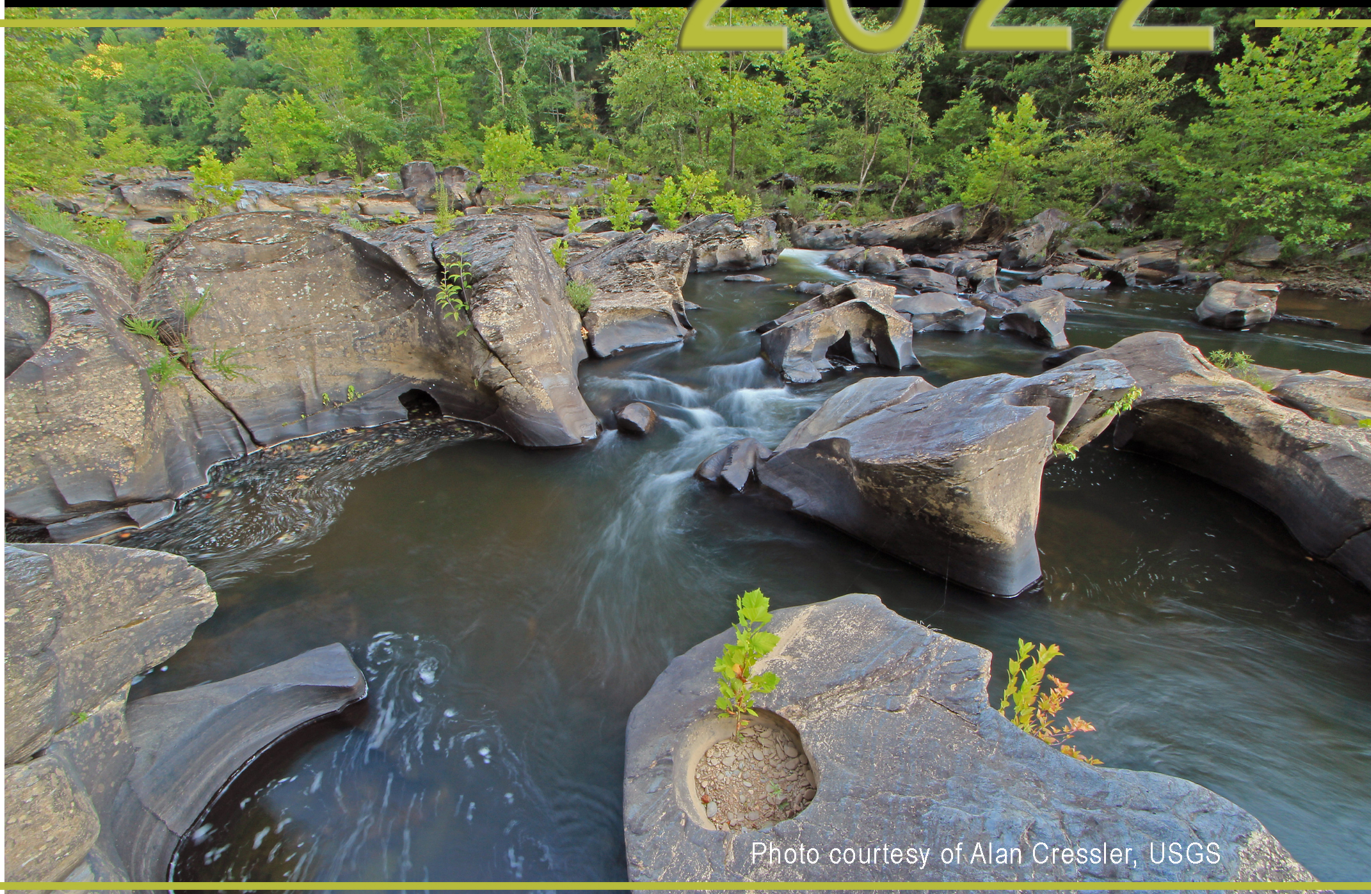
PROCEEDINGS of the 2022



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TENNESSEE WATER RESOURCES SYMPOSIUM

APRIL 20-21, 2022

Proceedings from the

Virtual 2022 Tennessee Water Resources Symposium

Sponsored by: **Tennessee Section of the American Water Resources Association**

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8:15 a.m.

Thursday, April 21

Keynote Address *by* Dr. Charles Sims, UT, Knoxville, cbsims@utk.edu

CLIMATE CHANGE POLICY: A SHALLOW DIVE INTO A DEEP CHALLENGE

In 1988, Dr. James Hanson gave Congressional testimony on climate change that helped raise broad awareness of global warming. Since that time, our understanding of the physical effects of climate change have improved considerably. However, public policy to reduce these impacts has not kept pace. This talk will briefly discuss some of the features of climate change that make it such a difficult public policy issue. The talk will draw from recent research on the economic impact of climate change and climate change policy.

SESSION 1C

MICROBIAL ASSEMBLAGES
(Moderator: Qiang He (JS))

GROUNDWATER STUDIES, MEMPHIS
(Moderator: Scott Schoefernacker, CAESAR)

SESSION 2A

STORMWATER MANAGEMENT
(Moderator: To be determined)

SESSION 2B

WATERSHED PLANNING & ASSESSMENT
(Moderator: Tom Lawrence, TLE, PLLC)

SESSION 2C

GW/SW MANAGEMENT
(Moderator: Daniel Saint, TVA)

SESSION 1A

FLOODS & HYDROLOGIC MODELING

(Moderator: Ken Barry, S&ME, Inc.)

9:00 a.m. - 10:30 a.m.

Simulation of Flooding of Trace Creek in Humphreys County, Tennessee
J.T. Brackins, M.M. Arms, B.A. England, and A.J. Kalyanapu

Communicating Flood Risk with ArcGIS Story Maps Using the Trace Creek Watershed as a Case Study
M.M. Arms, B.A. England, J.T. Brackins, and A.J. Kalyanapu

Comparing Area Precipitation Interpolation Methods from Point Measurements for Five Basins in the Tennessee Valley
N. Barber

FLOODPLAIN MODELING & MANAGEMENT

(Moderator: Mary Bruce, Metro Water Services)

10:45 a.m. - 12:15 p.m.

Improved Remote-Sensing Imagery Techniques to Identify Riparian Corridor Characteristics in Headwater Streams and Inventory Wetlands, Lakes, and Permanent Streams in West Tennessee
Berkay Tok, Youngsang Kwon, Brian Waldron, and Mary Yaeger

Large-Scale Hydraulic Modeling of the Tennessee River Basin
J. Schlamp

A River Runs Through It: I-24/I-75 Interchange Hydraulics
B. Zoeller

SIMULATION OF FLOODING OF TRACE CREEK IN HUMPHREYS COUNTY, TENNESSEE

John T. Brackins[1*], Maci M. Arms[2*], Brady A. England[3*], and Alfred J. Kalyanapu[4]

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On August 21, 2021, NWS Nashville announced that 17.02 inches of rainfall had been recorded in 24 hours at McEwen, Tennesssee, setting a new statewide all-time 24-hour rainfall record for Tennessee. This study will simulate the resulting August 21-22 pluvial and fluvial flooding of ungaged Trace Creek which occurred in Waverly, Tennessee. Although the locally unprecedented extreme precipitation was a major factor in the flooding, local officials have expressed their concern about other possible factors contributing to flood risk in Waverly, including potential loss of channel capacity. In order to better understand what roles are played by various factors affecting flood risk, hydrologic and hydraulic models can be used to simulate a wide variety of scenarios, including extreme events. Therefore, the objective of this study is *to simulate the August 21-22 flooding of Trace Creek in Waverly, Tennessee in order to better understand the potential factors and processes involved*. Comparisons will be made between simulations of the flooding using a variety of hydrologic and hydraulic models, including the Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS), HEC River Analysis System (HEC-RAS), and the National Water Model version 2.1. Simulated high water marks will be compared against high water marks surveyed by the United States Army Corps of Engineers (USACE).

COMMUNICATING FLOOD RISK WITH ARCGIS STORY MAPS USING THE TRACE CREEK WATERSHED AS A CASE STUDY

Maci M. Arms[1*], Brady A. England[2*], John T. Brackins[3*], and Alfred J. Kalyanapu[4]

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Flood risk education is an important aspect in water resources management. While developing hydraulic models are essential in understanding flood risk, an often-underappreciated aspect of flood risk management is communicating results to the public. In this communication process, it is important to ensure that both technical and non-technical audiences can easily understand the presented information. One increasingly popular method of involving the public in spatial decisions is with ArcGIS Story Maps. As opposed to traditional public communication methods, ArcGIS Story Maps allow for an interactive experience with the user through photos, videos, and maps. While this tool is helpful in conveying ideas, many in the public have little to no experience using it. Therefore, the goal of this project is *to provide an educational tool for the public to communicate flood risk in a non-technical manner using the Trace Creek watershed as a case study*. In order to complete this objective, an ArcGIS Story Map was developed to better display hydraulic model results to a non-technical audience. To ensure this resource was useful for technical and non-technical audiences, all technical terminology was defined, and outside resources were provided for those interested. A preliminary survey revealed that 74% of non-engineering participants and 70% of engineering participants strongly agreed that the Story Map was easily understandable. While this study focused on the use of ArcGIS Story Maps to communicate flood risk, a similar methodology may be applied in other engineering applications.

COMPARING AREA PRECIPITATION INTERPOLATION METHODS FROM POINT MEASUREMENTS FOR FIVE BASINS IN THE TENNESSEE VALLEY

Nathan Barber, Water Resources Engineer, Tennessee Valley Authority

The Tennessee Valley Authority (TVA) benefits from a sufficiently dense precipitation gage network based on minimum density recommendations by the World Meteorological Organization (WMO). The benefits of this network include remotely monitoring precipitation events in real-time, comparing point precipitation totals to alternative or satellite/radar-derived data sources to understand bias, and the ability to generate spatially, continuous precipitation data for use in hydrologic models. While TVA no longer relies exclusively on this network for hydrologic model inputs (as a more complex, multi-source dataset produced by the National Weather Service is used), it can offer a viable and equivalent alternative. This study compared the results of three spatial interpolation methods using only the precipitation gage network, to a multi-source, gridded precipitation product developed by the National Weather Service (NWS) for the record, wet yet year of 2020. Additionally, gages were selectively removed from the algorithms as a function of the distance from the center of each basin, to assess impacts on performance. Resulting grids were spatially averaged at five representative (and diverse) basins throughout the Tennessee Valley and then passed into a rainfall/runoff model where performance could be objectively analyzed. Results indicate that simpler methods utilizing only the existing precipitation gage network generally perform as well as the more complex MRMS product at basin scales used in this study (70 – 800 mi^2). As gages are removed within the vicinity of each studied basin, performance across chose methodologies diverge with Theisen Polygons proving to be more resilient and robust. For regions of the basin lacking substantial elevation-precipitation relationships (in stratiform precipitation events), all methods are generally robust against gage removal.

