Proceedings of the

2018 IWSS Spring Conference: Advances in Water Resource Science and Management in West Virginia and the Northeastern U.S.

Tuesday, February 20, 2018 from 9 a.m.–7 p.m.
and Wednesday, February 21, 2018 from 9 a.m.–3 p.m.

at the WVU Erickson Alumni Center
1 Alumni Drive, Morgantown, WV

presented by:

INSTITUTE OF WATER SECURITY AND SCIENCE

4121 Agricultural Sciences Building | Morgantown, WV 26506-6108
304.293.2472 | iwss@mail.wvu.edu | iwss.wvu.edu

Table of Contents

Conference Organizing Committee

Dr. Jason A. Hubbart
Jason.Hubbart@mail.wvu.edu

Laura Tinney
Laura.Tinney@mail.wvu.edu

Dr. Elliott Kellner
Elliott.Kellner@mail.wvu.edu

This conference was partially supported by the Dan and Betsy Brown Speaker Fund
at West Virginia University and the National Science Foundation under Award No. OIA-1458952.
Other funding and support provided by West Virginia University

Conference Agenda

February 20, 2018: Watershed Management and Water Quality

9:00 AM Welcome and Introduction of Keynote Speaker
Dr. Jason Hubbart, Director, WVU Institute of Water Security and Science

9:15 AM Keynote Address: *Lessons from the Chesapeake Bay TMDL* – Nicholas DiPasquale, Former Director, U.S. EPA Chesapeake Bay Program Office

10:00 AM *Restoring Appalachian River Networks in a Changing Climate* – Dr. J. Todd Petty, Professor and Associate Dean of Academic Affairs, Davis College of Agriculture, Natural Resources & Design, West Virginia University

10:20 AM *USACEHR Advances in Water Toxicity Sensors and Technology* – David Trader, Executive Officer, Research Biologist, IACUC Chair, U.S. Army Center for Environmental Health Research

10:40 AM Break

11:00 AM *Soil Water Quality of Reforested Mine Site Twelve Years After Reclamation* – Dr. Amir Hass, Associate Research Professor of Soil Water and Natural Resources Management, West Virginia State University

11:20 AM *Sensing and Educating the Nexus to Sustain Ecosystems (SENSE): Implementation of the Kentucky-West Virginia Partnership* – Dr. Mindy Armstead, Associate Professor Integrated Science and Technology, Marshall University

11:40 AM *IWSS Update/Introduction to West Run Watershed Experimental Research Collaborative* – Dr. Jason Hubbart, Director, Institute of Water Security and Science, West Virginia University

12:00 PM Lunch

1:00 PM *Mapping the Blue Marble: Using Space-Based Observations for Improved Global Water Security and Sustainability* – Dr. John Bolten, Associate Program Manager of Water Resources, NASA Applied Sciences Program

1:20 PM *The Confluence of Scientific, Social and Economic Aspects of Water in West Virginia Today* – Angie Rosser, Executive Director, West Virginia Rivers Coalition

1:40 PM *Utilizing eDNA Metabarcoding for Fish Community Analysis in Appalachian Headwater Streams* – Dr. Yvette Halley, Postdoctoral Research Fellow, West Virginia University

2:00 PM *Inorganic carbon and CO_2 from karst springs and mine waters* – Dr. Dorothy Vesper, Associate Professor of Geology, West Virginia University

2:20 PM Break

2:40 PM *Improved Landscape Characterization for Modeling Receiving Stream Conditions* – Dr. Michael Strager, Professor of Resource Economics and Management, West Virginia University

3:00 PM Panel Discussion with all Speakers of the day

4:00 PM Synthesis for the day

4:30 PM Poster Sessions and Reception

7:00 PM End of Day 1

February 21, 2018: Water Availability and Treatment

9:00 AM Welcome and Housekeeping – Dr. Jason Hubbart, Director, WVU Institute of Water Security and Science

9:10 AM Message from the Dean – Dr. Daniel J. Robison, Dean, Davis College of Agriculture, Natural Resources and Design, West Virginia University

9:20 AM *Innovative Fe-based technologies for Improving Food-Energy-Water Nexus Efficiencies in Coal Producing Regions* – Dr. Lian-Shin Lin, Professor, Civil and Environmental Engineering, West Virginia University

9:40 AM *The MUB Monitor: A Source Water Protection and Spill Response Tool* – Mr. Evan Hansen, President, Downstream Strategies

10:00 AM Break

10:30 AM *A Comparison Between Shale Gas in China and Unconventional Fuel Development in the United States: Water, Environment and Sustainable Development* – Dr. Paolo Farah, Assistant Professor of Public Administration, West Virginia University

10:50 AM *The Appalachian Water Tower: The role of mountain catchments in regional water security* – Dr. Nicolas Zegre, Associate Professor of Forest Hydrology, West Virginia University

11:10 AM *Treating Effluent Streams at Coal Power Plants* – Dr. Nicholas Siefert, Research Mechanical Engineer, U.S. Department of Energy National Energy Technology Lab

11:30 AM *Water Resource Management: The Economic Perspective* – Dr. Levan Elbakidze, Assistant Professor of Resource Economics and Management, West Virginia University

11:50 AM Lunch and Removal of Posters

1:15 PM Panel Discussion (1hr)

2:15 PM Synthesis and Closing (20-30 Minute + 15-20 Minute Q&A)

3:00 PM End of Conference

Speaker Abstracts

DAY 1: Watershed Management and Water Quality

Lessons from the Chesapeake Bay TMDL

Nicholas A. DiPasquale, Former Director, Chesapeake Bay Program Office, U.S. EPA

Mr. DiPasquale's Keynote Address will provide a brief overview of origins of the Chesapeake Bay restoration effort, the structure of the Chesapeake Bay Partnership, progress in the restoration effort to date as measured by key indicators, the essential components of TMDL in achieving water quality improvement and how this fits with the eco-system based initiative, funding the recovery effort, the importance of the role of local governments and the challenges facing the program in achieving TMDL goals by 2025. The presentation is intended to inform other estuary restoration efforts.

Restoring Appalachian River Networks in a Changing Climate

Dr. J. Todd Petty, Professor and Associate Dean of Academic Affairs, West Virginia University, Davis College of Agriculture, Natural Resources & Design

River restoration seeks to recover aquatic ecosystem functions lost from historic impacts. However, restoration actions must also consider the potential complicating effects of climate change. Dr. Petty will present the results from two studies of brook trout restoration in the Appalachian region. First, he will describe a process for identifying watershed restoration priorities within the context of expected impacts from climate change. This process can be used to direct resources towards restoration actions that have the greatest potential for producing benefits to brook trout populations under threat from climate change. Second, Dr. Petty will present results from a long-term assessment of restoration actions in the upper Shavers Fork, WV designed to recover brook trout populations and build resilience to future impacts from climate change. His results indicate that targeted watershed scale restoration actions can be used to re-establish connectivity among tributary populations and larger, productive main stem rivers that may be vulnerable to future warming. The synthesis of these two studies together is used to propose a path for conserving cold-water ecosystems in the face of climate change.

USACEHR Advances in Water Toxicity Sensors and Technology*

David Trader, Executive Officer, Research Biologist, IACUC Chair, U.S. Army Center for Environmental Health Research

The United States Army Center for Environmental Health Research (USACEHR) develops surveillance capabilities to detect, assess, and prevent undesirable health effects in Soldiers from adverse environmental, physiological, and psychological exposures. This session will discuss the strides USACEHR has accomplished in the area of developing biologically-based toxicity sensor technology for assessing potable field water. Current laboratory capabilities at USACEHR will also be discussed. The USACEHR has previously developed an automated fish biomonitor, a fish cell-based cartridge and a ticket-based pesticide assay for rapid toxicity testing of water, as well as several other technologies for Preventive Medicine Personnel. With the future emphasis on dense urban environments, the Army is also interested in developing rapid toxicity tests for coliform bacteria and toxic industrial chemicals in drinking water.

**The views, opinions, and/or findings contained in this publication are those of the author(s) and should not be construed as official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citations of commercial organizations or trade names in this publication do not constitute an official Department of the Army endorsement or approval of the products or services of these organizations.*

Soil Water Quality of Reforested Mine Site Twelve Years After Reclamation
Dr. Amir Hass, Associate Research Professor of Soil Water & Natural Resources Management, West Virginia State University

Forestry reclamation approaches (FRA) shown to improve success of reforestation of mine sites in Appalachia by alleviating soil compaction and selection of proper topsoil replacement materials conducive to root growth. Material selection and management practices also expect to affect soil water quality and composition. This study evaluates the effect of FRA practices, namely the use of oxidized vs. reduced sandstone spoils as topsoil replacement material, and loose vs. compacted placement thereof on soil water quality of WV mine site, 12 years after reclamation. Experimental plots established in 2005 and shallow wells and zero-tension pan lysimeters (at 30 to 80 cm) installed in the spring of 2017 to collect and monitor water quality. Water samples were collected weekly from June to mid-November 2017 and analyzed for total alkalinity and elemental and ionic composition, as well as dissolve oxygen, pH, temperature, and redox potential. Initial results showed levels of alkali and alkaline earth metals within the range of benchmark reference values for surface water in WV (0.8 – 1.9 times the reference levels) while that of Fe, Mn were much higher (878, and 604 times the reference levels of 0.019, and 0.016 mg L-1, respectively). Levels of heavy metals were elevated as well (1.8, 23, and 37 times the reference levels of 0.0076, 0.0027, and 0.0008 mg L-1, for Ni, Zn, and Cu, respectively). Overall, redox processes and seasonal variation therein seemed to govern metal solubility, nitrogen speciation, and pH of the reclaimed mine site soil solution 12 years after reclamation.

Sensing and Educating the Nexus to Sustain Ecosystems (SENSE): Implementation of the Kentucky-West Virginia Partnership
Dr. Mindy Armstead, Associate Professor Integrated Science and Technology, Marshall University

The potential for management opportunities of large river systems to minimize the incidence of harmful algal blooms (HABs) is being investigated with the implementation of a high-frequency data collection program and multi-sector collaborations. With the incidence of HABs increasing nationwide, more resources are directed toward monitoring and predicting bloom locations and severity. Factors complicating these predictions in large river systems are their extension across state and federal regulatory boundaries, multiple land use scenarios, numerous and diverse stakeholders, and multiple designated uses of the resource. Responding to the challenges, Sensing and Educating the Nexus to Sustain Ecosystems (SENSE) is a research program funded by NSF-EPSCoR (2016-2020) that supports cyber-infrastructure development in the partner states. With the specific goal of investigating the influence of food and energy production on aquatic ecosystems and HAB formation, the project has grown through outreach and partnering with stakeholders sharing common goals. Project objectives include real-time monitoring of water quality parameters associated with HAB development in Kentucky Lake and the Ohio River with the goals of establishing relationships among water quality and quantity and bloom formation to better predict bloom development and to potentially reduce the incidence of HABs in the targeted water bodies. High-frequency monitoring of general water chemistry, chlorophyll a, phycocyanin, nitrates and phosphates will be discussed, along with strategies for stakeholder/partnership development on the large river ecosystems, successes and failures of deployment designs and instrumentation, sampling plans and their modifications, and strategies for moving forward with predictive HAB model development.

Mapping the Blue Marble: Using Space-Based Observations for Improved Global Water Security and Sustainability

Dr. John Bolten, Associate Program Manager of Water Resources, NASA Applied Sciences Program

Of the 7.4 billion people on the planet, roughly one billion people currently lack access to clean water, and with the projected increases in population and water demand, these stresses on water are expected to increase significantly in the next decade. The same stresses on water resources are also driving technological advances in Earth observations, notably satellite-based remote sensing and numerical modeling approaches for improved monitoring and management of water resources. NASA is a leader in the global monitoring of water from space. Satellite- and aircraft-based sensors now have the ability to measure the height of water bodies with centimeter accuracy, monitor the movement of water beneath the surface of the earth, detect the amount of water being used by vegetation, and accurately measure the amount of snow captured in the mountains and in the soil. Combined with a water management strategies and innovative land surface modeling approaches, NASA Earth observations are being used to carefully monitor and assess current water conditions and design potential scenarios of future changes in water resources and water demands. These scenarios then enable experts to formulate development pathways and consider synergies and trade-offs for using water resources more efficiently and effectively to meet national priorities within the sustainability framework. This talk will highlight recent advances in the use of satellite, airborne, and ground-based sensor networks to measure the quantity and quality of hydrologic resources in the U.S. and internationally, provide information to water managers to improve water resources management, and support risk-based decision-making.

The Confluence of Scientific, Social and Economic Aspects of Water in West Virginia Today

Angie Rosser, Executive Director, West Virginia Rivers Coalition

Most citizens are not deeply aware how policies and practices that influence water quality and watershed management affect their everyday lives. West Virginia Rivers Coalition strives to connect the dots between the scientific, social, economic and political aspects of water in our state. This presentation provides an overview of the socio-political backdrop of watershed management in West Virginia, as well as opens discussion about current issues that present threats and opportunities for water security for the state and region.

