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Abrams, Robert

Authors: **Robert Abrams**, Florida A & M Univ. College of Law

Category: Science, stakeholders and decision-making
Session Title: Governance and Regulation

Operating Dams: Triage, Fairness, and Takings of Property

In 2012, the United States Supreme Court decided the case of Arkansas Game and Fish Commission v, United States, 133 S.Ct. 511(2012). That case presented a claimed taking of property lodged by a downstream riparian owner located 115 miles downstream against the Army Corps of Engineers after the Corps changed dam operations. As a result of the changed operations, the landowner's flood plain parcel experienced a more extend period of inundation each spring that lingered into the active growing season of a hardwood forest, killing the trees. While the Court answered the narrow question that a temporary inundation could constitute a taking, it offered little guidance to the Corps or property owners about the other issues that will now arise in the case—how great an imposition on riparian rights will amount to a taking and whether the Corps can avail itself of doctrines based on avoiding a greater public harm or reciprocity of advantage to defend against takings claims in this or similar cases in the future. This presentation will explore those remaining issues with a particular emphasis on the increasingly important triage role that is being played by the Corps and others as de facto water managers faced with adapting the operations of water control infrastructure to the less predictable future ushered in by the loss of stationarity. The presentation will identify a small number of instances in which condemnation or compensation should be required, and for the remainder of cases, suggest ways in which the burdens of protecting the greater public from flooding should be distributed.

Alonso, Alice

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Unintended Consequences of Engineered Water Systems: Understanding the spatio-temporal dynamic of hydrological interactions between a human-transformed NW Costa Rican watershed and the downstream degraded Palo Verde Ramsar wetland

During the last decades, many places around the world have been facing major changes in land use due to the implementation of engineered water systems. These systems aim to answer the ever growing need for food, energy, and water by withdrawing, storing, conveying and/or transferring the resource. Most often, those systems have been planned and managed to address a limited set of objectives, which often results in unintended consequences on the ecosystem. This study focuses on the 5404 km2 Tempisque watershed in NW Cost Rica that faced drastic transformations with the late 70's implementation of a large-scale water transfer project for hydroelectric power and irrigation. Today, it is largely recognised that the basin suffers from severe ecological degradation. Amongst others, the Palo Verde coastal wetland, situated in the lower part of the watershed and internationally recognized as a Ramsar site, has shown major degradation with a dense cattail invasion and decrease in the bird population. There is no clear evidence regarding causal factors but understanding these is critical from a management and restoration perspective.
In this study, we hypothesize that ecological degradations are linked with transformations in the upper watershed, and consequent impacts in the dynamic of water quantity and quality. The complexity of the water system makes the establishment of a direct causal-relationship difficult. High resolution time series data of rainfall, discharge and water level in the wetland were analysed with explanatory, dimension-reduction time-series analysis tools (Single Spectral Analysis (SSA), phase-space reconstruction, Dynamic Factor Analysis (DFA)) in order to (i) infer the emerging patterns in the water flow and wetland hydroperiod; (ii) identify the drivers; and (iii) identify hydrological relationship between the upper watershed and the lower wetland.

Amini, Adib

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Sustainable Energy and Nutrient Recovery from Swine Waste: A Life Cycle Environmental Impact and Cost Assessment

Swine production represents approximately 40% of the world's meat production, and swine wastes contain high concentrations of organic matter, nitrogen (N) and phosphorus (P). Swine production is intensifying as meat demand increases and concentrated animal feeding operations (CAFOs) containing up to 10,000 pigs become increasingly common, thereby making it difficult to treat the waste generated. A holistic system for treatment of swine waste generated in CAFOs is being investigated to sustainably generate energy and recover both N and P as saleable fertilizer through anaerobic digestion (AD) followed by struvite ($MgNH_4PO_4 \bullet 6H_2O$) precipitation and N recovery through ion exchange onto natural zeolites. Nutrient and methane recovery mitigates both eutrophication of receiving waters and greenhouse gas emissions caused by untreated waste. Struvite recovery also addresses global P shortages and produces a slow-release fertilizer, while N adsorbed zeolite further meets agronomic N demands. The economic and environmental sustainability of such additional treatment, however, remains unknown. The objectives of this study were to investigate: (1) recovery of N and P via struvite precipitation from anaerobically digested swine waste at the pilot scale, (2) evaluate content/quality of struvite precipitate form by XRD and SEM-EDS analysis, (3) perform a life cycle environmental impact and cost assessment to quantify the benefits of the holistic system for energy and nutrient recovery being investigated. Initial results show over 90% removal of P via struvite precipitation as well as XRD and SEM-EDS analysis that confirm struvite presence. Further results will be presented along will results of the life cycle environmental impact and cost assessment.

Arnold, Thomas

Authors: **Thomas Arnold**, University of Florida
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Evaluating shifts and sources of organic matter input to Lake Harris, Florida, USA.

A recent study of Lake Harris (Kenney et al. 2010) used multiple geochemical proxies to identify a pre-settlement shift in primary producer community structure (PPCS) that was not associated with significant changes in sediment phosphorus composition. This shift in PPCS may have been associated with the onset of a wetter climate at the end of the Little Ice Age, ca. 1850. Geochemical analysis of the complete sediment record revealed that the recent shift in PPCS was unique in the history of the lake. To further elucidate shifts in PPCS, molecular and isotopic analyses of lipid biomarkers will be performed on the sediment sampled from the Lake Harris core. Lipid biomarkers that are indicative of particular vegetative communities (algal, cyanobacteria, and higher plants) will be used to assess changes in the relative contributions of allochthonous and autochthonous organic matter to the lake. The carbon isotope composition (δ13C) of individual plant biomarkers will be compared to the δ13C signature of the total sedimentary organic matter to further evaluate shifts in primary production throughout time.

Arteaga, Marliz

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Hydroelectricity development in the Amazon: clean energy option in a climate change scenario?

In the Amazon, large dams have been built or are planned along the Amazon River and its tributaries affecting water quality, aquatic wildlife and socioeconomic systems bringing enormous human and environmental costs. This paper presents a review and an analysis of perspectives as well as approaches regarding potential climate change effects related to hydroelectric development in the Amazon. Methods included literature review and analysis of research collaboration using social network analysis of peer-reviewed publications on the intersections between climate change and hydroelectricity development in the Amazon. Results indicate that hydrodams are often framed as clean energy, given the lower greenhouse gases (GHG) emissions compared to thermal energy sources (e.g. coal, oil, and natural gas). However, research indicates that GHG emissions from hydroelectric dams may actually be greater than fossil-fuel plants in the first years of operation, especially CH4 (methane) emissions, which is more pollutant than CO2. Additionally, the indirect impacts of hydroelectric dam construction on land-use and land-cover change from deforestation and urbanization are poorly understood. There are contradictory perspectives and lack of consensus about framing hydropower as clean energy between scientists and society. We conclude that more research is needed in the Amazon, in order to identify the direct and especially indirect effects of dam construction in a climate change scenario.

Athayde, Simone

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Category: Water security: the water-energy-food nexus
Session Title: Water-Energy Nexus

Amazon Dams Program: Advancing Integrative Research on Social-ecological Dynamics of Hydroelectricity Production in the Brazilian Amazon

The Amazon biome is an important global climate regulator and provider of critical ecosystem services that are threatened by ongoing and planned infrastructural development, including the implementation of hydroelectric dams for energy supply in several critical Amazonian watersheds. Escalating social-environmental uncertainty about the risks and benefits of dam construction is due to the existing piece-meal approach to impacts analysis, which fails to integrate knowledge and data about the potential for large-scale transformation of the Amazonian landscape by proposed dams, suggesting an urgent and timely need for coordinated interdisciplinary research. The University of Florida Amazon Dams Program involves the formation of an international, multi-institution, inter- and transdisciplinary network to foster integrative and shared understanding of the coupled human-natural systems transformed by hydroelectric dams in the Amazon by focusing on the Tocantins and Madeira watersheds in Brazil and comparing these systems with the Glen Canyon Dam in the US. The network applies a progressive integration approach for understanding nested interactions between watersheds, rivers, and the built environment while considering social actors, processes and drivers that affect and are affected by these ecosystems and their often complex interactions. Our emphasis on inter- and trans-disciplinary knowledge production emphasizes the promotion of dialogue between polarized sectors in energy, water, society and natural resources. We believe that the network has a great potential for developing integrative solutions for a variety of pressing social-environmental problems in the Amazon and other regions across the globe.

Barry, Savanna

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Morphological characteristics and patterns of biomass allocation of Thalassia testudinum in relation to nutrient regimes off Florida's Gulf Coast

Variation in environmental conditions can profoundly influence the biology and ecology of seagrasses. Light availability, for example, is considered a primary determinant of seagrass distribution and production. During periods of low light, below-ground tissues are presumed to serve as an energy reserve that supports basal metabolic demands and maintains a positive carbon balance. In addition, seagrasses in oligotrophic conditions may allocate more carbon to roots to increase nutrient uptake from sediments. Little is known, however, about the relative allocation of photosynthetically derived resources to above- and below-ground tissues under different nutrient regimes. Altered partitioning in response to nutrient availability is likely to have implications for the morphology and shoot density of seagrasses, with subsequent effects on a broad suite of ecosystem services. For example, dense seagrass stabilizes sediment, facilitates deposition of particles, increases water clarity, and provides habitat for fish and invertebrates. To test this hypothesis, blade area, shoot height, shoot density, and above-ground and below-ground biomass were measured for seagrasses along a known phosphorus gradient off the central Gulf coast of peninsular Florida. We related these important structural characteristics of seagrasses to surface water nutrient concentrations. Water column N:P ratios were negatively related to blade area per shoot, blade biomass per shoot and above- to below-ground biomass ratios for Thalassia testudinum, but positively related to shoot density, rhizome biomass per m^2 and root biomass per m^2. In contrast, total biomass per m^2 and per shoot and blade biomass per m^2 were weakly or not significantly correlated with water column N:P ratios. These results suggest that T. testudinum maintains a relatively consistent amount of total biomass across the range of nutrient concentrations sampled during this study, but the seagrass adjusts its above-ground morphology and allocation of carbon to above- and below-ground tissues at least partially in response to surface water nutrient concentrations.

Bauer, Mace

Authors: **Mace Bauer**, UF/IFAS

Category: Managing water for people and the environment
Session Title: Poster Session: Managing water for people and the environment

Implementation of Advanced Irrigation Management on North Florida Farms

North Florida's Lower Suwannee River Basin (SRB) is a major field crop production area, particularly for corn and peanuts. Supplemental watering is required to achieve maximum economic production due to sandy, porous soils. More than 32,000 acres of agricultural land in the basin have been fitted with overhead irrigation systems to meet water demand and achieve economic optimum production. The Suwannee River Water Management District reports that on average, production agriculture withdraws 180 million gallons of ground water per day. More than 2,000 center pivot irrigation systems in the SRB account for most of this consumption.
Agriculture is facing increasing pressure from citizens and regulators to show efficient use of water resources. Continuously measuring soil moisture and climate data using current, affordable technology are an excellent method to optimize irrigation management for water conservation and economic optimum management. Recording systems are automated and relatively maintenance free. However, gaps exist in both technical and agronomic knowledge which reduces on-farm implementation of this technology.
The objectives of this project are to 1)) Assemble the equipment and education into a package that can be readily adopted by producers; 2) Deliver this package to producers in the region and help them integrate it into their production system; and 3) Demonstrate groundwater withdrawal reductions realized from this program.

Berg, Sanford

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Category: Science, stakeholders and decision-making
Session Title: Governance and Regulation

Best Practices in Water Regulation

The fundamental lesson that emerges from this survey of water utilities in developing countries is that sector regulation has to be embedded in an adequate and consistent institutional framework in order to have a positive impact on performance. Sector regulation, by itself, is no guarantee of performance improvements in the drinking water supply and sanitation sector. Case studies and empirical analyses suggest that without significant changes in the supporting institutions, the standard tools of regulation will not be effective. The study's conclusions also apply to Florida, where water management districts, the Department of Environmental Protection, the Florida Public Service Commission, municipal governments and local Boards of Directors provide oversight—which can be overlapping or conflicting. The problem boils down to getting a broader set of institutions to support regulatory and managerial actions that promote good sector performance. This means getting the governance structures right (rules of the game) and the substantive actions right (play of the game). Conflicts usually arise in the politically-sensitive water services sector, so the regulator also needs to develop tools for conflict resolution. Thus, the conclusion that the institutional environment matters also provides a rationale for establishing a comprehensive set of governance reforms. These reforms may go beyond the jurisdiction or immediate responsibility of the regulatory agency itself. The regulatory system goes beyond the regulatory agency and the water utility to include stakeholders that are in a position to support, block, or blunt reforms that would improve performance. Without broad institutional support, even a technically competent agency will find itself marginalized by political forces that are far stronger. Ultimately, a sound regulatory system requires coherence, creativity, real-time communication, collaboration, consultation, and credibility. The study is based on a report for the Economic Commission for Latin America and the Caribbean (UN), 2013: http://www.eclac.org/publicaciones/xml/1/49891/Bestpracticesinregulating.pdf

Bohlen, Patrick

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Category: Water quality protection and treatment
Session Title: Environmental Services

Trade-offs Between Hydrologic Changes and Ecological Taxa in a Payment-for-Environmental-Services Program on Florida Ranchlands

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Agricultural lands can provide ecosystem services beyond food and fiber production, and the production of these other ecosystem services can be encouraged through various incentive programs. Payment-for-environmental-services (PES) programs are one mechanism for enhancing the provision of multiple ecosystem services from agricultural lands, but few studies have examined how payments for one kind of service, such as hydrologic benefits, influences or creates trade-offs for other services, such as changes in ecological communities. We are evaluating tradeoffs among hydrological and ecological services in a PES program that pays ranchers to provide water-related ecosystem services of water and nutrient retention in wetlands on Florida ranches. In addition to collecting in-depth hydrologic data to document these services, the project is (1) quantifying biodiversity and production services (vegetation, aquatic vertebrates and invertebrates) and (2) evaluating the degree to which provision of water services might create positive or negative trade-offs for the additional ecosystem services of biodiversity, invasive species or forage production. In this talk we present results relating water depth and other factors, such as time since flooding, ranch site, and growing degree days, to the abundance and diversity of wetland plants, vertebrates and invertebrates in ranch wetlands with hydrologic regimes that have been modified by ranch water management. Plant cover and species richness was negatively related to maximum water depth in wetlands, and the cover of exotic species was negatively related to natives. The abundance of animal groups was also influenced by depth, with most groups more abundant in shallower water, but the relationships were more complex, and were affected by factors such as time since flooding began, and ranch site, and varied among taxonomic groups. These relationships are being used to develop hydroecological models, and to inform decisions about how ranch water management may affect wetland plant and animal communities.
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Bottcher, Del

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Category: Water quality protection and treatment
Session Title: Springs Protection and Management 2

Environmental Assessment of the Okeechobee Basin Using WAM

Anthropogenic activities within the Okeechobee Basin have resulted in an impairment of its receiving waterbody (Lake Okeechobee). To address the TMDL that has been set for the Lake, FDEP is currently developing the Lake Okeechobee BMAP including associated load allocations. FDEP is using the Watershed Assessment Model (WAM) results from model runs recently done for a separate project for the SFWMD to assist in their development of the load allocations. WAM was setup and calibrated for all of the contributing watersheds to the Lake except for the Everglades Agricultural Area that only has occasion discharges to the Lake. The WAM model will be briefly described, but the primary focus will be on how the WAM results are being used for helping determine the BMAP load allocations and how it can be used to assess future mitigation / abatement strategies.

Bowden, Chandra

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

The relationship between perceived government influence and water preservation behaviors of Floridian residents

Previous research has demonstrated that Americans are concerned about water quality and feel that the government should play a role in ensuring protection of natural resources. There have been few studies, however, that elucidate how perceptions of the government's approach to environmental policy impacts citizens' engagement in water-preserving behaviors. Water preservation behaviors include water conserving behaviors (e.g., not irrigating lawn during rain events) and well as water protecting behaviors (e.g., not pouring grease down the drain). It is important to explore this relationship as government environmental policy (e.g., water restriction days) has a systematic influence on all citizens. The objective of this study is to determine how perceptions of government control in environmental policy predict frequency of water preservation behaviors. An online survey was distributed to a group of Florida residents representative of the population in December 2012 using a panel created by a national market research firm. 469 responses were collected from participants who represent the geographic, age, gender, and race/ethnicity distributions comparable to the 2010 population Census of Florida. We hypothesize that an increase in perceived government support will be positively associated with an increase in water preservation behaviors, and that an increase in perceived government control will be negatively associated with an increase in water preservation behaviors.

Boyer, Mackenzie

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Category: Managing water for people and the environment
Session Title: Poster Session: Managing water for people and the environment

Big Data Indicates Big Irrigation Potential of Florida-Friendly Landscapes

The impact of water conservation programs can be maximized when water customers with the highest use are targeted for participation. Utilities may be able to maximize irrigation conservation by first identifying irrigating customers, then focusing conservation activities on these irrigators. This research will discuss how customers in southwest Florida were categorized as either irrigators or non-irrigators and will then estimate the potential water conservation impact of the Florida Friendly Landscaping (FFL) program.
Big Data (i.e. over 44 million records) consisting of monthly potable combined (indoor and outdoor) water billing records and property appraiser data for 650,000 customers were used for this analysis. Irrigation applied per unit area was estimated by subtracting estimated indoor use from total water use, then dividing by the estimated irrigated area. Theoretical gross irrigation required was calculated using an irrigation efficiency and a daily soil-water balance that included weather and soil inputs at each customer's parcel. Ratios of irrigation applied to irrigation required were calculated for each customer and were used in a k-means statistical procedure to classify customers as either irrigators or non-irrigators.
An alternative landscape such as FFL is generally characterized by greater plant diversity and a lower irrigation requirement. Based on analysis of the billing records for 125 FFL homes and their neighbors, FFL homes used 72% less irrigation than their traditionally landscaped, turf-dominated neighbors. By applying this water savings to the customers, the estimated irrigation savings if all irrigators converted their landscapes to FFL was predicted to be 16 billion gallons per year.

Boyer, Treavor

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 1

Impact of Sea-Level Rise on Saltwater Intrusion and Formation of Brominated Disinfection Byproducts during Chlorination

Sea-level rise (SLR) resulting from climate change is expected to increase saltwater intrusion and contamination of fresh groundwater. An overlooked process during saltwater intrusion is the co-transport of bromide with the chloride. Although bromide is present in saltwater at much lower concentrations than chloride, bromide can form disinfection byproducts (DBPs) during water treatment whereas chloride is an aesthetic concern. The objective of this research is to quantify the impact of SLR on the potential to alter groundwater chemistry and increase the formation of brominated DBPs during chlorination step of water treatment. This presentation will highlight the results from three research tasks: (1) modeling saltwater intrusion in a coastal aquifer in Florida under different projections of SLR, (2) investigating the spatial and temporal variability of the chloride-to-bromide ratio, and (3) modeling and experimental data on the formation of bromine-containing DBPs during chlorination based on the varying degrees of saltwater intrusion. Illustrative results are as follows. The groundwater modeling predicted the total dissolved solids (TDS) concentration as a function of time for different SLR scenarios. The TDS concentration was converted to chloride and bromide concentrations using standard seawater composition. The groundwater modeling results showed that for different projections of SLR, the bromide concentration exceeded 200 ug/L at an earlier time than the chloride concentration exceeded its secondary standard (250 mg/L). Preliminary estimates using the DBP models predicted elevated formation of brominated DBPs at 200 ug/L bromide. Thus, the preliminary results suggest that saltwater intrusion, induced by SLR, can result in elevated formation of brominated DBPs before the traditional concern of exceeding the secondary standard for chloride. This presentation will highlight the changes in water chemistry that occur in a coastal aquifer in the context of SLR projections over a 100-year timeframe, and consequent formation of brominated DBPs during drinking water treatment.

Bridger, Kristina

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Chris Anastasiou, Southwest Florida Water Management District

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Planning and Management

Bridging the Gap between Scientists, Policymakers, and the Public: Case Study of the TMDL Working Group for Kings Bay

A total maximum daily load (TMDL) is the scientific determination of the maximum amount of a given pollutant that a surface waterbody can absorb and still meet the water quality standards that protect human health and aquatic life. The purpose of a TMDL Working Group is to bridge the gap between the public, policymakers, scientists, and other stakeholders. It provides an opportunity for municipalities (City and County governments), scientists across multiple disciplines, local interest groups, the public, the Florida Dept of Environmental Protection (FDEP), and the Southwest Water Management District (SWFWMD) to communicate and collaborate during TMDL development. The TMDL Working Group model allows for detailed, focused discussions and input into the development of water quality models and data analysis. This level of technical participation results in a stronger TMDL document based on local knowledge and the best available science.
Kings Bay and several of its springs were verified by the Florida Dept of Environmental Protection as impaired for nutrients (algal mats) and were included on the Verified List of impaired waters for the Springs Coast Basin that was adopted by Secretarial Order in February 2012. In 2013, nutrient TMDLs were developed for Kings Bay, Hunter Spring, House Spring, Idiot's Delight Spring, Tarpon Spring, and Black Spring. At the TMDL Working Group meetings, the parties presented local data, experience, research studies, and additional information, which provided the Department with a better understanding of the system. The TMDL Working Group meetings were instrumental in establishing the water quality target limits for Kings Bay and its impaired springs.

Britt, Mike

Authors: **Mike Britt**, City of Winter Haven

Category: Managing water for people and the environment
Session Title: Water Supply Planning

Sustainability: A New Operating System for Water Resource Management

A colleague once said “regulation is a blunt tool for solving problems”. In 1972, the current framework for Florida water management was adopted and a new era began. Overall, many would say that some improvements to water resources resulted, but few would say that water resources in general are in better condition today than in 1972. The primary purpose of existing regulations has been to establish minimum standards, not facilitate long term solutions.
Florida is projected to grow by approximately 230,000 people per year for the next three decades. This translates into a demand for over 600,000,000 gallons of additional water supply per day and will bring additional impacts to stormwater quality and aquifer recharge which are allowed under today’s regulations.
One of the most important questions becomes “if we continue to follow today’s approach, will water resources be better, the same, or worse in the future”? In Winter Haven, where there are 50 lakes with low lake levels and declining water quality, we have answered this question as a resounding ‘worse’. Many other communities in Florida are reaching the same conclusion. Florida needs a new approach. The decision-making framework needs to incorporate the incredible complexity of all that water has to offer for economic growth, social benefit as well as environmental health. The idea that we can create a sustainable future for water is worthy of consideration and is looking more like a possibility.
An interesting perspective is that sustainability is as much about process as an end result. Concepts such as adaptive management and strategic planning are vital. Changing science and hydrologic conditions can be incorporated. Ecosystem services would be a foundation to meet established goals. Regulations become less significant. This presentation will review a new framework for making sustainable water management decisions based on these concepts.

Brown, Amy

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

A comparison of the impact of diffuse and point source recharge on surface and groundwater quality

Unconfined karst aquifers can have complex interactions with rivers that receive runoff from upstream reaches with less permeable sediments, where surface runoff after rainfall can cause a rapid rise in river stage. If river stage exceeds the hydraulic head of adjacent aquifers, surface runoff from storms can intrude into the aquifer through spring vents, resulting in point source recharge and temporary storage of surface water in the aquifer. This intrusion of river water can be moderated or eliminated if groundwater heads are elevated by diffuse recharge. To assess the influence of diffuse recharge and temporary storage of river water on water quality, we examined changes in hydraulic head and chemical composition of water during and after two storms at Madison Blue Spring in north Florida. In March 2012 rain fell mostly in the upper portion of the river drainage basin and runoff caused a rapid increase in river stage. As a result, Madison Blue spring began reversing after the river stage exceeded the hydraulic heads in the spring, the conduits, and the aquifer matrix. The river water that entered the aquifer was enriched in organic carbon (OC). The breakdown of OC during temporary storage of surface water resulted in enhanced calcite dissolution, and consumption of oxygen and nitrate in the matrix adjacent to the conduits. In contrast, rain in June 2012 fell predominantly on the unconfined springshed. The hydraulic head of the groundwater remained above river stage because of the diffuse recharge, and the spring did not reverse. Since no OC-rich river water entered the aquifer, the OC breakdown with its corresponding reactions did not occur in the aquifer. Instead, spring water continued to discharge, altering the composition of the river water. These events illustrate that distribution of precipitation across a watershed impacts the exchange of surface water and groundwater.

Campoverde, E. Vanessa

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Educating Environmental Horticulture Producers about Water Quality and Conservation Impacts on Plant Production

(Application for the UF/IFAS Symposium Scholarship)
Conservation and protection of Florida's water resources are vital to the future of container nursery and greenhouse production. Container plants are grown in small volumes of soilless substrates in which the water is usually replenished daily. Consequently, large amounts of water are applied frequently, often with low application efficiency.
To achieve more efficient irrigation applications, a team of state and county UF/IFAS Extension faculty with expertise in irrigation water quality and conservation was formed. The objective of this team was to transfer information and technology about water conservation and water quality impacts on plant production to producers. The Water Team worked with educational partners such as Water Management Districts, County Agencies, USDA Natural Resources Conservation Service Mobile Irrigation Lab, South Dade Soil & Water Conservation District Mobile Irrigation Lab, UF/IFAS BMP Implementation Team, and Florida Nursery, Growers and Landscape Association members.
The Water Team has conducted educational programs in central and south Florida since 2012 with 92 attendees. Participants received classroom instruction and applied their knowledge in the field with hands-on exercises such as irrigation uniformity measurement. Pre- and post-survey questions were used to access knowledge gain. Participants reported that their knowledge increased from 24 –71% across educational programs.

Capece, John

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Category: Water security: the water-energy-food nexus
Session Title: Water-Energy Nexus

Trade-offs between biofuels energy production, land use and water use in Florida

Reflecting rapidly growing interest in biofuel, Florida has aggressively pursued the development of a biofuel industry, including experimenting with various bioenergy crops to meet its energy goals. However, various implications of these new alternative energy sources on limited natural resources and the State's agricultural production require investigation. Agricultural land use expansion to accommodate biofuel crops and the escalation of agricultural production intensity on existing farm/ranch lands is a direct indicator of agricultural water demands.
This study (1) estimates the land use and water footprint of biomass production in Florida using various bioethanol crops, (2) provides a simplified measure of these crops efficiency in delivering energy products (bioethanol) and (3) evaluates the land use and other natural resources implications of using biofuels as a substitute for petroleum-based gasoline to meet an average Floridian fuel needs.
Florida has over 19,000,000 inhabitants, over 14,000,000 registered vehicles with an average annual mileage of 13,348 miles/vehicle/year and an average E10 fuel consumption of 23.5 miles/gallon. Assuming bioethanol having 66.7% energy content of petroleum-based gasoline per unit volume, an average 625.7 gallons of bioethanol (E100) per year per Floridian would be needed, if only bioethanol was used as a vehicular fuel. Results show a range from 0.54 ac/person using Eucalyptus to 2.16 ac/person using Switchgrass to produce the volume of E100 necessary to deliver the equivalent energy of gasoline consumed by the average vehicular fuel needs of one person in Florida. This represents 127% to 507% of all available agricultural land in Florida.
It is expected that potential expansion of biofuels cultivation will occur largely at the expense of natural areas and pastures. If all bioethanol (E100) needed for Florida transportation sector was to be produced solely from Sugarcane, about 14.5 million acres of land would be needed for that. Such conversion would increase overall Florida's water use by 89%. If Sorghum was used as the only crop to meet the E100 demands, Florida's water use increase would be 347%.