IMPROVED REMOTE-SENSING IMAGERY TECHNIQUES TO IDENTIFY RIPARIAN CORRIDOR CHARACTERISTICS IN HEADWATER STREAMS AND INVENTORY WETLANDS, LAKES, AND PERMANENT STREAMS IN WEST TENNESSEE

Berkay Tok, Dr. Youngsang Kwon, Dr. Brian Waldron, and Dr. Mary Yaeger

Headwaters are one of the most endangered river ecosystems and continue to be threatened by land-use changes and river engineering. Headwater streams influence downstream parts of the river network in various ways such as retainment or transmission of sediment and nutrients, organic and inorganic carbon, wood, and the creation of habitats for diverse organisms. Previous research suggests that it is important to monitor the dynamics and condition of headwater streams, but in-situ monitoring of headwater streams is a challenging task, especially in small tributaries at regional scales. Currently, the most detailed and wide range streamflow-related dataset is National Hydrography Dataset Plus (NHDPlus), although classifications in this dataset are one-time field observations mostly conducted in the mid to late 20th century. Prediction of streamflow permanence is important to understand and predict the overall state of these smaller streams and riparian corridors and allows restoration and preservation attempts to be focused or redirected to more important areas of the watershed by providing up-to-date data and insights. Even though streamflow permanence studies have been conducted in small scales, recent studies show that models that combine physical characteristics of headwaters with regional climatic data could be instrumental in gaining an understanding of regional-scale streamflow permanence which allows annual and monthly changes to be reflected on the streamflow permanence model and its outcomes. Furthermore, stream integrity is usually lower in areas where urban and agricultural development is high. This is true for small tributaries in the Mississippi River that are consist of the Lower Mississippi-Hatchie basin which flow through Tennessee's agricultural region. Due to various factors such as soil erosion and stream channel degradation, water quality is a continuing issue in these areas. According to a 2015 report prepared for U.S. Environmental Protection Agency (EPA) that most watersheds in West Tennessee have a low health index and are prone to further degradation. The purpose of this paper is to apply and test the Probability of Streamflow Permanence (PROSPER) model from USGS to West Tennessee tributaries by incorporating climatic, geological, and environmental data as predictors to create streamflow permanence data, especially for the Lower Mississippi-Hatchie Hydrologic Unit (HUC 4-0801), to examine current wetlands, lakes, and permanent streams in the region. In addition, National Agricultural Imagery Program (NAIP) and Light Detection and Ranging (LiDAR) data will be used to identify and inventory riparian corridors and buffer strip characteristics using high-performance computing clusters and Google Earth Engine.

APPROACH

The first objective of the paper is the application of the PROSPER model to West Tennessee tributaries to produce a stream permanence probability dataset where water quality is a current problem with the risk of further degradation. PROSPER model uses Random Forest learning algorithm to predict a stream's year-round streamflow permanence probability by using physical and climatic datasets as independent variables for training and allows prediction of wet and dry conditions for a given stream. Probability of Streamflow Permanence (PROSPER) is a Geographic Information System (GIS) based model that has been developed by U.S. Geological Survey (USGS) and uses Random Forest (RF) algorithm to predict streamflow permanence. PROSPER model is developed for and used in the Pacific Northwest region in the United States. As the PROSPER model is built on a random forest classification model it requires predictive variables that are updated either annually or monthly. In PROSPER's context, these variables are named Continuous Parameter Grids (CPGs). These CPGs are used to predict streamflow permanence by RF classification algorithm and categorized as climatic and physical variables. Climatic CPGs include Air Temperature, Evapotranspiration, Precipitation, and Snow Water Equivalent and physical CPGs include Baseflow Index, Irrigated Land, Land Cover Types, Permeability of Surface Geology, Soils Data and Topography Data. In total, there are 292 individual variables that can be utilized as predictive variables. 257 of these variables are climatic and 35 of them are physical. One of the focuses of this project is to attempt to implement the PROSPER model in West Tennessee streams to predict if a stream has year-round flow, in other words, if a stream is wet all year round or not. For the development of the PROSPER model in West Tennessee, databases in Table 1 will be compiled to create relevant CPGs in West Tennessee.

Category	Data source	References
Physiographic Land Use Land Cover data	National Landcover Dataset (NLCD)	Fry et al., 2011; Homer et al., 2007; Homer et al., 2015
Topography	National Hydrography Dataset Plus version 2 (NHDPlus v2)	USEPA and USGS, 2012
Soils	STATSGO2	Soil Survey Staff, 2016
Permeability data	State geological maps	TDEC Div. Of Geology
Climate Data (Temperature and Precipitation)	PRISM Climate data	Daly et al. 2017
Evapotranspiration	Operational Simplified Surface Energy Balance (SSEBop)	Senay et al., 2013
Snow water equivalent	Snow Data Assimilation System (SNODAS) Version 1	Barrett, 2003

Table 1 Datasets to compile predictive variables

After the data training process, the validity of probability maps from the PROSPER model will be assessed using US Fish and Wildlife Service National Wetlands Inventory (NWI) maps compared to randomly selected field surveys and measurements as well as data collected from state agencies that are currently conducting restoration and conservation efforts. To validate project results of riparian characteristics, field data will be utilized from two different paired streams sites. The first of these pairs consists of Meridian Creek (TN0801020517_1000) and Bond Creek (TN0801020512_0700) and the second pair consists of Spring Creek (TN08010208019_1000) and Piney Creek (TN08010208027_1000). For streams that might be missed by the PROSPER model, we will be utilizing NAIP imagery analysis and canopy height models derived from LiDAR data.

The second objective of the study is to create an inventory dataset of riparian corridors and buffer strip characteristics surrounding headwaters using NAIP imagery and LiDAR data. For this study's purposes, 4-bands collected by the NAIP program that are going to be used for Vegetation Indices (VI) are Red, Green, Blue, and Near-Infrared bands which will be extracted from NAIP imagery along with LiDAR-derived canopy height model to identify riparian corridors in smaller streams and condition of the riparian corridor and buffer strip vegetation. In recent years NAIP and LiDAR data have been used to characterize riparian buffers. NAIP imagery is a dataset collection of suborbital imagery that is flown every other year and acquired at a 1-meter resolution starting from 2008 to 2016. In 2018 resolution has been improved to 60-cm. Both natural color and four bands of imagery are available consisting of blue, green, red, and infrared bands in the collected imagery. Hayes et al., (2014) was the first study to use NAIP imagery for the classification of riparian characteristics and delineation but hypothesized that for large areas parallel processing clusters would be required. As high-resolution aerial imagery, as well as LiDAR data, are computationally tasking, to overcome processing power demand for these datasets, Google Earth Engine (GEE) will be utilized for processing NAIP image processing and High-Performance Computing (HPC) facility at the University of Memphis will be used to process LiDAR canopy height model analysis. Among the indices that will be calculated for this project are Normalized Difference Water Index (NDWI) for water, Enhanced Vegetation Index (EVI) for vegetation, Normalized Difference Vegetation Index (NDVI) for riparian vegetation, Green-Red Vegetation Index (GRVI) for bare ground and Modified Soil Adjusted Vegetation Index (MSAVI).

Expressions of these indices are as follows:

$$NDWI = (Green - NIR) / (Green + NIR)$$

$$EVI = G * (NIR - Red) / (NIR + C1 * Red - C2 * Blue + L) * 100$$

$$NDVI = (NIR - Red) / (NIR + Red)$$

$$GRVI = Green / Red$$

$$MSAVI = 2 * NIR + 1 - \sqrt{(2 * NIR + 1)^2 - 8 * (NIR - Red)} / 2 * 100$$

where Red, Green, Blue, and NIR are the NAIP imagery bands. The coefficients adopted in the EVI algorithm are L = 1, C1 = 6, C2 = 7.5, and G (gain factor) = 2.5.

EXPECTED RESULTS

Taken together, it is expected that the combination of these two methods to provide a better understanding of headwater streams in the area and create models that can be utilized by state agencies as the new data arrives to improve and optimize management and monitoring efforts. Outcomes of the datasets that are going to be produced can be combined for further understanding of streams that have a headwater lake. These replicable and scalable methods can help agencies to track restoration and conservation efforts, their results, and new areas to focus these attempts by offering an understanding of spatio-temporal dynamics that influence streamflow permanence as soil conservation efforts in West Tennessee agricultural lands require better quantification. The resulting predictions are pixel-based and correspond to National Hydrography Dataset. It is expected that an inventory of headwaters, riparian corridor, and buffer strip characteristics, as well as a method to model streamflow permanence, will assist stream restoration work by supplementing ground monitoring and providing better targeting of conservation attempts in most vulnerable areas. Methodological outcomes of the project such as the production of R code for PROSPER model and Python code for NAIP and LiDAR automation to be used in HPC or GEE can also be beneficial for state agencies and can be implemented again as newer data is available as the project is mainly built on free or publicly accessible data and require minimal licensing, such as ArcGIS software.

LARGE-SCALE HYDRAULIC MODELING OF THE TENNESSEE RIVER BASIN

Janelle Schlamp, Barge Design Solutions, Inc.

Hydraulic modeling of natural river systems poses many challenges, particularly on a large-scale. This presentation provides an overview of large-scale reservoir system modeling including approximately 1,200 river miles utilizing the United States Army Corps of Engineers' (USACE) Hydrologic Engineering Center-River Analysis System (HEC-RAS) unsteady flow model.

Significant challenges must be overcome to accurately model storms of varying magnitude with varying storm centering to determine a Probable Maximum Flood (PMF). The scope of the flood evaluation necessitated a highly-variable model capable of computing discharge at 32 dams for complex operations, configurations, and breach scenarios. The breach analysis comprises seismic, overtopping, internal erosion, and dam specific potential failure modes for earthen and concrete main dams, spillways and saddle dams, as well as any resulting cascading failures. The model process incorporates detailed reservoir storage accounting for storage areas such as bays, inlets, coves and small tributaries. Modeling a PMF through this reservoir system requires calculating discharge considering tailwater effects and using variable coefficients in dam rating curve computations. This model was accomplished through more than 10,000 lines of user-defined unsteady flow rules at inline and lateral structures and storage areas. The rules are flexible and broadly applicable to all breach scenarios and precipitation events. The well-defined rules allow for maximum scenario flexibility while also increasing computational efficiency.