Utilizing eDNA Metabarcoding for Fish Community Analysis in Appalachian Headwater Streams

Dr. Yvette Halley, Postdoctoral Research Fellow, West Virginia University

Historically, the conservation and management of aquatic organisms and ecosystems was dependent on a thorough understanding of species' distribution and/or community composition. However, distributional and compositional data can be difficult to obtain across relevant scales due to limited resources and potential logistical issues associated with certain taxa (e.g., sampling cryptic or threatened and endangered species). The utilization of environmental DNA (eDNA) is an innovative development in the non-invasive monitoring of aquatic target species and communities. These novel technologies focus on the capture and utilization of genetic material (i.e., hair, feces, urine, feathers, skin, and saliva) shed by various organisms into their environment. Since, aquatic eDNA is susceptible to environmental variables (i.e., UV irradiation, extreme temperature, pH, salinity) it experiences a high rate of degradation over short periods. Thus, allowing for discrete detection windows, which is generally associated with recent species' presence. For the present study, we utilized an aqueous environmental DNA filtering approach in conjunction with chloroform:isoamyl alcohol extractions, metabarcoding and next-generation sequencing technologies to survey fish assemblages in Appalachian headwater streams.

Inorganic carbon and CO_2 from karst springs and mine waters

Dr. Dorothy Vesper, Associate Professor of Geology, West Virginia University

The flux of dissolved inorganic carbon (DIC) from groundwater to surface water, and from surface water to the atmosphere, is a critical component in the terrestrial water-carbon cycle. Scientists who study the geochemistry of karst (limestone) systems have estimated values for the CO_2 partial pressure (P_{CO2}) extensively in their characterization and interpretation of karst waters. The amount of CO_2 in the water is closely linked to the solution pH and the likelihood that the water will either dissolve or precipitate carbonate minerals. DIC and CO_2 may also exist in waters associated with coal mines. In karst systems, limestone dissolution is typically driven by atmospherically derived H_2CO_3 but in mine waters dissolution is typically driven by sulfide-derived H_2SO_4. In the first case, the net flux of sequestered carbon is zero but in the later there is a net release of sequestered carbon.

Vesper's research group is currently measuring and comparing DIC and CO_2 concentrations from karst springs, sandstone springs and coal mine discharges. In the karst springs, they estimate CO_2 from the pH and alkalinity; for the other locations, we measure CO_2 and DIC directly using an Anton Paar carbonation meter. The estimation method works well in the karst waters but not in mine water because they are chemically unstable after being discharged from the subsurface. They find that mine waters can have higher fluxes of CO_2 than the karst springs; and are currently investigating the temporal changes in the concentrations. Lastly, Vesper's team is testing new methods for measuring CO_2.

Improved Landscape Characterization for Modeling Receiving Stream Conditions

Dr. Michael Strager, Professor of Resource Economics and Management, West Virginia University

One frequently studied aspect of the hydrological cycle is modeling the relationship between the landscape and receiving streams. Landscape analysis is often performed with easily accessible land cover data sources– however, these data may not have adequate spatial resolution to represent localized features. In addition, readily available land cover datasets (such as the National Land Cover Dataset) may also have poor temporal correspondence with associated in-stream datasets. Our goal in this study was to improve the landscape characterization process with newer machine and deep learning algorithms applied to high temporal and spatial resolution aerial photography. The process has proven to be beneficial to map unique local features in North Central Appalachia such as oil and gas disturbance. In addition to feature mapping, we highlight the importance of terrain characteristics, (specifically flow paths to receiving streams) as an improvement in modeling the landscape to receiving stream condition. This is performed using a weighted flow path model which includes the length, direction, and complexity of terrain. The advantages of this approach are that it can account for both positive and negative factors that influence water quality. This improved landscape characterization which includes both the mapping of land features and inclusion of terrain paths weighted to the features provides promise in the area of spatial hydrology.

Speaker Abstracts

DAY 2: Water Availability and Treatment

Innovative Fe-based technologies for Improving Food-Energy-Water Nexus Efficiencies in Coal Producing Regions

Dr. Lian-Shin Lin, Professor, Civil and Environmental Engineering, West Virginia University

A regional approach using innovative iron-based technologies was developed to enable new food-energy-water (FEW) interlinkages to improve nexus efficiencies in pollution reduction, energy efficiency, and better nutrient management for food production. This presentation focuses on identifying opportunities for using iron as a green agent in developing innovative Fe-based technologies and demonstrating their technological feasibility. The technologies include a Fe-dosed anaerobic biological process for wastewater treatment, and extracting useful chemical elements (Fe and Al) from acid mine drainage. The Fe-dosed treatment process does not require aeration, which represents a saving of 50-75% of electricity cost compared to typical wastewater treatment plants using aerobic biological treatment. Results showed that Fe/S ratio is a key factor affecting the Fe-dosed treatment process, and overall better treatment performance was obtained under Fe/S molar ratio 1 than ratio 0.5. The AMD-extracted elements are used in making Fe- and/or Al-coated sorbent. The sorbent is versatile in its applications ranging from removing phosphorus from nutrient-laden wastewaters to for phosphorus management in crop production. Phosphorus adsorption capacity of a Fe-coated sorbent was as high as 0.2 lb PO4/lb Fe. The sorbent-bound phosphorus was bioavailable for tomato growth, which render the sorbent an effective agent for nutrient management and food production.

The MUB Monitor: A Source Water Protection and Spill Response Tool

Mr. Evan Hansen, President, Downstream Strategies

In 2014, a chemical leak contaminated drinking water for approximately 300,000 West Virginians. In response, legislation required water utilities to implement new source water protection measures, and in Monongalia County, the Morgantown Utility Board implemented a comprehensive Source Water Protection Program. The MUB Monitor is at the core this program. It provides secure, web-based decision-support tools to utility managers to respond effectively to spills, rank the threats posed by aboveground storage tanks, manage risks from potential contaminant sources upstream from the intakes, and communicate effectively should contamination occur.

A Comparison Between Shale Gas in China and Unconventional Fuel Development in the United States: Water, Environment and Sustainable Development

Dr. Paolo Farah, Assistant Professor of Public Administration. West Virginia University

China is believed to have the world's largest exploitable reserves of shale gas, although several legal, regulatory, environmental, and investment-related issues will likely restrain its exploitation. China's capacity to face these hurdles successfully and produce commercial shale gas will have a crucial impact on the regional gas market and on China’s energy mix, as Beijing strives to decrease reliance on imported oil and coal, and, at the same time, tries to meet growing energy demand and maintain a certain level of resource autonomy. The development of the unconventional natural gas extractive industry will also provide China with further negotiating power to obtain more advantageously priced gas. This article, which adopts a comparative perspective, underlines the trends taken from unconventional fuel development in the United States, emphasizing their potential application to China in light of recently signed production-sharing agreements between qualified foreign investors and China. The wide range of regulatory and enforcement problems in this matter are increased by an extremely limited liberalization of gas prices, lack of technological development, and barriers to market access curbing access to resource

extraction for private investors. This article analyzes the legal tools that can play a role in shale gas development while assessing the new legal and fiscal policies that should be crafted or reinforced. It also examines the institutional settings' fragmentation and conflicts, highlighting how processes and outcomes are indeed path dependent. Moreover, the possibilities of cooperation and coordination (including through U.S.-China common initiatives), and the role of transparency and disclosure of environmental data are assessed. These issues are exacerbated by concerns related to the risk of water pollution deriving from mismanaged drilling and fracturing, absence of adequate predictive evaluation regulatory instruments and industry standards: this entails consequences for social stability and environmental degradation which are inconsistent with the purposes of sustainable development.

The Appalachian Water Tower: The role of mountain catchments in regional water security
Dr. Nicolas Zegre, Associate Professor of Forest Hydrology, West Virginia University

The Appalachian Mountains play a critical role in provisioning fresh water ecosystem services to the eastern and mid-western United States, yet the role and reliability of mountain water as a strategic resource is largely unknown. Due to complex topography, the convergence of different weather systems, and extensive forest cover, West Virginia generates a disproportionately large amount of precipitation and streamflow than lower lying regions. West Virginia therefore acts as a water tower to downstream areas, providing water directly to communities in the Chesapeake Bay and Ohio River watersheds that include important and rapidly expanding urban economies such as Washington, D.C. and Pittsburgh, PA. This upstream-downstream configuration creates a hydrological and social dependence that should be recognized in order to create new opportunities for water resources management, economic development, and to increase water security across the region. In this research, we quantify climate and streamflow under different climate change scenarios at a high resolution (4-km, daily) to assess current and future water resources availability throughout the Appalachian Mountains region, as well as for regions downstream that are dependent on Appalachian water. In addition, we develop a water tower model to identify locations on the landscape that play a larger role in freshwater provisioning to downstream economies to highlight regional dependence between cities and the mountains. Our water tower model provides an innovative approach for studying coupled human-water systems, potentially offering decision makers a means of prioritizing water resources management across the region to promote economic growth and water security.

Treating Effluent Streams at Coal Power Plants
Dr. Nicholas Siefert, Research Mechanical Engineer, U.S. Department of Energy National Energy Technology Lab

A 21st century America will need to count on abundant, sustainable fossil energy as well as water resources to achieve the flexibility, efficiency, reliability, and environmental quality essential for continued U.S. security and economic health. Due both to water scarcity challenges in the Western U.S. and to recent EPA effluent limitation guidelines at coal power plants, there is urgent need to develop cost-effective technologies to reduce fresh water consumption at power plants and to reduce effluent waters discharged from power plants. This talk will focus on R&IC's current and future research and development efforts that are focused on treating effluent streams at coal power plants. This talk will include: (1) a summary of current EPA regulations on effluent discharge from coal power plants, (2) a detailed summary of the current options for treating these effluent streams, such as Reserve Osmosis and Mechanical Vapor Recompression, and (3) a summary of NETL-funded research into overcoming the operating limitations of commercially-available RO and MVR processes.

Water Resource Management: The Economic Perspective

Dr. Levan Elbakidze, Assistant Professor of Resource Economics and Management, West Virginia University

Human activities depend on and influence supply and integrity of fresh water resources. While some emerging new technologies enable savings in water use, other technologies, like unconventional oil and gas production, introduce new demands for water resources with implications for both quantity and quality in regional water systems. At times of scarcity, in terms of quantity and/or quality, re-evaluation of distribution may be required taking into account tradeoffs and opportunity costs. The discipline of economics is fundamentally concerned with how best to distribute scarce resources across unlimited wants. This approach generally implies allocation of water to its highest value use. However, because of "non-market" nature of water resources, determination of the value in a quantitative sense is difficult and often requires interdisciplinary approach. This talk will highlight some of the water resource challenges in this region, emphasizing interdependencies between natural and human systems, and will review basic economic principles involved in water resource management.

Poster Session Titles

Development of a cost-effective and energy efficient iron-dosed anaerobic wastewater treatment system. Musfique Ahmed and Lian-Shin Lin, West Virginia University.

Effects of Opioid Abuse Potentially Mediated by Epigenetic Histone Modifications. Tanner Bakhshi, Ramin Garmany , Diane Dawley, James Kessler , Will O'Toole, Daniel Crow, Taylor Beatty, Richard Egleton and Philippe T. Georgel, Marshall University.

Where is all the Water From? Spring Water Quality and Quantity along Peter's Mountain in Monroe County, WV. Emily A. Bausher and Dorothy J. Vesper, West Virginia University.

Effects of acid mine drainage on downstream water quality. Karen Buzby and Lian-Shin Lin, West Virginia University.

Utilizing a water balance model approach in assessment of forest response to drought conditions. Brittany Casey, Brenden McNeil, Edward Brzostek, Nanette Raczka, Nicolas Zegre and Luis Guillen, West Virginia University.

Beef Cattle Effluent Treatment in a Denitrifying Bioreactor. Bethani Chambers, Louis McDonald and Tom Basden, West Virginia University.

Effects of Imidacloprid Treatment of Hemlocks on Aquatic Ecosystems: Is the cure worse than the disease? Sara Crayton, West Virginia University.

Stream sediment microbial community function is sensitive to alterations in water chemistry associated with watershed land use. Chansotheary Dang, Gregory Martin, Jason A. Hubbart, Elliot Kellner, Charlene Kelly, Kristen Stephan, Rene Miller, Zachary Freedman and Ember Morrissey, West Virginia University.

An innovative continuous sulfidogenic wastewater treatment with iron sulfide sludge oxidation and recycle. Dongyang Deng, North Carolina A&T State University; and Lian-Shin Lin, West Virginia University.

Appalachian Sandstone Springs. Autumn R. Downey and Dorothy J. Vesper, West Virginia University.

Modeling Flood Plain Inundation Along Upland Streams Using Lidar-Derived Elevation Data and a Two-Dimensional Grid Cell Hydrodynamic Model. Robert N. Eli and Paul J. Kinder, West Virginia University.

Effects of Unconventional Oil and Gas Production on Water Chemistry and Fish Community Structure. Kevin Eliason and Josh Ankeny (primary authors), Eric Merriam and J. Todd Petty, West Virginia University.