Cardenas, Bernard

Authors: **Bernard Cardenas**, University of Florida
Michael D. Dukes, Professor & Irrigation Specialist

Category: Managing water for people and the environment
Session Title: Water Demand Management

Can soil moisture sensors improve irrigation efficiency? A review of multi-study results and future implications

This is a review presentation with the objective of summarize and relate the main findings of different research projects carried out in Florida, that evaluated diverse commercially available soil moisture sensor systems (SMSs) for residential irrigation control. The initial goal of the experiments was to find out if SMSs could reduce irrigation water application as compared to typical residential irrigation systems without sensor feedback. The effect of different threshold settings and irrigation frequencies on water application and turf quality was also evaluated. Other research goals included evaluating the consistency of different SMS units and their precision in measuring soil water content. Results on turfgrass plots showed that the 7 days per week (d wk-1) irrigation frequency significantly reduced the water applied compared to 1 and 2 d wk-1 scheduled frequencies. During rainy periods, the SMSs tested reduced irrigation by 42% to 72% on average, depending on specific testing conditions, while maintaining good turf quality. During dry periods, the average savings decreased to -1% to 64%, and the resultant turf quality was sometimes below the minimum acceptable level. Therefore, under sustained dry weather conditions or in dry climates, the run times, irrigation frequency, and/or low threshold settings should be carefully considered. Some SMS brands were more consistent and precise in measuring soil water content and saved more water than other brands. Under residential conditions, SMSs installed for more than 5 years had decreased the water application by 62%, compared to homes with automated irrigation systems without sensor feedback, while maintaining good turfgrass quality. Overall research results clearly demonstrate that SMSs in Florida, when properly installed, set, and maintained, could lead to significant irrigation water savings while maintaining turf quality at or above the minimum acceptable rating. Partial results of SMSs installed on landscapes irrigated with reclaimed water will also be presented.

Chang, Seungwoo

Authors: **Seungwoo Chang**, University of Florida
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Quantifying the relative uncertainties in future rainfall, temperature and evapotranspiration projections across the USA using CMIP5

Understanding climate change and its potential impacts on regional hydrology and water demand is important to reduce risks and increase resilience in water supply planning. For effective regional water resources planning, estimation of the range of possible regional precipitation, temperature and evapotranspiration scenarios considering climate change is necessary. Also, a better understanding of future regional water demands considering changes in climate, population and land use is needed. The objective of this study is to analyze the uncertainty of applying GCMs climate change projections to hydrologic and crop water use models in order to predict future changes in water demands. Reference evapotranspiration is estimated in order to assess the risks and uncertainties of future water demand using the Coupled Model Intercomparison Project Phase 5 (CMIP5) retrospective climate model predictions and future climate projections for different GCMs and 4 future scenarios (RCP 2.6, 4.5, 6.0 and 8.5). The uncertainty of reference evapotranspiration is assessed due to different evapotranspiration estimation methods such as the Penman-Monteith, Hargreaves, Turc, Irmak, Blaney-Criddle and Hamon ET estimation methods. Retrospective reference evapotranspiration predictions are compared with reanalysis reference evapotranspiration (R2 reanalysis data) to evaluate the relative uncertainties across the USA. The results and methods of this study will be used to estimate and range of precipitation, evapotranspiration and water demand projections for future hydrologic study.

Cherrier, Jennifer

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 2

An 'Activated' Green Infrastructure Water Management Approach for Mitigating Runoff-Related Contaminant Loading to Inland and Coastal Waters

Rain garden and bioretention cell systems have been gaining wide recognition as a promising ecosystem-based best management practice for controlling stormwater and irrigation runoff. These low impact systems provide on-site management of water runoff, thereby reducing financial burdens on businesses and municipalities but unlike conventional 'grey' infrastructure, retention ponds, and constructed wetlands, they do not require a large land footprint. The problem with these systems, however, is they are passive and their effectiveness for contaminant removal is variable and inconsistent. A solution to improve the efficiencies of these systems is to introduce some degree of engineering that makes their effectiveness more consistent and allows them to better adapt to changes in the operating conditions. Recent work carried out by our research group has led to the development of this type of 'hybrid' solution, by integrating engineering principals into a passive rain garden/bioretention cell approach. Our group found that soil composition, water retention time & proximity of water to plant root zone are critical for maximizing the efficiency of rain gardens or bio-retention cells for contaminant removal. We therefore developed an ecosystem-based water retention and re-use system (eco-WARES; patent pending) technology that can control both of these variables. When integrated into the design of a rain garden or bioretention cell, eco-WARES technology 'activates' these systems to significantly and consistently enhance contaminant removal efficiencies and also allow for water reuse, aiding in conservation. eco-WARES is completely scalable and customizable for any terrain or flow control, from applications ranging from smaller scale residential lawns or municipal parks to large scale municipal, agricultural or industrial facilities. With water resources under increasing anthropogenic pressures and their sustainability in question, low impact development approaches such as this create functional landscapes and prevent and/or reduce runoff-related contaminants from entering our inland and coastal waters.

Cohen, Jamie

Authors: **Jamie Cohen**, UF/IFAS Marion County Extension

Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Composting and its Benefits: Achieving Practice Change Through Education to Reduce Nutrient Loads and Increase Agriculture BMP Usage.

Situation: The 2007 Small Farms Ag Census Data shows Florida having 10,414,877 acres in "small farms". Marion County, Florida "Horse Capital of the World", has 3496 small farms, a significant percentage of those being horse farms. Marion County is also home to two first magnitude freshwater springs, both currently in the Basin Management Action Plan (BMAP) Process. Several of Florida Department of Agriculture and Consumer Services (FDACS) Best Management Practices (BMP's) Manuals recommend composting as viable best management practice (BMP) options to correctly handle animal waste. Besides helping to protect the surface and ground waters by helping to decrease non-point source pollution, it can also improve soil health and be a tremendous soil amendment.
Methods: Composting workshops are continually delivered to farm owners/managers, having equine and other livestock, on cost-effective and practical animal waste composting. Each program given is tailored to educate on manure's adverse affects on water, how composting manure can improve soil health after land application and how proactive change of manure management systems is improved BMP usage to reduce nutrients to the ground and surface waters. Education is further given on available farm improvement cost-share options.
Results: Pre and post-test workshop results showed a (n= 51) 63% increase in knowledge gain from information taught to n= 81 of total participants attending. Six-month follow-up test will be given to verify BMP improvement and composting usage of farms; two farms are currently in talks with SWFWMD for composting bin cost-share construction as a result of programs delivered.
Conclusion: The end results/impacts are to improve water quality and decrease nitrate levels for improvement of ground and surface water nitrogen levels in Marion County and the state. Improved farm management practices are derived from increased knowledge and understanding of BMPs and manure management, both coming from continuing education.

Cohen, Matthew

Authors: **Matthew Cohen**, UF/SFRC
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Category: Water quality protection and treatment
Session Title: Springs Protection and Management 2

Controls on Metabolism in Florida Streams and Spring Fed Rivers

Ecosystem-scale primary production and respiration, which together comprise metabolism, integrate the various drivers of aquatic ecosystems. Primary production is at the base of aquatic food webs, and respiration provides an integrated measure of ecosystem energy use. In flowing waters, these two quantities can be measured directly based on diurnal (i.e., 24-hr) variation in dissolved oxygen, a solute that is produced during photosynthesis and consumed by respiration. The controls on primary production and respiration are myriad. Among the most important is mineral nutrients, the availability of which has been shown to control primary production in lakes. Increases in nutrient concentrations can stimulate primary production, leading the oxygen consumption at night, with potentially deleterious effects on aquatic organisms, and shifts in the composition of the autotrophs, often from vascular plants to algae. In this work we synthesize multiple data sets for Florida's streams and spring-fed rivers to explore the controls on ecosystem metabolism and specifically test the hypothesis that nutrient concentrations exert important control. Our synthesis includes over 50 separate measurements of metabolism in springs, often over extended periods, and 4 short-term seasonal measurements in over 150 of Florida's streams (i.e., over 600 metabolism measurements). Our results are unequivocal. In both data sets, nutrients (both mineral N and mineral P), which varied in concentration over two orders of magnitude, are uncorrelated with gross primary production (GPP), respiration (R) or net ecosystem production (NEP = GPP – R). The strongest driver of GPP is light, which is revealed by the strong effects of season and riparian cover. Respiration was most strongly predicted by color and by GPP, both of which provide the source of respired organic matter. This has important implications for the setting of numeric nutrient and dissolved oxygen criteria for flowing waters because if metabolism is independent of nutrients, then nutrient levels cannot be invoked as an explanation for low dissolved oxygen levels. Strong seasonal variation in GPP, with peak production several months prior to peak insolation, illustrates that light limitation of GPP has led to phenological adaptions among aquatic autotrophs that further reinforce the commanding role that light limitation plays in primary production in flowing water.

Colli-Dula, Reyna

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 1

Treated Municipal Wastewater Effluents Altered Molecular Signatures and Pathways of Fathead Minnows

Contaminants of emerging concern (CECs) present in treated municipal effluents have the potential to adversely impact exposed organisms prompting elevated public concern. In this study, we used a transcriptomics approach (microarrays and pathway analysis) to identify molecular events associated with exposure to municipal wastewater effluents diluted to 5% original concentrations that had previously undergone secondary-treatment (HTP) or advanced primary-treatment (PL). Of 32 effluent CECs analyzed 28 were detected in the effluents including pharmaceuticals, personal care products, hormones, and industrial compounds. Gene expression patterns differed between effluents. ANOVA analysis revealed a large number of transcripts significantly altered relative to control water among fish exposed to the effluents. Exposure to PL effluent caused changes in steady state levels of transcripts involved in metabolic pathways (e.g., lipid transport and steroid metabolism). Exposure to HTP effluent affected transcripts involved in signaling pathways (e.g.,focal adhesion assembly and extracellular matrix). But, there were also observed changes in genes related to pathways for xenobiotic detoxification, oxidative stress, and apoptosis in both effluents. This study provides novel insights into effects from exposures to complex chemical mixtures containing CECs.

Contreras Arribas, Eva

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Process and network complexity: evaluation of land use change and ecological services through an actor-based model in the Southwest Amazon Region

Changes in society, technology and infrastructure have contributed substantial net benefits to human welfare and economic development, but often with growing costs in the degradation of many ecosystems and their environmental services. The long-term sustainability of the global system, including water resources, will depend of how managers, government and society face up these interactions in the future. This study was conducted to determine the implications of the construction and paving of the Inter-Oceanic Highway in the MAP (Madre de Dios/Peru-Acre/Brazil-Pando/Bolivia) frontier of southwestern Amazon and its effects in land use changes and consequent changes in ecological services. To explore these dynamics, a series of agent-based models considering several different levels of household and landscape complexity were developed with a multidisciplinary team of social scientists, ecologists and biological engineers. Each model version represented different levels of process and network complexity. Process complexity refers to the incorporation of increasingly intricate algorithms, parameters, and feedbacks while network complexity considers the diversity of local agents and their interconnections, markets, land tenure and forest resources. Each model version simulates the temporal and spatial impacts of highway paving on household livelihoods, market connectivity and land tenure along with changes in land use/land cover and concomitant ecological services. As a result, the increase of the complexity within each model version allows a different and comparative representation of the heterogeneous spatial environment, showing results at local and regional scale, including interactions and mutual feedbacks between human behavior and environmental consequences. Each of these agent model renditions provides useful insights into complex decision making and adaptive, spatial management amongst local populations, governance agents and the ecological services.

Couch, Annie

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Category: Water security: the water-energy-food nexus
Session Title: Poster Session: Water Security: the water-energy-food nexus

Growth, Yield, and Nitrogen Accumulation by Sesame (Sesamum indicumL.) grown in North Central Florida.

Sesame has the potential to be a new agronomic crop for Florida with important drought tolerant and nematode resistant properties. However, because commercial production in FL began in 2012, little is known about the crop's phenology, physiology, nutrient uptake patterns in this semi-tropical environment. Research was initiated at the University of Florida's Plant Science Research and Education Unit in Citra, Florida to evaluate six commercial varieties and six experimental varieties for physiological plant characteristics such as yield, leaf area index (LAI), root growth, and dry matter accumulation. Root architecture will be evaluated in situ using minirhizotron imaging throughout the season. In addition, the amount of nitrogen accumulated in sesame during the 2013 and 2014 growing seasons will be quantified using total Kjeldahl nitrogen (TKN) for the above ground biomass of one experimental and three commercial sesame varieties at five times during the growing season. TKN will also be measured for the below ground biomass for two of the three commercial varieties. Soil samples will be taken throughout the season to determine the available nitrogen in the soil. A nitrogen budget will be completed based on the data collected.

Cowart, Lisa

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Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 1

Effects of Reduced Stream Flows on Instream Habitat Conditions in a Tributary of the Lower Flint River

The Lower Flint River and its tributaries in southwestern Georgia have experienced diminished flows in recent decades in response to increased water use for agricultural irrigation. Flow reductions are greatest during droughts and cause extensive dewatering of stream habitat during the summer irrigation season. We are conducting an instream flow assessment in one tributary watershed (Ichawaynochaway) to develop relationships between stream discharge and the quantity and quality of instream habitat and to document biotic responses to these habitat changes. This watershed encompasses several hydrogeomorphic stream types and associated habitats that are common in the region, and the existence of stream discharge records dating back to the 1930s allows for comparisons of flow conditions before and after the advent of widespread irrigation. Elevation profiles were measured at several locations for three ecologically critical habitats that are particularly susceptible to dewatering: shoals, snags, and stream banks. Analysis of these profiles in conjunction with water elevation-discharge relationships and historic discharge records showed that reductions in summertime minimum flows below historic (pre-irrigation) levels increase habitat loss from dewatering; for example, most shoal habitat remained wet during extreme droughts in the past but dries under similar climate conditions today. Shoal drying may also create barriers to passage for fish and other aquatic species. Diel temperature and dissolved oxygen profiles were tracked during summer low flows in pools, which can serve as refugia for stream organisms during droughts. At extreme low flows, pool temperatures were highest (daily maxima of 30-31oC) at downstream sites where the stream channel was wider and less shaded. Oxygen minima reached levels considered stressful (< 2 mg/L) at sites in the upper watershed. At higher flows, water temperatures were lower and oxygen levels were higher throughout the watershed. Studies are underway to assess biological responses to these habitat changes.

Creamer, Anne Elise

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Category: Water security: the water-energy-food nexus
Session Title: Poster Session: Water Security: the water-energy-food nexus

Biochar as a Low Cost Carbon Dioxide Capture Material

It is agreed that reducing CO2 emissions is a necessary step for a sustainable world; therefore, a great deal of research attention has been given to designing materials to capture CO2. Postcombustion capture methods, which separate CO2 from flue gas after energy generation, are considered the most “marketable technology”. The main challenges of this method are in the separation of gas, high flow rate, and low partial pressure. A porous carbon framework, called biochar, has received attention for its ability to remove contaminants, sequester carbon in soils, and concurrently improve soil quality. Biochar does not require activation, can be produced from waste biomass, is 10x cheaper than AC , and is environmentally friendly.The surface properties of biochar give it excellent potential for CO2 capture because not only do they tend to be polar and hydrophilic, but the extensive micropores allow biochar to achieve comparatively high surface area-to-weight ratios.
The overarching objective of this work was to determine biochar’s potential as a low-cost CO2 capture material. Two commonly used feedstock materials were converted into the biochars through slow pyrolysis at 300, 450, 600˚C and the chars were assessed for their adsorption of CO2. This study shows that biochar is a promising framework for adsorption of CO2. The sugarcane bagasse feedstock produced at 600˚C showed the most adsorption, with over 1.4mmol CO2/g biochar; however, even when the feedstock was exposed to only 300˚C pyrolysis, it was still able to adsorb .8mmol CO2/g char. Although CO2 weakly sorbs to the surface of the char, the large surface area allows it to be among the highest of physical adsorbents. In future study, metal oxides, amines and other materials can be added to biochar to enhance bonding and functional group attraction.

Crones, Charles

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Category: Managing water for people and the environment
Session Title: Poster Session: Managing water for people and the environment

Hydroelectric Dams in the Amazon: Direct and Indirect Socio-Cultural Impacts on Local Communities

This project developed within the Amazon Dams Project, under the direction of the Tropical Conservation and Development Program and the Center for Latin American Studies at UF. The Amazon Dams Project is actively developing an interdisciplinary network of international researchers addressing questions related to the social-environmental impacts of hydroelectric dams. To meet the nation's projected energy needs, Brazil's government has begun implementing its plans for a massive network of hydroelectric dams in the Amazon. Development of this scale will have dramatic effects, including the disruption of river functionality, intensified deforestation, and accelerated methane emissions. The direct and indirect impacts of dam construction escalate both social and environmental uncertainty and risks, most notably the loss of ecosystem services. These services provide critical benefits such as climate regulation (i.e. flood/drought cycles), nutrient cycling, carbon sequestration, water storage, etc. Research will focus on three main variables confronting Indigenous and embedded local communities: water quality and water related diseases; rivers as means of transportation; and rivers as food providers. This research aims to better understand the direct and indirect socio-cultural and health effects within the designated area of direct affect, as well as the areas up and down river indirectly affected through a loss of river connectivity. Specifically, research activities for this project poster will consist of gathering existing data from current hydroelectric dam sites in two Amazonian watersheds, the Tocantins and the Madeira. Data will then be analyzed and preliminary findings will be reported. By understanding the impacts to local population health, as well as ecological and socio-cultural systems, we aim to identify useful analytical tools with the potential to help policy and decision-makers find the best paths forward as they consider new hydroelectric dam projects.

Cumming, Andrea

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Evaluation of Coagulation and Adsorptive Treatment Technologies for Phosphorus Removal from the Middle St. Johns River Basin

Background:
Nutrient pollution is a widespread issue affecting Florida surface water. Phosphorus pollution, in particular can induce algae blooms and other water quality changes that can detrimentally affect the environment. A high priority and challenge for the stakeholders of water resources is to effectively identify and control phosphorus loading from non-point sources and in polluted surface water in order to reduce eutrophication and improve water quality.
The Problem:
The St. Johns River has been identified by the St Johns River Water Management District (SJRWMD) as “impaired for nutrients”. Geographically, the impairment is located within the upstream reaches of the Middle St Johns River basin in Lake Harney to the downstream reaches of the Lower St Johns River basin. The SJRWMD has initiated efforts to develop nutrient reduction projects that will address the impairment of the St. Johns River.
The Study:
Several innovative uses of adsorptive materials (including reuse of industrial by-products) are being considered for use in nutrient treatment of surface water. Isotherm models and column testing were conducted for four solid adsorbents including dried alum sludge, fly ash, Bold & GoldTM (UCF), and SorbtiveMEDIATM (Imbrium Systems Inc). Additionally, jar testing of two liquid coagulants aluminum chlorohydrate (ACH) and poly aluminum chloride (PACl) was conducted to determine their effectiveness for total phosphorus removal. Toxicity testing using Microtox was also included to evaluate secondary water quality impacts from these technologies.
The Benefit:
This study provides detailed insight into the potential for phosphorus treatment using various by-product materials as well as several proprietary technologies and the flexibility of their applications in the environment.

Dang, Viet

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 1

Insight into bioaccumulation of persistent organic pollutants (POPs) acquired by trophic transfer

The presence of legacy organochlorine pesticides and personal care products in the environment draws much attention to the public because these contaminants are bioavailable to aquatic organisms and subsequently can bioaccumulate at higher trophic levels. Fish introduced into mesocosms of Lake Apopka, FL, which are historically contaminated with organochlorine pesticides (OCPs), had OCP concentrations 20-300 times higher than those of pre-treated fish. Here, we conducted a trophic transfer to track body burdens of contaminants. Two freshwater organisms including blackworms (Lumbriculus variegatus) and fathead minnows (Pimephales promelas) were used in this model. Surficial soils were collected from the least contaminated area of Lake Apopka's north area. Contaminated soils were prepared by spiking either single chemicals or a mixture of p,p'-DDE, dieldrin, triclosan, triclocarban, and fipronil dissolved in methanol into a slurry of soil and water. The slurry was agitated continuously for 28 days and then stored for one month prior to use. The bioaccumulation study was accomplished by exposing worms to spiked soils. In addition, worms were exposed only to spiked water and then fed to fish. Worm and fish samples were collected after 2, 7, 14, 21, and 28 days of exposure to determine body burdens of chemicals. Preliminary data show that bio-uptake in worms reached a steady state within a week. Exposure study indicated that worms incur body burdens through 2 pathways, exposure to contaminated soils and contaminated water. Data from this study will be useful for both risk assessment of contaminated aquatic systems and decision making for site remediation.

Dari, Biswanath

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Rao Mylavarapu, Professor
Willie G Harris, Professor

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Model Parameters from Soil Test Data for Input into Phosphorus-loss Predictive Models

Florida sandy soils are susceptible to phosphorus (P) loss from an agricultural or animal production system into nearby water bodies via surface or subsurface pathways. Leaching is a predominant mode of P transport from these soils. Chemical equilibrium models often use the P bonding strength (Langmuir KL) or the Freundlich coefficient (KF) to predict P release from a soil. If KL or KF can be obtained from an oxalate or a soil test solution, it would offer an easy means of obtaining "K" for modeling. Phosphorus LEAching from Soil to Environment (PLEASE) is a simple P loss predictive model based on P sorption mechanism in a soil and its potential movement into surface water. Our objective was to relate the P saturation ratio (PSR) to isotherm parameters based on the hypothesis that KL or KF will be related to the PSR as determined from P, Fe and Al concentrations in an oxalate solution. Isotherms were constructed on soil samples collected from A, E and Bt horizons of a manure-impacted dairy sprayfield and KL and KF values were computed. All soils were analyzed for P, Fe and Al in an oxalate extract. Results indicated that there is a relationship between PSR and Langmuir KL or Freundlich KF suggesting that it might be possible to obtain these "K" values from P, Fe and Al in an oxalate solution for input into the PLEASE Model. The Model uses P adsorption parameters, precipitation, soil test phosphorus and groundwater height as inputs to predict loss of P. Performance of PLEASE model might be comparable with other reliable methods for estimating P loss from an agricultural system into surface water.

Davis, Stacia

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Improving the model for evaluating the efficacy of weather-based irrigation controllers

Smart controllers are evaluated for irrigation scheduling efficacy using the Smart Water Application Technologies (SWAT) testing protocol. The SWAT test is considered the industry standard by the Irrigation Association and the government standard by the EPA WaterSense program. The SWAT test was designed as a daily soil water balance with many simplifications to a complex system that rarely reflect dynamic soil water responses. However, government agencies and water purveyors require SWAT results for rebate programs in attempts to increase water conservation efforts. The objective of this research was to evaluate models that can determine efficacy of weather-based irrigation controllers while more accurately representing the real system. In this study, the real system consisted of a bahiagrass pasture located in Citra, FL where time domain reflectometry (TDR) sensors measured soil moisture at various depths across a 94 cm root zone. Volumetric water content was collected at fifteen-minute intervals from 1 January 2004 to 22 June 2004 totaling 173 days. Rainfall and irrigation were measured using a tipping bucket rain gauge. Soil moisture was predicted using three models: A) the original SWAT test, B) hourly soil water balance, and C) modified Green-Ampt with Redistribution (MGAR) model. In addition to the timestep change from daily to hourly in the hourly soil water balance model, restrictions to soil water level at maximum allowable depletion and field capacity were updated to permanent wilting point and saturation, respectively. Additionally, drainage was estimated using a decreasing exponential function. The MGAR model was updated to incorporate irrigation and evapotranspiration in addition to rainfall. It is expected that both the hourly soil water balance and MGAR resulted in better representation of the measured soil moisture while increasing the likelihood of translating from SWAT test performance to real world performance.

Desmarais, Timothy

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Category: Managing water for people and the environment
Session Title: Water Demand Management

SJRWMD development of agricultural water use database in Florida, Georgia, South Carolina, and Alabama for estimating water conservation potential and groundwater recharge

The district hired Royal Consulting to develop an irrigated lands geodatabase (ILG). The goal of this database will be to use it in the development of Ag water conservation potential in the District using the Districts Comparative Farm Agricultural Water Conservation Tool (CFACT) and for use in developing recharge credits in groundwater modeling.
The resulting set of ILG for each state incorporate the best-available information. The irrigated areas for Alabama and South Carolina rely solely on the National Agricultural Statistics Service (NASS) data. The irrigated areas for the panhandle portion of Florida are one step better, incorporating FLUCCS. The irrigated areas for Georgia were based on manually digitized polygons and thus Georgia is considered to be the most accurate coverage from a geometry perspective.
The data for Alabama, South Carolina, and the panhandle portion of Florida were roughly tensioned to the Ag Census data. To do this, crop adjustment factors were defined that reduced the geometric area by a certain factor. No adjustments were made to the Georgia dataset.
Not surprisingly, the largest discrepancy between the ILGs and the Ag Census data is for Georgia. The total irrigated for the ILG is roughly 35% greater than the Ag Census. Tensioning Georgia's data is not recommended because at one point or another, these fields could be irrigated. The Ag Census data is for the calendar year of 2007. The input irrigated areas coverage for Georgia does not specify the time frame it represents, but considering the amount of effort that must have been spent on this, it is more than likely that it includes parcels that were not irrigated in 2007.
The project produced monthly values from January 2000 to December 2010 for each parcel of irrigated ag land.

Engel, Angelica

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Category: Water quality protection and treatment
Session Title: Environmental Services

Hydroecological Modeling for Predicting Ecological Responses to Hydrologic Changes in a Payment-for-environmental-services Program on Florida Ranchlands

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A payment for environmental services (PES) program began in 2008 in South Florida to pay ranchers for the environmental services of water retention and nutrient treatment provided on their ranch. The intent of this program was to decrease the excessive flows and nutrient loads to the Lake Okeechobee-Everglades ecosystem. It is widely known that agro-ecosystems provide various ecosystem services like food and fiber production. It is less known or practiced that the same agro-ecosystems could provide other environmental services like water storage and biodiversity. To determine if the latter environmental services can actually be quantified and be incorporated into PES programs, ecological measurements were taken (2009-2012) at the ranches that participated in the water storage PES to evaluate the environmental services ecological services (wetland plants, invertebrates, amphibians, and fish) and disservices (mosquitoes, invasive plants, and loss of cattle forage). The prediction of biodiversity is necessary should it be added to the water storage PES. Measured data and predictions from a hydrological model were combined with the ecological data, to develop hydroecological regression models to predict the ecological responses to changes in wetland hydrology. Simple linear regressions showed that ecological changes can be predicted from changes in hydrology (e.g. increase in abundance of wetland plant cover due to increases in inundation area, depth, and hydroperiod; R2 =0.72). More detailed, non-linear models indicate that there are additional factors driving changes in ecology and biodiversity in the wetlands on the ranchland. Examples include evidence of site specific importance and interactions between ecological variables. These models utilized negative binomial distributions of the data in mixed linear models and zero-inflated models. While these models provide more insight into what is occurring at specific wetlands, they currently lack high predictive ability. Efforts are undergoing to develop non-linear models. Depending on the regression models' (linear and non-linear) performance, specific models will be selected and integrated with a Decision Support System (DSS) to facilitate trade-off evaluation of the positive (ecological diversity PES) or negative effects that accompany increased water storage on ranchland.
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Ezell, John

Authors: **John Ezell**, University of Florida
Jonathan Martin, University of Florida
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Impacts of lowering aquifer heads on surface water-groundwater interactions: A study of spring reversals and their impact on aquifer water quality

Water tables have decreased in regions around the world in the last century, largely due to aquifer pumping and rainfall variations. This drawdown has been linked to land subsidence, salt-water intrusion, and wetland deterioration, but one less studied topic related to drawdown is the impact on surface water-groundwater interactions. These interactions are particularly important in karst aquifers where springs may reverse flow when river stages rise above groundwater heads during flooding, directing river water into aquifers, thereby impacting groundwater chemistry. To investigate relationships between groundwater elevation, groundwater chemistry, and spring reversals, legacy records of groundwater elevations were collected from three wells in north Florida and compared to stage records from the Suwannee and Withalacoochee rivers in north Florida. Data loggers were installed in Peacock Springs (near the Suwannee River) and Madison Blue Spring (discharging to the Withalacoochee River) cave systems to measure high frequency variations in water characteristics. Low frequency water samples were also collected to measure chemical compositions during spring reversals. All three well data records show aquifer heads declining at 1 to 8 cm/yr. Elevated river stages show no change in trend over the last 80yrs. Decreasing water table elevations increase the hydrologic gradient toward the aquifer during floods of similar magnitude potentially causing an increase in the frequency of reversals. During sampled reversals, DOC concentrations in aquifer systems increased from less than 1 mgC/L pre-reversal to over 20 mgC/L at the peak of the reversal. The river water, which is more acidic than groundwater, increased dissolution rates by six orders of magnitude more than baseflow aquifer waters and thus may impact land surface movement, including sinkhole development. The decline in water tables and potentially increasing frequency of spring reversals suggest that pumping may contribute to the compromise of water quality by allowing increased intrusion of surface water.

