***Amruta Sakalker, University of Texas, Arlington - Environmental Planning, Community Stewardship, and Water: A Comparative Assessment of Green Infrastructure in Texas Cities.** Riparian lands, the interface between terrestrial and water ecologies, play a critical role in keeping ecosystems healthy. They serve as buffers for any form of disturbance on land that might affect the well-being of a water body or any threats that the waterbody might cause to its neighboring land. However, in Texas, rapidly sprawling metropolitan regions continue to urbanize environmentally vulnerable areas around rivers and streams to meet the housing demand or to expand regional transportation infrastructure. In urban areas, through land use changes, land cover changes, multi-ownership, and multi-use, fragmentation of riparian lands further complicates their management.

To address this fragmentation, planners and governing entities create many types of environmental plans that develop environmental management strategies. Within such plans, growing trend of using nature-based and environmental stewardship-based projects as tools to protect, restore, and manage riparian lands. However, environmental justice scholars show that though these plans meet the environmental mitigation goals, they fail to address equity and justice, as economic growth is the driving force for creating such plans.

This research aims to identify, describe, and categorize the relationship between environmental planning, environmental stewardship capacity, and equitable methods of preserving ecologically vulnerable urban riparian lands. My overarching research question seeks to determine how urbanization affects the environmental stewardship capacity of communities. In doing so, the supporting questions are:

1. What is the relationship between neighborhood characteristics and riparian land quality?
2. What strategies can planners employ to enhance community environmental stewardship?

2 aims to find out if there is an unequal geographic pattern of riparian environmental changes in the study area and if it correlates to the socio-demographics of the place. Literature has shown that socio-demographics plays a significant role in the environmental well-being of a community. I use ANOVA to study whether the socio-demographics of a neighborhood make a difference in the relationship (land use/zoning or accessibility) with riparian land. The main intention is to check if there is a weakening or strengthening relationship between riparian land and the community in its watershed.

***Austin Thompson, North Carolina State University - Paying for Urban Nature-Based Solutions: Case Studies of Innovative Funding and Financing Approaches from Four US Metropolitan Areas.** Local governments are increasingly expected to provide more services at the same level of revenues, intensifying competition for scarce financial resources. As a result, securing adequate funding and/or financing to implement nature-based solutions is often a challenge, particularly for projects that aim to address environmental inequities. Nevertheless, in some cities, local government staff and officials have found ways to advance more equitable implementation of urban nature-based solutions by developing analytical tools that assess the status quo and highlight areas of most need, and seeking partnerships, funding sources, and financial solutions to address these inequities. In this study, we highlight several of these financial strategies, drawing on examples from Seattle/King County, WA; Durham, NC; New York City, NY; and Milwaukee, WI. Through interviews and focus groups with key informants and document analysis, we assemble case studies that investigate the local drivers for the project, the decision-making process, and the respective payment mechanism. The results of this study are two-fold: first, we detail these innovative funding and/or financing mechanisms that can be used by practitioners to pay for nature-based solutions, with specific attention to those projects that advance environmental equity. Second, we offer insights into the importance of the local context, including federal or state mandates, local goals, strategic partners, and community support in reducing financial barriers to implementing urban nature-based solutions. Together, the cases reflect broader calls within public administration to consider social equity in the distribution of resources, even financial resources, at the local level.

***Bethany Kharrazi, Central Washington University, Ellensburg, WA - A Conceptual Framework for Managed Aquifer Recharge near Yakima, Washington.** Increasing demands for water, overallocation of surface water, and a changing climate in the Yakima Basin in south-central Washington are leading to a loss of water storage and increasing demands in drought years. A warming climate has reduced snowpack in the Cascade mountains, a vital reservoir for the irrigated agricultural industry which serves as the backbone of the basin's economy. Mitigating this impending water crisis is essential for the economic output of the region. Managed aquifer recharge (MAR) is a sustainable and cost-effective approach for securing water supply by storing water underground for recovery during drought. Diminishing groundwater levels in regional basalt aquifers over the last several decades suggests there is significant storage available for intentional groundwater recharge of these aquifers.

This study focuses on the ridge and valleys east of Yakima, WA, particularly the area served by the Roza Irrigation District. The region consists of east-west trending folds and faults of the Yakima Fold Belt (YFB). The bedrock is composed of the Grande Ronde,

Wanapum, and Saddle Mountain formations of the Columbia River Basalt Group, as well as sedimentary interbeds of the Ellensburg Formation. There is greatest interest in utilizing the basalt aquifers for MAR due to the immense depths and vast spatial extent of the formations, the water-bearing vesicular flow tops and interbeds, and the structural controls of the YFB.

Informed by the 2011 USGS Columbia Plateau groundwater study, this research quantifies the groundwater storage capacity in various basalt aquifers to assess the viability of MAR east of Yakima. In order to investigate storage potential, we developed a conceptual hydrogeologic model depicting the relationship between geology and flow dynamics at depth. Well logs were used to construct cross sections of stratigraphy and water levels, and previous pump tests were used to decipher structural barriers to flow that maximize or minimize MAR efforts. This model is used to make preliminary quantitative estimates of available storage volume and to assist in identifying recharge sites within the study area. Applications of this methodology can be impactful for improving water security in other regions of the world, especially those with continental flood basalts or complex folds and faults.

***ByungHyun Lee & *ByungSik Kim, Kangwon National University, Samcheok-Si, Korea - Development of Rainfall Information Production Techniques Using Optical Rain Sensor and AI Techniques.** Various flood disasters are also increasing due to the increase in localized torrential rains, and in order to prevent flood damage, rainfall information is a very important factor, and research on this is being actively conducted.

The optical rain sensor is a rainfall observation method that can measure precipitation in unmeasured areas where rainfall measurement is difficult and generate rainfall information in real time. Unlike general rainfall detectors, optical rain sensors use a phenomenon in which light scattering occurs larger as water particles become larger. Large scattering decreases the value input to the optical lane sensor, which means high precipitation, and indoor experiments were conducted to confirm this relationship, and the results were used as learning data for the ANN model.

In order to verify the results of this study, the observation value of the optical rain sensor installed in the experimental vehicle operating in Jeju Island was applied to the learning model to calculate rainfall information, and the verification was performed by comparing it with rainfall information at nearby ground stations. The rainfall ideas used for verification were compared for a total of 7 ideas, and the average coefficient of determination of 7 ideas was 0.98, confirming the reliability of rainfall information.