Projected changes in atmospheric water supply and demand across the Appalachian Region during the 21st century. Rodrigo Fernandez and Nicolas Zegre, West Virginia University.

Coal Run Stream Rehabilitation Project. Mark Flood, Makayla Metzger, Chhoksum Bista, Stephanie Slaubaugh, Mike Bragg, Fairmont State University.

Impact of Coal Mining and Low-Level Urbanization on Stream Microbial Communities in Southern WV. Thomas Ford, Christopher Richards, Mason Stuter and Dustin Spivey, Concord University.

Growing Season Responds to Humidity in Temperate Forests: Implications for Long- Term Evapotranspiration. Brandi Gaertner, Nicolas Zegre and Rodrigo Fernandez, West Virginia University.

Evaluating the stability of headwater reference catchments from long-term paired watershed studies: An eastern perspective. Luis Andres Guillen, Nicolas Zegre and Rodrigo Fernandez, West Virginia University.

Habitat Suitability of Restored Wetlands for Turtles in West Virginia. Alissa Gulette, James T. Anderson, Joseph Hatton and Donald J. Brown, West Virginia University.

White Park: Oil and Mounds in Morgantown, WV. Vaike Haas, West Virginia University.

Channeling Rosgen in coursework: Outcomes of introducing Dave Rosgen's stream restoration principles to undergraduate landscape architect students of LARC 360: Natural Systems Design. Vaike Haas, West Virginia University.

Experimental Watershed Study Designs: A Tool for Advancing Process Understanding and Management of Mixed-Land-Use Watersheds. Jason A. Hubbart and Elliott Kellner, West Virginia University.

Characterization of Sub-Watershed-Scale Stream Chemistry Regimes in an Appalachian Mixed-Land-Use Watershed. Elliot Kellner, Jason A. Hubbart, Evan Kutta, Kirsten Stephan, Ember Morrissey, Zach Freedman and Charlene Kelly, West Virginia University.

Forest and Agricultural Land Use Impacts on Floodplain Water Table Response to Precipitation Events. Elliot Kellner and Jason A. Hubbart, West Virginia University.

Application of UAV (Drone) imagery in aquatic physical habitat assessment. Angela Klein Hentz, Jason A. Hubbart, Elliot Kellner and Paul Kinder, West Virginia University.

Is the Global Redistribution of Anomalous Surface Heat Fluxes Associated with ENSO Events Symmetric? Evan Kutta, Jason A. Hubbart, Anthony R. Lupo, Bohumil M. Svoma and Timothy P. Eichler, West Virginia University.

Agricultural Opportunities in Appalachia's Changing Climate: A Case Study of West Virginia. Evan Kutta and Jason A. Hubbart, West Virginia University.

Carbon Dioxide and Inorganic Carbon Flux from Coal Mine Drainage Waters in Southern Pennsylvania and Northern West Virginia. Kyle J. Lee and Dorothy J. Vesper, West Virginia University.

Influence of Dissolved Carbon and Iron on Water Color Differs between Forest and Grassland Headwater Catchments in Northern West Virginia. Lili Lei and Louis McDonald, West Virginia University.
WVU students, Water Quality Perceptions and Behaviors. Jonas Levêque and Robert Burns, West Virginia University.

Long-term fish community response to watershed scale acid remediation. Rebecca Long, Eric Merriam and J. Todd Petty, West Virginia University.

Stream temperature response to habitat restoration in a large Appalachian river. Eric R. Merriam and J. Todd Petty, West Virginia University.

A novel method for creating CO2 dissolved-gas standards using commercial cola bottles as acid reactors. Jonney Mitchell and Dorothy Vesper, West Virginia University.

Hydrogeologic evidence and implications of post-flooding structural failure of main entries in a coal mine. Bryant D. Mountjoy and Joseph J. Donovan, West Virginia University.

Short-term Variations in Monongahela River Water Quality. Duane G. Nichols, Upper Monongahela Area Watersheds Compact.

Quantifying Suspended Sediment of a Mixed-Land-Use Appalachian Watershed. Rivkah Nisan and Jason A. Hubbart, West Virginia University.

Adaptability of a Thermophilic Anaerobic Digester Microbiome Toward Rapid Shifts in Wastewater C/N Ratios. Vadesse Lhilhi Noundou, Emmanuel Chavarria-Palma, Natalia Montenegro-Garcia, Ifeoma R. Ugwuanyi, Teodoro Espinosa-Solares and David H. Huber, West Virginia State University.

Adsorption Studies of Activated Carbon Synthesized from Herbaceous Biomass. Oluwatosin Oginni and Kaushlendra Singh, West Virginia University.

Relationship Between E. coli and Land Use Activities in the West Run Watershed. Fritz Petersen, Jason A. Hubbart, Elliot Kellner and Evan Kutta, West Virginia University.

Origami Platform for Optical Reporting. Kathryn Pitton, David Neff, Andrea Hensley and Michael Norton, Marshall University.

Using Sustainability Indices to Measure the Impact of Resource Extraction Industries on Appalachian Watersheds. Pariya Pourmohammadi and Michael P. Strager, West Virginia University.

Plant-microbial interactions control the ability of forests to minimize water stress. Nanette Raczka and Edward Brzostek, West Virginia University.

Acid mine drainage coated sand as a soil amendment and phosphate delivery system. Alex Rubenstein, Karen Buzby, Nicole Waterland and Lian-Shin Lin, West Virginia University.

Investigating Spatial Associations Between Herbaceous Plants and Tree Species in a Central Appalachian Hardwood Forest. Lacey Smith and Kirsten Stephan, West Virginia University.

Contrasting Carbon in Soil and Vegetation of Forested Wildland and Urban Sites along an Urbanization Gradient. Kirsten Stephan, Jason A. Hubbart, Katlin Beaven and Elizabeth Spiegel, West Virginia University.

Influence of Time on Soil Health Metrics in WV Reclaimed Mine Lands. Katie D. Stutler, Eugenia M. Pena-Yewtukhiw and Jeffrey Skousen, West Virginia University.

Spatiotemporal Variability of Stream Stage in a Small Mixed-Land-Use Watershed of Appalachia. Parameshwor Takhachhe and Jason A. Hubbart, West Virginia University.

Distribution of river sediment microbial diversity reflects correlations of phylogeny and geochemistry. Ifeoma Rosemary Ugwuanyi, Sridhar Malkaram, Amir Hass, Natalia Montenegro-Garcia, Vadesse Lhilhi Noundou, E. Chavarria-Palma, A. L. Kemajou and David H. Huber, West Virginia State University.

Davis College Reedsville Restoration Research Plan. Hannah Warner and Jim Anderson, West Virginia University.

Poster Session Abstracts

Development of a cost-effective and energy efficient iron-dosed anaerobic wastewater treatment system. **Musfique Ahmed and Lian-Shin Lin, West Virginia University.**

Anaerobic wastewater treatment system has gained extreme recognition due to its energy efficiency, low sludge production and minimal use of chemicals. Building upon our previous successful studies on co-treatment of acid mine drainage and municipal wastewater, an innovative iron-dosed anaerobic wastewater treatment method was recently developed to render the abovementioned benefits. In this study, various Fe/S molar ratios were used to evaluate the effects of iron dosage on organics removal and its organics oxidation kinetics, a key design factor for large-scale applications. Specifically, two Fe/S molar ratios (0.5 and 1) with stoichiometrically equivalent electron acceptors (Fe3+ and sulfate) were examined and compared for the organics removal efficiency of a bioreactor used to continuously treat a sulfate-containing synthetic wastewater. Ratio 1 resulted in higher COD removal (89 ± 4% vs. 84 ± 3%), sulfate reduction (98 ± 2% vs 90 ± 4%) and iron retention (99 ± 0.2% vs 98 ± 0.8%) than ratio 0.5, hence overall better effluent quality. The effects of Fe/S ratio on COD removal kinetics are studied by using fed-batch bioreactors. Faster COD oxidation rates were observed with higher Fe/S ratios among the three different Fe/S ratios examined. The solid materials were quantified for their production rate and characterized for morphology and chemical composition. These results are beneficial for further developing this novel treatment technology with iron as a green agent and for evaluating the utilities of iron reducing bacteria for wastewater treatment applications.

Effects of Opioid Abuse Potentially Mediated by Epigenetic Histone Modifications. **Tanner Bakhshi, Ramin Garmany, Diane Dawley, James Kessler, Will O'Toole, Daniel Crow, Taylor Beatty, Richard Egleton and Philippe T. Georgel, Marshall University.**

The alarming rate of Neonatal Abstinence Syndrome (NAS) at Cabell Huntington Hospital, which is well above the national average, demonstrates the scale of the opioid epidemic in West Virginia. NAS refers to the withdrawal symptoms that occur in infants exposed to drugs (often opioids) in the womb. To help alleviate the symptoms of opioid withdrawal, buprenorphine is administered over a period of weeks, followed by progressive weaning off of the drug. The administration of buprenorphine coincides with many aspects of neurodevelopment in the fetus, and opioid exposure has been shown to affect the development of the newborn's brain. More broadly, additional studies have demonstrated that illicit drugs, such as opioids, may be present in the local water supply due to inadequate filtration of wastewater. We hypothesize that opioids at a.) doses matching those found in the plasma to which neonates are exposed and b.) lower doses that may be equivalent to those found in the local water system, may lead to changes in gene expression via histone post-translational modifications (PTMs). We are currently investigating global trends in histone PTMs as a function of buprenorphine exposure (50 ng/mL) over time (0, 2, 12, 24, and 48 hours) in two model systems: rat brain microvascular endothelial cells (RBMVEC) and oligodendrocyte precursor cells (OPC). Thus far, we have observed global changes in levels of H3PanAc, H4PanAc, and H3K9me3 in RBMVEC. These and further results may provide evidence for buprenorphine's epigenetic effects, both in neonates and those who drink from the local water supply.

Where is all the Water From? Spring Water Quality and Quantity along Peter's Mountain in Monroe County, WV. **Emily A. Bausher and Dorothy J. Vesper, West Virginia University.**

Monroe County, WV residents rely on private and public water supplies that flow from the folded and faulted rocks on the western side of Peter's Mountain. Determining water quality and quantity is crucial to protecting and preserving this water. Over 250 springs have been mapped in this area; 13 of those springs

and 5 stream locations are currently being continuously monitored and sampled on a regular basis. Data loggers monitor temperature, conductivity, and/or pressure depending on location. Discharge rating curves were compiled for the stream locations to estimate the total flow leaving the study area. Sample analyses include temperature, conductivity, pH, major ions, total organic carbon, and indicator organisms (E. *coli* and total coliforms).

Springs flow from three geomorphic settings: (1) mountain slope springs; (2) carbonate valley springs; and, (3) thermal springs near the St. Clair thrust fault. The mountain slope springs (from shale and mixed carbonate-shale units) have variable Ca^{2+}/Mg^{2+} ratios, either consistent or significantly variable temperature responses, and low discharge and specific conductance. Valley springs have higher indicator organism counts and two chemical signatures: temperature variable limestone springs (Ca^{2+}/Mg^{2+} ratios >1) and temperature-consistent dolomite springs (Ca^{2+}/Mg^{2+} ratios ~1). Thermal springs have warmer temperatures, high conductivity and elevated SO_4, B and Li concentrations.

Total discharge ranges from 1-15 m^3/s; one stream accounts for approximately 40% of the total flow. Surface waters have higher indicator organism concentrations than the springs. Higher concentrations of B and Li concentrations indicate potential deep thermal input in select surface waters.

Effects of acid mine drainage on downstream water quality. **Karen Buzby and Lian-Shin Lin, West Virginia University.**

This study examined water quality parameters associated with acid mine drainage (pH, specific conductance, iron, aluminum, and sulfate concentrations) at a site in the lower reaches of the West Run watershed in an effort to understand the magnitude and variability in those parameters. Although much of the acid mine drainage occurs in the upper reaches of the watershed, the lower reaches may also be affected. The pH (range 4.8 to 7.8) was generally circum-neutral but occasionally dropped below 5.0. Specific conductance averaged 772 µS/cm with a range of 420 to 1307 µS/cm. Total iron concentrations remained low (< 0.6 mg/L) through the summer but increased to an average of 2.72 mg/L between November and June. During this period, the dissolved iron concentration remained less than 0.24 mg/L indicating that almost all of the iron were particulates rather than in the dissolved phase. Aluminum also increased from low concentrations during the summer to an average of 3.71 mg/L with most in the particulate phase during the winter. Sulfate concentrations averaged 310 mg/L with a range from 127 to 662. There was no apparent seasonal pattern in sulfate concentration. This study has demonstrated that in the lower part of the watershed, far from the AMD sources, some parameters associated with acid mine drainage, particularly iron and aluminum concentrations can be highly variable, while others such as pH, specific conductance and sulfate concentration were more consistent.