Felter, Liz

Authors: **Liz Felter**, UF/IFAS Orange Co.
Tracy Irani, Family Youth & Community Sciences Dept.
Paul Monaghan, Agricultural Education & Communications
Hannah Carter, Agricultural Education & Communications
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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Water Demand Management

An examination of community based social marketing strategies to increase water conservation practices by homeowners with automated irrigation systems in central Florida

In a recent study conducted to examine the perceptions of homeowners in Orange County, Florida who have automated irrigation systems concerning Community Based Social Marketing (CBSM) strategies that could be employed to reduce water used for lawn care. Specifically, the study utilized the theory of planned behavior and theory of diffusion of innovations to understand what influenced homeowners to increase water conservation behaviors. The study also looked at the pragmatic approach of social marketing and the effectiveness of CBSM to bring about behavior change. The practical strategies used by CBSM seek to determine the barriers of behavior change and understand the accepted societal behaviors also known as norms. Once barriers and norms are established the use of CBSM has a greater opportunity to be successful.
This study used qualitative research methods through the use of focus groups to determine whether a CBSM approach would be a successful method to increase water conservation practices. The focus group participants consisted of residents from Orange County, Florida who were determined by the water utility company to be high water users. A total of four focus groups were conducted which included 32 participants, and represented 20 different homeowner associations (HOA's).
Emerging themes for barriers to reduce water use revealed pressure from the HOAs to have perfect grass, lack of knowledge about proper lawn care, confusion over when to water per week and the inability to use the irrigation timer correctly. Participants indicated that the norm was to abide by the water restrictions and have a nice lawn. The responses also indicated that following water restrictions was their primary means of conservation.
Responses from the focus group participants will be presented and recommendations for possible solutions through the use of CBSM will be discussed.

Fitzgerald, Casey

Authors: **Casey Fitzgerald**, St. Johns River Water Management District

Category: Water quality protection and treatment
Session Title: Springs Protection and Management 1

Overview of the Springs Protection Initiative in the St. Johns River Water Management District

Florida's springs are facing unparalleled challenges. Order of magnitude nutrient concentration increases and dramatic ecological changes are the norm. Total Maximum Daily Loads (TMDLs) established for springs frequently call for nitrate load reductions of up to 80%. In response, the St. Johns River Water Management District has launched a Springs Protection Initiative that aims to 1) support projects that will reduce nitrate loadings and improve flow rates, 2) elucidate scientific causality underlying the ecological changes, and 3) identify the most cost-effective, long-term solutions for the major springs in the district. The analyses undertaken and the diagnostic/predictive tools developed will also be employed in future water supply planning efforts and enhancement of regulatory programs such as Consumptive Use Permitting, Environmental Resource Permitting and Minimum Flow and Level development.
This presentation will provide an overview of the Springs Protection Initiative with a special focus on the $47 million invested during the first year of the initiative toward springs protection and restoration implementation projects. It will also address significant project funding opportunites in the upcoming year.

Fletcher, James

Authors: **James Fletcher**, UF IFAS Extension-Osceola County

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Education and Decision Making

Agricultural Water Supply Planning

application for the UF/IFAS Symposium Scholarship.
Agricultural water supply is critical to economic development in the region. This need for water can sometimes conflict with public water supply as the state continues to grow. In 2012 this agent initiated a program to educate policy makers on the importance of protecting agricultural water supply in the region. Two key aspects of the program included first, tours for decision makers to help them better understand the issues of agricultural water supply and second, bringing together a group of Osceola County agricultural producers and a legislator to discuss concerns over agricultural water supply availability. At the request of the legislator this agent wrote a white paper over water issues affecting agriculture. The white paper offered three suggestions to help protect agricultural water. One of these suggestions was to empower Florida Department of Agriculture and Consumer services (FDACS) to project future water supply demands for agriculture. Senate bill 948 was passed this year ensuring FDACS had a seat at the table in the discussion of water supply planning. In addition this agent has worked with the Central Florida Water Initiative (CFWI), an ongoing initiative to develop water planning strategies for Lake, Seminole, Orange, Polk, and Osceola. In August the CFWI proposed creating a solution planning team to help develop alternatives to meet water demands for the region. This agent was appointed by FDACS to represent agriculture interests on this team. The CFWI process can be used across the state as a way to bring public water supply, agriculture, environmental, and other interested stakeholders together to discuss the future demand used of water. It is critical to keep our decision makers informed of water issues affecting agriculture. As the second largest user of water in the region this program has ensured that agriculture is represented at the table.

Flower, Kaitlyn

Authors: **Kaitlyn Flower**, University of Florida
Treavor Boyer, University of Florida

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Spatial and temporal variability of bromide-to-chloride ratio in coastal groundwater: Literature review and field data

Saltwater intrusion, which can be caused by groundwater pumping, changes in recharge, and sea-level rise, will increase the potential for the contamination of freshwater with seawater constituents such as bromide and iodide, ions that are frequently disregarded because their concentrations in saltwater are significantly lower than that of chloride. However, elevated bromide and iodide levels will increase the formation of carcinogenic byproduct chemicals during the disinfection of drinking water. Therefore, the objective is to understand how exposure to carcinogenic byproduct chemicals can be quantified by evaluating the fluxes of bromide and iodide from saltwater to freshwater. This will be accomplished by quantifying the potential of saltwater intrusion to alter groundwater chemistry, specifically by analyzing the spatial and temporal variability in the ratios of bromide-to-chloride and iodide-to-chloride in selected coastal aquifers. An experimental matrix will include field sampling for one year at each location to account for seasonal variations, and samples will be analyzed for total dissolved solids, chloride, bromide, and iodide. The aim is to explore the application of said ratios as a predictable indicator of the levels of bromide, iodide, and the subsequent formation of disinfection byproducts. The significance of this work is to develop an understanding of how population growth, urbanization, and climate change may influence human health risks that need to be incorporated into the long-term planning and management of drinking water treatment.

Frank, Kathryn

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Planning and Management

Adapting to Climate, Sea Level, and Other Changes: A Survey of Florida's Coastal Public Water Supply Utilities

Public water supply utilities in Florida face numerous challenges in the future, including climate change, sea level rise, and population growth. These challenges compound problems and exceed thresholds, such as with the case of saltwater intrusion. Without changes in utilities' operations and management, they will struggle to meet future demands for water. The U.S. Environmental Protection Agency has developed guidance to water utilities for adaptation to climate change, but anecdotal evidence suggests that many utilities are not planning for the changes ahead. To encourage and facilitate planning among utilities, more information is needed about utility managers' views of the future, including climate change, their current adaptation planning and strategies, and the barriers and opportunities for improvement. This presentation will report the results of a survey of Florida coastal public water supply utilities that gathered this information, with a focus on the issues of sea level rise and saltwater intrusion. This study is a part of an interdisciplinary research project investigating the impacts of saltwater intrusion on public water supply quality and the health implications.

Friedman, Kenneth

Authors: **Ken Friedman**, Northwest Florida Water Management District
James Heaney, University of Florida

Category: Managing water for people and the environment
Session Title: Water Demand Management

Predicting and Managing Residential Potable Irrigation Using Parcel Level Databases

The Conserve Florida Water Clearinghouse research team has developed internet based software called EZ Guide to assist Florida water utilities in evaluating water use efficiency. Our process based modeling approach estimates single family outdoor water use for every parcel using a uniform statewide property appraisers' database to estimate irrigated area for each parcel. Water utility billing data are needed to estimate the irrigation application rates for each parcel, although few utilities have made this link. Analyses using these unique databases for a benchmark utility in Florida provide new insights into the overall impact of single family outdoor water use and cost-effective management options. A key result is that only a small percentage of homes are large irrigators which are candidates for irrigation best management practices. However, this study also shows a dramatic rise in the prevalence of in-ground sprinkler systems over the last few decades, which has led to increased irrigation application rates. The methodology also includes establishing a benchmark irrigation application rate that can be compared with theoretical irrigation rate estimates from a daily time step irrigation simulation model. Water savings are then evaluated for all irrigators as the difference between actual usage and the established benchmark application rate. Only the small subset of customers who over irrigate should be considered for outdoor BMPs which are aimed at reducing irrigation to a desired threshold. The impact of not selectively targeting this subset of irrigators is also presented.

Gates, Michael

Authors: **Michael Gates**, Southwest Florida Water Management District

Category: Managing water for people and the environment
Session Title: Water Supply Management

Development of a Groundwater Management Plan to Mitigate Pumping During Freeze Events in West-Central, Florida

A groundwater management plan was recently developed to address excessive pumping of groundwater for crop protection during freeze events in the Dover/Plant City area of west-central Florida.
For nearly fifty years, farmers in the Dover/Plant City area of Florida have used groundwater to protect strawberries, blueberries, citrus, and vegetable crops by irrigating when the ambient temperature is expected to drop below 32 °Fahrenheit (F). Damage can occur to fruit and plant tissue when the temperature falls below 31 °F. Applying groundwater can protect plants from freeze damage.
The temperature of groundwater is 72 °F when applied during irrigation. The heat of the liquid groundwater helps to protect the plants from freezing. In addition, heat is generated when the irrigation water changes from a liquid to a solid. By irrigating during freeze events the temperature of the plants stabilizes at approximately 32 °F, preventing tissue damage.
During a typical freeze event, farmers will irrigate at full capacity for the duration of the event. Numerous growers pumping groundwater concurrently can cause aquifer levels to rapidly decline, resulting in residential pump and/or well failure and the formation of sinkholes.
In January 2010 during an 11-day freeze event, approximately 750 residential wells were impaired and more than 150 sinkholes developed in the Dover/Plant City area because of excessive groundwater pumping. Following the 2010 freeze event, the Southwest Florida Water Management District developed a multi-faceted plan to reduce the impact of groundwater pumping for future freeze events. Parts of the plan include: declaring a 256-square-mile water use caution area, establishing special well construction standards in the area, establishing a minimum aquifer level, expanding the data collection network in the area, and increasing economic incentives for using alternative frost/freeze protection methods.

Gefvert, Cynthia

Authors: **Mark Elsner, P.E.**, South Florida Water Management District
Cynthia Gefvert, South Florida Water Management District

Category: Managing water for people and the environment
Session Title: Water Supply Planning

Water Supply Planning Projections – How hard could it be?

Water supply planning is necessary to ensure the appropriate quality and quantities of water are available to meet anticipated demands. Because the design, funding, and construction of infrastructure projects require a number of years, it is important to have strong projections at the project outset. In Florida, water management districts develop water supply plans for regions where the traditional sources of water will not be sufficient over the next 20 years. These plans are updated every five years using best available information. Primary drivers for water demands are population and irrigated acreage –projecting these is challenging in a dynamic world; population and agricultural growth may increase demand while conservation, changing agricultural and irrigation methods, and economic factors may result in decreases in demand.

Public water supply projections are based on population growth and per capita water use. While the University of Florida's Bureau of Economic and Business Research is the basis for future growth projections, a number of factors must be considered including developments of regional impact, sector plans, area-specific economic conditions, changing demographics, and tourism. Per capita water use is generally declining as a result of increased conservation and other factors. However, changes in housing style from moderate to high end may see an increase with more irrigated landscape and water using amenities.

Agricultural acreage projections are challenging because they are based on local, national and international markets, future crop plans are proprietary to the grower, diseases affect some crops, the demand for agricultural lands for other purposes, and the methods of farming.

We live in a fluid world. These drivers demonstrate the need to update water supply plans regularly to stay current and effectively plan for future water needs. This presentation will reflect on 15 years of water supply planning experience at the South Florida Water Management District.

Glodzik, Katie

Authors: **Katie Glodzik**, UF Wildlife Ecology and Conservation
Sean Sharp, University of Florida
Rachel Bouchillon, University of Florida

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Saltwater intrusion impacts to coastal wetland topography and soil organic matter

Saltwater intrusion driven by water extraction, coastal modifications, and climate change can potentially alter coastal wetland topography. Increased salinity and inundation can stress fresh or brackish vegetation, leading to decreased productivity and tissue death. Implications include reduced organic matter input to sediment, which slows accretion, and decreased root density, leading to soil compaction and erosion. Sulfate in seawater may accelerate microbial decomposition, reducing sediment organic matter content. We used a preserve on the Gulf Coast of Florida, where road construction isolated wetland to the north of the road from freshwater inputs it previously received, causing increased salinity, cabbage palm die-off, and decreased soil elevation evidenced by exposed tree roots. We took continuous water level and salinity measurements in saltwater-intruded areas to the north versus unaffected areas to the south. To determine whether soil organic matter cycling factors into observed soil elevation change, we measured labile and recalcitrant soil organic matter content at different depths, and decomposition rates. We found a sharp salinity increase to the north of the road, dampened tidal influence to the south, and significantly lower organic matter content to the south. Results suggest reduced organic matter content may be a factor in decreased soil elevation.

Gravois, Uriah

Authors: **Uriah Gravois**, Univeristy of Florida

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Analysis of long term tide gauge records in Florida.

Five of Florida's longest continuous tide gauge records are analyzed to investigate sea level rise. The analysis method used fits the tide records with first and second order theoretical model equations. The gauges are operated and maintained by the National Ocean Service (NOS) but they are also available from the Permanent Service for Mean Sea Level (PSMSL). A comparison is made of the data types and availability from these two sources and recommendations are made for which source is preferred, depending on the application. Finally, the results of this analysis are discussed in terms of previously published analysis for these five Florida tide gauge records.

Greco, Stacie

Authors: **Tatiana Borisova**, Alachua County Environmental Protection Department
Stacie Greco, Alachua County Environmental Protection Department

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Water Demand Management

Reducing residential landscape water use in Alachua County

Public water supply represents the second largest freshwater use category statewide, and it is the largest water use category in Alachua County. Since up to 60% of residential water use occurs outdoors, landscape irrigation restrictions are imposed to improve irrigation efficiency and reduce outdoor water use. The Alachua County Environmental Protection Department (ACEPD) is actively enforcing restrictions through an inspection program. Neighborhoods characterized by substantial landscape irrigation are monitored outside of the designated irrigation schedule, and a warning letter is sent to all parcels that appear to be out of compliance with the restrictions. The objective of this study is to estimate the effectiveness of ACEPD's inspection program. We used fixed effect regression analysis to examine monthly water use of 538 residents for the periods before and after the recept of the ACEPD warning letters. In addition, 3020 neighbors that never received the warning letters were used as a control group. The results show that ACEPD is targeting the warning letters to households with higher than average water use (on the neighborhood level). The warning letters were effective in reducing water use. The maximum reduction of water use occurred in the period of four to six months after the ACEPD warning letter, and the maximum estimsted savings were up to 6.7 thousand gallons per month per house. These results indicate that actively enforcing irrigation restrictions can be an effective tool in reducing residential water use in Alachua County and other locations. This presentation will discuss the methodology used to estimate water savings and economic implications for households.

Havens, Karl

Authors: **Karl Havens**, Florida Sea Grant

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 2

Ecological responses of a large shallow lake (Okeechobee, Florida) to climate change and potential future hydrologic regimes

We considered how Lake Okeechobee, a large shallow lake in Florida, USA, might respond to altered hydrology associated with climate change scenarios in 2060. Water budgets and stage hydrographs were provided from the South Florida Water Management Model, a regional hydrologic model used to develop plans for Everglades restoration. Future scenarios include a 10% increase or decrease in rainfall (RF) and a calculated increase in evapotranspiration (ET), which is based on a 1.5° C rise in temperature. Increasing RF and ET had counter-balancing effects on the water budget and when changing concurrently, did not affect hydrology. In contrast, when RF decreased while ET increased, this resulted in a large change in hydrology. The surface elevation of the lake dropped by more than 2 m under this scenario compared to a future base condition, and extreme low elevation persisted for multiple years. In this declining RF/increasing ET scenario, the littoral and near-shore zones, areas that support emergent and submerged plants, were dry 55% of the time compared to less than 4% of the time in the future base run. There also were times when elevation increased as much as 3 m after intense rainfall events. Overall, these changes in hydrologic conditions would dramatically alter ecosystem services. Uncertainty about responses is highest at the pelagic-littoral interface, in regard to whether an extremely shallow lake could support submerged vascular plants, which are critical to the recreational fishery and for migratory birds. Along with improved regional climate modeling, research in that interface zone is needed to guide the adaptive process of Everglades restoration.

Hensley, Bobby

Authors: **Robert Hensley**, University of Florida
Matthew Cohen, University of Florida

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Profile "smearing" and its effect on inferring nutrient removal pathways and kinetics

Recent development of in-situ sensors has enabled detailed investigation of nutrient dynamics at high sampling frequencies. This has led to a better understanding of removal pathways and ecosystem response to increased nutrient loading. However in rivers with large residence time distributions, removal signals may become “smeared” as a result of temporally varying removal (autotrophic uptake as a function of sunlight for example) and dispersion/transient storage effects. This is true of data collected from a Eulerian (time series) perspective, where the mixture of day and night water prevents identification of a true nighttime baseline. It is also true of data collected from a Lagrangian perspective (longitudinal profiling) where a sampling craft travelling at the channel velocity overtakes water retained in transient storage zones, resulting in sampling of water which is a mixture of newer and older water. The decrease in profile variability (both Eulerian and Lagrangian) due to mixing inhibits our ability to differentiate removal pathway (i.e. assimilation versus denitrification). Also inhibited is our ability to infer removal kinetics (i.e. how the system will respond to increased nutrient loading) because these processes may influence the geometry of the profile to a much greater extent than reaction order. This has important management implications; for example a river where autotrophic uptake is a zero-order process (saturation) is capable of producing an exponentially declining longitudinal profile suggestive of first-order kinetics (nutrient limitation). Resolving these issues requires the development and implementation of a reactive transport model which can account for temporal variability in removal rates was well as dispersion and transient storage effects.

Henson, Wesley

Authors: **Wesley Henson**, University of Florida/ USGS
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Wendy Graham, UF Water Institute

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Examining Denitrification in the Upper Floridan Aquifer near Point and Non-point Sources

Interactions between point and non-point source nitrate pollution and aquifer complexity present many land and water resource management issues; specifically managing anthropogenic nitrogen loads to springs under changing hydrologic conditions and in light of numeric nutrient criteria. Increased nitrogen loading in the Upper Floridan Aquifer (UFA) has contributed to observed ecological shifts in aquatic flora and fauna in many spring systems. The hydrogeologically complex UFA includes well-developed karst conduits, highly permeable limestone, and varying degrees of aquifer confinement. This complexity leads to heterogeneous aquifer properties, groundwater residence times, geochemistry, and hydraulic connectivity with the land surface that complicate management of nitrate pollution, interpretation of geochemical data, and estimates of nitrate attenuation in the aquifer. Significant differences between the estimated nitrogen loads in springsheds and observed nitrogen export from spring vents have been identified, suggesting that denitrification is mitigating the effects of nitrogen loading.

The objective of this study is to characterize denitrification in UFA springsheds near point and non-point sources of nitrate and examine factors that contribute to enhanced denitrification, using spatially distributed measurements of aquifer geochemistry, nitrate isotopes ($\delta^{15}N$ and $\delta^{18}O$), dissolved noble gases, and dissolved organic carbon. North Florida springsheds of the UFA provide an ideal test bed for examining how the degree of UFA land-surface connectivity, heterogenous aquifer properties, and spatial variability in nitrogen loads to the aquifer influence the occurrence or magnitude of denitrification. Information about nitrate transformations along groundwater flow paths is key to predicting the attenuation of nitrate in the aquifer and minimizing aquifer pollution in vulnerable areas. Future work will focus on improving water supply management decisions by combining information about nitrate transformations with potential changes in groundwater residence times due to groundwater extraction and climate change.

Hodges, Alan

Authors: **Alan Hodges**, University of Florida
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Stacie Greco, Alachua County Environmental Protection Department

Category: Water quality protection and treatment
Session Title: Springs Protection and Management 2

Economic Impacts of Springs in the Suwannee/Santa Fe River Basin of Florida

A significant share of economic activity in Florida is attributed to the tourism industry. Florida has a large number of freshwater springs that are a primary destination for many domestic and international visitors. Previous studies have evaluated the economic contribution of specific spring sites in Florida (Bonn and Bell 2003; Bonn 2004, 2008; FDEP 2011), or particular springs activities such as cave diving (Morgan and Huth, 2011). The objectives of this study were to (1) catalogue the variety of market and nonmarket services provided by the springs to society, (2) measure the economic impacts of spring-related tourism on the local economy, and (3) estimate the effect of ongoing changes in water quality and flow on recreational use. The study focused on six public and private recreational springs located in the Suwannee and Santa Fe River Basins. Data available from three state parks (Ichetucknee, Manatee, Fanning) indicates that total attendance at these sites peaked at 670,000 visitor days in FY 2007-08, then declined to about 500,000 in 2011-12. Information on current conditions and visitor spending related to recreational use of springs was gathered through interviews with public park managers, private springs owners, and other local businesses, such as equipment vendors, outfitters, campgrounds, lodging, and restaurants. The total economic contributions from annual spending by springs visitors in the local area were evaluated in terms value added (Gross Domestic Product), employment (jobs), and local/state government tax revenues. These estimates included indirect and induced multiplier effects assessed using the IMPLAN regional economic modeling system. Preliminary results of this analysis are expected in early 2014. The study findings will improve our understanding of the economic importance of healthy springs to local communities, and inform the current public policy debate regarding protection of springs and groundwater resources.

Holt, Nathan

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Sanjay Shukla, University of Florida
James Knowles, University of Florida

Category: Water security: the water-energy-food nexus
Session Title: Poster Session: Water Security: the water-energy-food nexus

Developing water and nutrient efficient bed geometries for raised bed, plastic mulch crop production systems using a vadose zone model.

The traditional bed geometry currently used in the raised bed, plastic mulch crop production system common to Florida tends to be short and wide. The dimensions of the beds were initially developed for seepage based systems and the geometries have remained relatively constant over the years even with the increased usage of drip irrigation/fertigation to supply water and nutrients. This study attempts to challenge the status quo by testing narrower and taller alternative bed geometries believing these alternatives can provide multiple benefits over the current traditional bed geometry including extra water storage capacity, protection against nutrient loss and root damage from flooding that can occur after a tropical rainfall event, better disease protection, decreased fumigation cost, yield protection, and plastic mulch savings.
This presentation aims to highlight a HYDRUS (2D) vadose zone model that in conjunction with measured water and nutrient data, evaluated alternative bed geometries with respect to water fluxes. Measured data was collected throughout a growing season at a tomato production farm near Immokalee, Florida. Three alternative bed geometries were monitored along with the standard bed used by the grower. The model was calibrated to real time soil moisture levels measured at various depths near the root zone in each of the four different bed geometries. Soil moisture characteristic properties, irrigation, weather, and water table depth were collected throughout and after the growing season and used in both model design and simulation. The model was designed to represent the cross section of the four different bed geometries tested. The finite element scheme employed by HYDRUS (2D) allowed for the full representation of the cross sections of the different bed geometries. The boundaries of the model domain were assigned as a no flux boundary on the surface representing plastic mulch covering the bed, atmospheric boundary conditions representing row middles, a variable flux boundary representing the drip tape, a variable head boundary representing the water table, and free drainage along the sides of the model domain. An hourly time step was employed by the model to capture rapid changes in water table levels.

Holtzhower, Darby

Authors: **Lantz Holtzhower**, University of Florida

Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

A decision support system to optimize wastewater treatment in the built environment

Water resource conservation and consumption is an integral component of future sustainable development given the increase in global population and subsequent growth in population density. Concern for both water quantity and quality will continue to grow globally as the need for and use of the resource is increased. Much attention is given to the supply side of the hydrologic cycle in all disciplines of built environment study; thus little is dedicated to buildings' wastewater save for quality studies conducted at the centralized treatment facilities.
This research first reviews various life cycle assessment studies conducted of centralized wastewater treatment facilities, onsite septic systems, and constructed wetlands for wastewater treatment. Upon literature review, common indicators of economic and ecological performance are revealed, as well as maintenance and infrastructure costs. The indicators and costs are plotted against one another to determine relationship, and a framework is established to select appropriate systems given a desired outcome. Combined life cycle assessment data from literature case studies and decision support system techniques creates a multiple variable tool to assist utilities, municipalities, developers with decisions concerning wastewater handling and treatment. A decision model is created to determine the optimum wastewater treatment approach of the three systems for various population densities. The decision model is spreadsheet based, and includes an easy to use interface to manipulate systems to achieve the minimum ecological impact or minimal costs.
By creating a decision support system with interchangeable units, performance can be measured against the various constraints of all scales and systems. The expected outcome is that integrated constructed wetlands will be a viable alternative to traditional wastewater treatment using sustainability indicators, however overall costs will likely favor traditional centralized methods.

Hu, Jing

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Alan Wright, University of Florida
Mark Clark, University of Florida
Ramesh Reddy, University of Florida

Category: Managing water for people and the environment
Session Title: Poster Session: Managing water for people and the environment

Influence of flooding and draining cycles on greenhouse gas emissions from peatlands

Climate change has been predicted to cause changes in precipitation patterns, which directly affect the duration of flooding and draining cycles and hydrologic conditions of peatlands. Fluxes of greenhouse gases (GHGs), including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), from soils are affected by the frequency and duration of flood-drained cycles. Objectives of this study were to: (1) determine the different responses of CO2, CH4, and N2O fluxes to various combinations of flooding and draining duration; and (2) determine the total global warming potential (TGWP) of GHGs fluxes from soils. A laboratory study was performed using intact soil cores (40 cm in depth) collected from peatlands of the Everglades Agricultural Area (EAA) in south Florida. Soil cores were subjected to different duration of flood periods (1 cm water table above soil surface) and drained periods (30 cm water table below soil surface) alternately for 6 months. Four cyclic treatments were included in this study: short-term draining + short-term flooding (SS), short-term draining + long-term flooding (SL), long-term draining + short-term flooding (LS), and long-term draining + long-term flooding (LL). Short-term and long-term duration refer to 2 weeks and 4 weeks time periods. Two controls, one continuously flooded (F) and the other drained (D), were also included. The preliminary results showed that, for all treatments, CO2 fluxes during drained periods were much higher than during flood. Fluxes of CH4 and N2O did not vary between drained and flood periods but flux pulses were observed after re-flooding events for both CH4 and N2O. Throughout the study, the treatment with a longer total drained period had higher cumulative CO2 flux, whereas cumulative CH4 and N2O fluxes were higher in the treatment with higher frequency of flood-drained cycle. Carbon dioxide was the major contributor to TGWP irrespective of the treatments.