***DongHo Kang & *ByungSik Kim, Kangwon National University, Samcheoka - Development of Threshold Rainfall Estimation using Multi-Method.** Recently, various disasters have occurred in Korea due to weather changes caused by climate change, and the damage is also increasing. When looking at weather phenomena and socioeconomic impacts, the disaster that causes the most damage is weather disasters.

Therefore, this study suggests a method of calculating the threshold rainfall to predict the impact of heavy rain. In order to calculate the threshold rainfall based on the Multi Method, the whole country was divided into a 1km and 1km grid, and a method of calculating the threshold rainfall was proposed by dividing it into four categories: standard watershed, Urban, river, and inundation trace map. This study attempted to verify the results of the threshold rainfall in the standard basin and city center, and the verification was conducted by applying the rainy season in summer 2020 and the typhoon HAISHEN in September.

As a result of the verification, it was checked that flooding occurred in the grid that actually caused flooding in Busan, where heavy rain caused urban flooding in July 2020, and the calculation of the grid that caused flooding in Gangneung, where typhoon High Line in September, also reflected the actual damage. If it is used in the impact forecast using the method of calculating the threshold rainfall and predicted rainfall information developed in this study, it is expected that it should be able to provide information on the impact of heavy rain to the victims as well as the forecast of rainfall.

***Edward Vlasenko, Central Washington University - Quantifying Dry Season Evapotranspiration Water Loss From the Floodplain of Taneum Creek, Central Washington.** Stream restoration was conducted in central Washington's Taneum Creek in 2008-2010. These efforts came primarily in the form of the addition of large woody debris (LWD) to the creek channel. This restoration has increased channel-floodplain connectivity, and thus resulted in significant changes in the site's geomorphology. It is possible that this increased channel-floodplain connectivity and associated reduction in flow velocity has resulted in increased floodplain groundwater storage. However, any gains in groundwater may be nullified by increased evapotranspiration (ET) water losses. In an effort to quantify ET, a weather-monitoring station, evaporation pan, soil heat flux plates, and soil temperature and moisture sensors will be used to measure relevant parameters through the dry season (late Spring to early Fall). Water samples will also be collected regularly from the main stream channel, side channels, and locations of standing water (beaver ponds, etc.) for stable isotope analysis. Preliminary stable isotope data from late summer 2022 has already been collected. Finally, empirical estimates of ET will be compared to estimates from the remote sensing based methods available on the online OpenET platform.

***Elizabeth Flint, British Geological Survey, Cheltenham - Water Supply Processes Have Significant Impacts on Nitrogen Cycling Across the US.** Nitrogen (N) is a fundamental element for global food production, however human activity continues to cause excess concentrations, predominantly as nitrate (NO3), and eutrophication within coastal and freshwaters across the United States (US). Developing more accurate N budgets and effective N management policies is imperative, and requires an improved understanding of N input and retention mechanisms within aquatic environments. Using publicly available data, we establish that freshwater abstractions from both surface waters and groundwaters, alongside watermains leakage from public distribution networks, are responsible for significant NO3-N fluxes across the US. We estimate that in 2015, 417 (min-max: 190-857) kt NO3-N yr-1 was temporarily retained from US freshwater systems as a result of freshwater abstractions, equivalent to 57% of US river denitrification estimates. Fluxes due to irrigation, thermoelectric power and public water supply collectively account for 87% of this total. Whilst we conceptualize this abstraction flux as internal on a national scale, water abstracted for both non-consumptive and consumptive uses may result in the transfer of N from one environmental reservoir to another, or act to temporarily store a significant amount of N on timescales relevant to nutrient management strategies. Transfers of abstracted water across county boundaries may result in these fluxes acting as imports and exports of N on smaller spatial scales that are relevant to policy making decisions. We also estimate that the leakage of public supply water from distribution network pipes was responsible for returning up to 7 (min-max: 6.3-7.7) kt NO3-N yr-1 into the environment for the year 2015. Although nationally this is equivalent to around 0.3% of leached agricultural N inputs, 170 counties have leakage NO3-N fluxes equivalent to over 10% of this flux. Around 79% are these counties are defined as urban, thus highlighting the significance of leakage NO3-N fluxes in urban areas. The significance of both abstraction and leakage fluxes makes them a nuance to be considered within future N budget methodologies, which in turn will aid the development of more effective N management strategies.

***Elizabeth Shields, University of Delaware Water Resources Center - Indigenous and European Place Names Along Streams and Waterways in Delaware (Lenapehocking)** Beginning in Summer 2021, this project was created to initiate important research, conversation, and recognition around the names of waterways and places in our state. There is a rich and long history of the relationships between the Lenape Haki-nk, Susquehannock, Choptank, Nentego/Nanticoke, and Pokomoke peoples and this land we now know as the State of Delaware. We acknowledge both the history and maintained presence of these Indigenous peoples, as well as the existence of their original connections and name associations to the land and water. The goal of this living project is to begin to uncover what available records show and tell of the lineage and possible meanings behind the Indigenous, early European settlers, and commonly known names. Through an analysis of the 1966 United States Geological Survey “Delaware Place Names” Report, a current total of 107 waterways and key land points have been organized, interpreted, and placed, producing a new alternative visual for mapping in Delaware. Next steps of the project will play out in the evolution of the printed sample into a living online map with additional content and context. Given the limitations of the 1966 USGS report, we plan to collaborate with other sources and initiate communication with Indigenous tribal leadership and members around the state for their input on variants, translations, locations, and other vital elements to this process.