A RIVER RUNS THROUGH IT: I-24/I-75 INTERCHANGE HYDRAULICS

Ben Zoeller, Barge Design Solutions

The I-24/-75 interchange on the south side of Chattanooga is the primary connection point between Middle Tennessee, East Tennessee, and North Georgia and was recently redesigned to increase capacity and improve safety and operation of the interchange. Construction was completed August 2021. Drivers passing through this interchange may not notice another major confluence in the area. Just southeast of the interchange lies the confluence of South Chickamauga Creek, West Chickamauga Creek and Spring Creek totaling approximately 430 square miles of drainage area. The confluence of these three streams creates design and construction challenges for an already complex project with six bridges over the streams and roadway widening in the floodplain fringe. Attendees of this presentation will get an understanding of the complexity of hydraulics and floodplain management associated with the I-24/I-75 Interchange Design Project.

SESSION 1B

WATER QUALITY & ANALYSES
(Moderator: Rodney Knight, USGS)
9:00 a.m. - 10:30 a.m.

Do Harmful Algal Blooms Contribute to Mussel Die-Offs in the Clinch River, Tennessee and Virginia?
T. Byl, R. Agbalog, J. Da Silva Neto, K. Hill, C. Cunningham, and B. Hogan

Periphyton Characteristics are an Accurate Indicator of the Trophic Status of a Shallow Lake in Middle Tennessee
J. Lebkuecher, A. Culley, B. Georgic, E. Hohman, H. Latta, N. Salman, T. Sennuga, D. Spruill, A. Zorney, and J. Atma

Land Use and Water Quality Trends in Coastal Alabama
A.C. Arnold, and G.A. Hastert

WATERSHED MANAGEMENT
(Moderator: John Schwartz, UT)
10:45 a.m. - 12:15 p.m.

OASIS and USGS Ecological-Flow Modeling for a Decision-Support System for Water Management and Regulatory Assessments
S. Qualls-Hickey, C. Caldwell, D. Jones, and D. West

A Method for Mapping Environmental Justice Factors by Watershed
M. K. Moffitt

Western Tennessee Floodplain Explorer – A Decision Support Tool to Maximize Floodplain Conservation Benefits
S. Morris

DO HARMFUL ALGAL BLOOMS CONTRIBUTE TO MUSSEL DIE-OFFS IN THE CLINCH RIVER, TENNESSEE AND VIRGINIA?

Thomas Byl[1,2], Rose Agbalog[3], Jeronimo Da Silva Neto[4], Kristi Hill, Champagne Cunningham, and Brittaney Hogan

Mussel die-offs and declines in pheasantshell mussel (*Actinonaias pectorosa*) have been noted since 2016 in mussel shoals on the Clinch River near the Tennessee and Virginia border that historically had thriving populations. Determining the cause of the die-offs has been difficult. Water and mussel tissue samples have been analyzed for metals, polycyclic aromatic hydrocarbons, viruses, pathogens and major ions with no success of identifying a single cause for the mussel deaths. It is possible that several factors have contributed to the ongoing mussel die-offs. A previous study by U.S. Geological Survey (USGS) found two cyanobacteria, *Geitlerinema splendidum* and *Oscillatoria princeps*, capable of producing microcystin (MC) toxin in the Clinch River. The USGS, in conjunction with the Tennessee Wildlife Resources Agency, and partnering with U.S. Fish and Wildlife Service, Tennessee State University and University of Tennessee, Knoxville, began a study to determine if harmful algal blooms contributed to the demise of the mussels.

Solid Phase Adsorption Toxin Tracking (SPATT) passive samplers were continuously deployed and switched out every 2-3 weeksfrom August through November, 2021, at mussel shoals located near: Kyles Ford, Tennessee; Sycamore Island, Virginia; and Artrip, Virginia. Shells from fresh dead mussels at Kyles Ford and Sycamore Island (note – no fresh dead shells were found at Artrip), and two moribund mussels, one from Sycamore Island and one from Craft Mill, Virginia (near Artrip), were collected and analyzed for MC as well. The moribund soft mussel tissues contained significant MC, (1.33 and approximately 35 nanograms per gram (ng/gram) freshweight, respectively). The SPATT samplers collected from Kyles Ford and Sycamore Island in August through early October showed low levels of MC toxin ranging from <0.1 to 0.3 ng/gram. High detections (0.74 to 5 ng/gram) were found in late October and early November in the samplers deployed at Sycamore Island and Kyles Ford. The Artrip samplers were placed above the known die-off zone and had trace amounts in August and September but below detection in October and November. Two of 7 shells analyzed from Kyles Ford and 1 of 5 shells from Sycamore Island had measurable amounts of MC. Mortality was detected at both Sycamore Island and Kyles Ford in fall of 2021, and no fresh dead or dying animals were detected at Artrip. The pattern of MC toxin detected in SPATT samplers, mussel tissue and mussel shells and

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the geographical distribution of mussel deaths support the hypothesis that cyanotoxins may contribute to mussel impairment and be associated with morbidity, but further tests are needed to conclusively prove a cause and effect.

PERIPHYTON CHARACTERISTICS ARE AN ACCURATE INDICATOR OF THE TROPHIC STATUS OF A SHALLOW LAKE IN MIDDLE TENNESSEE

Jefferson Lebkuecher[1], Alexis Culley, Brittney Georgic, Erin Hohman, Holly Latta, Nicole Salman, Taiwo Sennuga, Dakota Spruill, Anthony Zorney, and Jenna Atma

Biology Department
Austin Peay State University Clarksville, Tennessee 37044

Water column and benthic characteristics of Liberty Park Reservoir in Clarksville, Tennessee were evaluated to determine the reservoir's trophic status and to provide data needed to monitor changes. Water column characteristics of the reservoir include a high value for the light extinction coefficient, turbidity, concentration of total phosphorus, and concentration of chlorophyll *a*. The benthic characteristics include a high concentration of chlorophyll *a*, pheophytin *a,* benthic organics, inorganic sediments, and high values for algal trophic indices. The results demonstrate that nutrient enrichment of Liberty Park Reservoir is indicated by characteristics of the water column and periphyton communities.

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LAND USE AND WATER QUALITY TREDNS IN COASTAL ALABAMA

A.C. Arnold and G.A. Hastert

Geological Survey of Alabama, 420 Hackberry Lane, Tuscaloosa, AL 35486

Trends of rapid development can be readily identified using ArcGIS and the USGS Land Use - Land Cover (LULC) land use classification schemes. Historical land use patterns across Baldwin County from 1992 to 2016 have been established. The cumulative land use change map (LUCM) for the 24-year period highlights those areas of greatest impact from development. In Baldwin County, there are three areas that are now highly developed: (1) the Eastern Shore growing eastward, (2) the Highway 59 corridor south of I-10, and (3) the coastal cities of Gulf Shores and Orange Beach. The most rapidly developing land in Baldwin County is roughly 7 miles wide bound by Interstate 10 to the north and extends almost 20 miles southward. The LUCM reveals a pattern of land-use conversion from agriculture into subdivisions. The increased impervious surface areas inhibit shallow aquifer recharge. Available water quality data from USGS, EPA, ADEM, and GSA provide an overview of general surface water and shallow groundwater quality trends. These data have been analyzed to investigate the impact on water quality from land use changes, particularly areas of intense construction. Environmentally sensitive areas have been evaluated for potential deleterious impact to water quality. Sustainable growth, environmental impact, and operational carrying capacity of current infrastructure are of paramount importance given the current population growth within the coastal area of Alabama.

OASIS AND USGS ECOLOGICAL-FLOW MODELING FOR A DECISION-SUPPORT SYSTEM FOR WATER MANAGEMENT AND REGULATORY ASSESSMENTS

Saya Qualls-Hickey, Casey Caldwell, Danielle Jones, and Dustin West

For water resource managers to develop effective management plans, it is critical to understand the relationship between ecological stream health and its flow. These water management plans typically address multiple, and often conflicting, uses throughout a river basin. Considering ecological-flow modelling becomes naturally collaborative, it is helpful to interpret analysis results as (1) efficient generation of results with respect to the most ecologically relevant flow criteria; and (2) easily understood concepts such as the diversity of fish communities, i.e., number of fish species.

A flexible and transparent water allocation model, OASIS, is merged with the USGS ecological flow research for an effective decision-support system. OASIS is also well positioned for use by stakeholders for viewing tradeoffs within river basin water management. These models have been developed over a broad range of river systems from single reservoir for a town up to some of the largest river basins within the country. Currently, the model has been effectively linked to the USGS ecological-flow limit calculations for Tennessee.

The OASIS model and Ecological-Flows have been utilized for the Duck River to evaluate historical flows and the resulting impact on local aquatic ecosystems. Flows modeled from Normandy Dam through the City of Columbia are being analyzed for flow-ecology relationships. This presentation demonstrates modeling techniques used to evaluate adequate water resources for the future expansion of Columbia Power and Water’s water treatment operations while keeping in mind the neighboring utilities ability for potential increased withdrawal from the Duck River.

A METHOD FOR MAPPING ENVIRONMENTAL JUSTICE FACTORS BY WATERSHED

Madison K. Moffitt, Tennessee Technological University

Environmental justice (EJ), as defined by the Environmental Protection Agency (EPA), is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Since the rise in awareness of EJ issues in recent years, our government has declared it essential to identify and address infrastructure problems of communities with EJ concerns. Currently, there is little data available on EJ factors within various environmental settings; EPA's EJSCREEN is one of them. However, EJSCREEN's data can only illuminate how communities are affected at the census tract level with only a few specified EJ indicators. To better understand these EJ factors' influence on a watershed-based level, we have incorporated more parameters and developed a model that can be useful for future research and administrative purposes. Moreover, the findings from this study can provide state and federal governments with a tool to understand how EJ and environmental factors interact within these communities and watersheds. With the effects of climate change becoming more pronounced, communities with EJ concerns may face the most impact. The purpose of this project is to develop a method for mapping Tennessee watersheds and quantify their relative EJ factors, such as people of color, low-income, and indigenous communities, alongside environmental factors such as water quality, flood zones, and superfund site proximity. The goal of this research is to use ArcGIS Pro and data obtained from the Tennessee Department of Environment and Conservation's (TDEC) Division of Water Resources (DWR), EPA's EJ SCREEN, and United States Census Bureau's American Community Survey (ACS), to develop a spatial and statistical methodology as an environmental justice tool for watersheds in Tennessee.