Utilizing a water balance model approach in assessment of forest response to drought conditions. **Brittany Casey, Brenden McNeil, Edward Brzostek, Nanette Raczka, Nicolas Zegre and Luis Guillen, West Virginia University.**

The possibility of increased severity and frequency of drought conditions, as a result of global climate variability, greatly complicates our ability to forecast future forest functions such as productivity and carbon sequestration. Throughfall exclusion (TfE) experiments are potentially useful tools to simulate realistic drought conditions within intact forest ecosystems, but the inherent large size and siting of these experiments creates potentially large uncertainties in the experimental design. Water balance models account for factors of both supply and demand by incorporating climatic, topographic, and edaphic data, and thus can be useful to reconcile the relative effects of reducing water supply via TfE against inherent geographic differences in site water demand. We used a GIS water balance model to assess the relative degree to which topographic site differences in solar radiation potentially affect a 50 percent TfE experiment conducted during the 2016 growing season within the Elizabeth Woods Nature Preserve near

Morgantown, WV. Model outputs reveal that the control (no TfE) plots had less sunlight, which resulted in an average of 12-17% lower water demand relative to the experimental plots. This result agrees well with measured soil moisture data, and appears to reinforce the TfE in reducing relative water availability at the experimental plots. Our future work will seek to replicate this result using more detailed radiation data in 2017, as well as address uncertainties related to vegetation structural effects on the forest microclimate, tree species differences in water use, edaphic variation in soil moisture storage, and uneven groundwater flow affecting soil moisture supply. Collectively, constraining these uncertainties can advance understanding gained from experimental forest drought studies, and thereby improve their utility in forecasting forest functioning under the drought conditions that may come with global change.

Beef Cattle Effluent Treatment in a Denitrifying Bioreactor. **Bethani Chambers, Louis McDonald and Tom Basden, West Virginia University.**

Excess nutrient runoff, nitrates and phosphates, has led to the development of algal blooms and associated hypoxic zones that have degraded aquatic ecosystems such as the Chesapeake Bay and other such watersheds. Based on a report from the Chesapeake Bay Foundation, nearly half all nutrient sources come from agricultural production with a quarter coming solely from animal manures. The purpose of this project is to determine if a novel adaption of a denitrifying bioreactor, which has demonstrated removals of agricultural nutrients, will have implications on the removal and treatment of manure nutrients. These subsurface bioreactors work by providing a substrate, usually as woodchips, which acts as a carbon source to support denitrifying bacteria which in turn systematically convert nitrate to nitrogen gas via microbial denitrification. Furthermore, in recent years biochar products have shown some effect on the leaching of soil nutrients and may aid in the capturing of nutrients in these bioreactors. For our study, a hardwood mix was chosen as the carbon substrate with five treatments of biochar additions at 0, 1.0, 2.5, 5.0, and 10% by weight. Treatments were incubated in a slurry for 72 hours under anaerobic conditions. After, samples were collected at times 0, 1, 4, 8, 12, 16, and 24 hours. These samples were then evaluated for total kjeldahl nitrogen, nitrate, pH, and EC. The expected results from this project will help with development and implementation of this new practice onto operations within the Mid- Atlantic region.

Effects of Imidacloprid Treatment of Hemlocks on Aquatic Ecosystems: Is the cure worse than the disease? **Sara Crayton, West Virginia University.**

The insecticide imidacloprid is widely used to prevent infestations of the invasive Hemlock Woolly Adelgid (HWA) but scientific evidence is beginning to suggest that imidacloprid has a negative impact on stream resources. Studies have demonstrated that imidacloprid negatively impacts macroinvertebrate assemblages and some amphibian species, although no studies have yet assessed the effects of imidacloprid on stream salamanders. We used high-performance liquid chromatography (HPLC) to measure the concentrations of imidacloprid in stream water samples. We quantified salamander and benthic macroinvertebrate abundance and diversity at 12 streams treated with imidacloprid and 12 control streams in the New River Gorge area of West Virginia. Benthic invertebrates were sampled with D-nets and identified to genus or species. Using standard sampling protocols, salamanders were captured within pools and riffles by flipping cover objects and searching through leaf litter. Salamanders were identified, weighed, and measured to quantify body condition and toe clipped to identify recaptured individuals. We used a YSI meter to measure several water quality metrics such as pH and conductivity. We also measured several habitat metrics such as number of cover objects, stream width and depth, canopy cover, and percent leaf litter cover. Statistical analyses will be performed that quantify the explanatory power of treatment intensity on salamander and macroinvertebrate abundance and diversity, and salamander body condition. Environmental factors will be included in analyses as covariates.

Stream sediment microbial community function is sensitive to alterations in water chemistry associated with watershed land use. **Chansotheary Dang, Gregory Martin, Jason A. Hubbart, Elliot Kellner, Charlene Kelly, Kristen Stephan, Rene Miller, Zachary Freedman and Ember Morrissey, West Virginia University.**

Urbanization and agricultural intensification can transform landscapes. Changes in land-use can lead to increases in storm runoff and nutrient loading which can impair the health/function of stream ecosystems. Microorganisms are an integral component of stream ecosystems. Due to the sensitivity of microorganisms to environmental perturbations, changes in hydrology and water chemistry may alter microbial activity and community composition. These shifts in microbial community dynamics may, in turn, impact higher trophic level organisms via their role in determining stream metabolism and water quality. This study examines the effects of land-used and associated changes in water chemistry on sediment microbial communities. This research was conducted in the West Run Watershed (WRW), a tributary of the Upper Monongahela River in West Virginia. The mixed-land-use of the WRW makes this an ideal system to study anthropogenic impacts. To quantify microbial activity and community composition, stream bank sediments were sampled biweekly (May-September 2017) at six sites representing different land-use in WRW. Overall, anaerobic respiration accounted for 20% of total respiration. Aerobic respiration was highest in the urban impacted streams and lowest in streams with agricultural runoff. Microbial respiration was positively correlated with micronutrients and conductivity, while bacterial abundance was negatively correlated with several micronutrients, dissolved oxygen, and conductivity. Despite differences in community respiration, microbial biomass was similar across sites, suggesting differences in the active stream bank microbiome. These results suggest that microbial function is influenced by land used/cover and consequently that microbial communities may provide insight into the impacts of land use on stream health.

An innovative continuous sulfidogenic wastewater treatment with iron sulfide sludge oxidation and recycle. **Dongyang Deng, North Carolina A&T State University; and Lian-Shin Lin, West Virginia University.**

This study evaluated the technical feasibility of packed-bed sulfidogenic bioreactors dosed with ferrous chloride for continuous wastewater treatment over a 450-day period. In phase I, the bioreactors were operated under different combinations of carbon, iron, and sulfate mass loads without sludge recycling to identify optimal treatment conditions. A COD/sulfate mass ratio of 2 and a Fe/S molar ratio of 1 yielded the best treatment performance with COD oxidation rate of 786 ± 82 mg/(L·d), which resulted in 84 ± 9% COD removal, 94 ± 6% sulfate reduction, and good iron retention (99 ± 1%) under favorable pH conditions (6.2-7.0). In phase II, the bioreactors were operated under this chemical load combination over a 62-day period, during which 7 events of sludge collection, oxidation, and recycling were performed. The collected sludge materials contained both inorganic and organic matter with FeS and FeS_2 as the main inorganic constituents. In each event, the sludge materials were oxidized in an oxidizing basin before recycling to mix with the wastewater influent. This process exhibited treatment stability with reasonable variations, and relatively consistent sludge content over long periods of operation under a range of COD/sulfate and Fe/S ratios without sludge recycling. The bioreactors were found to absorb recycling-induced changes efficiently without causing elevated suspended solids in the effluents.

Appalachian Sandstone Springs. **Autum R Downey and Dorothy J Vesper, West Virginia University.**

Research on the hydrogeology of the Appalachian Valley and Ridge province has focused on carbonate aquifers while groundwater within clastic rock units has been generally overlooked. Although springs sourced from shale and sandstone rock units (“sandstone springs”) tend to be small and

ephemeral, they play an essential role in creating headwater streams, recharging the carbonate aquifers, sustaining regional base flows, and providing habitats for flora and fauna. Sandstone springs are often located on ridgelines within synclinal or anticlinal structures and discharge water from fractured clastic bedrock or at a sandstone-shale contact.

Eight springs in central PA and northern WV were sampled and monitored for temperature fluctuations. Chemical analyses include pH, temperature, specific conductivity (SC), major ions, alkalinity, and bacterial contamination indicators (E. coli and total coliforms). Temperature data recorded using Onset Hobo® data loggers between April 2017 and October 2017 show a variety of results. Spring temperatures range from 9°C to 19°C. Some springs are closely tied to storm events and others are not. In contrast to karst springs, sandstone springs flow from a mostly insoluble matrix resulting in water with lower pH (4.3-6), alkalinity (0-0.3 meq/L), and SC (13-83 µS/cm). Ca concentrations range from 1.6-3.9 mg/L with an average Ca/Mg molar ratio of 1.4; the Ca/Mg ratio of meteoric water within the area is approximately 4.0, suggesting that cation exchange is important along the flowpath. More extensive data collection is planned in order to better understand how these clastic aquifers contribute to the overall water resources in Appalachia.

Effects of Unconventional Oil and Gas Production on Water Chemistry and Fish Community Structure. **Kevin Eliason and Josh Ankeny (primary authors), Eric Merriam and J. Todd Petty, West Virginia University.**

We assessed the effects of unconventional oil and gas (UOG) development on headwater stream chemistry and fish communities within the Monongahela River watershed, WV. We sampled water chemistry at 53 study sites differing with respect to their individual and combined influence from UOG, conventional oil and gas (COG), coal mining, and residential development. We identified 10 sites with pre-UOG disturbance fish assemblage data from which we conducted post-UOG disturbance sampling to assess community response using a before-after-control-impact-assessment framework. Principal components analysis identified 3 dominant (~60% cumulative variance explained) dimensions of variation in water chemistry. Principal component (PC) 1 (~35% variance explained) was associated with dominant ions (Ca, Mg, K, Na, and SO_4^{-2}), as well as Sr and Br. Multiple regression analysis suggested increasing PC 1 scores were significantly associated with UOG and COG well densities (no./km^2), with UOG having the strongest effect. We did not detect any significant change in fish community structure following UOG development. Our results suggest UOG development is having a significant effect on water chemistry in receiving headwater systems. Additional sampling is needed to improve our ability to detect changes on fish community structure, as well as consider potential combined effects of UOG and pre-existing land use stressors.

Modeling Flood Plain Inundation Along Upland Streams Using Lidar-Derived Elevation Data and a Two-Dimensional Grid Cell Hydrodynamic Model. **Robert N. Eli and Paul J. Kinder, West Virginia University.**

Two-dimensional (2-D) modeling of flood plain inundation has become practical in part due to increasing availability of high resolution Lidar-derived surface elevation data. As a result, there has been an increase in 2-D model development in the literature that can produce time dependent maps of the unsteady propagation of flood waves in rivers and the inundation of flood plains. De Almeida, Bates, Freer, and Souvignet (2012)* demonstrated the successful application of a simplified "local inertial formulation" of the shallow water equations (which are derived from the laws of conservation of mass and momentum) to flood wave propagation and flood plain inundations along a large lowland river, using a square grid of computational cells. Their application was characterized by low flow velocities and small

slopes. The local inertial formulation starts to lose accuracy when the stream Froude Number F_r exceeds a value of 0.5 (F_r is the ratio of average flow velocity divided by the surface disturbance wave speed $\sqrt{gd}$, where g=acceleration of gravity and d=depth of flow). Upland rivers and streams commonly experience $F_r > 0.5$, and can even exceed a value of 1.0 where the flow becomes supercritical at points of localized steep slope (e.g. rapids and waterfalls). The local inertial formulation breaks down in these latter cases due to its simplification of the momentum equation that eliminates terms accounting for the flux of momentum. We restore these terms to the momentum equation, but retain the simplicity of the "semi-implicit" finite difference method used by De Almeida, et al. Verification tests against exact analytical solutions of wave propagation on initially dry surfaces and against standard cases of supercritical flow transitions show excellent agreement. We also present examples of flood wave propagation down small upland streams.
*(Water Resources Research, Vol. 48, W05528,2012)

Projected changes in atmospheric water supply and demand across the Appalachian Region during the 21st century. **Rodrigo Fernandez and Nicolas Zegre, West Virginia University.**

For this study, we analyze changes in climatic variables across the Appalachian Region. We use downscaled GCM outputs of precipitation, solar radiation, temperature, humidity, and wind to calculate atmospheric water supply and demand for a historic period (1950-2005) and 21st century projections. Water demand is calculated using the Penman-Monteith model with the downscaled data. We investigate changes in their relation or aridity index (AI=EP/P) to spatially determine places becoming wetter or drier. Moreover, we explore how their changes are distributed throughout the year, i.e. changes in the seasonality for P and widening of the intra-annual cycle of EP. The states of New York, Pennsylvania, Ohio, Virginia, and inland North and South Carolina and Alabama are likely to become wetter, with West Virginia having mixed results. Most of the changes in P are projected to take place during winter in Ohio and New York, whereas they are likely to happen in summer south of Ohio and Pennsylvania. These results highlight areas where water availability will change given projected changes in atmospheric water supply and demand across the Appalachian region. These changes can have important implications to water resources. Changes of precipitation that occur during summer are likely to be partitioned towards evapotranspiration whereas changes in winter are likely to be absorbed by land surface components of storage and runoff. Furthermore, widening of the intra-annual cycle of EP means that there will be water demand for a longer part of the year (earlier in spring and later in autumn).