Huang, Laibin

Authors: **Laibin Huang**, Soil and water Science Department
junhong Bai, Beijing Normal University

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

The effects of soil properties on soil seed-spore bank germination in Pearl River Estuary, China

Abstract: Coastal wetlands play critical roles in maintaining water quality; however, the impacts of predicted sea level rise on coastal wetlands is not well understood at this time. In this study, the relationship between soil properties and seed-spore bank was analyzed by CCA, which indicated that most cryptogam seeds (i.e. Xd1, Xd2, Xs1 and Xs2) were found far away from heavy metals zones. Emergence of environmentally sensitive cryptogam seeds were inhibited in soils with high levels of heavy metals in the Pearl River Estuary. Another significant result detected in CCA analysis is that salinity and heavy metal-Cd were the main influence factors to the seed-spore bank of the estuary wetland ecosystem. Two groups of detailed experiments with three replicates (untreated group and treated group) were conducted to further delve into the influence of salinity and heavy metal-Cd on seedling emergence. The treated group was incubated with three salinity gradients of 2000, 4000, 8000 mg/kg, and three Cd concentration levels of 3.5, 4.0, 4.5 mg/kg.. The results shows that higher salinity and Cd levels inhibit seed germination, but their suitable level ranges (i.e., [0, 200 0mg/kg] for salinity and [0, 4.0mg/kg] for Cd) can activate seedling emergence, such that more seedlings germinated under the intersectional levels at 2.1mg/kg Cd and 1200mg/kg salinity. If sea level rises quickly and permanently, salinity will act as the most important stressor of vegetation rehabilitation, and possibly result in salt-tolerant communities dominated in this area. This study has clear implications for the construction and function of treatment wetlands with predicted rises in sea level.

Huq, Mohammad

Authors: **Mohammad Huq**, University of Florida
Khaled Hasan, Professor
Kazi Matin Ahmed, Professor

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Relationship between the geomorphic features and spatial arsenic distribution patterns in part of Meghna Floodplain, Bangladesh

This present study investigates a relationship between the identified geomorphic features and the spatial arsenic distribution patterns in lower stretch of the Meghna floodplain in Bangladesh using Geographic Information Systems and remote sensing techniques.

Thirteen geomorphic features have been identified within the research area using an ASTER VNIR satellite image, which are: meander ridge, meander swale, older floodplain, new floodplain, new floodplain-1, major channel and rivulet, perennial water body and/or bog, oxbow lake, abandoned channel, chute, new char, point bar, and natural levee. The existing dataset of the study area collected from Bangladesh Arsenic Mitigation Water Supply Project and fieldwork suggested that 74% of the tested hand tube wells contain arsenic above the Bangladesh limit of >50 µg/L while the WHO/US EPA standard is 10 µg/L. Among the identified features, proportions of safe wells were highest at the 'new char' unit (55%) and lowest at the 'point bar', and 'meander swale' units (0%). The presence of clay-rich bottoms in the 'meander swale' aided in water logging, which attenuated percolation and thus the flushing of arsenic. Additionally, the relationship between the arsenic concentration and well depths has also been investigated. Most of the existing wells in this study area are clustered at 50-100 feet, and arsenic contents are found to be higher at these depth ranges in most of these identified geomorphic features. The safe deeper wells (>150 feet) were found at the 'older floodplain', 'natural levee', and 'new floodplain' units. The proportion of safe wells declined with increasing well depths at 'meander ridge', and 'new floodplain-1' features. Shallow and deeper aquifers have been found relatively safer only at 'new char' unit.
This study revealed that sand dominated areas in lower Meghna floodplains have more arsenic-safe wells that may be because of more flushing and dilution of arsenic.

Hwang, Syewoon

Authors: **Syewoon Hwang**, University of Florida
Wendy Graham, Director, Water Institute, UF

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Assessing the future change of precipitation and reference evapotranspiration over Florida using ranked CMIP5 model ensemble

The ultimate goal of this study is to assess future water vulnerability over Florida, based on the change in precipitation and evapotranspiration estimated using the most advanced Global Climate Model (GCM) ensemble. We evaluated the skills of CMIP5 (Climate Model Inter-comparison project, phase 5) climate models in reproducing retrospective climatology over the state of Florida for the key climate variables important from the hydrological and agricultural perspectives (i.e., precipitation (Precp), maximum and minimum temperature (Tmax and Tmin), wind speed (Ws), and relative humidity (Rhs)). The biases of raw CMIP5 were estimated using three different grid-based observational datasets as references. Based on the accuracy of various predictors such as mean climatology, temporal variability, extreme frequency, etc., the GCMs were ranked for each of the different reference datasets, climate variables, and predictors. The variation of the ranks was examined and rank-based GCM weights were assigned. The weights were then used to develop future ensembles (for 4 different RCP gas-emission scenarios) for the annual cycle of monthly mean and variance of precipitation and reference evapotranspiration (ETo). Finally the differences between the retrospective and future ensembles were investigated to assess future climate change impacts on water vulnerability using simple indices (e.g., ETo/Precp, drought index, and standardized Precp index). The uncertainties of the assessment were quantified by the spread range of ensembles and a reliability factor for the GCMs estimated using a measure of model biases and convergence criterion.

Icerman, Jason

Authors: **Jason Icerman**, Jones Edmunds

Category: Managing water for people and the environment
Session Title: Water Demand Management

SJRWMD spatial distribution of existing water use estimates for the North Florida Southeast Georgia Groundwater modeling process

The District hired Jones Edmunds and Associates to disaggregate water use for urban and commercial/industrial/institutional (CII) water uses by parcel for use in developing water conservation estimates and developing recharge credits for groundwater modeling.
The objective of the proposed work is to spatially distribute USGS (or other existing) water use estimates by county to parcels or Census blocks by land use type in specified counties in Florida, Georgia, South Carolina, and Alabama. This work will make use of the District's current process for estimating consumption by land use code. It will particularly make use of the single family consumption load profiles (a large sample distribution of parcel level water use) and CII benchmarks of use to infer consumption in the counties and will be calibrated to the USGS (or other existing planning level) water use estimates by county. The product of this work will be used to spatially distribute existing county-level water use estimates for use in estimating water conservation potential in Florida and the development of groundwater recharge calculations for the NFSEG groundwater modeling effort.

Irani, Tracy

Authors: **Tracy Irani**, Center for Public Issues Education
Erica Odera, Center for Public Issues Education
Lisette Staal, UF Water Institute

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Education and Decision Making

Creating Stakeholder Collaborations for Water Use Planning in an Uncertain Future: The Case of the Florida Water and Climate Alliance

The FloridaWCA, initiated in 2010, is a stakeholder-scientist group made up of hydrologists, public water suppliers, water resource managers, and climate scientists. Their shared goal is to make climate prediction models and sea level rise data more applicable and useful for decision-making amongst water and utility planners in Florida. In addition to the technical and scientific goals and outputs of the group, an overarching question and challenge was how can we build and sustain a community of scientists and stakeholders that can have wide-reaching impact for water supply planning in the face of climate uncertainties in Florida and beyond?

This presentation will focus on using the FloridaWCA working group as a case study in methods of how to sustain a group that will help translate the most current science around climate change into forms useful for practitioners and planners. It will examine the experiential learning framework that guides the process, the importance of understanding learning styles and communication differences of group members, the mechanisms used for knowledge management, and take an evaluative approach to how the group has worked towards reaching its mission. Through regular workshop meetings to discuss the needs of different group members and assessing the scientific tools that currently exist, the group has been able to begin critically determining whether or not the climate and sea level rise models will be useful for Florida based utility and water management planners.
The authors hope that by outlining the successes and challenges of the FloridaWCA group, other individuals interested in solving critical water issues through creating diverse stakeholder platforms may find lessons to learn from the FloridaWCA story.

Ishii, Stephanie

Authors: **Stephanie Ishii**, University of Florida
Treavor Boyer, University of Florida

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Urine source separation at the University of Florida: Assessing impacts and student support from a life cycle perspective

Reevaluation of the current water–wastewater paradigm is needed to advance the conservation and protection of natural resources. The drawbacks of conventional wastewater treatment have become increasingly apparent, including the use of potable water for waste conveyance and the insufficient removal of contaminants from wastewater prior to discharge. Furthermore, wastewater treatment must cease to be viewed as the handling of unwanted residuals and instead be treated as the opportunity to recover valuable resources, such as water, fertilizer, and energy. Alternative approaches to wastewater management involving urine source separation provide the opportunity to simultaneously and radically improve multiple aspects of wastewater treatment.

Urine source separation is the separate collection and treatment of urine through the use of urine diverting toilets and waterless urinals. Urine source separation reduces the demand for potable water and allows resources and contaminants to be more specifically targeted for removal. Previously conducted and ongoing studies have addressed the technical challenges associated with urine source separation; however, the social implications of urine source separation and community support for this alternative water-wastewater system are largely unknown.

The goal of this work is to evaluate student support for the implementation of urine source separation at the University of Florida. This will be achieved through the dissemination of an online survey to dormitory residents. Survey questions are designed to designate individuals as “supporters” or “rejectors” of this alternative water-wastewater system based on declared intentions and predicted behavior, e.g., willingness to pay and willingness to change behavior. Furthermore, surveys include questions to determine the major drivers of an individual’s support, such as perceived environmental and economic impacts, social norms, and ability. Lastly, the relationship between respondent support and the dissemination of life cycle assessment data pertaining to urine source separation at the University of Florida is investigated.

James, Kyle

Authors: **Kyle James**, Georgia Institute of Technology
Taylor Tyger, Georgia Institute of Technology
Nathan Gallentine, Georgia Institute of Technology
Kait Morano, Georgia Institute of Technology
Tharunya Balan, Georgia Institute of Technology

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Education and Decision Making

Education and Research Overlay for Georgia Institute of Technology Campus Stormwater Management Master Plan

Additional authors include Audrey Spiegel, Jesse Zaro-Moore, Chris Allen, Carrie Coburn, and Bruce Battle.
Our presentation will build upon an existing stormwater management master plan for the Georgia Institute of Technology campus through comprehensive education and research overlays. The overlays will demonstrate award-winning stormwater management practices and introduce mechanisms for connecting education and research. The education component will focus on demonstration projects, integration into course curriculum, and community outreach to local elementary and secondary schools. The research component will support water quality monitoring and evaluating projects for infiltration, water retention materials, evapotranspiration, and sediment control. Methods will include reviewing the existing master plan, engaging a stakeholder input process, conducting research on emerging stormwater management strategies being utilized on campus, case studies on stormwater education initiatives led by other institutions, and developing models for curriculum and STEM programming. As a component of our overlays we will include a site design for a demonstration education park. Development of the overlays will incorporate feedback from Georgia Tech's City Planning and Civil Engineering schools, Office of Capital Planning and Space Management, Center for the Enhancement of Teaching and Learning, and Center for Education Integrating Science, Mathematics, and Computing. Our proposed overlays will translate the campus stormwater plan into a learning and research tool that connects the academic institutional environment with the surrounding watershed and supporting ecosystems. Our presentation will provide a framework for other institutions seeking to engage stakeholders through education and research and will address the opportunities and challenges presented during this process.

Jawitz, Jim

Authors: **James Jawitz**, University of Florida

Category: Water quality protection and treatment
Session Title: Springs Protection and Management 1

Why we should monitor flows more and concentrations less: Stationarity and inequality from the Mississippi to the Kissimmee

What controls the temporal dynamics of the load of solutes, such as nitrogen (N) and phosphorus (P), from watersheds to receiving water bodies? For example, the external load of total P from tributaries to Lake Okeechobee has exceeded the regulatory limit of 140 tonnes/year by an average of more than 300 tonnes/yr for more than two decades, despite concerted efforts to reduce P application rates in the basin. Based on a synthesis of data from the basins of the Baltic Sea, Lake Okeechobee, and the Mississippi River, it is shown that inter-annual variations in exported loads for geogenic constituents, and for total N and total P, are dominantly controlled by discharge. Emergence of this consistent pattern across diverse managed catchments is attributed to the anthropogenic legacy of accumulated nutrient sources generating memory, similar to ubiquitously present sources for geogenic constituents. Further, a framework is introduced for characterizing the temporal inequality of stream discharge and solute loads, illustrated with application to the Kissimmee River and other tributaries to Lake Okeechobee. While flux-averaged solute concentrations are likely to be stationary, intra-annual flows and loads are shown to be highly non-uniformly distributed. Multiple decades of daily observations are used to show that 90% of the total flow is generated in as little as 10% of the time. Because of biogeochemical stationarity, the temporal inequality of loads tracks that of flows nearly exactly. Important implications are that (1) inter-annual variations in load can be robustly predicted given discharge variations arising from hydro-climatic or anthropogenic forcing, (2) water quality problems in receiving inland and coastal waters may persist until the accumulated storages of nutrients have been substantially depleted, and (3) remedial measures designed to intercept or capture exported loads must be designed with consideration of the intra-annual load inequality.

Jayasinghe, Sumith

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 1

Application of in vitro bioassays for screening of water quality

A large number of industrial chemicals, pharmaceuticals and personal care products are found in treated water, having escaped through primary, secondary, and sometimes even tertiary treatment procedures. Some of these chemicals can interact directly with soluble hormone receptors or can interfere with the natural synthesis or metabolism of endogenous hormones and thereby obstruct the normal function of these processes in exposed organisms. Presently, environmental monitoring relies mostly on chemical analyses, even though these analyses can have significant limitations due to (1) too many chemicals to measure; (2) difficulties in detecting non-target compounds and transformation products; and (3) difficulties in measuring the effects of mixtures. However, toxicity testing using in-vitro bioassays can overcome some of those limitations, since these high throughput assays test the chemicals based on mode-of-action criteria. We have identified and optimized commercially available in-vitro bioassays based on human cell lines in order to select suitable assays for agonism and antagonism of estrogen, androgen, progesterone, glucocortisone, and pharmaceuticals that activate the peroxisome proliferator activated receptor gamma. We applied these in-vitro bioassays to test several water extracts that were received from Australia, Switzerland and California while participating in interlaboratory comparison studies. Currently we are applying these assays to several water extracts collected from water treatment facilities and natural water bodies in Florida. Overall our findings suggest these in vitro bioassays are suitable to test water quality in drinking and other reclaimed water as well as important to include in routine screening of water quality in parallel to chemical analysis.

Johnson, Alexis

Authors: **Alexis Johnson**, University of Florida
David Kaplan, University of Florida Department of Environmental Engineering Sciences
Robert Hensley, University of Florida School of Forest Resources and Conservation

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

The Effect of Variable Hyporheic Exchange on Nitrate Removal in Florida Springs: A Smart Tracer Approach

One of the most pressing issues facing the waterways of Florida is anthropogenic nitrate pollution due to more than fifty years of rapid population growth and increased agricultural activity. In light of recently declared numeric nutrient criteria, a full understanding of nutrient cycling processes is crucial for proper water quality and quantity management. In-stream nitrate removal due to denitrification is thought to be positively correlated with high velocity gradients and increased hyporheic exchange. However, previous studies in tidally influenced springsheds have noted greater nitrate retention at lower velocities, possibly due to increased residence times. This study aims to identify the connection between velocity gradient and nitrate removal rate using the biologically reactive tracer resazurin to directly measure the amount of spring discharge subject to hyporheic exchange under varying flow conditions. Tracer studies will be performed during various tidal stages, and breakthrough curves of resazurin and its byproduct resorufin will be analyzed and compared to in-situ nitrate measurements to determine the contribution of hyporheic exchange to denitrification. Greater reduction of resazurin is expected during low tide due to the high velocity gradient and subsequently increased water-sediment exchange. The use of this “smart” tracer for hydrologic studies is a relatively new application, and this work will not only contribute to a greater understanding of nutrient cycling, but will also aid in the development of direct methods for quantifying the role of the hyporheic zone in the biogeochemical processing of contaminants of concern in aquatic ecosystems.

Johnson, Nathan

Authors: **Tonya Simmons**, SJRWMD
Nathan Johnson, SJRWMD

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

SJRWMD development of regional water shortage management responses and recommended phased response methods

The District hired the Contractor Simmons Environmental which begin this project with a literature review of methods, process, both quantitative and qualitative, used to develop phased approaches to demand management in cases of water shortage. After the literature review was complete and the methods explored in the literature review were identified and summarized, the contractor recommended a resource based approach. The spatial extent of sentinels or key indicators was determined, in order to identify the monthly demand data necessary for analysis.
A pilot area was selected and regional water resource data was provided by District staff for the analysis phase of the project. The sentinels or key indicators analyzed considered the springs and lake regional systems and the respective regional aquifer they impacted. The analysis included the development of percentile groundwater levels converted to phases of drought. Probabilities of occurrence and interactions between phases for going into and coming out of drought were calculated in order to assist internal staff in developing District wide processes. A geospatial map of the Middle St. Johns Groundwater Basin was developed illustrating spatially how the developed triggers would have behaved during the last two significant drought events. The analysis included investigative, testing, and conclusion phases.

Kalakan, Chanyut

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Dimensionless Analysis for Investigation of Saltwater Intrusion and Recirculation of Seawater

Saltwater intrusion and the recirculation of seawater at a coastal boundary have been investigated for three problems, namely the Henry constant dispersion and velocity-dependent dispersion problems and a larger field-scale problem. Based on dimensional analysis, saltwater intrusion and the recirculation of seawater can be dependent functions of as many as five independent ratios, which are (1) az, defined as the ratio of freshwater advective flux relative to the density-driven vertical buoyancy flux; (2) the aspect ratio □, defined as the ratio of horizontal and vertical dimensions of the cross-section; (3) the ratio b, defined as the product of the constant dispersion coefficient treated as a scalar quantity and aquifer porosity divided by the freshwater advective flux; (4) rα = αz/αx, the ratio of the vertical and horizontal dispersivities; and (5) rK = Kz/Kx, the ratio of the vertical and horizontal hydraulic conductivities. In the two-dimensional cross-section for all three problems, freshwater inflow occurs at the upgradient boundary, and recirculated seawater outflow occurs at the downgradient coastal boundary. The upgradient boundary is a specified-flux boundary with zero freshwater concentration, and the downgradient boundary is a specified-head boundary with a specified concentration equal to seawater. Equivalent freshwater heads are specified at the downstream boundary to account for density differences between freshwater and saltwater at the downstream boundary. The effects that changing the independent ratios az, □, b, rα, and rK have on saltwater intrusion and recirculation for these problems have been investigated using the numerical groundwater flow and transport code SEAWAT for two conditions, i.e., first for the uncoupled condition in which the fluid density in the flowfield is constant and then for the coupled condition in which the fluid density is a spatial function of the total dissolved solids concentration in a variable-density flowfield.

Kaplan, David

Authors: **David Kaplan**, University of Florida
Daniel McLaughlin, UF School of Forest Resources and Conservation
Matthew Cohen, UF School of Forest Resources and Conservation

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 2

Managing Forests for Increased Regional Water Availability

Forecasts of greater water scarcity in the southeastern United States present a critical challenge for water resources planners charged with maintaining hydrologic resources for domestic, industrial, and agricultural use while protecting natural systems, fueling a frenzied search for “new” water sources. A novel approach to this challenge is to identify land management strategies that increase water availability. Management of forests at lower tree densities, an existing habitat enhancement goal on public lands, may also increase water yield to the aquifer through decreased evapotranspiration (ET). To determine the potential water yield benefit of reduced biomass, we synthesized studies of precipitation and ET in southeastern coastal plain pine stands, yielding a statistical model of water yield as a function of management strategy, stand structure, and ecosystem water use. Our results point to the potential for an increase in water yield of up to 64% for slash pine stands managed at lower basal relative to systems managed for high-density timber production. These promising results have attracted attention from a diverse set of stakeholders, including agencies (Florida's five Water Management Districts, the Florida Division of Agricultural and Consumer Services, and the Florida Forest Service), public utilities, and industry partners, all of whom are seeking ways to offset increasing demands on surface and groundwater resources. A new statewide research project funded by this collaborative group aims to answer remaining questions about uncertainties in the magnitude of additional water yield, with a focus on climatic variation, between-site variability, water use in young pine stands, and fire effects. The resulting data will allow us to scale up the effects of forest management on regional water availability, providing support for continued public land purchase and management and (potentially) the development of a payment-for-services approach (i.e., “hydrologic easements”) for low-intensity forest management on private lands.

Katz, Brian

Authors: **Brian Katz**, Florida Dept. Environmental Protection
Kirstin Eller, Florida Department of Environmental Protection
Richard Hicks, Florida Department of Enviornmental Protection

Category: Water quality protection and treatment
Session Title: Springs Protection and Management 2

A Tool to Quantify Nitrogen Sources and Loading to Ground Water in the Silver Springs Basin

Silver Springs and the Silver Springs Group are major discharge points for water from the Upper Floridan aquifer (UFA) and provide the source of water to the Silver River. Silver Springs, the Silver Springs Group, and the Upper Silver River are impaired due to a biological imbalance caused by excessive concentrations of nitrate in the water. A Basin Management Action Plan (BMAP) is being developed by the Florida Department of Environmental Protection (FDEP) and other stakeholders to restore these impaired waters by reducing nitrogen inputs to meet their established total maximum daily load. As part of the BMAP process, FDEP developed a Nitrogen Source Inventory and Loading Tool (NSILT) to identify and quantify the major sources that contribute nitrogen to ground water within the Silver Springs BMAP area. NSILT is a GIS- and spreadsheet-based tool that provides spatial estimates of nitrogen inputs from farm and non-farm fertilizer usage, livestock wastes, septic tanks, atmospheric deposition, and the land application of treated wastewater and biosolids. Nitrogen loading to ground water from each nitrogen source input was estimated by weighting nitrogen inputs according to rates of ground-water recharge and by accounting for attenuation processes that remove nitrogen as it moves from the land surface through soil and geologic strata that overlie and comprise the UFA. Farm fertilizers and livestock wastes are the dominant sources of nitrogen loading to ground water in the BMAP area contributing an estimated 76, 66, and 63% of the total nitrogen load in high-rate (>12 in/yr), medium-rate (4-12 in/yr), and low-rate (<4 in/yr) recharge areas, respectively. The NSILT also has identified several areas near Silver Springs where ground water is highly vulnerable to contamination from nitrogen sources. These vulnerable areas are where nitrogen source reduction efforts could be focused to achieve restoration benefits to impaired waters in the BMAP area.

Khadka, Mitra

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Jonathan Martin, Department of Geological Sciences, University of Florida
Marie Kurz, Department of Geological Sciences, University of Florida; Current - Helmholtz Center for Environmental Research-UFZ, Germany

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Quantifying hyporheic exchange in a karst stream using 222Rn and its implication for carbon and nitrogen fluxes

Hyporheic exchange between sediment pore water and overlying stream water plays a significant role in chemical budgets of many important chemical constituents. Direct quantification of such fluxes requires knowledge of water exchange rates through the hyporheic zone. We tested a radon (222Rn) method to estimate the hyporheic exchange rates in the bottom sediments of the spring-fed Ichetucknee River, north-central Florida. Profiles of radon concentrations with depth through the sediments reflect mixing of stream water and pore water to 35-45 cm below the sediment-water interface. Based on a model that integrates the radon deficit with depth, we estimate the water exchange rates to be between 1.1 and 1.6 cm/day with an average value of 1.3±0.2 cm/day. The 222Rn approach directly measures the depth of hyporheic zone and water exchange between stream and hyporheic sediments, as opposed to in-stream tracer injection method. Our estimates of the magnitude and size of the hyporheic zone are larger than a previous tracer injection study that reflects essentially no hyporheic exchange, possibly from inflow from groundwater. Water exchanged across the sediment-water interface pumps oxygen into underlying sediments at a rate of 4.7 mM m-2 day-1, thereby enhancing organic carbon remineralization and consequently resulting in a flux of about 5.2 mM m-2 day-1 DIC as well as a N flux of about 0.4 mM m-2 day-1 to the water column based on the Redfield ratio for carbon and nitrogen. Decreasing nitrate concentrations with the sediment depth indicate that denitrification also plays role in the oxidation of organic matter. Although the present method is tested on a spring-fed karst stream, it has potential for any freshwater system (e.g. wetland, lake) where distinct radon activity and production between surface water and underlying sediments occur.

Khare, Yogesh

Authors: **Yogesh Khare**, Agricultural and Biological Engineering, University of Florida
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Rafael Munoz-Carpena, Professor, Agricultural and Biological Engineering, University of Florida
Robert Rooney, Post-doctoral Research Associate, Agricultural and Biological Engineering, University of Florida

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

A multi-criteria trajectory-based parameter sampling strategy for the screening type sensitivity analysis method of elementary effects

Processes specific hydrologic and water quality models are often integrated to build complex computer programs that can simulate large natural systems such as watersheds. These large scale models can assess impacts of natural and anthropogenic disturbances on natural systems and have become important decision making tools. A typical feature of such models is tens to hundreds of input parameters which makes it essential to evaluate the model through global uncertainty and sensitivity analyses. However, due to the high dimensionality of the problem in hand and limited availability of the computational resources, parameter screening i.e. separation of important model parameters from unimportant ones at a low computational cost becomes very important. The method of elementary effects, a global parameter screening method, is the most extensively used methodology for parameter screening. Due to issues like inefficient parameter screening, time requirements for parameter sample generation etc. development of an effective sampling strategy has been a research focus in recent years. In this work a new sampling strategy based on the generation of exact theoretical distributions and maximizing the trajectory spread – Uniformity Sampling – is presented. The performance of the new sampling strategy relative to traditional strategy - the Morris sampling and relatively new strategies - method of optimized trajectories and its modified version was evaluated using a number of criteria such as the uniformity of generated parameter distributions, time efficiency, and the spread of trajectories. The ability of the various sampling strategies to screen important parameters was assessed using five test functions in eighteen configurations covering a range of model sizes and complexities. The Uniformity Sampling, in general, performed better than other sampling strategies across tested functions and criteria, underlining the effectiveness of multi-criteria based sampling and the need to focus future efforts on combining various sampling criteria to obtain robust parameter screening results.

Kiker, Greg

Authors: **Greg Kiker**, University of Florida
Anna Linhoss, Mississippi State University
Rafael Munoz-Carpena, Agr & Bio Engineering, University of Florida

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Between the Devil and the Deep Blue Sea: Florida's Vulnerability To Sea Level Rise

Climate change (via sea-level rise and altered weather patterns) is expected to significantly alter low-lying coastal and intertidal areas, which provide significant seasonal habitats for a variety of shoreline-dependent organisms. This research effort has utilized the Sea Level Affecting Marshes Model (SLAMM), the MaxEnt species distribution model and the RAMAS-GIS metapopulation model to explore the current and future habitat/spatial distribution/population states as well as the spatial and temporal patterns of these uncertain results with Global Sensitivity and Uncertainty Analysis. Joint simulations of sea level rise at 0.2, 0.5, 1.0, 1.5 and 2.0 meters were conducted at 30m horizontal grid resolution for the Eglin Air Force Base/Santa Rosa Island areas and for the entire Florida Gulf and Atlantic Coasts (Pensacola to Naples; Miami to Georgia) at 120m grid resolution. While uncertainty levels are high, consistent simulation results from this integrated model show key results in two areas (1) potential habitat losses and (2) Snowy Plover population dynamics. The integrated models projected that the population size will decline faster than the area of habitat or carrying capacity, demonstrating the necessity of incorporating population dynamics in assessing the impacts of SLR on coastal species. Additional simulations were conducted for stakeholder meetings in Gulf and Atlantic coast communities. Results from these simulations were integrated into a multi-criteria decision analysis framework to assess tradeoffs in habitat restoration/protection and species-focused alternatives.