WESTERN TENNESSEE FLOODPLAIN EXPLORER – A DECISION SUPPORT TOOL TO MAXIMIZE FLOODPLAIN CONSERVATION BENEFITS

Shelly Morris,
The Nature Conservancy

The landscape of west Tennessee (WTN) is highly altered in terms of both hydrology and vegetation. Stream channels have been straightened and incised, levees separate rivers from their floodplains, and thousands of acres which were historically covered in bottomland hardwood forest have been converted to agriculture and other uses. Over time, the past decade especially, issues of nutrient pollution, habitat loss, and flooding have become more prevalent concerns to not only the conservation community, but to landowners and communities as well. Resources of both funding and staff capacity are limited, and a coordinated and prioritized approach to floodplain reconnection and restoration is needed in order to effectively address these issues.

The objective of The Nature Conservancy's (TNC) floodplain conservation work in WTN is to use the power of partnership to focus efforts and accelerate the pace and scale of meaningful projects. Working together, we can achieve more than we can alone, and we seek partner engagement from the beginning in order to co-develop an outcome that is useful to all involved.

To assist this effort, TNC and partners have worked together to codevelop the Western Tennessee Floodplain Explorer Tool. This online decision support tool uses local, regional, and national level data to help maximize multiple project benefits such as nutrient uptake, flood risk reduction, and wildlife habitat creation. The process of developing this tool has also helped to foster partnerships and conversation regarding floodplain conservation priorities in Western Tennessee.

SESSION 1C

MICROBIAL ASSEMBLAGES
(Moderator: Qiang He)
9:00 a.m. - 10:30 a.m.

Microbiological Linkages Between Drinking Water and Source Water
B. Swanson and Q. He

Impact of Urbanization on the Aquatic Microbiome in an Impaired Stream
C. Cianciolo, S. Liu, L. Cao, and Q. He

Microbial Populations Linked to Synthrophic Ethanol Conversion in Anaerobic Wastewater Treatment Processes
H. Newberry, S. Chen, and Q. He

GROUNDWATER STUDIES, MEMPHIS
(Moderator: Scott Schoefernacker, CAESAR)
10:45 a.m. - 12:15p.m.

Microbial Populations Linked to Syntrophic Ethanol Conversion in Anaerobic Wastewater Treatment Processes
R. Hasan DON'T HAVE THIS PAPER

Groundwater Flow and Vulnerability in Germantown and Collierville, Tennessee
D. Hainje, D. Larsen, and S. Schoefernacker

Investigation of Modern Water Leakage into the Semi-confined Memphis Aquifer at the Mallory Wellfield, Memphis, Tennessee
H. Mullenax, D. Larsen, S. Schoefernacker, and D. Leslie

MICROBIOLOGICAL LINKAGES BETWEEN DRINKING WATER AND SOURCE WATER

Clifford S. Swanson*
and Qiang He

*Presenting Author
Department of Civil and Environmental Engineering, University of Tennessee, Knoxville

One of the main goals of drinking water treatment processes is to reduce contaminants present in the source water, particularly pathogenic microorganisms such as *E. coli*. While conventional treatment processes are proven effective in safeguarding drinking water quality, particularly through the reduction of waterborne pathogens, the impact of treatment processes on the overall microbiological quality of drinking water has not been well established. In order to gain an understanding of the changes in microbiological quality of drinking water from the source to the point of consumption, water samples were collected from the taps at the point of use and from waterbodies used as the source water for water treatment. Source water samples were taken from the river where the water intake is located as well as tributaries to the river. Water quality parameters were compared between the drinking water and source water samples, including total dissolved solids, chemical oxygen demand, turbidity, and heterotrophic plate counts (HPC). The microbiological quality was compared with microbiome analysis of the water samples through 16S rRNA gene amplicon sequencing, which was subsequently used for microbiome-based source identification to determine the contribution of source water to the microorganisms present in the drinking water.

As expected, water quality analysis showed a significant reduction in turbidity from 1.57 NTU in the source water to below detection in the drinking water, a reduction in total dissolved solids from 303 ppm to 168 ppm, and a reduction in chemical oxygen demand from about 10.0 mg/L to less than 1.0 mg/L. It was also observed that the overall level of microbial abundance, measured as HPC, was 21,081 CFU/100mL for source water and 6,703 CFU/100mL for drinking water on average, with levels up to 65,800 CFU/100mL seen at particular points of the premise plumbing systems. Distinct differences were revealed in the microbiological quality by microbiome analysis between the source and drinking water, including the change in predominant bacterial populations from *Burkholderiaceae* and *Flavobacterium* in the source water to *Xanthobacteraceae* and *Mycobacterium* in the drinking water. Microbiome-based source identification showed that over 64% of the microorganisms in drinking water could be attributed to those in the source water. These results demonstrate that water treatment and distribution have significant impact on drinking water quality. Furthermore, the source water is a major determinant of the microbiological quality of drinking water, highlighting the significance of source water protection in enhancing water quality and public health.

IMAPCT OF URBANIZATION ON THE AQUATIC MICROBIOME IN AN IMPAIRED STREAM

Charlie Cianciolo, Songyi Liu, Liu Cao, and Qiang He

The effect of increasing urbanization on *Escherichia coli* (*E. coli*) quantities in urban streams is well documented, with these environments exhibiting consistently elevated counts of this potentially harmful indicator organism. However, little is known about how urbanization alters the holistic aquatic microbiome of these ecosystems, of which *E. coli* is only a miniscule component. In this study, water samples were taken from upstream and downstream locations on an urban stream (SC1) in Knoxville, TN under baseflow conditions over a one-year period. Between the two sampling locations, SC1 is exposed to a significant increase in urbanized area, as defined by impervious surface percentage. The water samples were first analyzed for *E. coli* presence. Afterwards, the remaining sample was set aside for high-throughput DNA amplicon sequencing, which provided an insight into the makeup of the aquatic microbiome in SC1.

E. coli counts were significantly higher at the downstream location, indicating that urbanization may introduce sources of fecal contamination into SC1. Amplicon library data support *E. coli* results, as greater abundances of other dominant human gut bacterial genera were found at the downstream site. Source tracking analysis found a significantly higher contribution of local sewage microbiota at the downstream site, further supporting the link between increased urbanization and fecal contamination in SC1. Together, *E. coli* and amplicon library data demonstrate that urbanization in the SC1 watershed contributes to microbiological contamination. Additionally, amplicon library data support the use of *E. coli* as an indicator of fecal contamination in SC1 under baseflow conditions.

MICROBIAL POPULATIONS LINKED TO SYNTROPIC ETHANOL CONVERSION IN ANAEROBIC WASTEWATER TREATMENT PROCESSES

Hope Newberry[1*], Si Chen, and Qiang He[2]

Anaerobic processes are sustainable options for wastewater treatment due to the potential for biogas production as a renewable energy source. However, the broader application of anaerobic treatment processes has been hindered by process instability due to the accumulation of metabolic intermediates generated in anaerobic conversion. Ethanol, a common intermediate from anaerobic decomposition of organic waste, is considered inhibitory in anaerobic treatment processes at elevated levels. Therefore, to gain an understanding of microbial responses during this process instability, it is important to identify microbial populations involved in the anaerobic biodegradation of ethanol.

In this study, elevated ethanol concentrations were established in continuous anaerobic digesters treating wastewater by periodic additions of concentrated ethanol solutions. During the periods of elevated ethanol, biogas production responded with stoichiometric increases of ~45% while pH remained consistent, signaling efficient conversion of ethanol into methane. Microbial community analysis revealed increases in the relative abundance of *Synergistaceae* and the hydrogenotrophic methanogen *Methanobacterium* in response to elevated ethanol, suggesting the involvement of these microbial populations in the syntrophic conversion of ethanol. *Methanosaeta* persisted as the dominant acetoclastic methanogen during the elevated ethanol periods, suggesting the metabolic robustness of this population.

These results provide insight into the understanding of microbial processes relevant to process stability in anaerobic waste treatment processes and the potential of exploiting microbial populations such as *Methanosaeta* and *Methanobacterium* in enhancing the stability of methanogenic treatment processes.

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GROUNDWATER FLOW AND VULNERABILITY IN GERMANTOWN AND COLLIERVILLE, TENNESSEE

Devin Hainje[1], Daniel Larsen[2], and Scott Schoefernacker[2]

The Memphis aquifer is the principal water source for the City of Germantown and Town of Collierville in Shelby County, Tennessee. The aquifer is semi-confined by clay in the upper Claiborne confining unit (UCCU) in most of the county, but the clay is absent in southeastern parts of the county making infiltration of contaminants a concern for recharge to the Memphis aquifer. Groundwater in this portion of the county flows west-northwest, from Collierville towards Germantown. Numerous water quality concerns exist because of Environmental Protection Agency (EPA) Superfund sites with trichloroethylene (TCE) and hexavalent chromium contamination located in central Collierville. The goal of this study is to identify how groundwater flow has changed over the last 60 years in Germantown and Collierville, estimate the time of travel of existing contaminants from Superfund sites, and identify susceptible wells/wellfields. Environmental tracers (tritium, sulfur hexafluoride, and noble gases) were used to identify modern water (<60 years) in production wells. Groundwater modeling in USGS MODFLOW identified groundwater flow paths and velocity changes over the past 60 years using historical water pumping and water level data. Environmental tracer data are compared to the simulated flow paths. Using the estimated velocities, a one-dimensional advection-dispersion equation is applied with groundwater flow and contaminant source data to assess travel time from Collierville sites to Germantown. Preliminary results indicate that flow paths are little impacted by increased pumping in Germantown and Collierville since 1960, and contaminants have not migrated outside of Collierville.

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INVESTIGATION OF MODERN WATER LEAKAGE INTO THE SEMI-CONFINED MEMPHIS AQUIFER AT THE MALLORY WELLFIELD, MEMPHIS, TENNESSEE

Heather Mullenax, Daniel Larsen, Scott Schoefernacker, and Deborah Leslie

Center for Applied Earth Science and Engineering Research (CAESER) and Department of Earth Sciences, University of Memphis, Memphis, Tennessee

Groundwater is the main source of water for municipal, industrial, and agriculture use in Shelby County, Tennessee. Groundwater is primarily pumped from the Memphis aquifer, which is mainly composed of Eocene-age, unconsolidated sand. Recent studies have documented modern water recharge entering the Memphis aquifer in or near major well fields. This study investigates the presence of modern water and recharge sources to the Memphis aquifer at the Memphis, Light, Gas, and Water (MLGW) Mallory well field near downtown Memphis.