***Emily Polizzi, *Lisa Ely & *Carey Gazis, Central Washington University - Shallow Floodplain Aquifer Storage Capacity of the Upper Yakima River Tributaries, Kittitas County, WA.** Large in-channel wood (LW) restoration projects are implemented in the Pacific Northwest to improve floodplain water storage, decrease channel incision, and provide safe spawning habitat for resident and anadromous fish species. In the early 20th century, destructive logging practices stripped Upper Yakima River tributaries of LW. In recent years, stream restoration efforts are being employed to both restore LW and increase floodplain groundwater storage. This storage can combat the adverse impacts of climate change, such as decreasing snowpack and early spring melting, which cause increased frequency and severity of droughts in the lower basin. Storing runoff snowmelt in shallow floodplain aquifers during peak flow, could allow the natural released of groundwater slowly, during the low flow summer months. Taneum Creek, Indian Creek, and Teanaway River have established LW projects but also possess a blue-gray glacial lacustrine clay that could affect potential aquifer transmissivity and storage capacity. Quantifying the floodplain composition and capacity considering the regional confining glacial clay layer will reveal the effects of glacial history on groundwater recharge, storage, and flow in shallow floodplain aquifers. Collection of floodplain stratigraphy and a maximum glacial clay elevation via exposed streambeds, auger cores and well logs, will contribute to a storage capacity calculation for the floodplain aquifer. Measuring grain sizes and infiltration rates through representative stratigraphic units will further constrain the transmissivity properties of the shallow floodplain aquifers. The maximum elevation of the blue-gray clay will be applied to surrounding tributaries to calculate realistic floodplain aquifer volumes in similar tributary watershed. Gaining a better understanding of the floodplain stratigraphy in the upper tributaries will permit a refined aquifer capacity calculation and inform interaction between past glacial processes and current water storage solutions in the Yakima River Basin.

***Gregory Post, Portland State University, - Identifying Disappeared Streams Linked to Urban Development in Portland, Oregon.** Many streams can be classified as being “disappeared” because they have been removed, buried, or moved during urbanization. We loctated potential disappeared streams in Portland, Oregon by analyzing historical topographic maps for multiple time periods, while linking them to urban development history. Historical topographic maps were evaluated to locate streams discernible on older maps but not visible in a more recent maps. Between1852 and1895, approximately 15% of streams disappeared, however the majority of

streams (65%) disappeared between 1896 and 1953. After 1954 this trend continued particularly in suburban areas with 12% of streams being removed from 1954 to 1989 while 8% disappeared from 1990 to 2017. The disappearance of urban streams is linked to residential development and earlier land conversion for agriculture which varied depending on the area and time period. Identifying the locations of disappeared streams can be used by urban planners to pin point where stream restoration or daylighting can be targeted.

***Hannah Whitley, Pennsylvania State University - Irrigated Agriculturalists' Perceptions of and Adaptations to Water Scarcity in the Klamath Project.** Future climate projections foresee further pressure on our already shortened water supply, which will significantly affect water and agricultural systems. The farmers and ranchers who rely on water for irrigation, particularly in regions with persistent drought, and the rural communities in which they live, will bear the brunt of these resource limitations. At a time when scholars and practitioners are asking how we can pursue climate solutions in an era of growing government distrust, scientific skepticism, and an increasing rural-urban divide, understanding the cultural, political, and ecological dynamics that drive farmer and rancher behavior is more critical than ever. Sharing findings from a broader dissertation on water governance in the American West, this poster will address the following questions: (1) How do farmers and ranchers who use water for irrigated agriculture operations perceive the risks of persistent water scarcity? (2) How, if at all, do these perceptions feed into individual response behavior, water management practices, and willingness to modify such practices?To answer these questions, I undertook an in-depth case study of the Klamath Project, a water-management project developed by the United States Bureau of Reclamation to supply farmers with irrigation water and farmland in the Klamath Basin. For over two decades, the Project has struggled with persistent water quality and quantity concerns and increasingly volatile stakeholder relations. I collected primary qualitative data through semi-structured interviews, 12 months of participant observation, and a unique form of participatory research called “photovoice” – a critical tool for facilitating conversation that asks participants to use photography to represent and reflect on lived experiences.Findings from this research will advance theoretical and applied scholarship related to nature-society relations, rural sociology, and the resilience of agriculture, natural resources, and rural communities by demonstrating the value of local perceptions of water scarcity in constructing social vulnerability. The expanded understanding of risk perception and its connection to climate change and community resilience is critical for incentivizing individual adaptation, strengthening local adaption pathways, cultivating the resilience of agricultural economies, and supporting agriculturalists as they continue adapting to increased water pressures.

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Haylie Fine, Jupiter Environmental Research and Field Studies Academy - Correlation Between Time Spent Outside with Willingness to Participate in Remediation of a Local Body of Water. Proximity to surface waters influence people’s motives to fund projects that protect and remediate environmental habitats. A private gated community in southeast, coastal Florida, Jonathan’s Landing (JL), consists of an integrated golf course (15,000 sqft) and marina with approximately 1,234 homes on or near the water (JL POA, 2021). The water traps on the golf course have culverts that spill directly into waterways, residential lakefront lawn care is year round, and all manicured facilities lack a riparian buffer. This created odd smells, colors, and algal blooms that alarmed residents. Disconsolate, home owners enlisted aid from students in the Jupiter Environmental Research and Field Studies Academy (JERFSA) at Jupiter Community High School to assist in the creation of a lake association that would educate and engage the community at large.

To provide the community with information on resident attitudes, a survey was developed in Survey Monkey and distributed anonymously via a link by the Property Owners Association (POA) to more than 440 homes. The questions utilized Tobler’s First Law of Geography along with the Theory of Planned Behavior to provide background information for geographic relationships and human beliefs. Results were better than expected as outcomes indicated that 96.77% agreed the lake was important. As expected, of the 73.78% of respondents who can see the lake from their backyard only 60.33% of people are willing/open to participate in volunteer projects. Additionally, of the 126 respondents 23% were not near the lake and 34% were unwilling to participate or fund any lake projects to improve its health. This indicates that the residents located closer to the lake were more inclined to respond, as they have a greater stakeholder in maintaining the lake's health. A new survey was distributed this year to a greater number of residents with a target focusing on the time spent outside in more activities involving their environmental habits. The results detailed that those who spent over two days per week outside were more willing to pay. The results will be used to further develop volunteer engagement.

