hazard. We attempt to situate our understanding within the geographic context represented by objective records of droughts and Google Trends in these two cities.

For further information, please see the conference website: https://aaes.auburn.edu/wrc/alwrc-conference/