The shallow and Memphis aquifers have distinct water chemistry with little indication of mixing. The piper diagram indicates that both the shallow and Memphis aquifer water samples are mixed cation bicarbonate composition, whereas the McNairy aquifer sample is a sodium-bicarbonate composition. Stable isotope data indicate nearly invariant stable hydrogen composition and a limited range for stable oxygen composition in the Memphis aquifer samples, whereas the shallow and McNairy aquifer samples show more depleted stable hydrogen and oxygen compositions, again suggesting little inter-aquifer water exchange. Results are pending for tritium, tritiogenic helium-3, noble gases, and sulfur hexafluoride to fully assess modern water leakage and inter-aquifer exchange processes.

Preliminary results of this study indicate that the Memphis aquifer beneath the Mallory well field receives little or no modern water leakage, despite evidence for the contrary from past sampling and recent pump tests. As such, almost all the water produced from the Memphis aquifer at the Mallory well field is likely from storage in the aquifer.

SESSION 2A

STORMWATER MANAGEMENT
(Moderator: N/A)
9:00 a.m. - 10:30 a.m.

Advances in Green Infrastructure Designs Using High-Flow Biofiltration Technology for Stormwater Quality Treatment
M.B. Miller

Hydraulic Modeling of Regenerative Stormwater Conveyances
G. Palino, J. Thompson, J. Schwartz, and J. Hathaway

A Stormwater Master Plan in Action
T. Crop

ADVANCES IN GREEN INFRASTRUCTURE DESIGNS USING HIGH FLOW BIOFILTRATION TECHNOLOGY FOR STORMWATER QUALITY TREATMENT

Mark B. Miller, P.G., Research Scientist, AquaShield, Inc., Chattanooga, TN, mmiller@aquashieldinc.com

Stormwater quality treatment practices have matured from relying largely on conventional public domain practices and end-of-pipe technologies to those stormwater control measures (SCMs) emphasizing Green Infrastructure (GI) designs and LID-based products and practices. For example, the New Jersey Department of Environmental Protection (NJDEP) now distinguishes between GI manufactured treatment devices (GI MTDs) and Non-GI MTDs (end-of-pipe) to meet SCM designs consistent with the 2021 NJ Stormwater BMP Manual. By NJDEP definition, GI MTDs shall either infiltrate runoff into the subsoil, or treat runoff through filtration by vegetation or soil to meet the 80% TSS removal requirement. The current NJDEP certified GI MTDs rely on biofiltration technologies. Further insight to the NJDEP GI MTD definition and example configurations will be explored. The Washington Department of Ecology also recognizes LID-based biofiltration technologies for treating TSS, dissolved metals, phosphorus and/or oil.
A challenge for GI MTDs is to provide treatment (infiltration) rates at a greater rate than land-based biofiltration (bioswale) rates while maintaining a small footprint. A facility design example illustrates how a GI MTD can complement land-based biofiltration infiltration rates to decrease drain-down (infiltration) times and minimize ponding. Plant selection is a critical aspect of GI MTD designs. Example plantings of native grasses, shrub grasses and ornamental perennials will be presented. Practical facility design considerations for GI MTD technologies include sustainability, maintenance, plant hardiness zones, mature plant coverages, and relative planting costs.

HYDRAULIC MODELING OF REGENERATIVE STORMWATER CONVEYANCES

Gillian Palino[1], Dr. Jessica Thompson[2], Dr. John Schwartz[3], and Dr. Jon Hathaway[4]

University of Tennessee, 1506 Middle Dr., Knoxville, TN 37916

In natural systems, stormwater moves to streams and river networks by way of wetlands, floodplains, and riparian forests which offer treatment and runoff detention. As watersheds are urbanized, these natural flow paths are short circuited by storm drains, pipes, and channels that bypass these ecosystem services. This causes increased peak flows in receiving waters with subsequent erosion and pollutant concerns. Regenerative stormwater conveyances (RSCs) are an emerging design solution to decrease runoff energy, increase infiltration rates, and improve water quality. Positioned at the stormwater outfall, RSCs are comprised of an open channel step-pool system lined with native vegetation and are sized to fully contain the 100-year storm. RSC's may also reconnect the urban floodplain by and allowing larger storms to spill onto the surrounding floodplain to further increase infiltration and storage capacity. With storm intensity predicted to continue increasing due to climate change, management strategies to safely convey stormwater will also continue to become more critical. Despite the demonstrated benefits of RSCs, design guidance for these systems has yet to be refined. This lack of scientifically informed RSC design guidance prevents more widespread application to protect receiving waters and surrounding urban areas. In Knoxville, TN, computational models were employed to optimize RSC pool dimensions and hydrologic performance. Preliminary results found that the number of pools did not impact hydraulic performance and instead pool/riffle geometry should be prioritized. The main objectives of the project are to better optimize and streamline the RSC design process thereby improving its repeatability and effectiveness.

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A STORMWATER MASTER PLAN IN ACTION

Trevor Cropp, Barge Design Solutions, Inc.

As cities grow, population is not the only statistic that changes. Local governments are tasked to maintain a variety of assets, from roadway systems to natural resources and everything in between.

The city of Germantown, a suburb of Memphis, saw explosive growth between 1970 and 2000. The surge in population leveled off around 2000, but the influx of people and limited land resulted in the need for new types of developments. Zero-lot-line and mixed-use buildings, often called “infill developments,” are designed to accommodate a large number of people in a small footprint. Infill developments often replace traditional quarter-acre lot residential subdivisions and create more impervious area per acre of land in the City, which affects the absorption of rainwater.

The large volume of added impervious area increased stress on Germantown’s aging stormwater infrastructure, as the system was initially designed with much different criteria in mind. This added stress can create flooding in areas which never previously had issues or worsen existing trouble areas. The City was aware of the potential issues and in 2016 decided to establish a plan to handle these trends in development and implement a strategy to prioritize stormwater drainage system improvement projects.

Typical for American cities, Germantown’s Capital Improvement Plan (CIP) is essential to the municipality’s ability to prioritize public projects. With great forethought, Germantown allocated resources in their current CIP toward improving the stormwater system. The City understood it was crucial to strategize, identify and organize flood mitigation alternatives.

The budget allocated in the CIP did not allow flood mitigation efforts to be completed for the entire City at once. In order to determine which assets to prioritize, the City had to take inventory of the current system and identify the most immediate concerns. Germantown teamed with Barge Design Solutions, Inc. to prepare a stormwater master plan. Barge’s inventory of Germantown’s systems has helped the City prioritize the numerous projects outlined in the CIP, validate the necessity of a stormwater strategy for the City's growth, and respond to emergent needs as they arise.

SESSION 2B

WATERSHED PLANNING & ASSESSMENT

(Moderator: Tom Lawrence, TLE, PLLC)

9:00 a.m. - 10:30 a.m.

Chattahoochee River High Definition Stream Survey (HDSS): Delivering Powerful Data for Water Resource Management
B. Connell

Mud Creek Stream Mitigation Project: A Case Study of Watershed Restoration
A. Brias

Evolving Capabilities, Standards, and Expectations for Environmental Software
G. Burnette

CHATTAHOOCHEE RIVER HIGH DEFINITION STREAM SURVEY (HDSS): DELIVERING POWERFUL DATA FOR WATER RESOURCE MANAGEMENT

Brett Connell, Trutta Environmental Solutions

The Chattahoochee River National Recreation Area (CRNRA) has challenges protecting the health of the river as a result of runoff from land development, wastewater overflow and impacts from the regulated water discharges of Buford Dam. To help better manage the river, the National Park Service (NPS) needed to document the streambank and channel conditions on all 48 miles of the river associated with the CRNRA.

To accomplish this, NPS contracted Trutta Environmental Solutions to assess the habitat type (riffle, shoal, run, pool), condition of the left and right streambank and water depth on 48 continuous miles of the Chattahoochee River. Additionally, a recreational-use suitability model that included wading and boating types was developed, requiring the additional parameter of channel roughness to be classified. Trutta conducted a longitudinal High Definition Stream Survey (HDSS) survey to collect a broad suite of video, sonar and GPS data. A standard set of classification criteria was applied to the field data to determine streambank and channel conditions and to develop the suitability model for recreational use. A StreamView video for the entire stream, a database including GIS layers for the three parameters of depth, habitat type, and streambank condition, a recreational use suitability model and a list of the 20 worst stream segments were provided. Additionally, the classification and development of GIS layers for the recreational use suitability model were included.

The HDSS approach was created to rapidly gather continuous, meter-resolution GIS data in a single pass for a broad range of stream corridor metrics by integrating GPS, video, depth, side scan sonar, and other sensors. Once the data are collected, the videos are combined into four simultaneous views of the river. Each second of video is linked to a specific GPS point which allows for the identification, selection, and prioritization of streambanks for restoration. The results can also be used to monitor restoration results, determine the extent and distribution of instream habitat, define the geomorphic condition for the stream, identify infrastructure impacts, and provide a powerful “virtual tour” experience.

MUD CREEK STREAM MITIGATION PROJECT: A CASE STUDY OF WATERSHED RESTORATION

Anthony Brais[1*]

Mitigation restoration projects offset environmental impacts by providing a net gain of environmental resources in a similar ecoregion or hydrologic unit. The Mud Creek stream mitigation site is located in the foothills of the Cumberland Mountains of east Tennessee. This project contains over four miles of stream restoration and five miles of stream preservation. Mud Creek is an example of watershed restoration with approximately 97 percent of contributing perennial or intermittent stream length permanently protected within a conservation easement. Watershed restoration provides additional ecological uplift to a mitigation site based on watershed control, headwater protection and a broader scope of ecological restoration. Historic land use at Mud Creek involved mining, agriculture of forestry. With near full watershed control, disturbance in the contributing drainage area of a stream reach is limited reducing potential future impacts to water quality from sediment, pathogens, etc. Headwater protection by placing preservation quality stream reaches within a conservation easement enable immediate biological recruitment to recolonize restoration sites. For example, nine amphibian species utilized restored floodplain habitat at Mud Creek for breeding within one to three months of construction completion. Watershed restoration projects also contain a wider variety of stream types. The Mud Creek project includes first through third order streams, watershed sizes ranging from 0.01 to 1.5 mi^2, Rosgen A-C, E streams, 0.5% to >10% valley slopes, etc. Different biotas favor different stream types. A watershed approach enables uplift across an entire stream ecosystem instead of a smaller selection of stream types.