Coal Run Stream Rehabilitation Project. **Mark Flood, Makayla Metzger, Chhoksum Bista, Stephanie Slaubaugh, Mike Bragg, Fairmont State University.**

Many sources such as streets, construction sites, institutions and hospital facilities, parking lots and houses are contributors to stormwater runoff which may enter streams directly or through built channel systems. Pollutants such as human and animal wastes, coliform, grease or oil and other unwanted chemicals could result in contamination of streams. Like in the majority of any urbanized areas, Coal Run stream pollution in Fairmont was not an unforeseen circumstance. This research focuses on collecting biological and chemical data from 12 different sites to help understand the water quality and find ways to rehabilitate the stream health in collaboration with the city of Fairmont. Biological data included coliform testing, assessment of benthic macroinvertebrates using the FBI index and *Daphnia magna* viability testing to help understand if the water quality is feasible enough for organisms to reproduce and survive. Chemical data including pH, dissolved oxygen, temperature and total dissolved solids were collected. Although data collection and analyses for Coal Run stream is in its nascent stages, stream health is not as poor as originally expected. None of the chemical parameters measured varied significantly between sites within each day that data was collected, but there was significant variability between different collection

days. The most challenging finding to rehabilitate will be the high levels of fecal coliforms in Coal Run stream. The preliminary data still gives us insight into the need of rehabilitating stream health and possibly finding solutions to proper stormwater drainage management.

Impact of Coal Mining and Low-Level Urbanization on Stream Microbial Communities in Southern WV. **Thomas Ford, Christopher Richards, Mason Stuter and Dustin Spivey, Concord University.**

In two different projects, we examined the effect of coal mining and low levels of urbanization on bacterial and fungal communities in headwater streams in southern WV. Terminal restriction fragment length polymorphism (t-RFLP) was used to characterize microbial communities using DNA extracted from water samples and leaf packs. To examine the impact of coal mining, we extracted microbial DNA from water samples collected from unimpaired streams and streams impacted by coal mine drainage in several watersheds. The bacterial and fungal taxonomic richness was lower in streams impacted by mine drainage than in unimpaired streams, although non-significantly for fungi. A significant difference in bacterial community composition was found among streams impacted by coal mining and unimpaired streams with pH and heavy metals influencing the differences in composition. Microbial communities were also examined along an urban to rural gradient in Brush Creek which initially flows through Bluefield-Princeton, WV and then through a more rural area as flow reaches the Bluestone River. Leaf packs were deployed at four different sites along the gradient and collected after 2, 4 and 6 weeks. Leaf packs were also transplanted between sites after 2 weeks. A preliminary analysis indicates that the bacterial taxonomic richness was similar among the four sites regardless of the surrounding land use with richness being highest after 4 weeks of leaf pack exposure. Further analysis is being conducted. The potential impact of the alteration of microbial communities due to stressors such coal mining and urban/residential land use on energy processing is discussed.

Growing Season Responds to Humidity in Temperate Forests: Implications for Long- Term Evapotranspiration. **Brandi Gaertner, Nicolas Zegre and Rodrigo Fernandez, West Virginia University.**

Forests are important for provisioning water but climate change has impacted growing season phenology and thus forest water cycling. Higher temperatures have resulted in greater water- holding capacity, higher evapotranspiration, and longer growing season lengths in the Central Appalachian Mountains of the eastern United States, a headwaters region that supplies drinking water to Washington DC and other population centers. Currently, the mechanism responsible for longer growing season lengths are unknown, though research has identified that temperature alone cannot explain the phenomenon. Furthermore, there is no consensus on the implications of a longer growing season on evapotranspiration and runoff. In this research, our objectives were to: 1. identify the primary drivers of lengthened growing season and 2. evaluate the influence of a lengthened growing season on increasing evapotranspiration trends. We implemented NASA MODIS and NOAA AVHRR remotely sensed NDVI data, USGS streamflow data, and 12 climate parameters from 1980-2012 in a linear mixed effect model (MEM) to evaluate both objectives. The MEM allowed the slope and intercept of the climate parameters to vary among site and year, which accounted for potential variations due to topography, climate, geography, and time. The results suggest that specific and relative humidity are the most important drivers of growing season and that growing season was at least partially responsible for variation in evapotranspiration over time. The results of this research imply that a longer growing season has the potential to increase forest water cycling and evaporative loss, which can lead to decreased water provisions to population centers.

Evaluating the stability of headwater reference catchments from long-term paired watershed studies: An eastern perspective. **Luis Andres Guillen, Nicolas Zegre and Rodrigo Fernandez, West Virginia University.**

Reference catchments are experimental watersheds in which direct anthropogenic activities have been reduced or completely eliminated over long periods of time. Reference catchments studies have greatly contributed to the advancement of hydrology science since the first half of the last century. This research looks at novel approaches to define the function of reference watersheds by combining the great amount of data available from reference catchments, and modern theoretical frameworks. Reference catchments play a critical role in experimental hydrology by providing a landscape-scale baseline of hydrologic conditions in the absence of disturbance. Reference catchments are assumed to be hydrologically stable overtime, yet climate and forest ecosystems are dynamic. This study tests the assumption of hydrologic stability of reference catchments by investigating long terms climate and hydrometric records of multiple headwater reference catchment across classic eastern US paired catchment studies of the Fernow (WV), Hubbard Brook (NH), and Coweeta (NC). A simple water and energy balance model based on the Budyko framework is used to quantify rainfall partitioning into runoff and evaporation and to quantify runoff sensitivity to changes in climate and catchment properties. Furthermore, our modeling approach is used to separate climate and land surface drivers to quantify dominant drivers of long-term change.

Habitat Suitability of Restored Wetlands for Turtles in West Virginia. **Alissa Gulette, James T. Anderson, Joseph Hatton and Donald J. Brown, West Virginia University.**

Wetlands serve as habitat for many fish and wildlife species. Substantial historical drainage of wetlands in the United States has been remediated in part by wetland restoration on agricultural lands through the Wetlands Reserve Program, operated by the Natural Resources Conservation Service. However, relatively few studies have assessed habitat suitability of restored wetlands for reptiles and amphibians. Aquatic turtles are particularly important components of semi-permanent and permanent wetland ecosystems, where they function as apex predators. In 2016 and 2017, we quantified use of restored wetlands in West Virginia by aquatic turtles, and obtained comparative data from reference wetlands on nearby agricultural lands. Our objectives were to compare habitat characteristics of restored and reference wetlands, and quantify relationships between habitat characteristics and turtle species abundance and population structure. At each wetland, we sampled turtle populations using baited hoop-nets, and we measured habitat characteristics. We collected species, sex, and size data, and recorded presence of ectoparasites from captured turtles. We measured water quality, surrounding land cover type, soil type, canopy cover, proportion of emergent plant cover, and wetland size and depth. Preliminary results show that Painted Turtle (*Chrysemys picta*) abundance decreased as percent canopy cover increased but increased as dissolved oxygen in water increased, and Eastern Snapping Turtle (*Chelydra serpentina*) abundance decreased as percent canopy cover increased. No difference in abundance of both species was found between restored and reference wetlands. The results of this study will provide managers with quantitative data on habitat characteristics that maximize suitability of restored wetlands for common aquatic turtles, which can be used to guide future wetland restoration actions.

White Park: Oil and Mounds in Morgantown, WV. **Vaike Haas, West Virginia University.**

White Park, in Morgantown WV, was used as an oil tank field from 1897-1940, but at least two of the circular mounds associated with the oil tanks appear to predate Eureka Pipeline Company land acquisitions of 1897. Historic photos show established trees remaining at the edge of the pasture when it was first converted to an oil tank field. Two open-grown, lone “wolf” white oak trees growing on mounds appear much older than 1897: the smaller of the two likely dates back to at least 1813. A photo from 1897 shows the newly built oil tanks, with the only disturbance or evidence of grading immediately atop the

mounds, and shrubs and trees growing on the sides of mounds. Furthermore, most of the circular mounds at White Park line up in a grid, which correlates with sunrise and sunset on summer and winter equinoxes. These observations raise the possibility that the mounds may be repurposed relics of Hopewell or Adena, who were historically present in the Morgantown area. This poster poses four questions for further research:

- How can 4-ft+ diameter white oaks be growing on top of mounds, if the mounds were built only 120 years ago, in 1897?
- In 1897 historic photos, doesn't established vegetation indicate mounds are older than one growing season?
- Why would an oil company arrange mounds on a grid aligned with sun patterns -- rather than compass points or topography?
- How can the complex history of this public site be addressed in park and trail planning?

Channeling Rosgen in coursework: Outcomes of introducing Dave Rosgen's stream restoration principles to undergraduate landscape architect students of LARC 360: Natural Systems Design. **Vaike Haas, West Virginia University.**

Dave Rosgen has been called "the Restoration Cowboy"; some states require his Wildland Hydrology short courses for bidding on stream restoration projects. However, through six weeks Rosgen training (among 150+ students), I encountered only one other landscape architect and two other educators. As water becomes an increasingly precious resource, strategies to elevate groundwater and improve urban stormwater management will become ever more important tools in the landscape architect's arsenal. This poster details the outcomes of introducing Rosgen's techniques and restoration principles to third-year landscape architecture students of LARC 360: *Natural Systems Design*.

Students in LARC 360 first learned stream survey skills collecting data (longitudinal profile, cross sections, sketch map) from the impaired urban stream of Popenoe Run at Krepp's Park. Students built technical proficiency using a self-leveling rotary laser and two automatic levels (also known as Dumpy or builder's levels). At Blackwater Falls State Park, students surveyed a reference reach to use as a restoration target. They applied Rosgen's classification system to interpret pattern variables, including: stream slope, sinuosity, width/depth ratio, and pool-to-pool spacing, and compared the reference reach to an impaired intermittent stream at Core Arboretum. They assessed stream bank erosion hazards and quantified stream bank erosion. Their stream restoration plans will contribute to a larger master planning effort for Core Arboretum.

Students generally commended the efficacy of field learning in their evaluations of the course. In addition to summarizing outcomes of the semester, I detail some of the challenges I encountered while introducing undergraduates to Rosgen's field techniques.

Experimental Watershed Study Designs: A Tool for Advancing Process Understanding and Management of Mixed-Land-Use Watersheds. **Jason A. Hubbart and Elliott Kellner, West Virginia University.**

Advancements in watershed management are both a major challenge, and urgent need of this century. The experimental watershed study (EWS) approach provides critical baseline and long-term information that can improve decision-making, and reduce misallocation of mitigation investments. Historically, the EWS approach was used in wildland watersheds to quantitatively characterize basic landscape alterations (e.g. forest harvest, road building). However, in recent years, EWS is being repurposed in contemporary multiple-land-use watersheds comprising a mosaic of land use practices such as urbanizing centers, industry, agriculture, and rural development. The EWS method provides scalable and transferrable results that address the uncertainties of development, while providing a scientific basis for total maximum daily

load (TMDL) targets in increasing numbers of Clean Water Act 303(d) listed waters. Collaborative adaptive management (CAM) programs, designed to consider the needs of many stakeholders, can also benefit from EWS-generated information, which can be used for best decision making, and serve as a guidance tool throughout the CAM program duration. Of similar importance, long-term EWS monitoring programs create a model system to show stakeholders how investing in rigorous scientific research initiatives improves decision-making, thereby increasing management efficiencies through more focused investments. The evolution from classic wildland EWS designs to contemporary EWS designs in multiple-land-use watersheds will be presented while illustrating how such an approach can encourage innovation, cooperation, and trust among watershed stakeholders working to reach the common goal of improving and sustaining hydrologic regimes and water quality.

Characterization of Sub-Watershed-Scale Stream Chemistry Regimes in an Appalachian Mixed-Land-Use Watershed. **Elliot Kellner, Jason A. Hubbart, Evan Kutta, Kirsten Stephan, Ember Morrissey, Zach Freedman and Charlene Kelly, West Virginia University.**

In order to improve management of water resources and aquatic ecosystems, methodological approaches are needed for detailed characterization of water quality regimes of low order streams. Therefore, an exploratory study was conducted in an urbanizing, mixed-land-use Appalachian watershed. Six study sites, characterized by contrasting land use/land cover, were instrumented to continuously monitor stream stage. Weekly grab samples were collected from each site and analyzed in a laboratory for elemental composition via spectrometric and spectrophotometric methods. Additional physico-chemical parameters were measured in situ at the time of sampling. Data were analyzed using a suite of statistical methods, including hypothesis testing, correlation analysis, and Principle Components Analysis (PCA). Significant differences ($p < 0.05$) between study sites were identified for every measured parameter except Cu concentration. However, different parameters showed significant differences ($p < 0.05$) for different site pairings. PCA results highlight consistent spatial differences between elemental composition and physico-chemical characteristics of streamwater samples. Correlation testing results indicate varying significant ($p< 0.05$) relationships between chemical characteristics and hydroclimate metrics, with certain elements (e.g. Ca, Sr) and physico-chemical parameters (e.g. specific conductance) displaying greater sensitivity to hydroclimate metrics at sites #1, #2, and #6, as compared to sites #3, #4, and #5. Given the geological, topographical, and climatological similarities between the sites, and their close proximity, it is reasonable to conclude that land use characteristics and associated hydrologic regime contrasts are the primary factors contributing to the observed results. Results comprise valuable information for land and water managers seeking to mitigate the impacts of land use practices on water resources and aquatic ecosystem health. The applied methodology can be used to more effectively target sub-watershed-scale remediation/restoration efforts within the watershed, thereby improving the ultimate efficacy of management practices. Furthermore, the applied methodology is globally transferrable, and applicable to a wide spectrum of anthropogenically-impacted watersheds.