***Henna Gavem, Florida Gulf Coast University - Environmental Impacts of Reclaimed Water for Long-Term Irrigation of Residential Landscaping in Southwest Florida.** This research assesses nutrient loads and potential impacts of reclaimed water for residential landscaping irrigation at one southwest Florida development, and the institutional factors that encourage or inhibit reclaimed water for irrigation. The Bonita Bay development comprises some 58 neighborhoods, 2,400 acres, 1,500 households, and 3,000 residents. Resource Conservation Systems (RCS) supplies non-potable irrigation water to Bonita Bay and a few other clients, using wastewater treatment effluent from Bonita Springs Utilities (BSU), supplemented by groundwater. Related research has documented nitrogen (N) and phosphorus (P) compounds in Bonita Bay’s soils, groundwater, stormwater detention ponds, and wetlands, greater than background and greater than Clean Water Act (CWA) targets for nearby waters. Stormwater ponds, not waters of the U.S. thus not

subject to CWA, receive and storm much of the N and P in residential runoff and non-stormwater sources, and are hydraulicly connected to nearby waters identified as N- and P-impaired. Findings to date show RCS effluent supplied varies substantially in chemistry, with TN of 1 – 20 mg/L and TP of 0.5 – 5 mg/L. Water is delivered to Bonita Bay at varying times, with varying N and P content; mixed with groundwater; and stored for unspecified periods, such that chemistry at time of irrigation also varies, without information that would allow mitigation strategies such as blending or time-averaging. That would require frequent testing – an attainable expense for well-resourced Bonita Bay but prohibitive for smaller entities. Florida policies and Federal regulations encourage wastewater reclamation for irrigation: Florida utilities currently reclaim nearly 50% of all treated effluent, and Florida S.B. 64 (2021) specifies 100% of effluent be applied to 'beneficial uses' by 2032. CWA favors reclamation because utilities that do not discharge to waters of the United States do not need to comply with NPDES regulations for surface water, sharply reducing regulatory burdens. Studies such as Bonita Bay show potential for negative impacts, of the kind CWA is designed to avoid, suggesting state and Federal agencies should develop regulations, guidance, or protocols to monitor and mitigate emerging impacts to environmental systems from the institutionally-perpetuated and continually-increasing application of reclaimed water to landscape irrigation.

Jae-Kyoung Lee & Suk Hwan Jang, Daejin University, Pocheon-Si - A Basic Study on the Variability Analysis Between Earthquake Occurrence and Hydro-environmental Factors on the Korean Peninsula. After Pohang and Gyeongju earthquakes and their aftershocks. there is no longer any zone which is safe from earthquake disasters in the Korean Peninsula. In order to monitor and predict earthquakes, correlation analysis of earthquakes and hydro-environmental factors is insufficient, and the development and application of hydro-environmental factor measurement equipment is still in the early stages. This study developed and verified a more precise radon measurement device. This study also analyzed the various relevant trends of domestic earthquake occurrences, in addition to the correlations and variability between the hydro-environmental factors and earthquake occurrences. Moreover, this study widely improved upon the accuracy of correlation analysis between hydro-environmental factors and earthquake occurrences through the application of radon measurement devices that were specifically developed for usage in this study and the comparison of observed hydro-environmental data with other major earthquake cases. Four specific earthquake cases (2019~2020) were selected, and the correlation of the analyses of the earthquakes and hydro-environmental factors (Radon, EC, WL, and WT) was conducted at the three specific groundwater stations. Therefore, firstly, among inland and undersea earthquakes, the earthquake correlation between the occurrence of the undersea lagged by an average of 2 months, and the figure for inland earthquakes was high (R2= 76.3%). Secondly, it was observed that the actual variability of the hydro-environmental factors dramatically fluctuated (having the tendency to increase or decrease at different intervals) at a certain time period around the moment when the earthquakes occurred. It was thereby confirmed that radon, WL, WT, and EC are affected by the earthquake occurrences or the presence of seismic movements, and this study proved that that there is a distinct correlation between earthquake occurrences and hydro-environmental factors. Furthermore, the variability of the EC showed an identical tendency over a certain period before an earthquake occurred, and, especially, the variability trends for radon, WL, and EC coincided at the time of the earthquake's occurrence.

***Jungah Wang, *Woojin Lee & *Hwandon Jun, Seoul National University of Science and Technology - Real-Time Flood Warning System on Excavation Construction Sites.** Construction sites have various danger factors. Workers are always faced with the possibility of workplace injury. In terms of flood damage, excavation sites are particularly vulnerable than others. As world urbanization is expanding, interests for underground space development are increasing and because of global warming, flash flooding becoming more frequent. The use of a real-time flood warning system specialized in excavation makes construction sites can provide a safer working environment to workers.

The measurement of risk of the warning system takes into account the flow velocities and depths of water that can harm people when they are moving to evacuate. They can be determined with 2D hydraulic modeling of the travel path areas. The pre-simulated model is considered because simulating time is important for the real-time warning system. Real-time rainfall is measured using a rainfall gauge on construction sites and rainfall prediction radar that can estimate 30 minutes to 6 hours rainfalls.

The warning system is divided by following 3-levels: Level 1) SAFE; Level 2) PREPARE; Level 3) EVACUATE. Level 3 which workers should evacuate immediately alerts with limit risk value that can occurs accidents obviously. Level 2 which needs constant vigilance for workers take risk value determined by limit risk value of Level 3. For classification of each level the discharge velocity of the watershed needs to be considered and it depends on its characteristics. Faster discharge velocity, shorter time between rising of alert Level 2 to Level 3 make absence of spare time to prepare to evacuate cause lower-level alert meaningless.

The proposed warning system has been tested on a hypothetical construction site created with GIS mapping tools on Yeondeungcheon watershed Yeosu, South Jeolla province, Korea. Results compared with creating different construction sites considering the conditions of travel areas for evacuating are varied by sites and the number of exits could be more than one.

***Sabrina Savidge, Bucknell University - Characterization of Transient Storage in Varying Small Stream Environments.** The transient storage zone processes are investigated in a small second order stream with a 0.8 square kilometer watershed. Sections of the stream study site are impacted by varying types of stream restoration practices and watershed management practices. The presence of transient storage zones in small streams impacts the available flow paths for water and results in a wider range of residence times for water and dissolved chemicals than would be predicted by considering only the main channel flow path. Residence time can be used to quantify the health of a stream as several biogeochemical and ecological processes occur in water slowed by transient storage. A combination of data collection, field experimentation, and data analysis is used to characterize the variability in transient storage zone processes and residence times in a small stream and to relate the identified storage zone processes to physical characteristics of the stream. Characterization of the physical characteristics of the study site includes a quantification of the proportion of stream surface area where transient storage zones are observed. Field experimentation includes conservative tracer studies with continuous injection in stream reaches with varying observed physical characteristics. Sampling throughout the tracer studies is targeted in transient storage zones as well as the main flow path. Data analysis leads to a preliminary understanding of how various stream and watershed management practices impact the presence of transient storage zones and the range of residence times and flow paths in small streams.