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EVOLVING CAPABILITIES, STANDARDS, AND EXPECTATIONS FOR ENVIRONMENTAL SOFTWARE

Gerald Burnette

We have always used a variety of different types of software in the environmental sciences. Different classes of software include models, data management systems, analysis packages, and presentation capabilities. Each of these categories of software have changed over the years. Evolution has been influenced by a number of factors: improved computing capabilities, increasing scientific knowledge, evolving public concerns, and even user expectations. This paper will discuss how these various factors have affected different categories of environmental software.

SESSION 2C

GW/SW MANAGEMENT

(Moderator: Daniel Saint, TVA)

9:00 a.m. - 10:30 a.m.

Particle Tracking Analysis of Fish Return Outfall at Sequoyah Nuclear Plant
J. Brazille

Floating Aquatic Vegetation on Wheeler Reservoir, Alabama
M. Boyington

Updated Map of Semi-confined Conditions in the Memphis Aquifer, Shelby County, Tennessee: A Work in Progress
D. Larsen, B. Waldron, and S. Schoefernacker

PARTICLE TRACKING ANALYSIS OF FISH RETURN OUTFALL AT SEQUOYAH NUCLEAR PLANT

J. Brazille

TVA's Sequoyah Nuclear Plant is working towards upgrading its cooling water intake structures with a more fish-friendly design. The project includes implementing new technology for the intake screens and constructing a new fish return line that will be used to route any fish caught in the screens back to the river. The plant's existing fish return currently discharges to a shallow embayment that is just upstream of the plant.

The project team wanted to know if the outfall location of the existing fish return was adequate in minimizing the risk of fish re-impingement at the intake or if another discharge location should be selected. Delft 3-D, a software suite including 3-dimensional hydrodynamic modeling and particle tracking capabilities, was utilized to help answer this important question. TVA partnered with Deltares to perform a particle tracking analysis on a total of 4 discharge locations – two upstream and two downstream of the plant – using a wide range of summer flow conditions that typically occur on Chickamauga Reservoir. In this analysis, fish were modeled as particles by assuming that the fish would be lethargic and remain neutrally buoyant throughout the model simulations.

The modeling results suggested that up to 25-50% of fish discharged at the upstream locations could be re-impinged at the intake under the flow conditions that were analyzed. Based on the study, the project team chose a downstream discharge location for the new fish return to minimize fish re-impingement.

FLOATING AQUATIC VEGETATION ON WHEELER RESERVOIR, ALABAMA

M. Boyington

Over the past several years there has been an increase in aquatic vegetation, particularly eelgrass, on Wheeler Reservoir, Alabama. Large amounts of this vegetation can be broken and uprooted from the reservoir bottom and form large floating mats. These mats have been ingested at power plant intakes, causing outages and resulting in revenue loss. To address these incursions, TVA has implemented regular field monitoring and is deploying a forecasting system.

A multitude of field instruments are in the process of being procured and deployed in Wheeler Reservoir. Over twenty visible-spectrum cameras will be installed at the power plant intake, on TVA transmission towers, and at Guntersville Dam. The images from these cameras will feed into an image recognition algorithm that quantifies the extent of floating aquatic vegetation (FAV) on the water surface. Echosounders, a sonar type device, will be located in tandem with several of the cameras to detect FAV amounts in the water column. Wave monitors will alert forecasters if vegetation breakage or detachment from the reservoir bottom is likely. Water quality sensor platforms will continually gather environmental and meteorological data. These observations and data will be used for real-time assessment of FAV as well as to calibrate the forecasting framework. Images and plots of detected FAV will be accessible to plant operators and management via a dashboard.

The TVA River Management forecasting system is being extended to include particle tracking, wave modeling, and a custom aquatic vegetation release function. The foundation of the forecasting system is a three-dimensional river model coupled with wave and particle tracking modules. Various water quality parameters, such as light penetration and water temperature, are combined with wave strength to determine when and where aquatic vegetation detachment and breakage occurs. The hydrodynamic model calculates the future movement and temperature of water in the reservoir, and the particle tracking module predicts the movement of FAV. The end result is a multi-day forecast of FAV amounts arriving at the power plant intake.

UPDATED MAP OF SEMI-CONFINED CONDITIONS IN THE MEMPHIS AQUIFER, SHELBY COUNTY, TENNESSEE: A WORK IN PROGRESS

Daniel Larsen, Brian Waldron, and Scott Schoefernacker

Center for Applied Earth Science and Engineering Research and Department of Earth Sciences, University of Memphis

Evidence for leakage of near-surface water through the upper Claiborne confining unit (UCCU) to the Memphis aquifer in Shelby County, Tennessee, was recognized in the 1970s and 1980s, and ultimately compiled as a hydrogeologic window map by Parks (1990) using water table, borehole log, and other hydrologic data. An updated map of semi-confined conditions, representing hydrogeologic windows or breaches through the UCCU, was initiated in 2016 utilizing borehole data, water-table depression maps, and tracer evidence of modern water obtained since 1990. Map locations suggesting semi-confined conditions were categorized depending on the available supporting data: confirmed locations are supported by compelling evidence from all three data types, suspected locations are supported by one or more data types, but significant uncertainty exists regarding location, origin and impact. The resulting map supports and refines most of the locations identified by Parks (1990), adding one more confirmed location. Four suspected locations are designated based mainly on water-table depressions and borehole data, and the remaining eight suspected locations are identified primarily by thinning or absence of clay intervals in the UCCU. Ongoing studies continue to refine our understanding of the distribution of semi-confined conditions in the Memphis aquifer; thus, the presented map will undoubtedly be updated in the coming years.

PROFESSIONAL POSTERS

Do Harmful Algal Blooms Contribute to Mussel Die-Offs in the Clinch River, Tennessee and Virginia?
Thomas Byl, Rose Agbalog, Jeronimo Da Silva Neto, Kristi Hill, Champagne Cunningham, and Brittaney Hogan

Differentiation and Prediction of Recharging Parameters Using MODFLOW Model and LSTM Code
Glou

North Chicamauga Creek Bank Stabilization Case Study
Maria Price and Ken Barry

Diversity and Inclusion Begins with You: No One Size Fits All
Kimberly M. Strong

Preliminary Assessment of Environmental Review Pursuant to the Tennessee Inter-Basin Water Transfer Act
J.C. Tucker

DO HARMFUL ALGAL BLOOMS CONTRIBUTE TO MUSSEL DIE-OFFS IN THE CLINCH RIVER, TENNESSEE AND VIRGINIA?

Thomas Byl[1,2], Rose Agbalog[3], Jeronimo Da Silva Neto[4], Kristi Hill[1], Champagne Cunningham[1,2], Brittaney Hogan[2]

Mussel die-offs and declines in pheasantshell mussel (*Actinonaias pectorosa*) have been noted since 2016 in mussel shoals on the Clinch River near the Tennessee and Virginia border that historically had thriving populations. Determining the cause of the die-offs has been difficult. Water and mussel tissue samples have been analyzed for metals, polycyclic aromatic hydrocarbons, viruses, pathogens and major ions with no success of identifying a single cause for the mussel deaths. It is possible that several factors have contributed to the ongoing mussel die-offs. A previous study by U.S. Geological Survey (USGS) found two cyanobacteria, *Geitlerinema splendidum* and *Oscillatoria princeps*, capable of producing microcystin (MC) toxin in the Clinch River. The USGS, in conjunction with the Tennessee Wildlife Resources Agency, and partnering with U.S. Fish and Wildlife Service, Tennessee State University and University of Tennessee, Knoxville, began a study to determine if harmful algal blooms contributed to the demise of the mussels.

Solid Phase Adsorption Toxin Tracking (SPATT) passive samplers were continuously deployed and switched out every 2-3 weeksfrom August through November, 2021, at mussel shoals located near: Kyles Ford, Tennessee; Sycamore Island, Virginia; and Artrip, Virginia. Shells from fresh dead mussels at Kyles Ford and Sycamore Island (note – no fresh dead shells were found at Artrip), and two moribund mussels, one from Sycamore Island and one from Craft Mill, Virginia (near Artrip), were collected and analyzed for MC as well. The moribund soft mussel tissues contained significant MC, (1.33 and approximately 35 nanograms per gram (ng/gram) freshweight, respectively). The SPATT samplers collected from Kyles Ford and Sycamore Island in August through early October showed low levels of MC toxin ranging from <0.1 to 0.3 ng/gram. High detections (0.74 to 5 ng/gram) were found in late October and early November in the samplers deployed at Sycamore Island and Kyles Ford. The Artrip samplers were placed above the known die-off zone and had trace amounts in August and September but below detection in October and November. Two of 7 shells analyzed from Kyles Ford and 1 of 5 shells from Sycamore Island had measurable amounts of MC. Mortality was detected at both Sycamore Island and Kyles Ford in fall of 2021, and no fresh dead or dying animals were detected at Artrip. The pattern of MC toxin detected in SPATT samplers, mussel tissue and mussel shells and the geographical distribution of mussel

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deaths support the hypothesis that cyanotoxins may contribute to mussel impairment and be associated with morbidity, but further tests are needed to conclusively prove a cause and effect.

DIFFERENTIATION AND PREDICTION OF RECHARGING PARAMETERS USING MODFLOW MODEL AND LSTM CODE

Gou

In this study, a three-dimensional finite-difference model has been used to investigate the water budget components in recharge studies in Jackson, Tennessee. This model was implemented, calibrated, and validated with MODFLOW 2005 mathematical model in a period of 38-month in GMS software. The recharge rate and output storage flow during this period have been evaluated. The precipitation forecast with the LSTM neural network model indicates a decrease in precipitation volume with relatively similar seasonal trends, which are generally more intense distribution. A decrease in precipitation directly leads to a drop in the water level in the area. However, a drop in the flow deficit does not lead to a slowdown in the discharge rate in the area, which indicates an exponential trend in the aquifer's effectiveness of recharging. In the aquifer flow prediction model based on the output produced by the LSTM model, 76-month calculations were performed on four general areas. Area criteria were different recharging coefficients, and land uses. The results indicate different velocities of inflow and outflow in a model element. Besides, the flow input section's forecasted model shows a 32% share of the river network infiltration. The inflow share through the permeable boundaries is also calculated as 34%, which shares the same range. In the whole area, 2% of the recharge output takes place as evapotranspiration, while zone-2 represents a minimum number close to 0% as the recharge output. Nonetheless, zone-4 has the highest discharge rate of 3%, so we can expect a substantial decrease in aquifer recharge by the urban territory development policy, especially by changing the direction of the water network profile or infiltration rate. In addition, it is worth adding that urban development can cause the aquifer recharge to decrease by 13%.