Kiker, Greg

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Category: Water quality protection and treatment
Session Title: Environmental Services

Development of a Decision Support System for Multi-Criteria Analysis of Ecosystem Services

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The decision-making process regarding agricultural enterprises and ecosystem services can be complex and seemingly intractable, principally due to the existence of trade-offs between production, financial, environmental and sociocultural factors. Research in the area of Multi-Criteria Decision Analysis (MCDA) has created practical methods and software tools for applying theoretical scientific decision approaches to complex environmental problems. While several commercial MCDA software platforms exist, we believe that the coupled modeling focus of our ecosystem service analysis is best served by a simplified spreadsheet approach for both understanding and transparency towards potential users. In this research, we created a spreadsheet model based on Girrard at al., (2005) providing several integration techniques such as a simplified weighted average method (Abdelrahman et al., 2008), compromise programming (Zeleny, 1973) or PROMETHEE (Brans and Vincke, 1985). Users can build upon or change the hypothetical relationship between the water availability/retention and ecological services and stressors to analyze the empirical ecosystem monitoring results or to explore their own beliefs concerning potential ecosystem effects on specific habitats within their management areas for different water management scenarios. Different hydrological and nutrient flow regimes can be input with representative tables showing aggregated hydroperiod and flow characteristics with respect to specific habitat areas. This spreadsheet allows for exploration of both criteria values or criteria weights (the relative importance of one criteria with respect to others). Thus, users can explore various “what if” scenarios with respect to their own management alternatives or through environmental drivers. In addition, they can explore the “sensitivity” of alternative rankings to various preference values or environmental inputs. Thus, users can view their own management choices through the lenses of other groups with differing values to their own to explore various compromise or conflict situations.
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King, Sean

Authors: **Sean King**, Southwest Florida Water Management District

Category: Water quality protection and treatment
Session Title: Springs Protection and Management 2

"In-Spring" Ecosystem Restoration

Many artesian springs and associated rivers in Florida are experiencing substantial ecological changes including filamentous algae proliferation, loss of macrophytes, and degradation of water quality and aquatic habitat. The solutions proposed to restore spring ecosystems have mostly focused on large-scale decreases in anthropogenic nutrient loading. Although this approach should eventually improve water quality, the results of decreased nutrient loading may not be evident in spring discharge for years to decades due to groundwater travel times in the aquifer. More importantly, spring ecosystems that have shifted from macrophyte to algae dominance may not respond to water quality restoration alone due to the influence of other drivers such as increasing salinity, manatee grazing, and disturbance. In algae dominated springs, direct “in-spring” restoration techniques may be necessary to shift the ecosystem back to a macrophyte dominated state. The Southwest Florida Water Management District is testing a variety of these techniques including: macrophyte re-vegetation (submerged and emergent), algae control (harvesting and ultrasound), and sediment removal. The District anticipates that these techniques will improve water quality and aquatic habitat over the short-term, and will complement efforts to reduce nutrient loading, ultimately restoring the ecology of Florida springs.

Klarenberg, Geraldine

Authors: **Geraldine Klarenberg**, UF, Dep of Agricultural and Biological Engineering
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Miguel Campo-Bescos, University of Navarra
Jane Southworth, University of Florida
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

A spatial and temporal analysis of the relationship between vegetation and hydrology in an area subject to Inter-Oceanic Highway road paving in the SW Amazon

Infrastructure projects such as road paving have proven to bring a variety of (mainly) socio-economic advantages to countries and populations. However, many studies have also highlighted the negative socio-economic and biophysical effects that these developments have at local, regional and even larger scales.
The MAP area (Madre de Dios in Peru, Acre in Brazil, and Pando in Bolivia) is a biodiversity hotspot where sections of South America's Inter-Oceanic Highway were paved between 2006 and 2010. The area has been subject to flooding in 1997 and 2012, and droughts in 2005 and 2010. An exploratory data analysis was conducted in this "MAP" area in order to start understanding the complex socio-ecological dynamics associated with the road construction, particularly from the perspective of ecosystem services provision. The analysis focused on vegetation dynamics as an indicator of ecosystem services, and included data on socio-economic and hydrological variables.
Time series of 10 years for vegetation (Enhanced Vegetation Index, EVI) were obtained for 100 communities in the area as the response variable. In addition, 34 socio-economic and physical time series were considered as candidate explanatory variables. Dynamic Factor Analysis (DFA) was applied to disentangle the spatial and temporal links between the explanatory variables and the response variable. DFA is a multivariate time series reduction technique which aims at decomposing the EVI spatio-temporal variance between unexplained variability represented by one (or more) common trend(s), and explained variability represented by the explanatory variables.
The outcome of the analysis provides insight into driving socio-economic and/or physical factors of vegetation dynamics in an area subject to road paving. For the purpose of this poster presentation, the vegetation-hydrology linkages and dynamics will be outlined.
Overall however, this exploratory research provides a conceptual framework to start linking social and ecological processes mechanistically, contributing to an ongoing NSF-CNH funded project.

Knight, Robert

Authors: **Robert Knight**, Howard T. Odum Florida Springs Institute
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Category: Water quality protection and treatment
Session Title: Springs Protection and Management 1

The Effect of Groundwater Pumping on Spring Flow Declines in North Florida

The Floridan Aquifer System (FAS) underlies approximately 100,000 square miles in the southeastern U.S., including the entirety of Florida. A preliminary water balance was prepared for the Florida portion of the FAS based on estimated recharge rates from rainfall and measured spring flows. The average predevelopment recharge and discharge estimated for the entire FAS was 13.9 billion gallons per day (BGD), including about 12.2 BGD of total spring discharge. About 10 BGD of that groundwater discharge is estimated to have occurred through North Florida's 1,000+ springs. Estimated recharge to the FAS in Florida is 8.1 BGD, indicating an average net inflow of about 1.9 BGD of groundwater from the coastal plain of Georgia and Alabama. Estimated pumping from the FAS in Florida was 2.4 BGD, or about 30% of Florida's share of the estimated recharge to the FAS. Substantial groundwater transfers are apparent between neighboring water management districts. For example, groundwater extractions in the Suwannee River Water Management District (WMD) are estimated as 10% of local recharge, while pumping in the Southwest Florida WMD is estimated to be 58% of local recharge. Average spring flow declines in Florida were independently estimated as 2.1 BGD or 21% overall, with a range from a slight increase in spring flows in the Northwest Florida WMD to a 63% reduction in the Suwannee River WMD. Existing consumptive groundwater allocations in these WMDs total over 4.6 BGD or about 57% of the entire FAS recharge in Florida. Due to their historical reliance on relatively constant inflows of groundwater, Florida's spring ecosystems are especially sensitive to small changes in average and low flows, in the general range of 5% or less. It is likely that the impairments widely documented in Florida's springs are in part due to excessive flow reductions resulting from excessive groundwater pumping.

Kreye, Melissa

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Planning and Management

Preferences and attitudes towards water protection programs

Conserved forest ecosystems are effective at protecting water quality by reducing soil erosion, sedimentation, and nutrient loading and pollution. When estimating values associated with forest conservation programs little attention has been paid to the importance of the context surrounding the program, like program features (e.g., protection via easement), as potential additional drivers of willingness to pay to support forest conservation. To examine the influence of program context on WTP for forest conservation we employed a contingent valuation, dichotomous choice (DC) method as well as best-worst scaling (BWS), a stated preference method grounded in random utility theory, to elicit public preferences for 20 attributes of a forest conservation program. Program attributes included use and non-use benefits and implementing organizations and processes. The DC and BWS tasks were incorporated into an online survey targeting Florida residents that also gathered geographic and socioeconomic information and included questions related attitudes and beliefs about how forests should be used and who should manage them. We found systematic variation in preferences among different levels of a monthly utility tax ($0.50, $1.00, $3.00, $5.00), how the program was implemented, different types of implementing organizations/agencies, nonuse values and use values. Results suggest that public support and WTP for forest conservation programs is likely not independent of program design, which has implications for WTP/WTA estimation and reliance on existing studies to inform policy decisions and policy formation.

Landers, Glenn

Authors: **Glenn Landers**, U.S. Army Corps of Engineers

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 2

Sea Level Change and Long Range Water Resources Planning for Florida

USACE and NOAA sea level change projections for the next 100 years will be presented along with an overview of direct impacts on SE Florida and NE Florida. Sea level change impacts in SE FL such as increasing flood frequency and hurricane risks will be identified as long term drivers for population shifts to NE FL which must be considered in long term water resources planning.

Landry, Kelly

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Category: Water security: the water-energy-food nexus
Session Title: Poster Session: Water Security: the water-energy-food nexus

Non-linear isotherm modeling of pharmaceutical removal in synthetic urine by ion-exchange resins

The presence of pharmaceuticals in the environment presents a challenge to researchers to develop new technologies to remove or destroy these contaminants. A major fraction of pharmaceuticals in the waste stream comes from urine, where ~70% of consumed pharmaceuticals are excreted. Only about 1% of the total waste stream is made up of urine therefore urine source separation has been proposed as a more efficient treatment method to isolate pharmaceuticals at a much more concentrated level and smaller volume. The purpose of this research was to investigate the removal of 5 common pharmaceuticals (diclofenac, ibuprofen, naproxen, ketoprofen, and paracetamol) in synthetic human urine under ureolyzed conditions. Ion-exchange equilibrium experiments were conducted using four resins (Purolite A520E, Dowex 22, Dowex Marathon 11, and Amberlite IRA958) to remove diclofenac (C0 = 0.2 mmol/L) from urine. The experimental equilibrium data was fit non-linearly using Matlab to the Freundlich, Langmuir, Dubinin-Radushkevitch (D-R), and Dubinin-Astakhov (D-A) isotherm models. It was determined from these isotherms that Dowex 22 had the highest affinity for diclofenac. The isotherm model was used to estimate resin requirements to remove diclofenac, and other pharmaceuticals at realistic concentrations in urine (C0 = 2000 µg/L). Equilibrium experiments of each pharmaceutical, as well as a mixture of acidic pharmaceuticals will be conducted in ureolyzed urine. It is expected that removal of the mixture of acidic pharmaceuticals will be additive. If the hypothesis is correct, the individual pharmaceutical isotherms can be used to predict how the removal of various mixtures of pharmaceuticals will behave. The resultant isotherms will be used to design a column experiment to understand the practical application of ion-exchange resins for pharmaceutical removal.

Langston, Amy

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Integrating science into comprehensive planning for sea level rise adaptation in rural coastal communities

Sea level rise (SLR) is a growing threat to coastal communities in Florida and around the world. One response local communities and municipalities can take to address the ecological and economic challenges of SLR is to incorporate adaptation strategies into city planning and policies. However most of these efforts have occurred in large cities, with a strong focus on the built environment. Coastal rural municipalities often have fewer resources to develop adaptation plans, and differ from their urban counterparts in two critical ways: they contain less infrastructure and the local economy is usually more dependent on natural resources. With these important differences in mind, this project seeks to develop a SLR adaptation plan for Yankeetown, Florida, a small coastal community on the Gulf Coast in Levy County. Yankeetown is dominated by natural resources that are vulnerable to SLR including freshwater wetlands, riverine wetlands, saltmarshes, oyster reefs, offshore islands, a large estuary, and the 413-acre Withlacoochee Gulf Preserve, which collectively comprise a proposed Natural Resource Adaptation Action Area (NRAAA). This project involved several novel approaches to local planning, including the development of a Science Plan for integration into the town's comprehensive plan. The Science Plan establishes a baseline of existing conditions within the NRAAA and proposes specific monitoring and management recommendations for long-term adaptation planning to preserve natural resources. Existing conditions were identified using publicly available GIS ecological and environmental data. The analysis was supplemented with a community outreach rapid assessment "bioblitz" conducted within the Withlacoochee Gulf Preserve. Long-term adaptation strategies provide restoration and adaptation methods for increasing ecological community resilience to environmental change in the face of accelerating SLR. Integrating science into the local government planning process is a new and unique approach for addressing SLR impacts in coastal communities in Florida and around the world.

Leitman, Steve

Authors: **Steve Leitman**, Waters Without Borders
Bill Pine, University of Florida, Wildlife Ecology and Conservation
Greg Kiker, University of Florida, Agricultural and Biological Engineering

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 2

An Investigation into the 2012 drought on Apalachicola River

The Apalachicola is the largest river in Florida in terms of flow and is the lower portion of a 19,600 square mile basin located in the southeastern United States. About 75% of the basin is in the State of Georgia, 12.5% in Florida and 12.5% in Alabama and therefore, flow in the river is more dependent on rainfall and water management above the Florida state line than Florida rainfall. In 2012 the ACF basin was experiencing the second year of a severe event drought with the average annual outflow from the Jim Woodruff Dam into the Apalachicola River being 7,605 cfs. This is the lowest average annual flow in the 90 year period of record for this location and only about 35% of the average annual flow experienced over the period of record. In the previous year, 2011, the average annual flow was less than 50% the historical average. This prolonged drought led to a severe decline in the oyster populations in Apalachicola Bay. This paper will investigate the question of whether the impacts from the 2012 drought could have been averted either through reservoir management practices or demand management in the ACF basin or whether the impacts are an event that must be accepted as a event whose impacts could not have been averted.

Llaneza, Veronica

Authors: **Veronica Llaneza**, University of Florida

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Surface modified nanoparticles as potential solution to the complex problems facing our nation's water resources

The degradation of our nation's water quality and the resulting pollution is a critical issue that requires innovation in drinking water technologies. A case in point is the issue of arsenic (As) contamination of water resources, which is well-documented and a serious global health problem. In the US, an action limit has been put forth by the EPA, and the maximum contaminant level (MCL) previously set at 50µg As/L has been lowered to match the World Health organization's (WHO) safe limit for drinking water of 10µg/L. There is a need for novel and efficient water treatment technologies to help meet the new MCL and protect water quality.

In this study, we take advantage of the increase in specific surface area and the decrease in kinetic reaction time offered by the nano-zero valent iron (nZVI) particles to remove As from aqueous solutions through a combination of sorption mechanisms. Batch sorption studies were conducted by equilibrating nZVI particles and As-contaminated water. The effects of key water chemistry parameters on As removal were investigated. nZVI particles were characterized by a combination of techniques including DLS, SEM-EDS, and XPS. Concentrations of As in aqueous phase were determined by hydride generation atomic fluorescence spectrometry (HG-AFS). The PVP-coated nZVI resulted in more stable and well dispersed suspensions as compared to bare nZVI. The experimentally determined rate (Kobs) of As removal from aqueous solutions by PVP-nZVI was 0.138 min-1 as compared to 0.056 min-1 for bare-nZVI. The determined maximum sorption capacities were 33.21mg As/g and 24.46 As/g for PVP-nZVI and bare-nZVI, respectively. However, this sorption capacity was negatively impacted by pH or increasing concentrations of competitive anions. Overall, the results show that PVP-nZVI particles can effectively remove As from solution down to levels below 10 µg/L. The ultimate goal of this research program is to develop a water filtration unit for removal of dissolved As and other toxic metals.

Loper, John

Authors: **John Loper**, Interflow Engineering
Tabitha Stadler, Rookery Bay National Estuarine Research Reserve
James Greco III, Interflow Engineering

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Education and Decision Making

Restoring the Rookery Bay Estuary: A Framework for Collaborative Decision-Making

A multidisciplinary team led by Florida's Rookery Bay National Estuarine Research Reserve (RBNERR) has embarked on a project to help local communities manage fresh-water flows in the Henderson Creek watershed in Southwest Florida. In consultation with an advi¬sory group consisting of hydrological engineers, social researchers, resource managers, and community stakeholders, the team is generating science to better understand the fresh water flows needed to maintain the health of the watershed's Rookery Bay Estuary. As part of this project, investigators are creating a framework that stakeholders can use to collaborate and make decisions about water issues into the future.

The Rookery Bay Estuary is one of the few pristine, mangrove-forested estuaries in the U.S. The health of the Estuary and its wildlife depend on seasonally appropriate flows of freshwater that range from nearly 134 million cubic feet per day in the wet season to none in the dry season. These freshwater flows also sustain communities in Collier County and Marco Island. Population growth and saltwater intrusion are placing further stress on available freshwater. Com¬pounding the situation are the area's highly managed water control structures and canals that mitigate flooding, but also disrupt the natural sheet flow necessary for estuarine health. This project aims to restore and adap¬tively manage the quantity and timing of the freshwater flowing into Henderson Creek and the Rookery Bay Estuary to ensure the health of the natural resources to meet long-term community needs.

The presentation highlights the development of a local-scale integrated hydrologic model of the Henderson Creek Watershed. Anthropogenic impacts to the freshwater flows are characterized through comparisons of simulated freshwater flows representing existing and historical conditions. These comparisons will be used in a future phase to evaluate water management scenarios having potential to restore the freshwater quantity and timing to near historical conditions.

Lowe, Edgar

Authors: **Edgar Lowe**, St. Johns River Water Management District

Category: Water quality protection and treatment
Session Title: Springs Protection and Management 1

The Research Component of the Springs Protection Initiative of the St. Johns River Water Management District

The ecological character of many of Florida's springs has changed substantially. Flow rates have fallen, nitrate concentrations have risen, populations of filamentous benthic algae and invasive aquatic plants have expanded, the abundance of native submersed aquatic vegetation has declined, and the structure of fish and invertebrate communities has changed. Recognizing the economic and ecological significance of springs, the St. Johns River Water Management District developed a Springs Protection Initiative that includes an applied research component. The research plan will support efforts to manage the drivers of primary producer community structure; specifically, the relative abundance of native submersed aquatic vegetation and filamentous benthic algae. There are three primary research objectives. 1) Improve the scientific foundation for management of nitrate loading to springs. In this objective, we will work towards a finer delineation of the spatial heterogeneity in the Silver Springs spring shed with respect to hydrologic conveyance to the springs, nitrogen sources (rates and forms), and routes and rates of nitrogen transformation and loss. 2) Evaluate whether nitrate reduction alone will be sufficient to restore the balance between benthic filamentous algae and native aquatic plants. Non-nitrate drivers of primary producer community structure could be sufficiently influential that management goals cannot be achieved even at much lower nitrate concentrations. 3) Assess the relative influence and manageability of each of the various drivers controlling the balance between benthic filamentous algae and native aquatic plants. If nitrate control is insufficient or infeasible, this ranking will indicate other drivers that might be managed to protect and restore primary producer community structure.

The primary focus of the research will be the Silver Springs system; the Wekiva system will be a secondary focus. In addition, cross-system analyses for all springs with sufficient data will be used to explore the interrelationships among environmental drivers and ecosystem attributes.

Luo, Jiexuan

Authors: **Jiexuan Luo**, University of Florida
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Mark Clark, University of Florida

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Nitrogen Loadings from Different Land Uses at University of Florida Determined by High-Resolution in situ Nitrate Sensors

Export of nitrogen from different watersheds across the United States is receiving increasing attention due to the impairment of water quality in receiving water bodies. Researchers have indicated that different land uses exerted a substantial influence on the water quality. Nitrogen loadings based on different land uses are being studied in many ecosystems, such as the Baltimore, Maryland Ecosystem and Phoenix, Arizona Ecosystem, but few focus in a smaller scale which can be better at identifying the specific nitrogen sources. A nitrogen budget is being developed for the University of Florida campus in Gainesville, FL. This study will use in situ nitrate sensors to collect continuous nitrate data, which will bring new tool to the interpretation of watershed hydrology and biogeochemical processes. The study areas include three sub-basins on the campus with different types of land uses (recreational with intensive fertilization management, urban with reclaimed water irrigation, urban without irrigation) in the Lake Alice watershed. The study will include the outfall point in Lake Alice where the flow discharges to the groundwater. Two in-situ nitrate sensors (SUNAs) are being deployed in different types of land uses each time for a week period taking NO3--N readings every 15 minutes. Continuous time series data will be compared to determine if the storm water NO3--N concentration from one land use is different from another land use. The weekly N loads are calculated as the summation of the products of daily average concentrations and daily average flow over a week. The results showed the weekly time series of NO3--N concentrations in the recreational land use are significantly higher than that from urban with reclaimed water irrigation and from urban without irrigation. The calculated N loads were greater from the recreational land use compared with the two urban areas.

Maleski, Jerome

Authors: **Jerome Maleski**, University of Florida
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Wavelet analysis of hydrological variables and predictors in the Apalachicola-Chattahoochee-Flint and Alabama-Coosa-Tallapoosa River Basins.

Drought prediction is an important tool for water management. In order to improve drought prediction this study identifies cyclical components in temperature and precipitation in the Apalachicola-Chattahoochee-Flint (ACF) and Alabama-Coosa-Tallapoosa (ACT) river basin along with cyclical components of potential predictors. This analysis of predicators is a first step in the creation of a regional predictive drought model. A Standardized Precipitation Evaporation Index (SPEI) model of drought is examined along with the relative contribution of temperature and precipitation to drought in the region.
The ACT-ACF provided the regional focus for our study due to the ongoing water conflicts between Georgia, Alabama, and Florida in these river basins. Better drought prediction will aid in water management and planning for this area.
Precipitation and temperature data were taken from United States Historical Climatology Network (USHCN) gauges across the area of interest over the time period (1895-2012). Wavelet analysis is used to look for cyclical components in precipitation and temperature as well as related cyclical components in possible predictors. Predictors analyzed for shared cyclical components were: Southern Oscillation Index (SOI), Atlantic Multidecadal Oscillation (AMO), Pacific decadal Oscillation (PDO), North Atlantic Oscillation (NAO), Arctic Oscillation (AO), and Bermuda High Index (BHI).
The previously discovered “warming hole” is found in our data and it is suggested that this needs to be removed from any temperature data before it can be used in a predictive model. Our data suggests that the recent warming hole has moderated drought in the ACT-ACF region over the 1960-1990 period.

Martin, William

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Jason Sciandra, CDM Smith

Category: Managing water for people and the environment
Session Title: Water Supply Management

Disaggregating Demands and Integrating Supplies

Collier County Water Sewer District (CCWSD) continues to be a leader in the development of alternative water supplies and integrated water resource management. In the 1980s CCWSD realized that it could not meet future demands of its customers solely with traditional water supplies. CCWSD committed to a program of alternative water supply development that included the use of brackish groundwater and Aquifer Storage and Recovery (ASR) for potable supply, and reclaimed water, supplemental groundwater and ASR for irrigation purposes. Building upon their success over the past 25 years, CCWSD has recently embarked on a program to identify better ways to meet future water demands within its service area. The resulting strategy has evolved from an original traditional view of a single demand and single supply to the current partial separation of both demands and supplies to the planned integrated management of multiple demands and multiple supplies. As a means to better serve the total customer water needs, CCWSD has begun development of a new business model which will shift the focus from development of additional potable water supplies to meeting a larger portion of the overall water demand with irrigation quality (IQ) water supplies.
Currently, the ratio of IQ water distribution to potable water distribution within the CCWSD system is approximately 40:60. Of the current potable demand however, approximately 1/3 is still attributable to irrigation use in older parts of the system. The vision for CCWSD is to further optimize available water supplies by substituting IQ water for non-potable uses with the intent to provide both economic and environmental benefits. Implementation of this vision will include development of additional supplemental IQ water sources and IQ ASR storage throughout the CCWSD service area.

Marzolf, Erich

Authors: **Erich Marzolf**, Suwannee River Water Management District
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Category: Water quality protection and treatment
Session Title: Springs Protection and Management 1

Relationships Between Discharge And Water Quality In Florida Springs

The health of Florida springs are challenged by nutrient enrichment, primarily nitrate, and declining discharge. Elevated nitrate levels have been implicated in ecological changes in springs, primarily proliferation of filamentous and epiphytic algae. In addition, many Florida springs are experiencing declining discharge during periods of drought with some ceasing to flow completely. Many are considered impaired based upon a specific nutrient criterion (nitrate > 0.35 mg N-NOx/L). Changes in discharge are primarily governed by rainfall, but may also be influenced by groundwater withdrawals from the Upper Floridan aquifer. The existence of long-term temporal trends in nitrate concentrations and discharge in some springs are well established, however less is known about potential interactions between time, nitrate, other water quality constituents and discharge. Here we present evidence that Florida springs exhibit a variety of relationships between time, discharge and chemistry. Springs within the Suwannee River Water Management District exhibited positive, negative and no trend in nitrate while also showing a positive correlation between nitrate concentration and discharge. Similarly, there were springs which showed positive, negative and no trend in nitrate concentration while exhibiting no correlation with discharge. Similar patterns exist between concentrations of nitrate and potassium, an indicator of inorganic fertilizer, indicating variable inputs of fertilizer nitrogen among springs. These relationships support a view that in some springs the flows are a mixture of older, less nitrogen enriched water and shallower, more nitrogen-rich water. Cost-effective restoration of spring health in BMAP areas will be more cost effectively prioritized and implemented when proximal causes are accurately determined. Reduction of pollutant loading, including nitrate, to springs will be more easily reduced when sources are more precisely determined. These results underscore the hydrogeologic complexity of springs and their management.

McBryan, Jeremy

Authors: **Jeremy McBryan**, South Florida Water Management District

Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 2

Everglades Restoration Strategies: Optimizing Performance of Water Quality Restoration Projects

The Everglades Forever Act, which was passed by the Florida Legislature in 1994, required the South Florida Water Management District to implement the Everglades Construction Project consisting of large constructed wetlands, or stormwater treatment areas, and the Everglades Agricultural Area best management practices program. Over 57,000 acres of stormwater treatment areas are now operational. Since 1994, substantial progress toward reducing phosphorus levels discharging to the Everglades has been achieved. Source controls and stormwater treatment areas have collectively removed more than 3,800 metric tons of total phosphorus. The performance of the existing water quality infrastructure continues to be optimized and a suite of additional water quality projects are underway in order to further reduce phosphorus concentrations consistent with water quality standards. The additional projects will add an additional 6,500 acres, and add 116,000 acre feet of storage in three flow equalization basins. The implementation of this large public works effort over two decades is an excellent case study on how science and engineering are integrated in the design, engineering, and construction of water quality features. Considerable advancements have been made on how water quality features are sized and designed to achieve water quality standards. Integrating water management features such a flow equalization basin into the treatment process and optimizing operational protocol can significantly improve project performance and reduced project costs.

McConnell, Robert

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Category: Science, stakeholders and decision-making
Session Title: Governance and Regulation

Linking MFLs and TMDLs- Recent Case Studies in Southwest Florida

Challenges in balancing water quality and quantity for human and ecosystem needs are increasing as pressures on water resources increase. Regulatory programs designed to ensure resource protection while meeting human needs for water supply or wastewater disposal are intersecting more frequently due to resource limitations. Consumptive use and pollutant discharge/loading impacts to water quality are handled by different agencies in Florida and the U.S. based on independent goals and standards, but addressing water quality and quantity impacts requires a more holistic approach. Water use permits and MFLs established by Water Management Districts in Florida typically include monitoring and assessment of downstream water quality impacts related to withdrawals, but do not consider upstream conditions or discharge impacts. Discharge permits issued by the Florida Department of Environmental Protection (FDEP) require meeting state water quality standards for a particular water body use, but do not require extensive monitoring or assessment of downstream conditions. In addition, TMDLs and related management actions are typically considered independent of any withdrawal-related effects or needs. For this presentation, two recent examples for estuarine systems in southwest Florida will be discussed. These systems have established MFLs and major permitted withdrawals for water supply, as well as TMDLs developed by the U.S. Environmental Protection Agency and the FDEP. These examples highlight the need for and value of integrated coordination of regulatory efforts. This presentation will provide an overview of monitoring, assessment and compliance issues identified, and approaches used to help bridge different considerations and requirements for these regulatory programs.

McLaughlin, Daniel

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Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 2

Evidence for a significant nexus between isolated wetlands and downstream water bodies

Recent U.S. Supreme Court rulings have limited federal protections for isolated wetlands except where a "significant nexus" to a navigable water body is demonstrated. Differences in specific yield between uplands and inundated wetlands create conditions where water level responses to atmospheric fluxes in uplands are amplified relative to wetlands. This leads to frequent reversals in hydraulic gradients, allowing wetlands to alternate between water sinks and sources. This process buffers surficial aquifer variation, a process we refer to as landscape hydrologic capacitance. In this way, even isolated wetlands may influence surficial aquifer dynamics, and thus stream baseflow. To test this hypothesis, we connected models of soil moisture, upland water table, and wetland stage to simulate the hydrology of a low-relief landscape and explore the influences of total wetland area and individual wetland size. Increasing total wetland area while decreasing individual wetland size substantially lowered water table variation (e.g., reductions in standard deviation by as much as 50% at 30% wetland area) relative to landscapes without wetlands. Greater total wetland area and smaller wetland size also lowered mean water table depth (by 7% at 30% wetland area) and reduced the frequency of water levels near the upland surface. Even at the same total wetland area, landscapes with fewer larger wetlands exhibited markedly lower hydrologic capacitance than those with more numerous smaller wetlands, highlighting the importance of small wetlands. Considering the strong influence of regional water tables on downstream systems, loss of isolated wetland area or mitigation of this loss at the expense of wetland distribution (i.e., large mitigation banks to replace small distributed systems) may increase the vulnerability of downstream waters to climatic variability. Our results suggest isolated wetlands provide landscape hydrologic capacitance, buffering surficial aquifer variation and ultimately creating an indirect but significant nexus with navigable waters.