Forest and Agricultural Land Use Impacts on Floodplain Water Table Response to Precipitation Events. **Elliot Kellner and Jason A. Hubbart, West Virginia University.**

To advance quantitative understanding of floodplain hydrological processes, two floodplain sites were instrumented with continuous, automated, in situ shallow groundwater monitoring using a gridded sampling design to facilitate spatiotemporal analysis of water table response to precipitation events. Data were collected at 30 minute intervals for the duration of the 2011, 2012, 2013, and 2014 water years in a bottomland hardwood forest and historic agricultural floodplain. A total of 403 precipitation events were observed. Results show significantly ($p < 0.001$) greater median water table response at the agricultural site (0.02 m), relative to the forest (0.01 m). The ratio of water table response magnitude to precipitation

depth was 8.3 and 3.3 at the agricultural and forest sites, respectively, a difference of more than 150%. Median shallow groundwater level lag time was shorter with respect to both precipitation and streamflow at the agricultural site (10 and 2 hrs. for precipitation and flow, respectively), relative to the forest (11.5 and 4.5 hrs. for precipitation and flow, respectively), thus indicating slower water table response and increased flood attenuation capacity by the forest site. Conversely, results show the agricultural site water table displayed greater response magnitude, responded to a greater number of precipitation events (including smaller events), and responded more quickly to precipitation than the forest, reflecting reduced relative flood attenuation capacity. Observed differences highlight the various impacts of forest vegetation on water table dynamics and emphasize the benefit of floodplain forests as a water resource management tool, including flood mitigation, in contemporary mixed-land-use watersheds.

Application of UAV (Drone) imagery in aquatic physical habitat assessment. **Angela Klein Hentz, Jason A. Hubbart, Elliot Kellner and Paul Kinder, West Virginia University.**

Effective evaluation of in-stream and riparian ecological impairments, stemming from anthropogenic activities on the landscape, is critical for decision making in planning for the conservation and restoration of these resources. *Rapid* Physical Habitat Assessment (rPHA) is a well proven method for data collection and analyses that reveal causal patterns in aquatic/riparian habitat degradation and provides a powerful tool for targeting sites for conservation and restoration. However, despite its advantages, rPHA is still costly; it is highly labor intensive and often limited by restriction on access. An alternative to relying entirely on rPHA field observation is to incorporate remotely sensed data and geographic analyses. However, traditional remote sensing methods can be equally, if not more, expensive and often cannot provide adequate temporal and spatial resolutions to support rPHA. Drone-based remote sensing technologies hold promise for less costly data capture with temporal, spatial, and spectral resolutions to support rPHA measurements. Our objective is to evaluate data accuracies of drone-based measurement in comparison to rPHA field observation. For this purpose, we selected Ruby Run on the WVU Ruby Farm in Reedsville, WV as an experimental site. We performed rPHA data collection on 60 stream cross-sections and simultaneously flew drone sorties over the study area to capture images with a consumer grade DJI Phantom 4 Professional drone and RGB camera. The UAV imagery was processed to obtain an orthomosaic, DSM, and 3D point cloud. Products derived from these remotely sensed data were used to generate cross-sectional data to be compared statistically to rPHA field measurements.

Is the Global Redistribution of Anomalous Surface Heat Fluxes Associated with ENSO Events Symmetric? **Evan Kutta, Jason A. Hubbart, Anthony R. Lupo, Bohumil M. Svoma and Timothy P. Eichler, West Virginia University.**

The unequal latitudinal distribution of incoming solar radiation forces the general circulation of Earth's atmosphere, which is modified by the El Niño-Southern Oscillation (ENSO). ENSO represents the dominant mode of global inter-annual climate variability, which is known to influence the North Atlantic Oscillation (NAO) and Pacific North American (PNA) patterns of intra-annual climate variability. However, the linearity of the interrelationship between ENSO, NAO, and PNA patterns is not fully understood, particularly for ENSO events of variable magnitude. To advance understanding of the interrelationship between ENSO, NAO, and PNA patterns ERA-Interim reanalysis output (1979-2016) was used to quantify symmetric and asymmetric components of anomalous fluxes of latent and sensible heat. Results suggested a quasi-direct interrelationship between ENSO, NAO, and PNA patterns of climate variability, but substantial intra-seasonal variability existed indicating traditional seasonal analyses may be of insufficient temporal resolution. A direct relationship between ENSO and NAO (PNA) patterns was found during November (January) and ENSO event magnitude influenced the position and duration of the relationship. Symmetric and asymmetric components of both latent and

sensible heat flux were of similar magnitude indicating the atmospheric response to El Niño and La Niña events is not equal and opposite. Additionally, the asymmetric component indicated positional shifts in anomalous circulations associated with NAO and PNA patterns indicating climatologically relevant implications for North America and Europe. Therefore, this work provides insight regarding the linearity of the spatial redistribution of excess tropical heat during ENSO events of variable magnitude.

Agricultural Opportunities in Appalachia's Changing Climate: A Case Study of West Virginia. **Evan Kutta and Jason A. Hubbart, West Virginia University.**

Increasing variability in temperature and precipitation patterns are reducing the security of natural resources including food, water, and energy in many locations globally. These climatic changes are particularly relevant to the agricultural sector, particularly given increasing demand for food, less predictable water supplies, and more expensive energy. Among these challenges however, opportunities may be emerging in previously less productive areas such as West Virginia with implications for the entire Appalachian region often typified by food deserts. The current work was undertaken to identify potential for such opportunities in the Appalachian region. To focus the current work, observed datasets of daily maximum temperature, minimum temperature, and precipitation for 18 individual observation sites in West Virginia dating back to at least 1930 were used. Daily data were averaged annually and spatially (all 18 sites) and the Mann-Kendall trend test were used to assess statistically significant (α = 0.05) trends in temperature and precipitation. Maximum temperatures were shown to decrease significantly over the entire period of record (1900-2016), minimum temperatures were found to increase during all three periods of record, and precipitation was found to increase significantly over the second half (1959-2016). Observed climate trends indicate that West Virginia may be becoming wetter and more temperate and thus potentially more supportive of a broader range of crops and a longer and more productive growing season. Therefore, this work suggests the food desert crisis impacting the Appalachian region could be alleviated by restoring the regions' agricultural sector, which could simultaneously improve human health and socioeconomic well-being.

Carbon Dioxide and Inorganic Carbon Flux from Coal Mine Drainage Waters in Southern Pennsylvania and Northern West Virginia. **Kyle J. Lee and Dorothy J. Vesper, West Virginia University.**

Acid mine drainage from coal mines, both active and abandoned, is a major issue worldwide and particularly prevalent within the Appalachian Region. The presence of carbonate units within or adjacent to coal seams can result in the release of geologically-bound carbon to these waters as dissolved inorganic carbon (DIC) in the form of CO_2 and HCO_3-. The object of this study is to determine the flux of CO_2 and DIC spatially and temporally and the trends in the associated chemical data. Data were gathered from four coal mine sites in West Virginia and Pennsylvania. These sites were selected to provide a diverse range of pH values and CO_2 concentrations. DIC and CO_2 are measured on an Anton Paar CarboQC carbonation meter (Vesper and Edenborn, 2012, 2015). Anion concentrations are determined via ion chromatography (IC). Major element concentrations are determined using inductively coupled plasma optical emission spectroscopy (ICP-OES). These data are supported by in situ pH, temperature, and specific conductivity (SC) data collected using a YSI Pro multimeter. Preliminary data documents pH's ranging from 2.8 to 6.5, discharges from 0.22 to 5.7 L/s, and CO_2 concentrations from <0.05 mmol-C/L to 6.5 mmol-C/L. The maximum CO_2 flux measured was 84-kg-C/d and maximum DIC flux was 293 kg-C/d. Those values were measured at the Wingfield Pines green space in Allegheny County, Pennsylvania. These ranges of values are comparable to other values reported for mine sites in the region (Vesper et al., 2016).

Influence of Dissolved Carbon and Iron on Water Color Differs between Forest and Grassland Headwater Catchments in Northern West Virginia. **Lili Lei and Louis McDonald, West Virginia University.**

Dissolved organic carbon (DOC) and total dissolved iron (Fe) have been observed as the main contributors to surface water brownification which deteriorate water quality. Given that the quality of DOC also influences water color by forming Fe-DOC complexations that provide additive effects and are influenced by dominant land use type within watersheds, the influence of quantity and quality of DOC on Fe and water color is poorly understood in fine-scale headwater watersheds. The aim of this study was to investigate how DOC and Fe relate water color in forest (FC) and grass pasture (GFC) headwater watersheds. Significant differences of DOC, Fe and water absorbance at 420nm (a_{420}) between FC and GFC were found ($p<0.01$). Dominant contribution was from DOC (92-72%) with a decreasing trend when Fe increased at GFC from 0.0215 to 0.085 mg/L. However, the dominant contributor depended on Fe and 0.03mg/L Fe was the break point for FC. Significant differences were found between FC and GFC and Fe on specific ultra-violet absorption at 254 nm ($SUVA_{254}$) and spectral slope ratio (S ratio). The response rate of $SUVA_{254}$ and S ratio with increasing Fe per unit was -0.0689 and -2.227 for GFC while they were -19.11 and -0.1977 for FC, respectively. These differences indicate land use can change quality of DOC, influence Fe-DOC complexations, and thus affects water color. However, more research is still needed to link Fe and DOC chemistry between headwater and associated soil to find out optimal management practice to mitigate surface water color increase.

WVU students, Water Quality Perceptions and Behaviors. **Jonas Levêque and Robert Burns, West Virginia University.**

An important goal of this study was to understand water quality perceptions among the student population at West Virginia University (WVU). This poster proposes to depict tap water quality perceptions and drinking behavior differences between the different categories of students (i.e. freshmen, sophomores, juniors, seniors and graduate students). More specifically, we sought to predict bottled water use, filter use and soda use. This was operationalized through students' perceived health risks, perceived taste, odor and color, their concern for the environment, and how likely they believed a chemical spill could occur in the near future in West Virginia. Data collection for this study took place over the Spring of 2017 between the months of April to June 2017, using an online questionnaire. The whole population of students at West Virginia University was contacted to fill the survey. A total of 26,073 students were contacted via e-mail. After accounting for online students (not eligible to participate in this study), an effective response rate of 17.5% was achieved, with a total of 4188 students completing the online survey about their water quality perceptions. There were 16% of Freshmen, 14% of Sophomore, 16% of Juniors, 20% of Seniors and 33% of graduate students. Using t-tests and logistic regressions, our findings show differences between water quality perceptions between the different types of students. Implications of these results will be discussed.

Long-term fish community response to watershed scale acid remediation. **Rebecca Long, Eric Merriam and J. Todd Petty, West Virginia University.**

We conducted a long-term (9-year) before-after-control-impact assessment of a watershed-scale acid mine drainage (AMD) remediation program implemented in 2010. Restoration was strategically designed to restore biodiversity and improve the native brook trout fishery by restoring connectivity and increasing available habitat. We used repeated measures analysis of variance to quantify and compare temporal changes in water chemistry and fish community composition (i.e., diversity, richness, and brook trout distribution) within and among treated and un-treated sites. Water chemistry (pH, alkalinity) within and downstream of treated sites improved significantly from 2008 (i.e., pre-restoration) to 2013, but remained

unchanged from 2013 to 2017. In contrast, fish diversity and richness in treated streams increased significantly from 2008 to 2013, and again in 2017. Although not significant, we also observed an increase in biodiversity across un-impacted control sites not associated with changes in water chemistry. Brook trout populations were also found to increase and spread throughout the watershed. A total of 88 brook trout were found in 5 sample locations prior to restoration. The number of sites occupied by brook trout increased to 6 in 2013 and 11 in 2017, with 131 individuals being captured in 2017. Fish communities and brook trout populations within treated sites continued to improve 7 years post-restoration as a result of strategically targeting AMD remediation to maximize network connectivity. Increased biodiversity within un-impacted control streams suggests restoration may be inflating community condition at the watershed-scale. Consequently, the full benefit of restoration within Abrams Creek may not yet be realized as fish populations continue to expand.