Keywords: GMS-MODFlow, LSTM, Memphis Aquifer, Water Budget, Recharge Rate

NORTH CHICKAMAUGA CREEK BANK STABILIZATION CASE STUDY

Maria Price, PE[1] and Ken Barry, PE, D. WRE[2]

Heavy precipitation and resulting flood flows in February 2019 in Hamilton County, Tennessee, resulted in numerous landslides and stream bank failures. Four residential properties along North Chickamauga Creek were severely affected. While erosion of the stream bank was an ongoing problem and the subject of past ad hoc fixes, the February 2019 flood resulted in a major bank failure that removed much of the backyards of the properties. The residents petitioned the City of Chattanooga for assistance. The City obtained funding from the Natural Resource Conservation Service (NRCS) to design and construct the repair and engaged S&ME to design the stream bank stabilization. S&ME performed geotechnical exploration, hydraulic analysis, National Flood Insurance Program Compliance, natural resource permitting, and civil design. Design and construction required coordination between various departments at the City, NRCS, the Tennessee Valley Authority, the US Army Corps of Engineers, the Tennessee Emergency Management Agency, the Tennessee Department of Environment and Conservation, the residents, and the designer. The streambank repair consisted of lowering the slope, constructing a rock toe, and installing vegetative stabilization on the bank above the rock toe, all at a very constrained site. Design began in late 2019, with construction completion in mid-2021.

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DIVERSITY AND INCLUSION BEGINS WITH YOU: NO ONE SIZE FITS ALL

Kimberly M. Strong, City of Chattanooga Water Quality Program

Diversity awareness is essential for the continued growth and vitality of an organization. Those organizations who intend to remain relevant today and long into the future recognize the strategic importance of diversity and inclusion both as a workforce and as a membership organization. There is no one-size-fits all method for diversity and inclusion. Kimberly was chair of the American Public Works Association's Diversity, Equity and Inclusion Committee from 2019-2021. She will share insights on what APWA is doing and provide you with tips on how you can advance diversity and inclusion with your members and volunteers. APWA has 30,000 members representing the US and Canada. This session will provide you with some quick fixes on how you can advance diversity and inclusion with your members and volunteers.

PRELIMINARY ASSESSMENT OF ENVIRONMENTAL REVIEW PURSUANT TO THE TENNESSEE INTER-BASIN WATER TRANSFER ACT

John C. Tucker[1]

Water transfers between hydrologic basins involve potential social, economic, and environmental costs and benefits. While the quantity of water being transferred is typically a primary focal point, there may also be impacts to the timing, distribution, structure, and quality of water resources, including impacts to fish and wildlife. In 2000, the Tennessee General Assembly adopted the Tennessee Inter-Basin Water Transfer Act (TIWTA) (TENN CODE ANN. §§ 69-7-201 – 69-7-212 (2019)). This law establishes a permitting program for transfers of water out of major river basins in Tennessee, to other basins either within or outside of Tennessee. The statute and implementing regulations (TENN COMP. R. & REGS. 0400-40-13 (2013)) contain criteria to assess and protect environmental attributes. The research question addressed by this study is whether these environmental criteria are being integrated into IWTA permits. Study methods include identification of key environmental criteria in the statute and implementing regulations and evaluation of the extent that these environmental criteria are integrated into actual permits. Preliminary results suggest environmental provisions are largely absent from TIWTA permits. Preliminary conclusions are that while the statute and regulations provide a solid framework to consider and protect environmental values impacted by inter-basin water transfers, future implementation will likely need to be strengthened to consistently incorporate environmental factors into permits to address increased environmental stressors to aquatic systems in Tennessee caused by human population growth and climate change.

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STUDENT POSTERS

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Champagne Cunningham, Michael Gibson, and Thomas Byl

An Assessment of Water Quality and Aquatic Macroinvertebrate Evenness in Duck River Tributaries
Jack Hartert

Comparison of AEM and Electrical Resistivity Data to Identify Hydrogeologic Windows in Upper Claiborne Confining Unit in Shelby County, Tennessee
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The Effect of Sulfide Rich Water on HEMP Seedling Growth
Baron Hill, Tom Byl, Emmanuel Omondi, and De'Etra Young

Gully Erosion of Martin and Little Indian Creeks
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Assessing Riparian Buffer Data Availability and Application in East Tennessee Communities
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Assessing the Success of Hydrological Restoration of Two WRP Easements in West Tennessee and Kentucky
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Jessica F. Prince

Recharge Assessment of the Memphis Aquifer Beneath an Urban Watershed Following Stream Restoration
J. Przybylski, D. Larsen, S. Schoefernacker, and R. Villalpando-Vizcaino

Electrochemical Disinfection as an Innovative Technology to Provide Safe Drinking Water
Caitlyn Smugor and Qiang He

Water Quality and Eutrophication in Tennessee State University's Wetland
Tyrese Stanford, Jonathan Alford, De'Etra Young, and Tom Byl

PRELIMINARY RESULTS OF MICROCYSTIN AND SAXITOXIN PRESERVATION IN FOSSIL MOLLUSKS OF THE LATE CRETACEOUS COON CREEK FORMATION LAGERSTÄTTE: IMPLICATIONS FOR A KILL MECHANISMS FOR MARINE REPTILES

Champagne Cunningham [1,2], Michael Gibson[3], and Thomas Byl[1,2]

The Upper Cretaceous Coon Creek Formation (CCF) of Western Tennessee is recognized for its pristine preservation of an abundant and diverse biota of invertebrates, vertebrates, and rare plants. The fossils are approximately 70-million years old and represent marine organisms that lived during the late Cretaceous period when the Gulf of Mexico extended into Tennessee. One of the taphonomic mysteries of the CCF is how multiple mosasaur specimens died and were buried within the same small area of seafloor. The pristine nature of preservation of the CCF fauna opens the opportunity to discover geochemical evidence of potential kill mechanisms, for example, the presence of saxitoxins (SXT) or microcystin (MT) produced by harmful algal blooms. Previous studies have shown that cyanobacteria and dinoflagellates were common in Cretaceous sediments; these are known to produce toxins that cause red tides and harmful algal blooms. There are many recent reports of MT and SXT occurrence in marine settings, with a recent publication reporting cyanotoxins in 4,700 year old Florida sediments. Herein, we report on detection of 70-million year old MT and SXT, the oldest occurrence reported in the literature. Several taxa of mollusks (oyster, mollusk, gastropod, cephalopod) collected from the CCF with enclosing sediment, and younger overlying soils were analyzed to determine the occurrence and survivability of MT and SXT within the CCF fossils. Results from the Enzyme Linked ImmunoSorbent Assay (ELISA) analysis found greater than 10 micrograms/gram (ug/g) of MT and over 7ug/g SXT in the bivalve fossils, mollusk *Pterotrigonia* and oyster *Exogyra*. Sediment levels of MT and SXT in overlying sediments were negligible, indicating that the fossils were not contaminated by terrestrial cyanobacteria release of MT and CCF. Our preliminary study demonstrates the presence of MT and SXT in the CCF fossil shells and potential evidence of harmful algal blooms in the Cretaceous period, as preserved in the fossil record of the CCF based on the concentration levels.

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AN ASSESSMENT OF WATER QUALITY AND AQUATIC MACROINVERTEBRATE EVENNESS IN DUCK RIVER TRIBUTARIES

Jack Hartert

Middle Tennessee is a known freshwater hotspot for biodiversity, and the Duck River is considered the most biologically diverse river in the United States. In maintaining a healthy river ecosystem, the conservation of biodiversity is a crucial yet difficult measure due to the complexity of fluvial environments. Over five weeks, data was collected on chemical indicators and macroinvertebrate abundance, representing water quality and biodiversity, respectively, to assess the effects of water quality on macroinvertebrate populations in six Duck River tributaries. Harmful concentrations of chemical indicators were expected to negatively affect macroinvertebrate populations. Significant differences between streams were observed in pH, water temperature, and electrical conductivity ($p < 0.001$), reflecting differences in site factors. *Pleurocera* freshwater gastropods were significantly more abundant in site 4 than in the remaining sites, which negatively correlated with electrical conductivity ($p < 0.05$). Significant correlations were observed between differences in water quality and species abundance by stream ($p < 0.05$), which may provide further evidence of the effects of alterations to stream ecosystems. Additional applications of water quality assessments will allow for the more effective implementation of conservational measures to protect fluvial ecosystems.

COMPARISON OF AEM AND ELECTRICAL RESISTIVITY DATA TO IDENTIFY HYDROGEOLOGIC WINDOWS IN UPPER CLAIBORNE CONFINING UNIT IN SHELBY COUNTY, TENNESSEE

Md Rizwanul Hasan[1*], Daniel Larsen[2*], Brian Waldron[3], Scott Schoefernacker[4], Rodrigo V Vizcaino[5]

Inter-aquifer exchange of poor quality water through hydrogeologic windows (absence or thinning of a low-permeability layer) in confining units can affect the water quality of confined water-supply aquifers. Identifying window location and geometry is essential for protecting and managing water resources. We use the electrical resistivity (ER) method to identify high resistivity zones, composed of sand-dominated sediments, in the clay-rich upper Claiborne confining unit (UCCU) overlying the Memphis aquifer. We compare the results with airborne electromagnetic (AEM) data collected by the U.S. Geological Survey on President's Island, Shelby County, Tennessee. The ER data were collected along short segments of an AEM flight line, where the UCCU is interpreted to be potentially absent. A 56-electrode dipole-dipole array was used for the ER survey to clarify lateral variation of the UCCU. The depth of penetration (DOP) for the ER lines with a 8 m and 10 m spacing ranges from 80-120 m, respectively. The AEM survey DOP is 85 m. ER and AEM resistivity patterns are compared to refine the potential hydrogeologic window and its extent. Borehole cores and geophysical log data have shown a strong correlation between higher resistivity on inverted ER profiles and sand-dominated sediments in the UCCU at other locations. Borehole core data along the ER and AEM profiles are not available but is anticipated to help determine the continuity of the UCCU at President's Island.