Migliaccio, Kati

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Water Demand Management

Improving irrigation using real-time information and smart apps

The use of evapotranspiration (ET) to schedule irrigation is not a new concept; however ET integration into the irrigation scheduling process has not received wide spread implementation due to a disconnect between the ET (or weather) data, how to convert it into an irrigation schedule, and user implementation. The availability of real-time and forecast weather data with greater spatial resolution as well as the growing use of smart devices provide an opportunity to better connect data with users in an applicable format. New smart irrigation apps have been developed that are commodity specific for citrus, cotton, strawberry, and urban turf by a University of Florida and University of Georgia team. These apps use real-time data and user input to generate an irrigation schedule in units of time. Apps also send notifications to users regarding previous rainfall and forecasted probability of rainfall the day before a scheduled irrigation event. Apps were developed for iPad, iPhone, and Android devices. Typically, use of ET based technologies average 30 to 40% water savings compared to a time-based schedule; actual water savings with these commodity-specific apps are currently being measured. Use of these smart irrigation apps are expected to reduce total volumes of water applied resulting in water conservation and protection of water supplies from nutrient leaching while maintaining plant production.

Miller, Lara

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Shannon McGee, UF/IFAS Extension Polk County
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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Watershed Education for Elected Officials, Resource Managers, and Concerned Citizens

Note: This is an application for the UF/IFAS Symposium Scholarship.
Around the globe, water availability and quality are significant issues and will continue to play a large role in the political decisions made by elected officials, resource managers, and concerned citizens. The University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) Extension Service hosts Water Schools in five southwestern Florida counties to provide local elected officials, county and municipal employees, community leaders, and the voting public with the background information needed to make informed decisions about water resource issues and management.
The primary goal is to increase participants' awareness and knowledge of local and regional water issues, regulatory stakeholders' responsibilities, scientific information available, and the influence water issues have on public policy. The objective for elected officials is for the knowledge gained to be utilized in making sound policy decisions regarding future planning and development.
Each Water School's format is unique to its target audience. Water Schools bring in experts from partnering organizations, provide the opportunity for an interactive panel disucssion, and include field tours to illustrate real-life implications of the principles discussed in class. The evaluation process involves a self-assessment of knowledge gained and potential behavior change.
Data collected from post-evaluations indicate participants gained knowledge and understanding of water systems and their interconnectedness to human activities within the watershed, learned of resources available to communities and governments to make better choices regarding water management, and acknowledged the need to consider potential impacts of future policy decisions on local and regional water supplies.
It is imperative for all citizens to become educated about water resource issues and learn how to positively impact the future water supply and demand. Water Schools serve as an ideal platform to accomplish this goal.

Morales, Miguel

Authors: **Miguel Morales**, University of Florida
James Heaney, University of Florida

Category: Managing water for people and the environment
Session Title: Water Demand Management

Assessment of Non-Residential Water Use Efficiencies through Sale and Employment Business Databases

The US EPA and the Water Research Foundation have both identified as a major research need, the development of a standardized methodology to classify commercial, industrial, and institutional (CII) water users. Schemes to classify CII customers differ greatly and often lack adequate disaggregation, making evaluations of CII water use across sectors difficult. The primary challenge in evaluating CII water use and classifying its customers is that water use patterns vary widely because of the diversity within the CII sectors such as aggregating small convenience stores and regional shopping malls. This large water use variability is driven by differences in water use processes and technologies, varying employee and visitor occupancy patterns, and seasonal effects driven by fluctuations in consumer demand and climactic factors.
In order to overcome these complex challenges, as part of a Water Research Foundation study, this paper demonstrates the process of spatially linking property appraiser and proprietary business data to CII water use records to arrive at an improved understanding of how CII customers use water. The process adopts a standardized approach that is widely applicable, including a link of proprietary business data to North American Industry Classification System codes and to water users. Additionally, building area (from property appraiser), employment, and sales (from business data) can be used to analyze water use relationships, classification homogeneity, and develop water use metrics. For this analysis, actual billing data for approximately 18,000 CII customers from Austin, Texas will be used.

Morgan, Kelly

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Water Demand Management

My Florida Farm Weather Program for the Florida Automated Weather Network

Weather-related information is essential to Florida's agricultural producers for making important decisions regarding the use water for irrigation and cold protection. The Florida Automated Weather Network (FAWN), a program of the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS), provides growers with a variety of weather-related tools that can aid them in making these decisions. The use of temperatures at FAWN sites can approximate evaporative demand and cold weather conditions at grower fields, but may not provide the level of specificity needed to ensure growers are operating their irrigation systems during optimal times. A system of site specific data from grower owned and maintained weather stations was developed by FAWN in 2013 in association with the Florida Department of Agriculture and Consumer Services (FDACS) as a Best Management Practice (BMP) cost share program. The program, called "My Florida Farm Weather" is expected to maximize agricultural water use efficiency, and can substantially reduce the amount of water consumed by agricultural producers. Nearly 75 grower weather stations were installed in the first year of the program to support the BMP effort with many more stations to follow. With its programming, database, and field expertise, FAWN is uniquely positioned to provide the data from these weather stations to growers. FAWN has completed deployment of a high resolution farm based weather station network that will provide growers with real-time site-specific data that can be accessed either via the FAWN website or smartphone app.

Morris, Kevin

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Jessica Bolson, Wharton Risk Management and Decision Processes Center

Category: Managing water for people and the environment
Session Title: Water Supply Management

Synthesis of Diverse Data in Developing a Decision Tool for Initiating Recovery from an Aquifer Storage and Recovery System

The Peace River Manasota Regional Water Supply Authority (Authority) serves a four county area in Southwest Florida with a total population of about 1 million. The utility's source of drinking water is the Peace River. Although the river intake is located 38 miles upstream from the open waters of the Gulf of Mexico, it is not unusual to experience brackish conditions during the dry season. Since the Authority's treatment processes will not remove salinity, it must harvest and store fresh water when it is abundantly available during the rainy season.

The Authority has two major storage elements: raw water is stored in off-stream raw water storage reservoirs and finished water is stored deep underground in Aquifer Storage and Recovery (ASR) Wells. One great challenge in managing the ASR system is determining the optimal time to turn on the wells and begin recovering stored water. If recovery is initiated too soon, the wells can suffer over pumping, resulting in water quality degradation. If recovery is initiated too late, there is an increased risk of a water shortage. It is extremely important to get the ASR Recovery timing decision right. Understanding the potential role of climate information in ASR Recovery decisions at the Peace River Manasota Regional Water Supply Authority provided motivation for our research.

This paper details the development of a multi-variant decision tool developed through the synthesis of historic data and forecasts resulting in a seasonally oscillating index value. Once the index value exceeds a prescribed threshold, ASR recovery is initiated. This index value serves as a guide to help insure the proper timing of ASR recovery. Although specifically developed for a narrow application, the process of how this index was developed may be useful for others seeking ways to synthesize scientific data to promote more informed decision making.

Morrison, Elise

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

The response of microbial communities to nutrient enrichment in the Florida Everglades

The Everglades is a naturally oligotrophic system that has been subject to phosphorus (P) enrichment from agricultural areas to the north. Resultant shifts in vegetation communities, enzymatic activities, and nutrient cycling have been documented between impacted and unimpacted sites, and indicate a shift from the natural P-limitation at unimpacted sites to a potential nitrogen (N) limitation at impacted sites. This nutrient enrichment has resulted in changes in the composition of functional genes within microbial communities. Through Geochip 3.0 microarray analysis, a suite of functional genes responsible for C cycling, P cycling, and N cycling were found in varying abundances between sites. The ratios of select gene abundances along the gradient were found to be consistent with the shifts in nutrient limitation. Further work is being conducted to better elucidate the dynamics of P-cycling genes at these sites, in order to better understand how P enrichment may influence the functioning of native microbial communities. Microarray analysis found genes for exopolyphosphatase, polyphosphate kinase, and phytase along the gradient. Additionally, genes for high substrate affinity phosphatase (phoX) and genes associated with C-P lyase (phnD) were found through PCR and transcriptomic techniques. By coupling microarray analyses with transcriptomics, we hope to provide a more comprehensive picture of the response of microbial communities to nutrient enrichment in sensitive, oligotrophic systems such as the Everglades. An understanding of the response of peats to nutrient pollution at the molecular level is critical to our understanding of the mechanisms through which wetlands serve to improve water quality. Information such as this will improve our ability to predict interactions between water quality, wetland function, and changing environmental conditions.

Muñoz-Carpena, Rafael

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

A simplified approach for simulating changes in beach habitat due to the combined effects of long-term sea level rise, storm erosion, and nourishment

Better understanding of the vulnerability of coastal habitats to sea level rise and major storm events are aided by the use of simulation models. Since coastal habitats also undergo frequent nourishment restoration works in order to maintain their viability, vulnerability models must be able to assess the combined effects of sea level rise, storm surge, and beach nourishment. The Sea Level Affecting Marshes Model (SLAMM) was modified and applied to quantify the changes in the beach area in a 5-km stretch of beach in Santa Rosa Island, Florida due to these combined effects. A new methodology to estimate spatial erosion patterns was developed based on measured erosion during three historic storm events representing a wide range of storm intensities over the study area (named storms Ivan (H5), Dennis (H4), and Katrina (TS)). Future major storms over the 2012-2100 period were generated based on the frequency distribution of historic storms using 4,000 simulations to account for uncertainty in the storms temporal distribution. Potential effects of individual, successive, and random storms occurring over the area under 0-1.5m nourishment schemes were evaluated. The risk of losing the beach habitat in 90 years for different scenarios is studied based on probability distribution contours constructed with the model results. Simulation results suggest that without nourishment, a major storm with a category of tropical storm or higher will reduce the beach at the end of the period by 97-100%. This loss can be reduced to 60% by maintaining a 1-m beach elevation and can further be reduced to 34% with 1.5 m beach nourishment.

Nelson, Natalie

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Blooms in the Bay: Modeling spatiotemporal chlorophyll-a dynamics exhibiting high inter-annual variability

Located south of the Everglades and west of the Florida Keys, Florida Bay's position within the landscape makes it an integrative indicator of upstream terrestrial disturbance. As a result, the ecological integrity of Florida Bay has noticeably waned as development has increased on the Florida peninsula, as has been made particularly evident through the recurrence and persistence of ecologically devastating algal blooms. Although several potential bloom triggers have been identified, linkages between the bloom response and changes in water quality have not yet been deterministically modeled across the expanse of the Bay due to the algal dynamic of this estuary exhibiting high inter-annual variability as compared to other estuarine systems. Therefore, this study was conducted to analyze and simulate these spatiotemporal relationships. Using SERC-FIU Water Quality Monitoring Network time series data (16 years, monthly time step) of several water quality constituents from 28 spatially distributed stations in Florida Bay, multilinear regression models were created. Chlorophyll-a, serving as a proxy to phytoplankton concentration, was used as a measure of algal bloom intensity. A model with a common set of explanatory variables, including site-specific limiting nutrients, turbidity, and autoregressive terms, was successfully developed for the entire domain. The regression coefficients were used to analyze the relative importance and spatial variability of the bloom drivers in the estuary. Additionally, uncertainty inherent to data collection in aquatic environments was considered in the interpretation of results. This work contributes to the development of explanatory models for highly variable algal dynamics in estuarine systems, and could be used to evaluate the future risk of blooms in Florida Bay in the context of forecasted development and Everglades restoration scenarios.

Nguyen, Tanh

Authors: **Tanh Nguyen**, University of Florida/Tropical Research and Education Center
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

An approach for evaluation and screening of measured data for wetland hydrologic model

Hydrologic models are used to evaluate a variety of water issues and depend on measured data either as input or to be used in parameter estimation and calibration. However, these measured data are uncertain. Modelers must decide how to include measured data uncertainty in their use of data as input and/or as calibration data. Thus, our objectives are to develop an approach for screening and validating both measured input and measured output calibration data and determine output sensitivity with and without validation. We used a wetland model as a "test scenario" to compare simulated output data using goodness-of-fit indices (Nash-Sutcliffe efficiency [NSE], ratio of the root mean square error to the standard deviation of measured data [RSR], and percent bias [PBIAS]). We also developed a protocol for evaluating measured input and tested the protocol. Study results showed that measured data without calibration resulted in reduced goodness-of-fit when comparing model predicted output to measured data and applying our protocol improved the ability to simulate a given system.

Nifong, Rachel

Authors: **Rachel Nifong**, University of Florida
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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Does the stoichiometry of ecosystem metabolism reflect plant species stoichiometry and composition?

Metabolism is an integrative metric of ecosystem energetics, synthesizing the relative contributions of multiple inputs, processes, and interactions. Ecological stoichiometry is a framework based on elemental ratios for understanding how organisms interact with their environment. Together, they have the potential to yield novel insight about how ecosystems use elements and energy. In this study, we sought to quantify the link between the stoichiometry of ecosystem metabolism, specifically the C:N:P ratios of integrated autotrophic assimilation, and the stoichiometric ratios observed in the dominant autotrophs. Using high frequency in situ nutrient sensors we estimated the assimilatory fluxes of C, N, and P in multiple spring-fed rivers of varying autotrophic species composition. We measured autotroph cover in each spring river, collected composite vegetation samples, and evaluated tissue stoichiometry; as expected, we observed large differences in C:N and N:P between algal and vascular plant taxa. We observed a strong association between measured tissue stoichiometry and elemental ratios at the ecosystem scale, suggesting that aggregated assimilatory fluxes may be useful for partitioning primary production and linking organismal nutrient content to the stoichiometry of ecosystem metabolism.

Normand, Anna

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Comparison of organic matter composition from shifting vegetation communities due to increased inundation of a subarctic mire in Abisko, Sweden

Climate change over the next century will affect vegetation communities in peatlands. External drivers such as precipitation and temperature may influence diversity of vegetation species composition. Particularly in the subarctic region, the temperature will increase more rapidly than the global mean, annual mean precipitation will likely intensify, and permafrost is projected to decrease by 37 to 81%. This will result in increased inundation of peatlands and consequently shift vegetation communities. These changes have already been observed in a subarctic mire ecosystem near Abisko, Sweden. Three vegetation community types dominate the system: 1) permafrost sites consisting of drained palsa areas with woody herbaceous vegetation; 2) intermediate thaw features with Sphagnum spp. where the water table is close to the surface; 3) wet fen dominated by Eriophorum spp. where the ground completely thaws. Over 40 years, the wet fen communities have established in former Sphagnum areas, and Sphagnum has recruited at degraded palsa hummocks. The altered hydrologic regime selecting for vegetative communities will dictate the quantity and quality of litter inputs. In this study, we examined the varying organic matter quality of the vegetation and litter from the community types. When present, live, standing dead, below ground biomass, and detritus were collected from fen, Sphagnum, and palsa communities across a 26 m transect. Total carbon (C), nitrogen (N), and phosphorus (P) and C and N isotopes determined differences in the vegetation composition. Solid State 13C Nuclear Magnetic Resonance (NMR) identified the relative abundance of C functional groups: carbonyl, O-aromatic, aromatic, O-alkyl, N-alkyl-methoxy, and alkyl. The ratio of alkyl/O-alkyl and aromatic peak area inferred differences in stability of the vegetative inputs. The molecular properties and stability of the vegetation inputs will ultimately dictate decomposition and stability of the resulting soil organic matter which is important for nutrient cycling and greenhouse gas (GHG) emissions.

Olsen, Eric

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Category: Science, stakeholders and decision-making
Session Title: Governance and Regulation

Implementation of Minimum Flows and Levels and Associated Prevention and Recovery Strategy

The water management districts must establish minimum flows and levels (MFLs) for surface water bodies and aquifers. An MFL is the point at which further withdrawals will be significantly harmful to the water resources or the ecology of the area. The Florida Department of Environmental Protection (FDEP), within Florida's Water Resource Implementation Rule, has promulgated guidance on MFLs.
If a surface water body or an aquifer is below an established MFL, the water management districts must adopt a recovery strategy to achieve the MFL. If a surface water body is an aquifer is projected to fall below an established MFL within the next 20 years, the water management districts must adopt a prevention strategy to keep the MFL from being violated.
Florida's water management districts have established a number of MFLs for surface water bodies, aquifers and springs. In many cases, the water management districts have determined that a surface water body, aquifer or spring is below the established MFL. In these cases, the water management districts have adopted recovery strategies to achieve the established MFL.
This presentation will examine the water management districts' implementation of the MFL program under FDEP guidance. The presentation will discuss how the determination of "significant harm," and when a water level or flow is low enough to cause "significant harm." The presentation will outline the consideration of structural alterations to a surface water body and other pre-existing conditions MFLs establishment.
The presentation will also examine adopted MFL prevention or recovery strategies to describe how the cause of the MFL violation was determined, the specific measures instituted to achieve the MFL recovery or prevent a future violation, and how those measures have been implemented by entities using water and requiring consumptive use permits.
The presentation will set forth realistic expectations for Florida's MFL program.

Oppong-Anane, Akua

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Towards a Geochemical Approach to Preventing Groundwater Pollution via Landfill Imposed Reductive Dissolution of Vadose Soil Iron Oxide Minerals

Landfilling is the most widely used method of waste disposal in the world including the USA. However, contamination of groundwater by landfill activities is becoming increasingly problematic. In recent years, groundwater contamination with iron (Fe) in landfill impacted aquifers has been on the increase in Florida, where Fe concentrations above the secondary drinking water limit of 0.3 mg/L have been measured in a number of groundwater monitoring wells. Interestingly, groundwater monitoring data collected from the same wells at or downstream of landfill sites indicated that detected Fe may not originate from the actual landfill, based on the behavior of key tracers common to landfill leachates. In fact, it now believed that Fe-reductive dissolution of Fe-(hydr)oxide minerals naturally occurring in vadose soil appears is the main source of dissolved Fe(II) detected in polluted groundwater. To investigate this hypothesis, laboratory batch experiments were conducted and the ability of native vadose soils to behave as source of Fe polluting the aquifer was tested. Vadose soil samples were collected from different sites falling along a transect with an apparent gradient in both organic matter content and degree of crystallization of Fe-(hydr)oxide minerals. The results show that organic-rich leachate can fuel the reductive dissolution of soil's Fe-(hydr)oxide minerals as organic matter undergoes oxidation during microbial anaerobic respiration by iron reducing bacteria. In addition to this microbial driven process, a non-biological process does exist as well. In the latter, reduced sulfur compounds (e.g. H2S) appear to be responsible for the Fe-reductive dissolution. However, the contribution of these biotic and abiotic processes under natural conditions remains to be determined. The ultimate goal of this project is to develop a geochemical model which incorporates key soil's physicochemical characteristics to help predict the potential of a given soil to respond to landfill activities with regard to Fe-reductive dissolution.

Ott, Emily

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Qualitative Social Research for Communicating Water Conservation

Not all research questions pertaining to human behaviors such as landscaping and water use are best answered by quantitative inquiry. Qualitative social research can be a valuable tool for understanding perceptions, values, and water use behaviors. This understanding can be used to develop relevant messaging that can influence pro-environmental behavior change such as increasing water conservation in residential landscapes.
One case study illustrates how qualitative inquiry can be used to develop communication strategies to influence water conservation behaviors. Focus group research among high water users in western Alachua County (within the Santa Fe River springshed) revealed these residents were concerned about future water security. Despite their concern these residents did not feel personally responsible for future water quantity and quality (i.e. security). The ways residents discussed their concern and their lack of control over water quantity and quality provided valuable insights to researchers. These insights have practical implications as they can be used to better communicate the importance of outdoor water conservation at least among these residents. Implications will be discussed including:
- communicating both the collective impact of residential water users and impact of individual residences on water security,
- changing norms of outdoor water use on a neighborhood scale, and
- utilizing informal communication networks including champions or “water stewards.”

Ouyang, Ying

Authors: **Ying Ouyang**, USDA FS, CBHR

Category: Water security: the water-energy-food nexus
Session Title: Water-Energy Nexus

Simulating Water Use and Nitrogen Fate in a Woody Biomass Production Ecosystem

Biomass, the most common form of renewable energy, has the potential to become a major global energy source in the next century. Although short-rotation woody biomass production technology has shown a promising potential to supply feedstocks for bioenergy production, the water use and nutrient fate in the woody biomass production ecosystem are still poorly understood. In this study, a STELLA (Structural Thinking and Experiential Learning Laboratory with Animation) was developed to estimate water use and nitrogen (N) fate in a soil-tree-atmosphere continuum from the woody biomass production plantation. The model was calibrated with reasonable agreement between the model predictions and the field measurements prior to its application. A scenario was then performed to estimate both diurnal and monthly water and N variations of a one-hectare mature cottonwood plantation over a one-year simulation period. A characteristic diurnal variation pattern was observed for simulations of soil water evaporation, leaf water transpiration, and root water uptake, with increases from sunrise to early afternoon followed by decreases from early afternoon to sunset. A typical monthly variation pattern also was found for the simulations of soil water evaporation, leaf water transpiration, and root water uptake, with increases from winter to summer and decreases from summer to following winter. Simulations further revealed that the rate of soil water evaporation was one order of magnitude lower than that of leaf water transpiration. In most cases, the relative monthly water loss rates could be expressed as: evapotranspiration > root uptake > percolation > runoff. Leaching of nitrate-N (NO3-N) and soluble organic N (SON) depended not only on soil N content but also on rainfall rate and duration. Leaching of NO3-N from the cottonwood plantation was about 2 times higher than that of SON. The relative monthly rate of N leaching was: NO3-N > SON > NH4-N.

Owens, Courtney

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Education and Decision Making

Changing Water Education: The Role of Extension

Water conservation is an issue of significant importance, affecting not only the agricultural community but also the general public on a national scale. By utilizing an already existing public outreach service, the Cooperative Extension Service (CES) and water conservationists can better communicate their message to the public, spreading information about water education practices and promoting conservation behaviors. By incorporating best management practices for water conservation into through curriculum, Extension programing can increase stakeholder involvement and engagement. Extension is the important change driver needed to impact change within society. By creating more quality programs focused on water conservation, CES has the opportunity to impact the conservation practices of members of the public and increasing awareness of water-related topics.

Extension has played a major role in disseminating education to stakeholders in the past. As the urban-rural interface continues to evolve, Extension will play an increasingly important role in educating the public in the future. To ensure water conservation is steadily emphasized throughout the State of Florida, more policies and changes must be made within Extension Services. Currently, Extension has numerous water management publications and fact sheets that are available and practical to the public. The problem stems from the public not knowing where and how to access these resources. Extension programing will have to improve upon the methods to deliver water education to the public and learn the best possible way to reach the individuals who need this information. By incorporating additional water conservation practices into the CES agenda, CES can better involve the public in water issue and increase the public's involvement in water conservation practices. CES will need to provide a variety of educational and outreach programs to the public: including social media, webinars, classes, and print media to engage the largest population possible.

Palacio, Darina

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Stream Restoration in Florida

Over $1 Billion is spent annually on restoration to improve or restore streams and rivers in the United States, however studies synthesizing restoration practices are now outdated and/or omit most stream restoration projects in Florida. This study synthesized stream restoration practices in Florida by compiling a Florida stream restoration database that characterizes 178 projects by type, spatial distribution, temporal trends and costs. Project types included: riparian management (23%), stream reclamation (19%), flow modification (13%), bank stabilization (12%), channel reconfiguration (11%), in-stream habitat improvements (11%), floodplain reconnection (6%), invasive species removal (4%), and dam removal (1%). Project types were clustered into three regions, reflecting a spatial distribution of agency initiatives, need, and funding. Restoration in the panhandle of Florida emphasized in-stream habitat restoration, while flow modification was most common project type in peninsular Florida. Stream restoration projects in the west central region were dominated by the restoration of tidal streams and stream reclamation projects to mitigate surface mining practices. The spatial analysis also revealed that a preponderance of projects were performed on public lands and less than 20% occurred in urban areas. An increase in both the number and diversity of projects was observed, from an average of 1.7 projects completed per year from 1979-1999 to > 4 projects per year since 2000. In contrast with earlier works, which did not fully utilize databases and practitioner knowledge, this study found that that Florida spends much more on stream restoration than previously documented. The average cost of stream restoration projects in Florida between 1979 and 2015 (projected) was $15.9 million, while the median cost was $180K, highlighting a strongly skewed distribution of project costs driven by the reconfiguration of the Kissimmee River channel ($980 million). Finally, this work highlights the need for a statewide restoration database to improve restoration tracking.

Parra, Sabrina

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Fortnightly variations in turbulent kinetic energy at a buoyant jet submarine groundwater discharge in a fringing reef lagoon

Neap-spring variations in turbulent kinetic energy (TKE) and discharge from a point-source submarine groundwater discharge (SGD) located within a fringing reef lagoon were investigated through velocity, temperature, salinity and pressure measurements. The principal factors considered for TKE and discharge variations were tides and waves. The field data indicated that TKE and discharge varied between high and low tides, as well as with neap and spring tides. Maximum values were observed during low tides, when the hydrostatic pressure over the spring was minimal, while high tides produced the lowest values. Spring tides produced consistent saltwater intrusion during high tides, while neap tides produced the greatest TKE of the time series. While previous studies have shown higher seepage SGD during spring tides rather than neap, the point-source SGD studied produced greater discharge during neap tides due to the flow reversals observed throughout high tides in spring tides. As the jet discharge intensified (most notably during spring tides), temperatures decreased, while at the same time, salinities increased. The decreasing temperatures suggest aquifer water is exiting the jet, since during this time of year the aquifer is cooler than the lagoon water. While increasing salinities suggest mixing of the aquifer water with sea water. Therefore, it is proposed that the jet conduit is connected to a chamber that is stratified with seawater below aquifer water. As the jet discharge intensifies, mixing between the two layers increases, which is evident in the increasing salinities with decreasing temperatures. While tides were the primary driving force of the discharge, waves also played a role. Wave effects on the discharge was more evident during high tides (than during low tides) when the discharge was weaker, thus more susceptible to wave forcing.

Pearson, Brian

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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Influence of mulch type and depth on stormwater runoff and leachate from simulated landscape soil boxes

Mulch is applied to landscape plant beds to enhance aesthetics, improve soil characteristics for plant growth, and reduce landscape maintenance through weed suppression. Mulch application modifies urban soil hydrology through precipitation interception and absorption, yet is poorly understood and largely undocumented. Influence of mulch type and depth on stormwater runoff and leachate provides landscape managers and stormwater modelers with information necessary to develop best management practices aimed at minimizing impacts associated with conventional landscape management practices. Eighteen runoff boxes were filled with two sandy soil types representative of those found in newly constructed residential communities in Central Florida. Pine bark, pine straw, mixed hardwood, and synthetic mulch were applied to depths of 0, 7.6, and 15.2 cm. Simulated precipitation was applied at a rate of 5.4 cm hr-1 for durations of 15 minutes to simulate short duration, high intensity rainfall representative of historical trends. Runoff and leachate was affected by a mulch x soil type interaction ($P<0.01$). Mulch reduced runoff and leachate from low sand soils by 90% and 100%, respectively. Runoff and leachate from high sand soils were not affected by mulch. Results suggest application of mulch may considerably reduce runoff and leachate from similar, low permeable soils and impede nutrient transport mechanisms.