Jiyoung Yoo, Ji Eun Kim & Tae-Woong Kim, Hanyang University - Investigating Spatio-temporal Drought Progress in East Asia Using Drought Dynamics Detection Techniques Algorithm. Drought, one of the costliest natural disasters, most often causes losses. A thorough investigation of drought progress is essential to mitigate the drought damage. The temperature and precipitation variability has been gradually increasing in East Asia, making drought damage increase. In this study, using the drought dynamics detection technique (DDDT), we investigated complex drought progresses in space and time in East Asia. The DDDT is a practical method to monitor the spatial tracks and temporal paths of drought, which includes three steps: (1) definition of a single drought event in space, (2) identification of the centroid of a drought event, and (3) linkage of temporally consecutive clusters. Using grid data from the Standardized Precipitation Evapotranspiration Index (SPEI) Global Drought Monitor for East Asia (1970–2018), the DDDT was illustrated to investigate the progression of drought. We found that spatiotemporally varying drought trajectories using the DDDT algorithm provided more detailed information of drought progress than conventional drought snapshot maps. The effectiveness of the DDDT-based drought monitoring technique was determined for the considered case study in the East Asian region (Korean Peninsula, Japan, and India). Another major conclusion is that DDDT-based drought monitoring is effective in identifying the causes of drought and improving knowledge about drought progression.

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***Jungyeol Choi & *ByungSik Kim, Kangwon National University - Development of a Korean Analysis Algorithm for Rainfall Thresholds of Landslide Using Rainfall and Topographical Information.** The purpose of this paper is to develop an automatic calculation algorithm based on the threshold of landslide-induced rainfall suitable for the Korean region. To this end, the history of landslide occurrence in Gangwon-do was collected, and a weather station near the landslide occurrence point was selected to collect rainfall. The automatic calculation algorithm for landslide-induced rainfall thresholds was written based on the R program and consisted of three main packages: input, calculation, and output. As a result of applying the developed algorithm to the target area, the affected meteorological zone was automatically selected based on the individual landslide point information, and the induced rainfall was derived using the individual landslide point information and meteorological zone information.

***Kallie Unger, Florida Gulf Coast University - Fecal Indicator Bacteria in a Tidal Stream, Estero River, Southwest Florida: Analyzing for Source Identification and Transport Variability.**

***Katelin Killoy, Eastern Washington University - Beaver Dam Analogs as a Stream Restoration Tool in Fire Affected Tributaries of the Methow and Okanogan Watersheds.** Increasing wildfires and droughts related to climate change are critical issues for incised streams, which are disconnected from their floodplains and no longer store water effectively leading to diminished ecosystem function, loss in critical riparian and aquatic habitat, and reduced biodiversity. Beaver activity improves incised streams by raising surface and ground water levels to reconnect with floodplains, retain phosphorus, and increase critical habitat and species diversity. Beaver Dam Analogs (BDAs) may be used when beaver reintroduction is not feasible, to mitigate damage from wildfires and stream incision. Though, it is not clear how effective BDAs are at mimicking natural beaver dams for wildfire affected stream restoration This study will begin a long-term assessment of BDA effectiveness over time. A Before-After-Control-Impact study design will compare five BDA restoration sites with paired control sites and three natural beaver dam complexes. In the summer of 2021, pre-restoration data was collected on 1) channel morphology using a laser level and stadia rod, 2) riparian vegetation using line-intercept method, 3) sediment composition using a Wolman pebble count, 4) turbidity and phosphorus loads that were collected throughout the year at upstream and downstream locations to assess transport, and 5) water retention during low flow using conservative tracer injections. Early results for water retention show control and pre-restoration streams have similar mean water travel times of

58 minutes (control) and 51 minutes (pre-BDA) for 200 m of stream, whereas through beaver dammed complexes, times are 7x to >400x slower (ANOVA, $n = 3$, $p < 0.05$).

Margeaux Carter, Nebraska Department of Natural Resources - Enhancing Integrated Water Management in the Lower Platte River Basin through Sub-regional Groundwater Modeling with MODFLOW-6 and AEM Geologic Data. Nebraska Department of Natural Resources (NeDNR) works with local Natural Resources Districts (NRDs) to manage regional water supplies in the near and long-term. Nebraska's integrated water management involves local, regional, and state water managers and employs the best available science to analyze the impacts of water use and evaluate the effectiveness of water management activities. Across the State of Nebraska, NeDNR has focused on modeling groundwater at the regional scale. This approach is effective across non-glaciated areas of Nebraska. In the eastern portions of the Lower Platte River Basin, the highly complex geology resulting from repeated glaciation events is difficult to model at the regional scale while also representing the local geologic complexity using MODFLOW-2005. However, MODFLOW-6's enhanced solver, more flexible framework, coupled model utility, and grid refinement capabilities have been critical to integrating recent airborne electromagnetic (AEM) surveys into sub-regional models with finer, more observation-based geologic representation. NeDNR is working with Lower Elkhorn NRD (LENRD) to finalize and test such a sub-regional model and is working to develop additional sub-regional models in other areas of interest. This new groundwater modeling framework will provide NeDNR, the NRDs, and local water managers a more detailed assessment of available water supplies, impacts of water use, and an improved understanding of the Lower Platte River Basin hydrologic system.

***Orlando Ferreira Neto & *Geoffrey Foaud, Monmouth University - Comparative Analysis of a Low-Cost Unmanned Aerial Vehicle Survey and High-Cost LiDAR Survey for a Flood Damage Assessment in Lake Como, New Jersey.** The coastal communities of the New Jersey Shore have an untold social and economic value to the state. Yet, each year, these communities are subject to the threat of floods due to the Atlantic hurricane season and the growing threat of more severe storms. Because of this, it is important to assess assets of the built environment subject to the threat of flooding. Such flood damage assessments require highly-resolved building information modeling (BIM) to provide the base heights of buildings, their square footage, and the potential damage of a given storm event. For some time now, expensive light detection and ranging (LiDAR) equipment has been used in BIM and by extension in flood damage assessments, however, with advances in the processing of low-cost photography using structure-from-motion (SfM) technology, the question is if an unmanned aerial vehicle (UAV) survey of color photography compares to the BIM and flood damage assessment of a more expensive LiDAR survey. Here, the two forms of surveys are applied in a flood damage assessment of the New Jersey Shore town of Lake Como, where widespread damage from flooding last occurred due to Hurricane Sandy in 2012. The extent of that flooding is mapped based on aerial imagery, and overlaid on the BIM derived from the two competing survey methods. The BIM of the LiDAR uses the return points to estimate the footprint and base heights of buildings. The SfM approach similarly generates a point cloud of elevation estimates based on the different angles at which overlapping images are taken, and the footprint and base heights of buildings are again estimated. The building information from both surveys is used to locate building footprints in the flooded area, and a depth-damage assessment is conducted using building base heights and the locally collected high water mark. The results of both the BIM and flood damage assessment from both survey methods are compared. The findings of this study illustrate how the point clouds from high-cost LiDAR and low-cost UAV surveys can be used for the complete analysis of BIM and flood damage in coastal communities at risk of flooding.