Stream temperature response to habitat restoration in a large Appalachian river. **Eric R. Merriam and J. Todd Petty, West Virginia University.**

We assess stream temperature response to habitat restoration efforts to improve thermal suitability and resiliency within the upper Shavers Fork, WV – a large river known to support a networked brook trout meta-population by providing supplemental foraging habitat and enabling dispersal among tributary spawning habitats. We first used paired sites and associated t-tests to determine if creation of deep pools resulted in channel unit-scale thermal refugia via increased interception of groundwater. We then used mixed effects models within a before-after-control-impact framework to determine if efforts to intercept groundwater and expedite water movement through key warming habitats altered summer (June – August) longitudinal warming patterns (mean daily temperature). Constructed pools did not significantly alter channel unit-scale thermal regimes (i.e., mean and maximum daily stream temperature), indicating minimal interception of additional groundwater. However, we did observe a significant effect of time (i.e., pre- and post-restoration) and a significant time by treatment (i.e., restored and control river sections) interaction on longitudinal warming, indicating a reduction in warming within the restored section. Thus, habitat restoration appears to have significantly altered thermal regimes within upper Shavers Fork, largely in response to efforts to expedite water movement through key warming areas. Reductions in warming will likely increase the capacity of large-river habitats to support key meta-population processes and reduce their vulnerability to climate change.

A novel method for creating CO_2 dissolved-gas standards using commercial cola bottles as acid reactors. **Jonney Mitchell and Dorothy Vesper, West Virginia University.**

In this study, a novel method was developed to create standard solutions for dissolved CO_2 in used, sealed commercial cola bottles. This method was designed to overcome problems associated with creating a dissolved gas standard. The standards are created in used and cleaned cola bottles using solutions of known dissolved inorganic carbon (DIC) concentrations made with calcium carbonate and DI water. Small hand-blown glass bulbs containing 2-4 mL of concentrated HCI are added to each bottle along with 4 steel ball bearings. The bottles are shaken, the glass bulbs break, and the acid converts the DIC into CO_2. The bottles are placed in an Anton Paar pressurized device that punctures the cap and transfers the solution without degassing to an Anton Paar CarboQC. A bypass valve redirects the excess solution into a flow-through cell where pH and temperature are measured. CO_2 was measured in triplicates for concentrations of 0.5, 0.75, 1, 4, 6, 8, 12, 14, and 16 mM DIC and the expected final DIC was calculated using the ionic strength, pH, and temperature of the DIC solution. Standards with 4-8 mM DIC had measured values close to the predicted (<10% error). Standards with less than 1 mM DIC were below the instrument detection limit (Vesper and Edenborn, 2012). Standards with > 12 mM DIC had greater error (>10%) but are higher than what is typically measured in natural water systems (Vesper et al., 2015).

Hydrogeologic evidence and implications of post-flooding structural failure of main entries in a coal mine. **Bryant D. Mountjoy and Joseph J. Donovan, West Virginia University.**

After closure, underground coal mines beneath regional drainage will eventually fill with water which must be treated before discharging to the surface. The high average hydraulic conductivity typical of coal mines results in small changes in hydraulic head across individual mines. This study examines water-level hydrographs for a coal mine near Morgantown, WV which closed in 1995. Operation of a transfer (injection) pump into this mine results in spikes in hydraulic head in the deep portion of the mine reaching heads of > 50 m higher than the shallow portion of the mine where water is withdrawn by pumping. This suggests the presence of an intramine blockage which restricts water flow within the mine. This is despite a set of 10 parallel main entries each measuring approximately 5 m wide and 2 m tall. Main entries are supported by large pillars of unmined coal and are not expected to fail. The blockage is proposed to be the result of post-flooding floor failure within the main entries. It is unlikely a roof collapse could have caused such an impermeable blockage. A probable location for the blockage was identified by analyzing mine workings using a large-scale mine map and supported with a groundwater flow model (MODFLOW). Such blockages restricting flow across closed mines are potentially problematic for water management after mine closure. Assuming water will flow freely through a mine aquifer may in some cases result in an unintended surface discharge.

Short-term Variations in Monongahela River Water Quality. **Duane G. Nichols, Upper Monongahela Area Watersheds Compact.**

The water quality of the Monongahela River is important because this river serves as the source of drinking water for hundreds of thousands of people in northern West Virginia and southwestern Pennsylvania. However, the flow rate, dissolved solids content and the pH vary substantially monthly and seasonally. These variations should be resolved in the interest of good public health conditions.

Data from the continuous monitoring stations of the USGS are available. Instantaneous sample data from other sources are also available to extend the analysis. Graphs are used to display these results. In addition to the levels of pH and specific conductivity, which indicates the dissolved solids, the content of sodium, calcium, iron, chloride, and sulfate are important.

The influence of tributaries is very significant. This includes the West Fork River and Buffalo Creek in West Virginia as well as Dunkard Creek and other streams in Pennsylvania. The influence of coal mine effluents and coal mining seepage are relevant. Generally, the public is unaware of the relative degree of dissolved solids loading in the public water supply or its variation.

Quantifying Suspended Sediment of a Mixed-Land-Use Appalachian Watershed. **Rivkah Nisan and Jason A. Hubbart, West Virginia University.**

Anthropogenic suspended sediment is one of the leading sources of nutrient pollution, freshwater ecosystem deterioration and overall water quality impairment for local watersheds. A study was conducted between October 1st and November 18th of 2017 in the West Run Watershed (WRW) located in North Central West Virginia to advance quantitative understanding of land-use suspended sediment relationships. West Run is a tributary creek located in Monongalia County, West Virginia, draining a watershed of approximately 13.7 km^2 into the Monongahela River. The WRW includes a mix of land use types including agriculture, urban, forested, and grasslands/pastures. Stream water grab samples were collected from six sampling sites, ranging from agricultural to forested land uses, every day between 1:00PM and 2:00PM for a total sample size of 294. Samples were analyzed to determine total suspended sediment (mg/l) and to examine sediment particle size using laser particle analysis (Microtrac Bluewave ™). All sites had a minimum TSS of 0.3mg/L. The average TSS from all locations (n=6) was 10.0mg/L

with a standard deviation of 20.0mg/L. Initial analysis indicated average TSS concentrations ranging from 3.6 to 20.5 mg/L between forested (site 17) and agricultural/pasture (site 13) land use types (respectively). Standard deviation percentage at site 13 was 270% being the highest variability of all sites. Further analysis will provide quantitative comparison of total suspended sediments and particle size class distribution from varying land uses types. This research will provide local land managers with information on reducing the impact of suspended sediments within Appalachian watersheds.

Adaptability of a Thermophilic Anaerobic Digester Microbiome Toward Rapid Shifts in Wastewater C/N Ratios. **Vadesse Lhilhi Noundou, Emmanuel Chavarria-Palma, Natalia Montenegro-Garcia, Ifeoma R. Ugwuanyi, Teodoro Espinosa-Solares and David H. Huber, West Virginia State University.**

High-strength organic wastewaters are routinely treated with anaerobic digestion (AD) which reduces chemical oxygen demand and environmental impact of the wastes, particularly in watersheds. AD systems are flexible toward diverse wastes but the limits of microbial community adaptation are not well understood. We tested the stability and adaptability of a microbiome in a thermophilic digester toward a unique (previously unencountered) substrate with quite different properties. Our model AD system had been adapted to a low C/N ratio substrate for several years. We challenged it with a new high C/N substrate (crude glycerol) that doubled the feedstock COD. The basal feedstock was poultry waste which has caused nutrient pollution in the Potomac River watershed. This experiment used five replicates 10-liter thermophilic (56C) bioreactors which had steady state conditions for 200 days prior to co-substrate addition. Crude glycerol was applied in three pulses to two of the reactors. Metabolism was evaluated with HACH tests and gas chromatography for fatty acids and biogas. Bacterial community structure before and after glycerol pulses was compared using Illumina sequencing of 16S rRNA gene diversity. Crude glycerol pulses caused rapid changes in total volatile acids, particularly acetate and propionate, and decreases in methane. Recovery of steady state metabolism occurred quickly following the pulses. The dominant bacterial phyla were: Bacteroidetes, Firmicutes, Proteobacteria, Thermotogae. Community structure (beta diversity) changed over time in all five reactors although the dominant species were stable. The community displayed high resilience toward rapid shifts in C/N ratio.

Adsorption Studies of Activated Carbon Synthesized from Herbaceous Biomass. **Oluwatosin Oginni and Kaushlendra Singh, West Virginia University.**

Recent studies had shown that conventional wastewater treatments are not effective in eliminating majority of the pharmaceutical active compounds. A residual quantity is found in the treated water and have been found to accumulate in drinking water. However, adsorption has become a well-established technique in removing pollutants and hence activated carbon finds an application in this area. The production of activated carbon via chemical activation is favored above physical activation due to its simplicity and good pore development of the activated carbon. The chemical activation process involves impregnation of the raw materials prior to activation. The impregnation process greatly influences the porous structure and surface chemistry of the activated carbon. Therefore, the aim of this research is to produce low cost activated carbons via two impregnation routes from herbaceous biomass feedstocks currently grown on reclaimed mine lands in West Virginia.

The activated carbons were produced by impregnating biomass and biochar samples with phosphoric acid and potassium hydroxide. The impregnated samples were activated at a temperature of 900 °C for 1 hour in an inert atmosphere. The textural properties, morphological and surface chemistry of the resulting activated carbons were characterized. The activated carbons were also used in adsorption test of pharmaceutical compounds.

The surface chemistry of the activated carbons showed a relative small amount of phosphorus which is due to the type of chemical agent (phosphoric acid) used for activation. The surface area of the activated carbons ranged between 161 to 1372.93 m^2/g and the activated carbons were found to be highly microporous in nature. The adsorption of the pharmaceutical compounds was influenced by the molecular size of the compound in comparison to the pore size of the activated carbon. Also, the hydrophobic nature of the activated carbon played a significant role in the adsorption of the compounds. Production of a low cost, highly efficient adsorbent from readily available biomass would enhance efficient removal of endocrine disrupting compounds in water that are dangerous to human health upon accumulation in human body.

Relationship Between E. coli and Land Use Activities in the West Run Watershed. **Fritz Petersen, Jason A. Hubbart, Elliot Kellner and Evan Kutta, West Virginia University.**

The relationship between land use practices and E. coli concentration in receiving water bodies is poorly understood in contemporary mixed-land use watersheds. To advance understanding, high resolution sampling regime was implemented in the West Run Watershed. Grab samples (125 mL) were collected from six monitoring sites within the watershed at daily time intervals from 10/01/17 to 11/18/2017 (n=294). Samples were analyzed using the Environmental Protection Agency certified IDEXX methodology to determine E. coli concentration at each sampling location. Site number 5, which drains a woodlot sub-catchment, had the lowest mean value ($\overline{x}$ = 118.22) and the smallest standard deviation (σ = 186.12) among the sites. Conversely, site number 4, draining a predominantly agricultural sub-catchment, had the highest mean value ($\overline{x}$ = 582.41) and highest standard deviation of (σ = 398.52) of all sites. Thus, there was a clear difference between the E. coli concentrations from different sites, likely caused by the varying land use practices. These results align with previous studies that reported natural areas are often associated with good water quality, whereas agricultural land use can have detrimental impacts on water quality. Results highlight the need to explore the extent to which land use activities can impact E. coli concentrations in water bodies. Improving scientific understanding of how land use practices influence E. coli concentration and load in waterbodies is required, thus providing impetus for ongoing investigation.

Origami Platform for Optical Reporting. **Kathryn Pitton, David Neff, Andrea Hensley and Michael Norton, Marshall University.**

DNA Origami is a powerful tool for the design and assembly of nanomaterials on platforms programmed to adopt a variety of functional shapes. Both “soft” (organic) and “hard” (inorganic) materials can be organized into patterns with close proximity and high resolution on these DNA based origami substrates. For applications in optical signal enhancement, we are using single stranded M13 bacteriophage as a scaffold and “staples”, short sequences of DNA which direct the folding of the scaffold through complementary base pairing, to generate rectangular “planks” measuring 100 nm X 32 nm. The long-term goal of this project is to generate a broadly useful testbed in which a fluorescent reporting moiety is positioned near the center of the origami and flanked by two gold nanorods for plasmonic enhancement of fluorescence. As part of this project, it was necessary to generate a robust support structure which would position the signaling moiety above the plane of the substrate and place it in the location of highest plasmon generated electric field strength. A tetrahedral structure, with edges 20 bp in length and consisting of 5 DNA strands was therefore designed, constructed and characterized using Atomic Force Microscopy (AFM). The location of the topographical feature observed in the AFM images on multiple platforms is consistent with the correct placement at the docking sites on the surface of the plank structure.