Pettit, Christopher

Authors: **Christopher Pettit**, Palm Beach County Water Utilities Department

Category: Managing water for people and the environment
Session Title: Water Supply Planning

Addressing Future Water Supply Challenges in SE Florida

Water and wastewater utilities and local governments face immense challenges in the coming decades as impacts from continued population growth, climate change/sea level rise, agricultural intensity, aging infrastructure and other as-of-yet unforeseen factors take their toll. Innovative approaches will be needed in the areas of water supply, wastewater service, reclaimed water delivery, land use, and stormwater storage and utilization. Palm Beach County has been a leader in the areas of alternative water supply, reclaimed water delivery, aquifer recharge, and the utilization of renewable energy and conservation methods. This presentation will provide some of the steps taken by Palm Beach County to put itself in a position of strength heading into the coming decades, as well as some of the innovative ideas that are being included in the latest iteration of the Water Utility Department's strategic plan. The presentation will discuss the potential of Aquifer Storage and Recovery, expansion of reuse delivery through conservation and supplementation, the need for and possibility of large scale regional projects or authorities, the potential for dealination as a water supply source, and possible regulatory or legislative changes that may be on the horizon. Lastly, the challenges faced by SE Florida will be put into context with challenges being faced by other areas of the State as a way of emphasizing the need for regional based solutions to unique water supply challenges.

Prasad, Rishi

Authors: **Rishi Prasad**, University of Florida
George Hochmuth, University of Florida
Davide Cammarano, University of Floirda
Senthold Asseng, University of Floirda

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Role of nitrogen budgets in evaluating nitrogen leaching from potato production in sandy soil: A model based approach to improve nitrogen management in Suwanee River Basin

Increasing concentrations of nitrate in ground water in the Suwannee River Basin has raised concerns over the past 30 years. Agriculture is a major industry in the basin and is considered as an important non-point source of nitrogen pollution. Best management practices (BMP) are being encouraged for agricultural fertilization and irrigation in this watershed, however nitrate concentrations in the springs remain elevated. There is a need for quantifying sources of nitrogen losses for different crops grown in the area. Knowing a crop N mass balance will help in understanding crop nitrogen use, requirements and losses and assist BMPs for reducing the N load in the watershed. Our research was conducted on a large, diversified livestock and row crop farm located in close proximity to the Suwannee River. The objective of this study was to quantify the N mass balance components associated with potato production in sandy soils with a center pivot irrigation system for four consecutive growing seasons. Field measurements and a model based approach were used to construct the N budget for the potato production system. The potato model SUBSTOR within DSSAT was calibrated, evaluated and used to optimize the N fertilizer rates, timing, and irrigation management. Leaching was found to be a major pathway for N loss from potato systems and comprised 35 % of the total N fertilizer input.

Ramirez, Samuel

Authors: **Samuel Ramirez**, GAI Consultants
Peter Schreuder, Schreuder Inc
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David Bolam, Clay County Utility Authority

Category: Managing water for people and the environment
Session Title: Water Supply Management

Integrated Water Resource Program (IWRP) for the Keystone Heights Surficial Aquifer and Lakes Replenishment Program

The IWRP intends to develop a water augmentation source from stormwater and excess surficial aquifer water collected from within FDOT right-of-way (i.e., S.R. 23 and S.R. 21) and reclaimed effluent from wastewater treatment plants in the area. In order to assess the feasibility of this program, the project stakeholders asked that a preliminary siting, detailed yield analysis, and environmental harm assessment be performed in the First Coast Outer Beltway (FCOB) from I-10 to SR 21 as a representative sample for the entire FCOB SR 23.
The harvestable water analyses indicate that there is a sustainable water yield available to harvest. Three independent approaches were used to determine the following yields:
• Urban development analysis relating to the increase in impervious areas within the watershed calculates a yield of 9.7 MGD for harvesting.
• Streamflow analysis for two streams within the area under investigation shows for the stream with urban development an increase of 7.5 inches of streamflow per year more than from the watershed without development. Using a mass balance with hydrological average condition parameters, a yield of 9.7 MGD is possible for harvesting without reducing runoff from the natural conditions of the area.
• Preliminary analysis using the numerical Stormwater Harvesting and assessment for Reduction of Pollution (SHARP) computer modeling software indicates a yield of 10 MGD. The SHARP model will be fully completed for TM 2.
These findings demonstrate that there are excessive amounts of water available to be harvested within the project's watersheds.

Reijo, Courtney

Authors: **Courtney Reijo**, University of Florida
Matthew Cohen, University of Florida, School of Forest Resources and Conservation

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Opening the Benthos Box: Assessing stream response to reduced nitrate concentrations

As nitrate levels in lotic systems have increased, nutrient reduction strategies have become the centerpiece of water quality standards to protect and restore stream ecosystems. While reducing anthropogenic nitrate loads has many positive effects, we lack a fundamental understanding of how lotic systems respond to changing concentrations, making it difficult to predict whether reductions will meet management goals. In-stream methods exist to characterize nutrient uptake behavior as nutrient concentrations change from ambient to saturation, but no methods exist to estimate these effects at concentrations below ambient levels. To fill this knowledge gap, we developed a chamber-based method, which allows characterization of nitrate utilization along the two major uptake pathways at concentrations below ambient levels. The clear Plexiglass chamber blocks flow by insertion into upper sediments but allows light in, and sediment-water-air interactions to occur. Using in-situ sensors, we measured water quality (nitrate, dissolved oxygen, pH, oxidation-reduction potential, temperature, and light) at high temporal resolution (15 min. intervals) over several days as nitrate was depleted. At Gum Slough Springs, a spring-fed river in Marion County, Florida, nitrate reduced from ambient levels (1.20 mg N/L) to below regulatory thresholds (ca. 0.20 mg N/L) within one week. Daytime nitrate uptake, resulting from both plant uptake and denitrification, was consistently greater than nighttime uptake, which is denitrification alone. Estimates of uptake rates were not significantly correlated with changing nitrate levels for either pathway. Replicating measurements in other systems, refining the decoupling of nitrate removal pathways, determining system responses to reduced nitrate levels across gradients in sediment and vegetation properties, and assessing other drivers of primary production are priorities for future work. The method shows promise as a tool for in-situ ecosystem-scale assessments of nutrient retention below ambient concentrations, and thus may enable future investigations focused on predicting how rivers will respond to enrichment and restoration.

ReVoir II, Gary

Authors: **Gary J. ReVoir II, P. E.**, Tetra Tech

Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 1

Potable Reuse: The Next Generation for Use of Reclaimed Water

As fresh water supply sources quickly diminish regulators and municipalities are quickly searching for new drought-proof, reliable water supplies. For many coastal communities, seawater desalination is quickly becoming a technically viable solution to meet water shortages. However, many areas of the United States are either inland or have limited access to a large water body for either desalination or use as a reliable supply. Coupled with the fact that local efforts to optimize conservation and reclaimed water often times produce efficient results, water purveyors are left wondering where is the next reliable source of supply. In most cases, the development of either a new seawater desalination or surface water supply requires a long supply main, a new complex treatment system and significant modification to the existing distribution system relative to incorporating the new supply with existing infrastructure. The capital costs for the new supply sources (alternative water supplies) are staggering when compared to expansion of traditional sources. Additionally, increased regulatory pressures for effluent disposal such as TMDLs and the recently enacted numeric nutrient criteria (NNC) has pushed treatment levels for municipal wastewater closer to drinking water quality than ever before.

The concept of potable reuse have been around for decades. Even though the exposure to this concept has gained popularity through the space program, public opinion has always ceased the efforts to successfully push technically possible projects to reality back on planet Earth. Predicting victory over public opinion may never be quantifiable, advances in high-level treatment processes has made the concept more affordable for potential consideration by utilities. This is of great importance, as diminishing water supply resources and increased regulatory limitations have left most water utilities with a limited number of alternatives.

This paper will provide a review of technologies associated with producing direct (DPR) and indirect potable reuse (IPR) as compared to the costs for high-level wastewater treatment coupled with the costs for desalination and surface water treatment.

Roper, Caroline

Authors: **Arthur Leal**, University of Florida
Caroline Roper, Graduate Student
Courtney Owens, Graduate Student

Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Understanding the public: Utilizing perceptions to change water conservation behaviors

Understanding public perceptions of conservation practices is vital in the development of a well-informed public that is willing to engage in conservation behaviors. Research shows that although the public is aware of some of the water shortages and conservation issues, they become increasingly aware during times of crisis; such as, droughts and ecological disasters. Research also shows that members of the public are willing to practice some conservation practices such as installing low-flow shower heads and irrigation sensors. Although they are willing to engage in these types of conservation behaviors, the public are reluctant to acknowledge their own connection to existing water issues. By understanding the public's perceived attitudes toward conservation as well as their involvement in current conservation practices, water providers can better frame and communicate with the public about their actions and encourage them to practice new water conservation behaviors. Currently, a certain level of distrust exists between water providers and consumers, which has caused a disconnect with current water issues. Although the public engages in selected conservation behaviors, encouraging them to adopt new behaviors has been challenging. For water providers, understanding the knowledge gap and public attitudes toward water conservation is crucial when engaging the public in new conservation behaviors. Creating new communication initiatives to improve the communication between the water industry and the public will help reduce the existing disconnect, resulting in more awareness and realization of current water issues. The development of strategic communication, concerning water conservation practices, will encourage the public to engage in new water conservation practices and increase their awareness surrounding water issues. Communication efforts will also help reconnect the public to the water industry, leading to more informed decision-making by the public.

Rozin, Alexandra

Authors: **Alexandra Rozin**, University of Florida
Mark Clark, Soil and Water Science, University of Florida

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Exploring in situ optical sensors for the measurement of nitrate

Assessing the impact of nutrient concentrations on aquatic ecosystems requires an in depth understanding of dynamic biogeochemical cycles that are often a challenge to monitor at the high spatial and temporal resolution necessary to understand these complex processes. Traditional sampling approaches involving discrete samples and laboratory analyses can be constrained by analytical costs, field time, and logistical details that can fail to accurately capture both spatial and temporal changes. Optical in situ instruments may provide the opportunity to continuously monitor a variety of water quality parameters at a high spatial or temporal resolution. This work explores the suitability of a Submersible Ultraviolet Nitrate Analyzer (SUNA) produced by Satlantic, to accurately assess in situ nitrate concentration in several freshwater systems in north Florida. SUNAs with different path lengths were deployed to measure nitrate at five different water bodies selected to represent a range of watershed land uses and water chemistry in the region. In situ nitrate measurements were compared to standard laboratory methods to evaluate the effectiveness of the SUNA's operation and the difference in path length. Other optical sensors were used to measure the spectral properties of absorbance, fluorescence, and turbidity (scatter) in the same Florida water bodies. Data from these additional sensors were collected to quantify possible interferences that may affect SUNA performance and guide instrument specification recommendations. A better understanding of the capabilities and possible limitations of differing path lengths associated with these relatively new analytical instruments will allow researchers to more effectively investigate biogeochemical processes and nutrient transport and enhance decision-making to protect our water bodies.

Sanagorski, Laura

Authors: **Laura Sanagorski**, University of Florida Department of Agricultural Education and Communication

Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Water Demand Management

Extension Programs for Irrigation Water Conservation: Evaluating for Social Marketing Principles and Program Planning

Many Extension professionals conduct educational programming to encourage sustainable practices that reduce water usage and preserve water quality. There is a great need to focus on the behavioral side of water conservation, and social marketing is a proven approach to changing behaviors. A social marketing approach seeks to enhance the benefits and reduce the barriers to adopting some behavior and may employ a number of strategies to encourage behavior changes. This presentation provides a case study of Extension programming in irrigation water conservation with a focus on formative audience evaluation. The behavior of interest in this case was the adoption of water saving practices and technologies.
An irrigation workshop was conducted to 1) Raise awareness of the need to conserve water; 2) Encourage participants to adopt water saving practices and technologies; 3) Increase knowledge of techniques for improving irrigation systems; and 4) Increase knowledge of tools and resources that can support more efficient irrigation practices. Following the workshop, participants were asked to complete a retrospective pretest-posttest program evaluation. The instrument was developed to determine the effects of the training on attendees' behavioral intentions, establish norms for this group, and identify barrier and benefits to adopting water saving practices and technologies.
This presentation comprises a synopsis of this Extension workshop, shares descriptive data on the audience, and provides programmatic implications and recommendations for professionals working to create water-conservation behavior changes. Suggestions for Extension educational programming will be presented within the framework of social marketing. Specifically, the discussion will focus on strategy of using audience norms and perceived barriers and benefits to encourage behavior change.

Seibert, Steven

Authors: **Steven Seibert**, triSect LLC

Category: Science, stakeholders and decision-making
Session Title: Governance and Regulation

The Intersection of Policy, Science and Politics: Lessons from the Tampa Bay Water Wars

2.5 million people needed drinking water along with the farms, yards and natural systems in the tri-county area. For decades a loosely-knit water supply authority had found the necessary water but these long-standing agreements were unraveling. Population growth was occurring rapidly in some parts of the area but not in others. A drought exacerbated the problem and serious environmental impacts were evident. The regulators were threatening to turn off the spigot. The politicians were publicly blaming each other. Lawyers were filing suits. Almost daily the press was fueling the dispute. If the region could not solve the problem the state legislature was preparing to step in and do so. These were the Tampa Bay Water Wars.
A group of business, government and civic leaders found the situation intolerable. Within a 5-year window they found that delicate intersection among policy, science and political imperatives. They created a new governing structure, planned for and funded a 15 billion gallon reservoir and the nation's largest desalination plant, significantly reduced groundwater pumping and laid the foundation for a drought-resistant water supply. What they created still stands, now almost 20 years later.
What can we learn from this extraordinary effort? Are the lessons still applicable and if so, how can they influence those same three sectors today?

Sheftall, William

Authors: **William Sheftall**, University of Florida IFAS Extension Leon County
Tom Brantley, Leon County Facilities Management

Category: Managing water for people and the environment
Session Title: Water Demand Management

Facility Retrofit to Harvest Rainwater for Irrigation Trains County Staff on Design, Installation and Maintenance of Water Conservation Technologies

Leon County Extension faculty programs which teach sustainable use of natural resources have been augmented by major infrastructure investments to "walk the talk." In 2009, with advisory committee and county support, we developed a scope of work for making our building a model within county government. We wanted to use and demonstrate rainwater harvesting to lessen our use of potable water from the Floridan Aquifer to meet expensive irrigation needs, and at the same time lessen the quantity of stormwater running off our property into the municipal stormwater system. The rainwater surplus we wanted to infiltrate on site to recharge groundwater. Objectives: We outlined retrofits that would achieve a 75% reduction in potable water drawn from municipal supply. The target reduction would be met by capture and storage of rainwater from 13,000 SF of roof, for use in meeting 82% of irrigation demand in the demonstration gardens housing 2000 plants. County staff would learn the permitting, engineering, construction and operation of the system by building and managing the project in-house. Their knowledge and skills would then be applicable to new construction projects and other retrofits within county government. Methods: Professional and technical staff at Facilities Management installed a 40,000-gallon rainwater harvesting system comprised of four 10,000-gallon repurposed fiberglass gasoline storage tanks, two pumping systems, and a closed loop of irrigation main line fitted with 10 value boxes for connecting micro-jet irrigation. County financial support for the project totaled $171,706. This included cost of materials plus in-house value of supervision, labor and equipment. Results: Significant cost savings have been realized by reducing our use of municipal supply for irrigation. Further economic and conservation efficiencies are anticipated from maximizing the percentage capture of annual rainfall. We plan to accomplish this by managing cistern storage in tandem with garden bed soil storage. Soil moisture sensors will inform transfer of water from cistern storage to soil storage in advance of predicted rains, to free up cistern capacity. Conclusions: The expertise of Facilities Management in understanding, operating and maintaining this water conservation system at Leon Extension can now be applied to other Leon County buildings.

Shukla, Asmita

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James Knowles, Southwest Florida Research and Education Center, University of Florida

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Role of Agricultural Detention Areas in Phosphorous Retention: Sink or Source?

Agricultural Detention Areas (ADAs) cover about 6% of the total farm area on a global scale however, they have not been well studied and documented in the past. This study focusses on Phosphorus (P) retention by an ADA located in the Everglades basin in south Florida. Water quantity and quality at the ADA was monitored for two years between August 2008 and August 2010. Water quantity monitoring included measurement/estimation of pumped inflow, rainfall, evapotranspiration, outflow, storage, and seepage. Water quality monitoring included inflow and outflow sampling and analysis of Total Phosphorus (TP). Contrary to the common belief that these systems work as a water quality Best Management Practice, ADA worked as a source of P during Year 1. It released 17% more P than what came in with pumped inflow and rainfall which resulted in an increase of 12% in the mean incoming P concentration. However, during Year 2 (Y2), ADA worked as a sink of P and retained 53% of the total incoming P load. Change in function from source to sink on an annual basis was mainly attributed to variable water retention and rainfall in conjunction with limited to negative soil P retention capacity. Soil samples (0-10 cm) analyzed for Mehlic-1 extractable Iron, Aluminum, and P were used to calculate Soil Phosphorus Storage capacity (SPSC). Majority of soil in the area had low to negative SPSC indicating limited to no soil P adsorption capacity. Year 1 was marked by a tropical storm which led to a large rainfall in a short span of time. Unusually high water levels inside the ADA after the tropical storm resulted in dilution of TP in the incoming farm drainage. This dilution effect combined with limited P storage capacity of the ADA soil led to the release of P.

Shukla, Sanjay

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Category: Water quality protection and treatment
Session Title: Environmental Services

Quantification of Water Storage and Treatment Services in a Payment-for-environmental-services Program in Florida

A payment for environmental services (PES) program was started in Florida in 2008 for the state agencies to pay cattle ranchers who provide environmental services of water retention and nutrient treatment (kg of P or N) that benefit the Lake Okeechobee-Everglades ecosystem. The program is “market-like” because i) rancher-sellers determine how much service to produce and how, ii) payments require documentation of the services and, iii) payments are a profit opportunity for working cattle ranches and are not limited to the cost for installing water control structures. During the design phase, eight ranches built projects and made ranch operation changes expected to provide the services. Each ranch project was instrumented to monitor water and nutrient fluxes. To evaluate the added services and disservices due to increased water storage on wetlands within each ranch, ecological responses (wetland plants, invertebrates, amphibians, and fish) and ecosystem disservices (mosquitoes, invasive plants, and loss of cattle forage) components were added in 2009 by taking ecological measurements at the ranchland wetlands that participated in the PES program.
We present monitoring and modeling results to verify the water storage PES and use of these results to develop hydroecological models and Decision Support Systems (DSS) for evaluating multiple PES. Verification of water storage PES using the 3-year hydrologic data was fraught with uncertainty due to variable rainfall during pre and post-PES periods. An integrated surface and groundwater model, MIKE-SHE/MIKE11 was used to help verify the water storage service as well as to develop a modeling framework to predict the ecological responses for different water storage scenarios (different levels of storage). The hydrological model was calibrated and validated using the measurements and was able to simulate the surface and groundwater levels within the wetlands and the watershed outlet effectively (Nash Sutcliffe Coefficient = 0.54 to 0.82). Combining simulation results with measurements showed reduced surface flows and increased subsurface storage, a desired outcome for protecting the lake and the estuarine systems against excessive flows. Results for a variety of water management scenarios showed that modeling can be used as an effective tool for optimizing the services of water storage and ecological diversity. Wetland water levels were combined with accurate LIDAR-based topography to predict spatio-temporal inundation. Measured and predicted surface flows from the watershed and wetland water levels for different scenarios are being combined with the ecological measurements to develop hydroecological models to predict the effects of water management on ecological diversity. Predictions of watershed-scale water storage PES and ecological services and disservices will be integrated within a DSS to evaluate the degree to which provision of water services might create positive or negative trade-offs for the additional ecosystem services of biodiversity, or forage production for sellers (agricultural landowners), buyers (state and federal agencies), and other interested stakeholders.
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Shukla, Sanjay

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Category: Water security: the water-energy-food nexus
Session Title: Water-Energy Nexus

Water Footprint of Bioenergy Crops in Florida

The use of biofuel crops for future energy needs will require considerable water. Favorable growing conditions for biofuel production exist in the sub-tropical environment of South Florida. Large-scale land use change associated with biofuel crops is likely to affect the quantity and quality of water within the region. Limited data exists to allocate water for growing the energy crops as well as evaluate the accompanying hydrologic and water quality impacts of large-scale land use changes. A 3-year study was conducted to evaluate the water supply and quality impacts of three energy crops: sugarcane, switchgrass, and sweet sorghum. Six lysimeters were used to collect data needed to quantify evapotranspiration (ETc), and nitrogen (N) and phosphorus (P) levels in groundwater, drainage and runoff. Each lysimeter was equipped to measure water input, output, and storage. Groundwater samples were collected bi-weekly and drainage/runoff sampling was event based; samples were analyzed for nitrogen (N) and phosphorous (P) species. Data collected over the three years revealed that the average annual ETc was highest for sugarcane (1464 mm) followed by switchgrass and sweet sorghum. Sweet sorghum had the highest total N (TN) concentration (7.6 mg/L) in groundwater and TN load (36 kg/ha) in discharge. However, sweet sorghum had the lowest total P (TP) concentration (1.2 mg/L) in groundwater and TP load (9 kg/ha) in discharge. Water use footprint for ethanol (liter of water used per liter of ethanol produced) was lowest for sugarcane and highest for switchgrass. Switchgrass had the highest P-load footprint for ethanol, but no differences were observed for that of TN loads. This is the first study to quantify water use and nutrient load footprint based on measurements in the southeast and perhaps the USA, and will be useful for selecting suitable biofuel crops in Florida and elsewhere with similar environment.

Siders, Zachary

Authors: **Zachary Siders**, University of Florida
Robert Ahrens, University of Florida
Grant Scholten, Tennessee Tech University

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 1

Considering the Future of Gulf of Mexico Sturgeon Management in the Apalachicola and Suwannee Rivers

The threatened Gulf Sturgeon is a species listed under the Endangered Species Act for which federal review is to be conducted in 2014. Seasonally moving between marine and riverine habitats, the Gulf Sturgeon is dependent on the availability of freshwater during the spawning and juvenile stages of the species' life cycle. We consider the fate of critical habitat within the species' range to aid federal review by reconstructing the historical population level of the species for two Florida rivers, the Suwannee and the Apalachicola. Our novel approach utilizes habitat indices and a stochastic stock reduction analysis to predict the theoretical ceiling of population size, termed carrying capacity. Decreases in carrying capacity reflect a habitat's diminished ability to harbor a species. Estimates of carrying capacity for the two rivers are 10,704 and 2,708 age 4 or older fish, respectively. Using these estimates, we project the carrying capacity of the rivers during three time periods, 2025-2049, 2050-2074, 2075-2099. Our projections incorporate changes to carrying capacity by habitat-wide reductions in freshwater availability due to drought and increased water demand from humans. Median carrying capacity fell by 33% and 77% by 2099 in the Suwannee and Apalachicola Rivers, respectively. By simulating increased water use efficiency, i.e. future human water use at 2007 levels, median carrying capacity fell 20% and 49% from current values by 2099, respectively. We simulated access to an additional 373 km of habitat above an a dam in the Apalachicola and found that median carrying capacity improved to 219% above current values by 2049, 77% by 2074, and fell 9% by 2099. From our analysis, we estimate extending habitat will improve carrying capacity in Apalachicola River and significantly buffer against decreases in carrying capacity across the species' range from predicted drought and increased human water withdrawals over the next 60 years.

Sidhu, Harmanpreet

Authors: **Harmanpreet Sidhu**, University of Florida

Category: Water security: the water-energy-food nexus
Session Title: Poster Session: Water Security: the water-energy-food nexus

Human Health Risks from Dislodged Residues of Endocrine Disruptors from Turf Irrigated with Reclaimed Water.

Endocrine disrupting chemicals (EDCs) occur in reclaimed water (RW) and constitute unknown risks to humans. The presence of EDCs in reclaimed water used to irrigate turf and in nearby water retention ponds was determined, and used in the first step of an assessment of risk to a child playing on recently irrigated turf and subjected to dislodged EDC residues. Five EDCs (estrone, 17ß-estradiol, 17α-ethynylestradiol, bisphenol A and 4-n-nonylphenol) were quantified in 28 samples of reclaimed waters (wastewater treatment plant effluents) and 64 samples from residential ponds. St. Augustine turf grass was irrigated with spiked RW to study dislodgement of the five EDCs using a drag sled method. EDCs were detected in both RW and ponds at parts per trillion concentrations. Maximum EDC masses were dislodged immediately after irrigation. Dislodged masses of estrone, 17ß-estradiol and 17α-ethynylestradiol decreased rapidly and were below detection limits 4 hours after application. Dislodged bisphenol-A and nonylphenol decreased more slowly, but were not detected 6 hours after application. The human health risk associated with dislodged residues of EDCs from turf irrigated with RW was minimal.

Sihi, Debjani

Authors: **Debjani Sihi**, University of Florida
Stefan Gerbar, Assistant professor
Kanika Inglett, Research Assistant Professor
Patrick Inglett, Associate Professor

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Inclusion of maintenance respiration alters temperature response in microbial soil organic matter decomposition model for wetlands

The response of soil organic matter (SOM) decomposition to warming is hypothesized to be determined by microbial carbon use efficiency and enzyme activity. Current microbial-decomposition model for uplands parameterize carbon use efficiency crudely via simple growth respiration. An alternative formulation is respiration based on biomass (or nitrogen) as organisms are required to maintain their metabolism, i.e. maintenance respiration. Application of microbial decomposition models for wetlands require the consideration of oxygen supply to decomposers. However, existing SOM models in wetlands are not coupled with microbial physiological properties, yet at the same time it is pertinent to estimate warming response of microbial SOM decomposition. Our objective was to explore current SOM models to understand the response of SOM decay to changes in temperature and oxygen supply. We hypothesized that modeled warming response of SOM decomposition and microbial activity depends on how microbial respiration is formulated and the current SOM models can readily be adapted to wetland soils by incorporating oxygen limitation. The long-term responses for carbon pools (soil organic carbon and microbial biomass) showed similar pattern but model behaviors differed at transient stage of decomposition. Oscillation frequency of carbon pools was higher in wetlands compared to the upland models. Modeled respiration per unit of substrate was lower in wetlands compared to upland models. Low oxygen constraints can lead to dynamic breakdown of microbial population and decomposition in wetlands. Explicit representation of growth and maintenance respiration changes in decomposition models affects the transient response of decomposition to warming. The introduction of oxygen limitation renders the model and its applicability in wetlands to be very sensitive to the difference of the two not well constrained parameters (enzyme kinetic parameter and microbial turnover). Combining incubation experiments with microbial models requires consideration of microbial physiology and the models temporal dynamics (transient vs. long term response).

Singleton, Thomas

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Mike Britt, Director, Natural Resource Division, City of Winter Haven, FL

Category: Managing water for people and the environment
Session Title: Water Supply Planning

Sustainable water resource management in Winter Haven, Florida: Linking environmental, social, and economic demands

Fifty freshwater lakes border or are contained within the city limits of Winter Haven, Florida, "the Chain of Lakes City." The lakes which cover almost one-third of the 25 square miles of the City are the lifeblood of the community: environmentally, socially, and economically. The lakes are a reflection of the enormous stores of water—for people and natural systems—that are contained within the landscape. The City's economy, its quality of life, and its current and future viability depend on preserving and sustaining the health of its water resources, the most valuable of which are the lakes. The lakes and water resources in Winter Haven are damaged and depleted. The FDEP has determined that 25 of the 50 lakes in the City have impaired water quality. The SWFWMD has designated all or part of eight counties—an area encompassing 5,100 square miles, including Winter Haven—water use caution areas. Groundwater withdrawals throughout the region have lowered aquifer levels more than 50 feet in some areas. Lake levels in some of City's lakes may have been lowered by as much as ten feet due to regional water use and local navigation and drainage projects. Past efforts to manage water by draining, piping, and covering recharge areas in the City's watershed and regional aquifer drawdowns have had, and will continue to have, negative effects on Winter Haven's water resources. At best, today's regulations keep things the same but do not provide for restoration. At worst, they allow the further gradual degradation of water resources. Winter Haven has conducted impact assessments and developed plans for water quality restoration and water resource sustainability. This presentation details the City's approach to sustainable water resource management, lake restoration, valuing ecosystem services, and building an institutional framework for local, regional, state, and national decision-making for sustainability.