***Victor Teng, University of Minnesota, Twin Cities – Are Long Short-term Memory (LSTM) Model Simulations of Watershed Discharge Improved When Water Storage is Included as Input? The Case Study at Rum River Watershed and Wild Rice River Watershed, MN.** In this study, we examine the relationship between discharge at the pour point of the HUC-8 watersheds, the Rum River watersheds and Wild Rice River Watershed in Minnesota, and the total water storage within the watershed. A calibrated HSPF model was applied to the watershed for the period 1955-2015 to synthesize watershed discharge and total water storage. We applied a machine learning (ML) algorithm based on LSTM (long-short term memory) architecture to emulate the discharge given the meteorological inputs used in the HSPFsimulation. The LSTM model was trained on the HSPF synthesized discharge both without and then with the synthesized storage included in the model architecture. The results show that with the inclusion of the water storage as an input to the LSTM, the discharge emulation is significantly improved. The next step was to examine the sensitivity of the emulated discharge to the discrimination of the total water storage among thevarious hydrologic compartments of the watershed, surface, soil, vadose zone, and shallow and deepgroundwater. Here the results showed that for the Rum River watershed and Wild Rice River Watershed the hydrologic storage component to which watershed discharge was most sensitive was the active groundwater component. An implication of these results is that if we are able to quantify total water storage in a watershed or water storage in some or all of the hydrologic storage compartments, it would be possible to predict the associated discharge.

***Paul Hurst, Portland State University, Portland, OR - Exploring the Efficacy of Moss (Orthotrichum lyellii) as a Reliable Indicator of Microplastic Deposition along an Urban-Rural Gradient in Oregon.** Air fall deposition of anthropogenic particle pollution (APP), a larger category that includes microplastics (plastic particles sized between 1 micron and 5 millimeters), has been noted throughout the world. Two megacities, Paris (France) and Dongguan (China) have begun focusing on the dispersion of APPs within the metropolitan area; still little is known about the dispersion or effects of APPs. In every pathway to environmental exposure, new

considerations arise about how to accurately and repeatably sample microplastics from the environment. Moss is a reliable bioindicator of heavy metal pollution in metropolitan areas due to their constant exposure and ability to absorb the pollutant. This study investigates if moss can reliably be used as a bioindicator of anthropogenic particle pollution in a metropolitan area. By sampling over 100 moss samples from an urban-rural gradient in Portland and Hood River, Oregon, we will determine the density of anthropogenic particle pollution. Fenton's reaction is used to digest the moss which is then filtered through a 10 micron polycarbonate filter for quantification under a compound transference microscope; confirmation of the polymer type to follow through FTIR. A heat-map visualization will be created to illuminate areas of concern geographically and NMDS statistical analysis will be used to highlight the relationship of the many variables that change between sample collections including land use, canopy cover, and tree genus among others. Moss can be used in line with state environmental guidance to highlight areas of concern within metropolitan areas and allow managers to identify areas where management will occur most effectively.

***Pritam Das, University of Washington - Monitoring Reservoir Operations of the Mekong River from Space: A Self-correcting Multi-sensor Approach.** Even though dams and reservoirs have become a crucial part of most river networks across the world, understanding their effect on rivers is still difficult due to a lack of availability of reservoir operations data. Using freely available satellite remote sensing data reservoir operations can be quantified on a global scale, for both time-critical decision making and for multi-decadal hindcast studies. Unlike in-situ monitoring networks, satellite remote sensing-based reservoir state observations can have high uncertainties due to challenging conditions, such as cloud cover, atmospheric haze, or dendritic shorelines. In this study, we propose the Tiered Multi-Sensor - Optical and SAR (TMS-OS) algorithm to monitor the reservoir state with multiple tiers of filtering and corrections based on inputs from multiple satellite sensors. Using a combination of different satellite sensors, deficiencies of individual sensors are self-corrected – such as the poor performance of optical sensors during high cloud cover and the poor performance of SAR sensors in dendritic reservoirs. This algorithm can quantify reservoir operations (storage change) with an average Kling-Gupta Efficiency (KGE) of 0.24 and a correlation of 0.77 for three validation reservoirs in Thailand. Compared to previous systems that could monitor reservoirs at a monthly to fortnightly frequency, TMS-OS observes the reservoir state at an improved 1-5 day frequency, allowing for weekly to sub-weekly estimation of reservoir operations. This self-correcting algorithm can also be easily extended with additional sensors as new data becomes available, making it possible to robustly monitor reservoir operations using only publicly available satellite data.

***Reetwika Basu, Washington State University, Pullman, WA - An Agent-based Model of Agricultural Water Markets Under Appropriative Rights and Droughts**. An Agent-Based Model (ABM) of agricultural water markets is developed to simulate trade and efficient water allocation at the watershed scale in response to drought. The application of ABMs to solve water transaction and allocation problems in water markets is relatively new. An ABM is based on a collection of synthetic (computer-based) autonomous decision-making bodies called 'agents' who make decisions based on defined objectives in resource constraints and opportunity sets. Efficient water allocation is prime concern in many developed and developing countries. Most western U.S. states use prior appropriation system for surface and groundwater use. During a drought in which junior rights are curtailed, the transfer of uncurtailed senior rights may increase the water value by allowing it to be transferred to higher-valued uses.