Using Sustainability Indices to Measure the Impact of Resource Extraction Industries on Appalachian Watersheds. **Pariya Pourmohammadi and Michael P. Strager, West Virginia University.**

An abundance of natural and energy resources in Appalachia makes it a unique study area to examine and apply sustainability indices. Since development expansion is a complex process influenced by various factors, decision makers are constantly striving to make efficient and environmentally friendly decisions for future land development patterns. Understanding the process of developed land expansion and its driving factors in the context of Appalachia will help decision makers and planners to consider these factors in their scenarios for the future. Identifying key factors in developed land expansion and the impact of developed lands on the land surface assets/capacities is valuable for future land development plans. The goal of this study was to investigate land change in Appalachia and determine the driving factors toward sustainability in the Appalachian region. Feature selection was used to select the most influential variables in the developed land change process, then the Land Surface Resource Impacts Indicators (LSRII) were applied to measure sustainability. These indices include impervious surface, loss of wetlands, change in crop lands, forest habitat, and density of settlements. Identifying the important influential factors which stimulate development and LSRII analysis facilitates sustainability assessment. Through this assessment, LSRII of developed lands was evaluated considering the variables in two classes of developed lands for urban and non-urban areas. This research applied the machine learning and statistics based models in feature selection of development expansion. The machine learning model applied in feature selection was Random Forest.

Plant-microbial interactions control the ability of forests to minimize water stress. **Nanette Raczka and Edward Brzostek, West Virginia University.**

Recent evidence shows distinct trait differences between trees that associate with ectomycorrhizae (ECM) and those that associate with arbuscular mycorrhizae (AM). ECM ecosystems have roots that allocate more carbon (C) to both free-living and symbiotic soil microbes, have slower soil nitrogen (N) cycling, and are associated with trees that have greater root allocation to access water under drought than those in AM ecosystems. Under drought, my hypothesis is that ECM trees maintain tightly coupled C and N cycles belowground that allow them to mitigate drought stress to a greater degree than AM trees.

To test this hypothesis, I implemented a throughfall exclusion experiment during the 2017 growing season at Elizabeth Woods, a West Virginia Land Trust property south of Morgantown, WV. There, I constructed two 20m x 20m experimental plots to remove 50% of the rainfall. One plot is dominated by ECM oak and hickory; whereas the other is dominated by AM sugar maple and tulip poplar. Each experimental plot is paired with a nearby control plot with similar species composition. During this time, I measured enzyme activity in the soil and link these to assays of plant-C investment belowground. My data suggests that ECM roots tend to stimulate complex C degradation in the rhizosphere, while AM roots downregulated enzyme activity during treatment. These results support mycorrhizal association as a dominant driver of plant-microbial interactions at Elizabeth Woods. This research will lay the foundation for a conceptual framework that can capture differences between tree species in their response to drought.

Acid mine drainage coated sand as a soil amendment and phosphate delivery system. **Alex Rubenstein, Karen Buzby, Nicole Waterland and Lian-Shin Lin, West Virginia University.**

Acid mine drainage (AMD), a water pollutant due to coal mining, is caused by exposure of sulfides to air and water from the surrounding rocks, forming sulfuric acid. Due to the highly acidic quality of the water, metals and toxic compounds are dissolved from surrounding surfaces into the stream. We developed a method to selectively extract metals from AMD and use them in coating sand particles to generate a sorbent for phosphate removal from various nutrient-laden wastes. We implemented phosphate saturated coated sand as a soil amendment to study tomato plant growth. AMD coated sand was initially

saturated with 200 mg/L phosphate solution. Testing consisted of three experimental groups: conventional sand receiving deionized water (DI), conventional sand receiving fertilizer, and phosphate saturated AMD coated sand receiving fertilizer without phosphate. Using atomic absorption spectroscopy and colorimetric methods, low concentrations of iron, aluminum, and phosphate were observed in plant leachate, or runoff, after applications of fertilizer. However, conventional sand receiving fertilizer displayed increasing concentrations of phosphate in leachate after each application. Phosphate runoff of AMD coated sand was found to have a concentration less than 0.1 mg/L after each fertilizer application, demonstrating the ability to reduce phosphate leaching into surrounding environments. As compared to conventional sand, plants grown in AMD coated sand showed slightly reduced growth, but successfully utilized phosphate from the experimental medium for growth. These results demonstrate AMD coated sand as a nutrient delivery system and soil amendment with minimal negative impact to plant growth.

Investigating Spatial Associations Between Herbaceous Plants and Tree Species in a Central Appalachian Hardwood Forest. **Lacey Smith and Kirsten Stephan, West Virginia University.**

The herbaceous layer is the most diverse, but commonly overlooked, vegetative stratum in temperate forests. While the herb layer represents less than 1% of the biomass of the forest, it can comprise 90% of the plant species of the forest and can contribute up to 20% of the foliar litter to the forest floor. Herbaceous plants are an efficient recycler of nutrients in the forest and may play an important role in forest nitrogen cycling. The objective of this study is to quantify the species richness, diversity and biomass of herbaceous plants under red and sugar maple trees typically associated with low and high soil nitrogen availability, respectively. This research will be conducted within four watersheds at the Fernow Experimental Forest near Parsons, WV. Herb layer characteristics will be assessed for watershed pairs differing in stand age (45 years versus 100 years), nitrogen deposition (fertilized versus unfertilized), and streamwater nitrate export levels (low vs moderate). In spring, early and late summer of 2018, herb composition, cover, and biomass will be assessed around nine sugar maple and red maple trees, respectively, in each watershed. We hypothesize that the herb layer characteristics will 1) differ under sugar and read maples within watersheds, 2) differ with watershed stand age, and 3) differ with watershed fertilization level. Our anticipated results will provide insights into potential relationships between overstory species ID and herb layer characteristics and provide a springboard for studying the role of the herb layer in soil nitrogen levels and streamwater nitrogen exports which is currently not understood.

Contrasting Carbon in Soil and Vegetation of Forested Wildland and Urban Sites along an Urbanization Gradient. **Kirsten Stephan, Jason A. Hubbart, Katlin Beaven and Elizabeth Spiegel, West Virginia University.**

Urban ecosystems generate up to 70% of annual greenhouse gas emissions. However, urban vegetation and soils are capable of sequestering substantial quantities of carbon (C). Soil total organic carbon (TOC), soil respiration (SR), and C stored in vegetation and multiple biophysical indices were quantified at six 50-m^2 study sites in the central United States, including a rural forest (UHF), bottomland hardwood forest (BHF) and four intra-urban sites. Soils (0-35 cm depth) at intra-urban sites contained the greatest TOC with 15.8 kg TOC m^{-2} and 22.8 kg TOC m^{-2} for an older neighborhood and parking area (PA), respectively. In contrast, the BHF contained 7.6 kg TOC m^{-2} and the UHF contained 7.11 kg TOC m^{-2}. Average growing season SR rates across sites ranged from 7.96 umol m^{-2} s^{-} at the UHF to 12.92 umol m^{-2} s^{-} at the PA site. Carbon storage in aboveground vegetation was highest at the BHF (124 t C ha^{-1}) and smallest at an urban bottomland floodplain grassland site (0.14 t C ha^{-1}). Results show that urban areas may have the potential to sequester more soil C than wildland counterparts.

Influence of Time on Soil Health Metrics in WV Reclaimed Mine Lands. **Katie D. Stutler, Eugenia M. Pena-Yewtukhiw and Jeffrey Skousen, West Virginia University.**

Soil health is the continued capacity of soil to function as a living ecosystem that sustains plants, animals, and humans, and is necessary for crops to provide a successful yield. Reclaimed mine soils are highly disturbed areas with compromised soil health. However, mine soil properties and functions may recover with time, leading to improved soil health. The objective of this research is to measure soil properties, plant diversity and productivity in minesoils of different ages and relate them to soil health. Our hypothesis states that time since reclamation will positively influence soil properties related to soil health, and their potential for agricultural production based on plant indicators. Three West Virginia reclaimed mine sites were selected based on age, the oldest at 14 years, intermediate at 11 years, and youngest at 3 years. Sites were similarly reclaimed and planted to mixed grass-legume pastures. Nine soil samples were taken to a depth of 15 cm at each site. Soil bulk density, dry aggregation, organic matter, and total biomass were measured. Corrected bulk density showed statistical differences between oldest (1.67 Mg m^{-3}) and youngest (1.46 Mg m^{-3}) sites. The oldest site showed lowest value (26.8±7.7mm) for dry aggregation. Soil organic matter showed a statistical difference between all sites, with the highest value at the oldest site (223±24g kg^{-1}). The highest biomass productivity was measured at the oldest site (2.2±0.4 Mg ha^{-1}). Preliminary data showed an increase in biomass productivity as time since reclamation increased, which may indicate soil health improvement over time and increased agricultural production potential.

Spatiotemporal Variability of Stream Stage in a Small Mixed-Land-Use Watershed of Appalachia. **Parameshwor Takhachhe and Jason A. Hubbart, West Virginia University.**

Streamflow is a critical variable for proper quantitative estimations and control of water pollution. However, variability of land-use/land-cover type can confound flow estimations and thus pollutant load. Stream stage was measured at subwatersheds (n=22) in West Run Watershed, a representative mixed-land-use watershed of Appalachia to understand streamflow dynamics and volume and variable land-use practices including (but not limited to) forest, agriculture, urban, industrial and mining. Highest stream stage recorded of 2505 mm was observed during summer following 53 mm precipitation storm event at site #22 (confluence with Monongahela river) and lowest of 360 mm during fall for site #22 whereas some sites at upstream had no flow resulting stream stage to be zero. Average stream stage value for site #1 (upstream) was 14.09 ± 2.79 cm and was 65.321 ± 12.205 for site #22 spanning 6.2 km reach. Stream stage was more responsive (i.e. flashy) to the events at subwatershed scales with urban (Mean = 27.08, SD = 6.05, Min = 51.12, Max = 108.6) land-use practice and least with forest cover (Mean = 52.082, SD = 16.763, Min = 13.710, Max = 106.94). This study will improve quantitative understanding of streamflow response in multiple land use types, which will help improve predictive modeling. In addition, information from this study will be useful to policy makers for managing streamflow quality and quantity.

Distribution of river sediment microbial diversity reflects correlations of phylogeny and geochemistry. **Ifeoma Rosemary Ugwuanyi, Sridhar Malkaram, Amir Hass, Natalia Montenegro-Garcia, Vadesse Lhilhi Noundou, E. Chavarria-Palma, A. L. Kemajou and David H. Huber, West Virginia State University.**

Healthy watersheds are critical natural resources that serve a variety of personal, industrial and municipal needs. Consequently, watersheds receive an enormous variety of anthropogenic as well as natural chemical inputs. Riverine sediment has been shown to harbor enormous microbial diversity and provide bioremediation and biodegradation functions. However, the microbial ecology of river sediment and the most important drivers of biogeographic patterns are poorly known. Our long-term goal is to understand the factors that determine the distribution of microbial functions in freshwater environments,

and to understand how human activities affect the essential microbial-based ecosystem services. Our model system is the Kanawha River watershed (West Virginia) which has been impacted for decades by local and regional disturbances including surface mining, chemical industry discharge, dredging, and traditional municipal inputs. To date, we have collected replicate sediment samples from six locations along a 60-km region of the river that runs from South Charleston upstream to Kanawha Falls. Analysis of 20 chemical variables (pH, metals, nitrogen compounds, sulfate and total organic carbon) was carried out with ICP-OES and ion chromatography. Microbial diversity was measured with Illumina sequencing of 16S rRNA genes following Earth Microbiome Project protocols. Correlation analysis showed that the phyla Proteobacteria and Spirochaetes had significantly different geochemical profiles. Separate clades within Proteobacteria (orders Burkholderiales, Desulfobacterales, and Syntrophobacteriales) also had unique overall correlation profiles that may indicate niche preferences. Two widespread genera (Burkholderia and Geobacter) showed weak correlations with most geochemical variables. Phylogenetic correlations with geochemistry help to explain sediment diversity patterns.

Davis College Reedsville Restoration Research Plan. **Hannah Warner and Jim Anderson, West Virginia University.**

Wetlands are valuable to an ecosystem for multiple reasons (e.g. erosion control, natural filters from pollutants, and rare fish and wildlife habitat). Impacts to water quality in wetlands that stem from anthropogenic causes can have lasting effects on structure and function. Impacts that occur due to erosion, sedimentation, or bank instability can affect fish and wildlife populations through alteration of habitat. To avoid these issues, restoration and mitigation of streams and wetlands has become important and effective approaches. Few studies have documented wetland structure and function before restoration or mitigation occurs. The restoration and mitigation efforts for the reservoir and Ruby Run at the West Virginia University Reedsville Farm provide a unique opportunity to assess physical stability of stream channels, and structural and functional changes in wetland and stream habitats before, during, and after restoration, as well as the complexities resulting in the observed changes. Through monitoring, we will be able to characterize and quantify the ecological response of the loss of the wetlands associated with the reservoir and the mitigation for the loss of the wetlands at Ruby Run. Monitoring will be conducted on a year-round basis and will include surveys on: 1) abundance and diversity of birds, wetland macroinvertebrates, small mammals, turtles, and anurans, 2) plant response, survival, and development to stream and wetland restoration efforts, 3) annual changes in in-stream community composition and physical habitat quality and complexity, and 4) relating observed biological response to patterns in physiochemical conditions and restoration treatments.