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THE EFFECT OF SULFIDE-RICH WATER ON HEMP SEEDLING GROWTH

Baron Hill[1], Tom Byl[2], Emmanuel Omondi[1], and De'Etra Young[1]

Previous research found water enriched in sulfide stimulated plant growth. The objective of the current study was to determine if groundwater from Tennessee State University's farm well naturally rich in sulfide stimulated hemp growth. *Cannabis sativa*, variety Henola, were raised in the lab under constant light and temperature using waters containing high sulfide concentrations (65-105 mg/L) or no sulfide. Sulfide-rich water from a single well was used for both treatments. Oxidized sulfate water was produced by titrating sulfide-rich water with hydrogen peroxide to oxidize the sulfide to sulfate so a comparison of sulfate versus sulfide-rich waters could be investigated. Ten days after planting, hemp raised in sulfide-rich waters were significantly taller (average 3 cm) as compared to seedlings raised in sulfate waters (2 cm tall, $p = 0.01$). Additional shoot, root, body weight and enzyme levels will be measured to determine if sulfide enhances hemp fiber production.

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GULLY EROSION OF MARTIN AND LITTLE INDIAN CREEKS

Jakob Hull

The purpose of this project is to establish a sediment budget and compare gully erosion of Martin and Little Indian Creeks. A watershed boundary was created for each creek and LiDAR elevation data of Jackson and Putnam County were used to go along with these boundaries. With the elevation data, hillshade and aspect maps were made to view the topography and geomorphic features. Using the hillshade as the base, gullies, landslides, and floodplains were digitized into their own respective feature classes. Land use data in the form of a National Land Cover Database or NLCD in order to determine what the land in the area is classified as. The hopes of this is to determine what land type gullies tend to form on and to potentially determine what caused them. I plan to look further into the land use classifications and work towards using the aspect map to determine the aspect of the gullies. Preliminary results indicate that the average slope of gullies in the Martin Creek watershed is 34.2% and the average slope of gullies in the Little Indian watershed is 30.1%. Floodplains cover approximately 970 acres and landslide areas cover a total of approximately 15 acres over the study watersheds. Results from this study will help to identify sediment sources within these two watersheds. Sediment runoff from landslides and gullies contributes to higher stream turbidity, and identifying sediment sources is the first step in managing sediment pollution.

ASSESSING RIPARIAN BUFFER DATA AVAILABILITY AND APPLICATION IN EAST TENNESSEE COMMUNITIES

Maddy Johnson,
University of Tennessee

Forested riparian buffers are an invaluable resource in any community, providing numerous ecosystem services that improve human and watershed health. Land-use changes and urbanization across East Tennessee have contributed to declining riparian buffer area, leading to detrimental effects on water quality. This issue is further exacerbated by a lack of public awareness of the importance of riparian buffers. There is little publicly accessible information available pertaining to the current state of riparian buffer quality and monitoring efforts, and therefore little understanding of where improvements can be made on a large-scale. The Community Riparian Restoration Program (CRRP) for Tennessee, an initiative led by the University of Tennessee Institute of Agriculture, aims to collaborate with stormwater professionals and other government agencies in East Tennessee to collect and analyze data pertaining to riparian forest health and water quality to create a cohesive database for public educational purposes, and to inform future restoration improvements. We will utilize data such as visual stream assessments and water quality measurements from East Tennessee municipalities and potentially other sources to identify relationships between vegetation management practices and water quality. This information will be used to develop interactive virtual educational resources to promote awareness and stewardship for riparian buffer health within communities, and to build capacity for municipalities to improve vegetation management, restoration, and monitoring. In this presentation, we will review the state of the available data for riparian buffers in East Tennessee communities and discuss future applications towards the goals of the CRRP.

ASSESSING THE SUCCESS OF HYDROLOGICAL RESTORATION OF TWO WRP EASEMENTS IN WEST TENNESSEE AND KENTUCKY

Collins Owusu, Nusrat Jannah Snigdha, Mackenzie T. Martin, and Alfred J. Kalyanapu*

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Wetlands are vital for sustaining biodiversity and other ecosystem services. Wetlands are dependent on the temporal and spatial regular cycles of inundation and drying, which makes hydrology a primary controlling variable for sustaining their functionality. This makes restoration of the hydrology of degraded wetlands very crucial. This study is part of the Wetland Reserve Program (WRP) by the Natural Resources Conservation Service (NRCS) which evaluates the performance of restoration practices implemented on the easements enrolled in the program to restore the degraded wetlands. In this study, we assess if hydrological restoration practices implemented under the WRP have increased water depth, hydroperiod, and retention times which will inform the potential benefits/detriments of such practices on the success of wetland restoration. The hydrologic restoration involved the construction of shallow water levees, adding water control structures, levee breaks, and ditch plugging. Beginning in 2019, continuous surface water level data were recorded in the wetlands using HOBO MX2001 water level loggers. The water level data coupled with climate and historical remote sensing datasets will be used to compare the pre-restoration and post-restoration water levels and hydroperiods. Statistical trend analysis will be carried out to detect significant changes in hydrology in the selected wetlands. Our study will show whether hydrological restoration methods can enhance wetland hydrology and also provide a methodology for combining remote sensing and in-situ datasets for wetland restoration assessment.

EVALUATION OF PRECIPITATION GAUGE DATA AND RADAR RAINFALL DATA FOR DEVELOPING FLASH FLOOD WARNING CRITERIA AT CUMMINS FALLS STATE PARK

Jessica F. Prince

Cummins Falls is the 8th largest waterfall in Tennessee -by volume- and is located on the Blackburn Fork River near Cookeville, Tennessee. The site is a popular attraction due to the large pool at the foot of the falls. Unfortunately, the site has been beset with deadly flash flooding events. TN State Parks has set up a flash flood monitoring system in hopes of issuing warnings to allow for the evacuation of the gorge. While a large amount of data has been collected by the flash flood monitoring system, accurate warning criteria have still not been determined. For example, warning system alarms are currently set to activate when 1 inch of rain falls in 15 minutes. This threshold, however, was arbitrarily chosen by system operators and is not based on data from actual rain events. This project aims to determine threshold warning criteria for rainfall amounts and stream gauge levels that are based on actual data. A second aim of the project is to evaluate the use of RADAR rainfall data to determine runoff patterns. Since RADAR rainfall data offer better coverage of the watershed than the five rain gauges currently in use, the data has the potential to aid in developing warning criteria. NEXRAD RADAR rainfall data from the National Weather Service were obtained in raster GIS format at approximately 6-minute intervals and analyzed using ArcGIS Pro.

RECHARGE ASSESSMENT OF THE MEMPHIS AQUIFER BENEATH AN URBAN WATERSHED FOLLOWING STREAM RESTORATION

J. Przybylski, D. Larsen, S. Schoefernacker, and R. Villalpando-Vizcaino

Stream restoration is being conducted by the West Tennessee River Basin Authority (WTRBA) to rehabilitate flow and correct major erosional problems in the Sandy Creek watershed, an urban site in Jackson, Tennessee. In this study, one year of post-restoration water balance data is compared to three years of pre-construction water balance data to better understand the short-term effects of stream restoration on the groundwater recharge rate beneath the Sandy Creek watershed. The Sandy Creek watershed overlies an unconfined section of the Memphis aquifer; thus, recharge beneath the watershed directly impacts important regional water resources.

Meteorological (precipitation, temperature, solar radiation, and wind parameters), stream discharge, and soil moisture data have been collected in the watershed since May 2017. Calculated recharge rates for the three years (October to September) of pre-construction data are 0.568 m/m^2 (2017-2018), 0.692 m/m^2 (2018-2019) and 0.559 m/m^2 (2019-2020). The annual rates are relatively consistent despite several data gaps during 2018-2019 and 2019-2020 that may result in substantial error for the calculated recharge rates. Construction for the restoration project finished in May 2021, so the calculated recharge rate of 0.409 m/m^2 for 2020-2021 includes six months of pre-construction data, two months of concurrent construction data, and four months of post-construction data. The short-term impacts of restoration will be evaluated by comparing monthly data average and standard deviation of pre-construction years to the post-construction results for 2021-2022. Preliminary results suggest little short-term impact of stream restoration on watershed recharge rates.

ELECTROCHEMICAL DISINFECTION AS AN INNOVATIVE TECHNOLOGY TO PROVIDE SAFE DRINKING WATER

Caitlyn Smugor and Qiang He, University of Tennessee, Knoxville, TN 37996

Current disinfection processes for providing safe drinking water are most commonly accomplished through the use of chemical oxidants, such as chlorine and ozone, to inactivate waterborne pathogenic microorganisms. These disinfection processes require sophisticated equipment, significant capital investment, specialized technical staff, and stringent safety measures to maintain reliable operation. However, this is not always a feasible option, especially for communities lacking infrastructure and economic resources. A potential alternative that is being investigated for effective water disinfection is electrochemical disinfection, which has become more technically feasible and environmentally sustainable due to the popularity of solar and wind energy, in the form of electricity. Electrochemical processes work by supplying a specific voltage to electrodes (anode and cathode) to promote desired oxidation-reduction reactions to occur. Previous studies show that electrochemical processes can convert chloride ions into chlorine through oxidation reactions occurring at the anode. The chlorine will ultimately react with water to form hypochlorous acid, the same desired disinfectant produced by conventional chlorination processes. With the objective to demonstrate the inactivation of waterborne pathogens through electrochemical disinfection, we are developing an electrochemical system and testing various system configurations, electrode materials, and process conditions to optimize disinfection efficiency. We are also investigating scenarios that the electrochemical processes can be used to simultaneously address both microbial and chemical contaminants in the water. Findings from this study will provide much needed insight into the implementability and sustainability of electrochemical disinfection processes for safe drinking water supply.

WATER QUALITY AND EUTROPHICATION IN TENNESSEE STATE UNIVERSITY'S WETLAND

Tyrese Stanford[1], Jonathan Alford[1], De'Etra Young[1], Tom Byl[2]

The wetland at the TSU research farm in Nashville, Tennessee, has been frequently overwhelmed by eutrophication and harmful algal blooms, posing a danger to livestock and wildlife. The objective of this research was to characterize the problem through time. Conditions were determined by measuring water chemistry, including microcystin toxin. Samples were collected at four locations in the wetland between summer 2017 through fall 2021 and analyzed for nitrogen, phosphorous, iron, sulfur, Secchi depth, chlorophyll a, phycocyanin, and microcystin. Continuous water-quality instruments were also installed at the inlet and outlet of the wetland to document dissolved oxygen, pH, temperature, specific conductance, and turbidity. Microcystin concentrations ranged from less than 0.15 to 25.1 µg/L. The U.S. EPA health advisory concentration for microcystin is 0.3 µg/L. Average microcystin concentrations were 0.119 µg/L during November-April and increasing to 0.985 µg/L during May-October.

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