The ABM model developed in this paper focuses on agricultural water transactions in response to drought. The model allows for variation in farm characteristics, water rights seniority, diversion location, differences in agent preferences, and alternative market frameworks. The model is used to examine the effect of drought on trading activity and gains under two different trading scenarios: Bilateral trading based on randomly matched buyers and sellers (like many trading platforms such as Craigslist); and a ""Smart Market"" process by which buyers and sellers submit bids and offers to a clearinghouse and are matched by a central planning process to maximize gains from trade.

The ABM model assumes profit-maximizing farmers who trade in response to drought subject to regulatory and water rights constraints. The model assumes the regulatory constraint that sellers must be upstream of buyers to avoid third-party impacts between them; and that the consumptive use amount of the sellers should be at least as much as that of the buyers. Modeling results show that when buyers and sellers are actively matched through a centralized matching system designed to maximize gains from trade, the number of transactions and the gains are higher relative to randomly matched bilateral trades. For both trading schemes, transactions tend to be highest under moderate drought severity, with a slightly higher number of water right sellers (senior rights) than buyers (junior curtailed rights). However, even in the most market-active scenarios, less than 30 percent of water market participation is observed due to regulatory and water rights constraints.

Samantha Wiest, Bennett Aerospace - A Phased Approach to Assessing Riparian Zones. Riparian zones are important transitional areas between upland and stream ecosystems that provide numerous functions such as their ability to improve water quality, provide ecological habitat and corridors, and maintain natural hydrologic processes. Riparian management has grown in prominence as these systems have become important foci of stream restoration efforts, stormwater best management practices, and greenspace corridors. Here, we present a simple, two-tier ecological assessment approach to inform decision making in riparian areas. First, we compiled over 50 prior studies on riparian buffer functionality, and we formally analyzed findings through the lens of

meta-analysis in relation to instream processes, hydrologic attenuation, and ecosystem connectivity. Second, we review field assessment procedures and protocols that have been applied in riparian zone management throughout the United States. Finally, we examine the potential of aligning these two approaches to create a phased riparian assessment methodology.

***Sanchit Minocha, University of Washington - Reservoir Assessment Tool Version 3.0: A Scalable and Easy-to-customize Software Architecture to Mobilize and Empower the Global Water Management Community.** Dams have become an indispensable part of our lives. With the increase in demand and usage of water for several different purposes like irrigation, hydropower-generation and domestic household, more dams can be expected to be constructed. With the increase in the number of dams, tracking the water availability impacted by reservoir operations globally has become more important than ever. Reservoir Assessment Tool (RAT) 2.0 couples data from satellite remote sensing with hydrological models to estimate, inflow, outflow, surface area and storage change in a reservoir and can thus provide a synopsis on historical and current patterns of reservoir operations worldwide. In its current form, RAT 2.0 is operational in the Mekong River basin. In order to globalize the tool and make it easy for users anywhere to co-develop, customize and implement such a tool in their basin of choice, RAT 3.0 was recently developed as a scalable and user-friendly architecture. We present here our effort via RAT 3.0 to create and develop a global community of users and developers akin to an open-source movement where improvements and new functions on reservoir monitoring can be openly shared and integrated in the architecture. A webapp has been created so that global reservoir monitoring information can be stored centrally.

***Shahzaib Khan, University of Washington-Seattle - Investigating Volumetric Uncertainty of Lakes and Wetlands Using Satellites and Citizen Science.** Lakes and wetlands play a crucial role in determining the health of biosphere, and hydrosphere. In short, they are the indicators of climate change. Globally, wetlands cover an area equivalent to the size of Canada, and there are 117 million small lakes. Despite their importance and a large number, our knowledge about the volume of water stored in them is limited. We studied the variations in the volume of water stored in small lakes and wetlands and factors affecting them using satellite remote sensing and lake water height data contributed by citizen scientists. We studied a total of 106 water bodies across the globe using satellite data. The uncertainty in volume estimation was studied as a function of geography and geophysical factors such as cloud cover, precipitation and water surface temperature. The study suggested that uncertainty is highest in regions with a distinct precipitation season, such as in the monsoon-dominated South Asia or the Pacific Northwestern region of the US. The small lakes and seasonal wetlands with alternating land use as water body and agricultural land, such as the wetlands of Northeastern Bangladesh, further add to the uncertainty. On an average, 45% of studied lakes could be estimated of their volume change with an uncertainty less than the expected volume in South Asia. In North America, uncertainty in volume estimation was found to be around 50% in lakes eastward of the 108th meridian, with the lowest uncertainty found in lakes along the East coast of the US. Through this study, stakeholders and city planners can make science informed policies in managing water-bodies in worst-case scenarios. Recently, Bangladesh Water Development Board used this study to understand the excess water that can be commercially withdrawn in an environmentally safe manner. The study provides a baseline for understanding the current state of the art in estimating the volumetric change of lakes and wetlands using citizen science in anticipation of the planned Surface Water Ocean Topography (SWOT) Mission.

Shuhui Dun, Pierce County Surface Water Management - Hydrologic Units Development for Stormwater Planning in Pierce County, WA. The Western Washington Phase 1 and Phase 2 Municipal Stormwater Permits require permittees to conduct Stormwater Management Action Planning (SMAP) and Receiving Water Assessment (RWA) to understand the relative impacts of urbanization and land use on receiving waters. These planning requirements necessitate the identification and delineation of watersheds and catchments at an appropriate scale. The sizes of hydrologic units (HUs) for RWA and SMAP are 1-20 square miles and 400-600 acres, respectively. For Pierce County, these HUs would equate to the 14- and 16-digit hydrologic units in the National Watershed Boundary Dataset (WBD). The federal standards and procedures for WBD are great assets for developing HUs that can be readily acceptable by stakeholders from different agencies and jurisdictions. To meet the current needs for SMAP and RWA, Pierce County Surface Water Management is partnering with the National WBD team to develop 14- and 16-digit HU boundaries for the County with a semi-automated approach. We adapted an Arc Hydro workflow to generate watershed boundaries directly from a lidar DEM with stream centerlines burned into the DEM and stream flow direction integrated into the flow direction raster. Where stormwater drainage pipes and ditches crossed the automatically generated boundaries from the Arc Hydro workflow, we used manual inspections and adjustments. The development of watershed boundaries at the 14- and 16-digit level in urbanized areas can be more challenging due to the significant impact of the artificial stormwater drainage network at the local scale. For future projects the stormwater drainage network dataset will be improve so that it can be leveraged during the Arc Hydro stormwater analysis procedures. This poster presents our major procedures and results of the Pierce County 14- and 16-digit HU development project.

Tae-Woong Kim, Dong Jin Lee & Jiyoung Yoo, Hanyang University - Modifying the Simple Water Balance Method for Re-evaluation of Dam Inflow and the Water Resource Availability Considering Evaporation in South Korea. Recently, due to climate change such as abnormal rainfall, it is very important to ensure the reliability of the dam inflow data, which is critical in planning and managing the supply and demand of water resources in a basin. However, the simple water balance model that is used in practice makes negative inflows and does not reflect the actual inflow characteristics. In this study, to address these issues, the existing water

balance formula was modified by considering evaporation which is available for calculation among other outflows. The modified water balance formula was applied to Soyang river dam. The results showed that the rate of negative inflows decreased in the re-evaluated dam inflow time series and it was possible to secure consistency for the total inflow volume. In addition, the water balance method considering evaporation made it possible to classify the water resource availability in terms of human and natural aspects by year with respect to the total amount of water resources in the Soyang river dam basin. In other words, the total sum of direct and indirect water resources used by both humans and nature in the watershed could be physically divided into available water resources (inflow) in the human aspect and available water resources (loss due to evaporation) in the natural aspect. According to this, it can be seen that direct water use in the human aspect was about 60%, and the indirect water use in the natural aspect was about 40%.

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Tor Andersen, Jupiter Environmental Research and Field Studies Academy - Results From a Ten Year Study Evaluating the Economic Behaviors and Cognitive Dissidence of Private Well Owners in Southeast Florida. There exists a gap in the psychological connection between individuals' behaviors and the self-reported concerns regarding the health of their drinking water. Although previous studies determined that consumers trust their water systems, the amount of respondents that purchased bottled water showed a statistically significant cognitive difference (Delaney et al, 2020). In Southeast Florida this has led to unsafe water in the homes of private well owners where twenty three cases of brain cancer were reported between the years of 2000 and 2007 (Bergonzoli & Thornton, 2012). The Palm Beach County Health Department reported that in this specific area there were not enough cases to call it a hot spot, but it was later discovered that the sample population chosen was small and that homes for reporting may have been specifically chosen with bias. Subsequent studies showed that chlorinated disinfectant by products and organic materials can in fact cause brain cancer through the exposure to trihalomethanes (Zumel-MArne et al., 2021). These results prompted the preliminary study in 2012 (Bergonzoli & Thornton, 2012) to qualify and quantify homeowner knowledge of filtration system/septic system management and its correlation to human health. The data was collected for approximately four years and then expanded for the next six years to Jupiter Farms, an area that annually floods 60-90 inches and whose septic systems lie approximately 2 feet above the water table. Throughout the study an anonymous survey in the electronic application Survey Monkey was utilized to determine knowledge and decision-making. Links to the survey were distributed using the community-based environmental monitoring research (CBEMR) program GET WET!. Homeowners in Loxahatchee and Jupiter Farms were surveyed regarding trust in their septic and private well systems as well as public systems. Knowledge of proper maintenance of said systems, and attitudes or motivations towards the use of tap water versus bottled water were the primary focus.
https://docs.google.com/document/d/1Y3lAg2KIe1Phnu6TEIIfmt44XnvDy3D1RRLUbeiIWQs/edit?usp=sharing

***Tori Guarino & *S. Carter Oleckna, Florida Gulf Coast University, Fort Myers, FL - Retention Pond Recovery Practices and its Effects on Water Quality and Littoral Vegetation.** In Lee County, Florida, there are more than 8,000 retention ponds which are critical in preventing flooding and reducing pollution. Most are performing poorly due to improper pond management. For the reduction of pollution, plants play an important role in this process because they act as a filter to sequester nutrients. In Southwest Florida, pollution control is often overlooked due to the aesthetics-driven management and the lack of enforcement of regulations within communities. The lack of knowledge on proper pond management causes an ineffective method of pollution removal through vegetation.

In this study, we examined the effects of a retention pond recovery program over a period of time. We implemented a "no-mow" zone, eliminated pesticide and copper dye applications, and removed an invasive plant species. To test the effects of the program, water quality was examined before and after implementation by examining levels of nutrients using standard protocols. Plant diversity and plant coverage data were recorded using multiple surveying techniques. Through the water quality and plant composition analysis, we were able to evaluate the effect of these restoration strategies. To evaluate the program effectively, we chose a retention pond located at Florida Gulf Coast University as a control to examine water quality and plant data.
The results showed that there were significant nutrient fluctuations after the change in management practices, including lower TN, TP, and TKN and varied trends in NO2 and NO3. We found both plant diversity and coverage increased over time. Comparisons to other ponds and controls will be discussed.

***Wuhuan Zhang, University of Virginia - Potential of Vegetation to Mitigate Deicing Salt Loading in Green Infrastructure Designs.** Concerns regarding non-point source pollution have been steadily increasing over recent decades in the United States. Sudden discharges of stormwater runoff from paved surfaces lead to flooding and water pollution into aquatic ecosystems. Thus, green infrastructure (GI) has been increasingly used for stormwater management and has been employed since the late 1990s in the hope of mitigating impervious surface hydrology effects. Bioretention (BR) is a typical GI system with a soil bed planted with suitable vegetation, and performs well in reducing runoff risks, such as deicing salt loading in winter on highways, which can easily travel with stormwater runoff from the highways to receiving waters and stresses plants and animals, as it impacts water quality. However,

few studies exist comparing the performance of BR designs with different types of vegetation in the same conditions. This research explores the potential of different vegetation types to mitigate deicing salt released from a bioretention. Six engineered soil columns were built in a laboratory to simulate a 1012 m2 bioretention basin along Lorton Road, Fairfax County, VA, USA. The effect of vegetation type (Blue Wild Indigo and Broadleaf Cattail) and influent salt concentration on flow volume were monitored and quantified for multiple storm events. For all storm events and vegetation types, Cl− load reduction ranged from 26.1% to 33.5%, and Na+ load reduction ranged from 38.2% to 47.4%. Different inflow salt concentrations yielded different removal rates of deicing salt, and columns planted with Broadleaf Cattail performed better for volume and salt mass reductions than columns planted with Blue Wild Indigo, which performed better than the controls.