Sivakumar, Rama

Authors: **Rama Sivakumar**, Georgia Tech, Center for GIS
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Thomas Debo, Professor Emeritus, Georgia Tech

Category: Managing water for people and the environment
Session Title: Water Supply Management

Sustainable stormwater management on an urban university campus, a case study from Georgia Tech

Georgia Tech campus is situated in a 400-acre dense urban setting. It has placed a high value in environmental stewardship by developing and implementing a number of integrated, ecologically based sustainable solutions to achieve its strategic goal of sustainability. This paper will highlight three different projects as a demonstration to showcase the concept of living laboratories of sustainable practices.

Stormwater plays a considerable role in influencing the ecological processes occurring on the built landscape of an urban campus. Current efforts to develop a master plan for one of the three storm water basins on Georgia Tech campus will be discussed and potential benefits from implementing the stormwater master plan will be highlighted. Various Best Management Practices are being included in the stormwater master plan (e.g., infiltration systems, cisterns, bio-swales, roof-gardens) to help control stormwater runoff quantity and quality before being discharged from the campus.

Various cisterns of different characteristics are deployed across the Georgia Tech campus. Sampling and analysis of water quality were conducted on selected large underground cisterns multiple times during 2011-2013. The cistern water quality was evaluated by pH, conductivity, temperature, turbidity, dissolved oxygen, chemical oxygen demand, total nitrogen, and total coliform. Comparative observations of water quality from selected cisterns will be discussed.

In 2012, a complete inventory of trees of size 2 inches or larger on campus was conducted. The inventory gathered more than three dozen attributes about each tree. The inventory enabled Georgia Tech to quantify various environmental and ecological benefits including rain fall interception by trees using i-Tree models developed by US Forestry Service. Results from the study will be presented.

Smith, Nathalie

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Brian Clayton, J.W. Jones Ecological Research Center
David Hicks, J.W. Jones Ecological Research Center

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 1

Effects of a multi-year drought on stream flows and freshwater mussels in tributary streams of the lower Flint River, Georgia

From 1998-2012 extended climatic and hydrologic droughts increased concerns about water supply and stream flow throughout Georgia. In the lower Flint River Basin, cumulative annual rainfall deficits ranged from 3-39 inches. Below normal rainfall, combined with large withdrawals from the upper Floridan aquifer and streams, caused growing season low flows of unusual duration and magnitude. Hydrologic records suggest that the major tributaries of the lower Flint were historically perennial, but segments dried or tended towards intermittency during several periods from 1998 to 2012. Freshwater mussel diversity of the lower Flint is noteworthy with 29 species, including 7 endemics documented from historical collections. The lower Flint and sections of its tributaries have also been federally designated (US FWS) as critical habitat for 4 endangered and 1 threatened mussel species. We sampled 2 major tributaries, Ichawaynochaway Creek and Spring Creek, for mussels in 1999, 2001, and 2012. We observed 2-11 mussels species at sampling sites in 1999 and only 1-8 species in 2012. Abundance also declined from 8-1028 individuals per 100m reach 1-429 individuals. Endangered species were rare at all sites and surveys. We observed rapid declines or extirpation of species at many sites during the initial 2 years of the 13 year period, followed by an ongoing decline of surviving individuals through 2012. Little evidence of recruitment, i.e., presence of smaller individuals, was observed. It appears that long-term declines in freshwater mussels continue in the tributaries of the lower Flint River. Remaining individuals are widely dispersed, with little evidence of recruitment. The recent trend towards intermittency probably makes many areas hydrologically unsuitable to support the species historically present. In developing habitat conservation plans for the lower Flint, consideration needs to be given to hydrologic restoration or to adjusting critical habitat designation to areas that can realistically support viable mussel populations under current flow regimes.

Smith, Chelsea

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Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 1

Influence of Stream Intermittency on Aquatic Insect Assemblages in the Lower Flint River Basin

A multi-decadal trend of reduced stream flows in the Lower Flint River Basin (LFRB) has resulted in an increase in the percentage of stream miles that are intermittent, i.e., periodically cease flowing. This increase is likely linked to the loss of groundwater support of stream baseflow during dry periods when aquifer recharge is low and irrigation demand is high. Ecological responses intensify as stream flow diminishes, and the complete loss of flow and associated stream fragmentation may constitute a significant threshold of environmental stress. The current extent of stream intermittency is difficult to quantify due to a lack of spatially distributed long-term flow records. However, available evidence indicates that several streams in the Ichawaynochaway watershed and large portions of the Spring Creek watershed are now intermittent during extreme droughts. Aquatic insects account for a significant fraction of stream biodiversity and secondary production. The scientific literature indicates that flow intermittency affects this assemblage by reducing habitat availability and connectivity and by altering water quality, food resources and interspecific interactions. Responses include transient increases in density as habitat area decreases, increased predation pressure, and shifts in community composition resulting from declines in sensitive taxa and certain functional groups (e.g., filter feeders that depend on flow to acquire food resources). The degree of intermittency (frequency, duration, and extent of drying) may be important in determining assemblage composition due to differential abilities to tolerate stressful conditions and to recolonize habitat once flow resumes. While habitat heterogeneity is a major determinant of insect production and composition in permanent streams, the frequency and rate of drying plays a larger role in intermittent streams. We are currently comparing insect assemblages in permanent and intermittent stream reaches in the LFRB to better understand the ecological significance of the trend towards increased intermittency.

Srifa, Akeapot

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Time-series analyses of relationships between zooplankton biomass and possible controlling environmental factors in a subtropical, nutrient-rich river

The St. Johns River is one of the largest rivers in the Southeastern United States and serves as a major source of freshwater for agriculture and urban communities of the region. The role of meteorological, physical and chemical factors in guiding the structure and dynamics of phytoplankton in the river has received considerable attention, but little is known about the factors that control the zooplankton community. An existing 16-year historical data set for phytoplankton, zooplankton and physical-chemical factors (from September 1996 – March 2011) was used to examine the factors that may be driving zooplankton structure and dynamics, including succession patterns and the influences of stochastic events (i.e. hurricanes, prolonged drought and exceptional freezing conditions) and phytoplankton blooms, which are a common feature in the St. Johns River. The study focused on a sampling site in the northern reach of the lower St. Johns River in Lake George (Volusia County, Florida, USA), which is located about half way along the reach of the river. Zooplankton abundance (as carbon biomass) exhibited temporal trends and dynamics, either annually or among the years in different genera. Major zooplankton taxa (i.e. rotifers, cladocerans and copepods) showed different peaks in density (individual L-1) and carbon biomass. Peaks in zooplankton biomass were usually observed in Spring and Summer. Rotifers usually showed two peaks in abundance, first in early Spring and later in Summer. Copepod biomass increased as water temperature through the spring. Cladocerans biomass usually peaked between peaks in rotifers and copepods. Zooplankton community dynamics will be discussed in the context of correlations and time-series analyses between zooplankton biomass and physical, chemical and biological parameters. The patterns observed in the St. Johns River will be compared with other subtropical aquatic systems. Climate change is also considered as a potential factor that could influence zooplankton dynamics.

Stofer, Katie

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Visualizing Data for Stakeholders From Varying Backgrounds

Working with complex issues requires involving stakeholder groups with varying levels of formal scientific expertise. Communication among those groups has come a long way from the early days of these processes, when materials were shared without considering and accommodating each others' strengths and weaknesses. The science of refining word choice and explanations without dumbing down content is reflected in high levels of trust in science.
However, where text materials have been revised and translated for broad meaning-making, scientific visuals that convey data are often still left unchanged from their original uses with highly-knowledgeable audiences. Research in science communication and education has offered ways for us to apply similar strategies to revising data visualizations for broad meaning-making. Interviews with professional researchers and undergraduates trying to make meaning from global satellite oceanography data give insight into what scientific experts have internalized after years of training with visualizations as well as what knowledge and cultural background people with little formal science training bring to the table. An experimental design with several versions of each visualization reveal what interventions help to communicate among these groups without leaving anyone behind or talking down to them, either. This presentation will discuss the research and offer practical strategies for revising many types of scientific visuals by including geographic labels for orientation, providing baselines for comparison, and strategically choosing colors to match cultural expectations.

Swain, Hilary

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Category: Water quality protection and treatment
Session Title: Environmental Services

Payments for Ecosystem Services in Florida Ranchlands: overview of hydro-ecological trade-offs

Hilary Swain*, Patrick Bohlen**, Elizabeth Boughton*, John Fauth**, David Jenkins**, Gregory Kiker†, Pedro Quintana-Ascencio**, and Sanjay Shukla†. Archbold Expeditions, Lake Placid, FL
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Agricultural lands provide many of the essential ecosystem services desired by society, beyond merely food and fiber, including regulatory, supporting, and cultural services. The diversity of services provided often declines with increasing management intensity and production often occurs at the expense of e.g. biodiversity, water quality, and soil conservation. Payments for environmental services PES programs offer the potential to enhance the provision of multiple ecosystem service through management of agricultural lands. However interdisciplinary approaches are needed to examine the interactions among ecological, physical, economic and social cost and benefits, and specifically to quantify delivery of trade-offs among multiple ecosystem services, and to consider how environmental stressors might affect the level of services provided.
We capitalized on an unprecedented opportunity to test for tradeoffs among ecosystem services within an ongoing PES program managing for one service (water retention) in cattle ranches in Florida, within the headwaters of the Everglades. This talk introduces the series of presentations in this session that quantify tradeoffs in biodiversity and production services in the context of this project. First we describe the establishment and implementation of the existing market based water services project, and its transition from the pilot program Florida Ranchlands Environmental Services Project (FRESP) to the market-based Northern Everglades Payments for Environmental Services (NEPES) program.
Here we describe our conceptual model to predict biodiversity responses (native plants, aquatic invertebrates, fish, amphibians) and production services (forage grasses) in the context of the provision of water services (including water storage and extended hydroperiods). We examine whether enhancing water storage might create positive or negative trade-offs for other ecosystem services of biodiversity, and forage production. In addition we address how the conceptual model includes the effects of enhancing water services on stressors such as pests (mosquitos) and invasive species. We introduce our interdisciplinary approach to combine hydrologic data and models with new ecological measures. We conclude with how our results can be integrated with decision support tools to provide flexible and transparent trade-off evaluation of multiple ecosystem services and agricultural production functions at scales relevant to decisions by ranchers and regional decision makers.

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Szafraniec, Mary

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 2

Using Constructed Wetlands for Wastewater Treatment to Reduce Nutrient Loading to Groundwater and Springs

Over the last decade, the Southwest Florida Water Management District has successfully implemented a water quality restoration program that constructed several large wetlands for treatment of urban and agricultural non-point source stormwater runoff prior to discharging to surface waters such as lakes, rivers, and estuaries. In many karst areas of the District, groundwater has become polluted due to anthropogenic nutrient loading. Elevated nutrient concentrations in groundwater discharging from springs have been associated with ecological impairments in springs. There are numerous regional domestic wastewater treatment facilities in spring recharge areas that are using land application (e.g. sprayfields, rapid infiltration basins) as a method of effluent disposal to groundwater. Land applied wastewater effluent has been determined to be a significant source of nutrients in spring recharge basins. To address this issue, the District is conducting a feasibility study to identify suitable locations to divert wastewater effluent prior to or instead of land application to constructed treatment wetlands. This project will reduce nutrient loading from wastewater effluent that is being applied within the District's highly vulnerable spring recharge basins and improve water quality in the groundwater and springs.

Timpe, Kelsie

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Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Assessing the effects of hydroelectric dam design on watershed hydrology and ecosystem services in the Amazon

The Amazon basin is an extremely valuable conglomeration of ecological and social systems, harboring complex feedback systems and providing innumerable ecosystem services. However, the Brazilian government plans the rapid development of a vast network of hydroelectric dams and supporting infrastructure in the Amazon over the following decades. This will not only directly impact river hydrology and biology, but will also generate land-use changes, such as deforestation, that will impact biodiversity and climate on regional scales. These changes will likely result in the loss of myriad ecosystem services. To understand the tradeoffs between the loss of ecosystem services and the generation of power by hydroelectric dams, a systems-level analysis of the socio-ecological system is required. This project will evaluate these tradeoffs by analyzing the ecological effects of altering the hydrologic function of Amazonian rivers via hydrologic modeling techniques. Three scenarios will be modeled and compared in the Tocantins and Madeira river watersheds: construction of a conventional dam; construction of a run-of-the-river dam; and no dam. This analysis will help quantify the direct and indirect impacts of hydroelectric dams on ecosystem services, including those amplified by feedback loops between land-cover change and hydrologic manipulation. The goal of this study is to paint a clearer picture of the practicality of damming Amazonian rivers, and provide guidance on which rivers and types of dams provide the optimum tradeoff between ecosystem services and power generation. The project is part of the Amazon Dams Program, an initiative of the Tropical Conservation and Development Program in the Center for Latin American Studies at UF, which is working to structure the inter- and trans-disciplinary network needed to foster the systems-level understanding vital for implementing scientifically informed management and development policies.

Treuer, Galen

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Planning and Management

The strategic use of behavioral science in ecosystem models of south Florida water management

The South Florida Water, Sustainability, and Climate Project (SF-WSC) is a five-year interdisciplinary collaboration that will create a hydroeconomic model of water allocation for the communities and ecosystems surrounding the Everglades. To effectively apply scientific water allocation models that balance economic and environmental impacts, behavioral research on how and why allocation decisions are made is essential. This is particularly true in south Florida where short term economic and political risks are often more salient for decision makers than long term environmental risks. These risks are further complicated by highly uncertain climate change impacts, including sea level rise and shifts in precipitation patterns.
We present an overview of a strategy for using behavioral science to ensure the efforts of the SF-WSC can be put to good use. This strategy contains three primary actions: (1) coordinated engagement with hydrologic, economic, and biological modelers to facilitate co-production of information, (2) mapping of regional decision makers' subjective mental models of short and long term risk, (3) experimental investigation of cognitive biases present in perceptions of how climate change impacts water related risks.
In addition to outlining formal and informal tactics used to ensure effective coordination of interdisciplinary research, we will present preliminary results from two studies. The first is a series of interviews with regional stakeholders who make key water allocation and infrastructure investment decisions. This qualitative investigation identifies key sources of perceived risk and trusted information gatekeepers who are sought out for expertise on these risks. The second study uses controlled experiments to examine the cognitive processes that dominate in individuals' use of scientific information and its impact on their support for investments threatened by potential climate impacts.

Ullman, Jeffrey

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Category: Water quality protection and treatment
Session Title: Water Quality and Treatment 2

Use of Vegetative Filter Strips on Surface Irrigated Fields and Development of a Decision-Support Tool to Optimize Water Quality Benefits

There is a continued need to develop and evaluate best management practices (BMPs) to mitigate agricultural nonpoint source pollution. This is particularly relevant for treating return flows from surface irrigated fields, for which limited BMP options currently exist. A novel implementation of vegetated filter strips (VFS) was examined by planting these systems at the end of furrow irrigated fields to reduce off-site transport of sediment and nutrients. Different vegetation types were tested to evaluate treatment efficacy across different filter strip widths. Mean removal rates for sediments, nitrogen and phosphorus exceeded 98% for all treatments and lengths, primarily attributed to the significantly increased infiltration rates. A new field hydrology model, the filter strip model VFSMOD and a watershed hydrologic routing model were integrated into the QnD decision support platform, along with relevant economic and social data. This decision making tool allows water resource managers to evaluate the potential impacts on watershed water quality following the hypothetical placement of VFSs (or other BMPs) within the basin. Coupled with output data on associated costs, this tool can help target BMP implementation to optimize use of available resources. Hypothetical model runs indicated a significant reduction in sediment loads within the study basin, reducing concentrations below environmental protection goals. Despite the promising results obtained from the field study and model runs, it was still determined that this unique use of VFSs should not be recommended as a BMP. This conclusion is due to the excessive maintenance requirements and difficulty in integrating these systems into typical farming operations. This study highlights the importance of evaluating BMPs on working farms (as opposed to at just research stations, etc.) to fully assess not only their treatment efficiency but also whether they are practical under real-world scenarios.

Valcarce, Christine

Authors: **Christine Valcarce**, UF
David Mazyck, UF

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Regression Modeling of PAC Performance

Powdered activated carbon (PAC) is the most widely accepted control technology for the removal of taste and odor causing compounds in water treatment. Increasingly, this technology is being used to remove other trace organics, such as endocrine disrupting compounds (EDCs).
PAC is often used because it offers advantages over other options such as membranes and advanced oxidation process in that it is not energy intensive, does not require large losses of residual water, and does not produce oxidation by-products that may be more dangerous than the parent compounds. PAC is advantageous for T&O and pesticides in surface waters because these problems are usually seasonal. Thus, PAC is applied when necessary and at dosages necessary to achieve desired removal.
Although PAC is effective for trace organics, the complex nature of adsorption phenomenon limits most treatment operators to select PACs based on conventional manufacture's specifications without taking into account the complex water characteristics and treatment process. This may result in improper performance or increased costs to meet finished water standards.
On-going research aims to create predictive metrics for an easy and economical method of selecting an effective PAC for the removal of trace organics. Motivation stems from the likelihood of scrupulous regulations surrounding EDCs in the future. Furthermore, continual decreases in water quality will likely result in T&O issues becoming more frequent.
Research goals include using multi-variable regression modeling to describe PAC's performance holistically, converging the paradigms about the relative importance of physical and chemical attributes that affect adsorption. Criteria for model selection include: 1) providing 95% statistical confidence that regression coefficients of variables are useful in predicting removal 2) predictor variables must optimize the adjusted R2 and 3) model validation of future outcomes within the mean standard error of the model.
Preliminary results indicate that regression modeling may be a powerful method for optimizing the selection of PACs in water treatment.

Viveros Bedoya, Paula

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Ed Phlips, Professor

Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 1

Seasonal Dynamics of Phytoplankton Composition and Abundance, River Discharge and Nutrients in Apalachicola Bay, Florida, USA

The growth of human development in many estuarine watersheds around the world has created difficult management challenges related to trophic state, minimum flows, and water levels. The Apalachicola River estuary is an example of a major ecosystem in jeopardy of significant change due to human influences. The overall goal of this study was to describe how spatial and temporal patterns in the structure and abundance of phytoplankton in the Apalachicola National Estuarine Research Reserve (ANERR) were affected by shifts in river discharge. In this subtropical system, river discharge is a key regulator of physical-chemical processes such as salinity, nutrient load and water residence time. In this study we examined how the river influences phytoplankton community structure, biomass and dynamics.
Phytoplankton composition and abundance, as well as physical-chemical parameters, were determined on a monthly basis for two years at a range of sampling sites within the bay. Chlorophyll trends were determined using a longer data set (2002-2012) collected as part of the ANERR System-Wide Monitoring Program.
Mean salinities in the Apalachicola Bay vary significantly between the low and high discharge periods. Nutrients concentrations vary seasonally and spatially, in response to both, river discharge and exchange of water with the Gulf of Mexico.
Mean chlorophyll a concentrations and phytoplankton biovolumes were higher in the low discharge season than in the high discharge season at a range of sampling sites. Seasonal patterns in discharge, salinity and nutrient regimes are major correlates in relation to abundance and variability in phytoplankton composition.
The results of this study indicate that the phytoplankton community in the Apalachicola estuary changes seasonally and is mainly dominated by diatoms, with some peaks in dinoflagellates and cyanobacteria biomass. The importance of river discharge in this system will be discussed in terms of its impact on the phytoplankton community.

Vyverberg, Karen

Authors: **Karen Vyverberg**, Department of Geological Sciences

Category: Impacts of changing drivers on water resources
Session Title: Poster Session: Impact of changing drivers on water resources

Evaluating the Potential for Rapid Sea Level Oscillations in Response to Sustained Global Warming

Predicting the rate and magnitude of future sea level rise is paramount to the management of coastal fresh-water resources. Because we do not have historical records for time periods warmer than present to provide potential analogues for future sea level change, another approach is needed to resolve the sensitivity of ice sheets and sea level to sustained warming. The response of sea level during the Last Interglacial (LIG) period (129,000 – 116,000 years ago), when the poles were a few degrees warmer than present, offers an opportunity to improve our understanding of how sea level will respond to current global temperature changes. During recent field work in the Seychelles, we observed two exposure horizons within fossil coral layers preserved from the LIG period. Each exposure horizon represents an ephemeral emergence that implies a brief drop in sea level. The observation that sea level oscillated at least twice on a meter scale during the LIG period implies significant dynamic changes in ice sheet volume resulting from small changes in temperature. If these rapid sea level oscillations did arise from only a few degrees of temperature change, then similar rapid changes may be possible in the future. As sea level rises, salt water intrudes into coastal potable aquifers: knowing the rate and oscillatory phase of such intrusion is crucial to the management of the remaining fresh water.

Weinkam, Grant

Authors: **Grant Weinkam**, University of Florida

Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Sustainable phosphorus management in land applied reclaimed water scenarios

Florida leads the nation in waste water effluent/reclaimed water use, at over 700 million gallons per day, and land applies over 75% of this volume. While these effluent waters are treated to reduce pathogen loads, phosphorus (P) concentrations can still be substantial, especially in long term application scenarios. Currently an estimated 3.3 million pounds of P are reintroduced to the landscape yearly (assuming effluent=2 mg P/L), compared to only 50,000 pounds that would be applied if irrigated with ground water (at ground water = 0.03 mg P/L). Research suggests that under long term applications of P receiving systems can reach a state at which they are no longer able to assimilate further loading potentially resulting in landscapes that are actively leaching and eroding P rich particulate matter to receiving hydrologic systems. This statement can be especially relevant given the large proportion of sandy soils in Florida that contain, relatively, low physical/chemical ion exchange capacity and high hydraulic conductivity, thus increasing the potential for water quality impairment. Due to the increasingly stringent allowable surface water P concentrations and many uncertainties regarding the long term fate and transport of P this research seeks to determine how different soil conditions and reclaimed water loading amounts have or can alter the leaching profile in Florida soils. Field sampling and lab studies at different reclaimed water sprayfield sites are used to determine the relative change in P sequestration potential with depth, using soil phosphorus saturation capacity (SPSC) analyses, and potential leaching risk in lab core experiments. The resulting information improves fundamental understanding of soil-phosphorus transport dynamics and provides insights into alternative techniques for the long term environmental sustainability of reclaimed water usage.

Wells, E. Christian

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Category: Science, stakeholders and decision-making
Session Title: Stakeholder Engagement in Planning and Management

Tourism and Water: An Evaluation of Perceptions and Practices of Sustainable Wastewater Management on the Placencia Peninsula, Belize

In this paper, we examine how human perceptions and practices related to wastewater management impact coastal health and livelihoods in tourism-dependent economies in the Caribbean. We focus our discussion on our NSF-PIRE research on the Placencia Peninsula of Belize, which has experienced dramatic growth in the tourism industry after Hurricane Iris devastated the region in 2001. Since the hurricane, the communities that occupy the peninsula have emerged as a 'development corridor' with tourism, transportation, and residential expansion seeking to be resilient to future climate threats such as increasing storm surge and sea level rise. Concerns about wastewater collection, treatment, and management have been raised in response to this rapid development, especially with regard to nutrient loading and pathogen contamination of the 24 kilometer-long tidal lagoon that edges the western side of the peninsula and serves as the foundation for current and proposed tourism. Partially treated wastewater released from aging domestic and hotel septic systems along with untreated effluent from commercial aquaculture have contributed to red and green algal blooms in the lagoon, which negatively impact ecosystem services, marine tourism, and fishing industries. To address the need for a comprehensive wastewater management system in the area, the Government of Belize recently received a $10 million loan from the Caribbean Regional Fund for Wastewater Management (Inter-American Development Bank) to design and install a sustainable wastewater collection, treatment, and disposal facility to be managed by Belize Water Services Limited. Our research explores the ways and extent to which local village councils, environmental NGOs, tourism organizations, and other community stakeholders are involved in this process as well as their beliefs about potential costs and benefits to the economy and environment. Importantly, we are also investigating local groups' interest and capacity to reclaim and use water, nutrients, and energy from the proposed wastewater system. The greater goal of our research is to better understand how more sustainable management of wastewater enables and constrains relationships between tourism, ecosystem health, local livelihoods, and wellbeing.

Wessel, Mike

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Category: Impacts of changing drivers on water resources
Session Title: Impact of Changing Drivers 1

Biological Monitoring in Compliance Assessments: Lessons Learned from 12 Years of Tampa Bay Water Hydro-Biological Monitoring in Tidal Rivers

Special conditions of the Southwest Florida Water Management District (SWFWMD) Water Use Permit for Tampa Bay Water required development and implementation of a comprehensive Hydrobiological Monitoring Program (HBMP) for the Alafia River and the Tampa Bypass Canal/Hillsborough River Water Supply Facilities. The HBMP incorporates programmatic criteria that have been included to ensure that the permitted withdrawals are consistent with SWFWMD rules throughout the lifetime of the permits. In the context of the HBMP, the term programmatic criteria refers to: 1) the criteria by which unacceptable environmental impacts are determined; and 2) the process by which appropriate management responses to detected conditions that constitute or could potentially lead to adverse environmental impact are determined and implemented. While water quality criteria have been codified in state and federal rulemaking for these systems, the relative effects of surface water withdrawals on water quality and/or biological integrity are difficult to determine within the context of "adverse impacts" and rely on interpretation of narrative criteria. Through annual data reports, interpretive reports, special studies, and sampling program optimizations, Tampa Bay Water has applied rigorous analysis and interpretation to the data collected as part of the HBMP to understand how this information can be used within a statistical framework to assess compliance based on water quality and biological monitoring elements. This presentation focuses on lessons learned from these analyses to help guide future efforts toward the efficient and effective use of biological monitoring in compliance assessment for surface water withdrawals in estuarine environments.

Wester, Julia

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Category: Science, stakeholders and decision-making
Session Title: Poster Session: Science, stakeholders and decision-making

Psychological and Social Factors Associated with Wastewater Reuse Emotional Distress in the United States

Wastewater reuse (WWR) technology has improved greatly in recent decades and may be an important solution to global water challenges. Nevertheless, several psychological and social barriers to widespread adoption still exist. Individual disgust reactions, also known as the "yuck factor," have been identified as central to attitudes toward WWR. It is not yet well understood what factors predict stronger emotional aversion, particularly how feelings of disgust might interact with personal moral ideology. The present study examined a wide range of factors in a large, context-neutral, web-based U.S. sample (N=207), focusing on which individual and psychological differences contribute to increased distress at the idea of using recycled water.
Being female, scoring high on indices for moral "purity and sanctity" and "fairness and reciprocity" and scoring high on measures of "pathogen disgust sensitivity" all were factors that were significantly and independently associated with reported distress. Past exposure to the concept of WWR and higher levels of education were negatively correlated with reported distress.

White, Erin

Authors: **Erin White**, University of Florida
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Category: Water quality protection and treatment
Session Title: Poster Session: Water quality protection and treatment

Bio-partitioning Tracer Technique for the Estimation of Microbial Biomass Effects on the Transport of Partitioning Solutes in Groundwater

A bio-partitioning tracer technique for the estimation of microbial biomass effects on the transport of partitioning solutes in saturated subsurface media is presented. Bioaugmentation is a remedial approach under evaluation for dense nonaqueous phase liquid (DNAPL) sources at sites with extreme geological complexities, such as fractured rock. Biomass accumulates in the subsurface following bio-stimulation activities and provides an expanded organic phase affecting the behavior of the solutes and tracers. If the magnitude of partitioning into the biomass is significant relative to the presence of residual DNAPL, the DNAPL saturation determined from traditional partitioning tracer techniques could be overestimated after bio-stimulation. For traditional partitioning tracer studies, such as those performed in conjunction with pump-and-treat or cosolvent flooding, microbial growth conditions remain relatively constant both before and after the remedial action. Accordingly, accounting for microbial biomass changes has been unnecessary historically. Because partitioning tracer studies are typically conducted both before active remediation and after to characterize changing DNAPL saturation, it is now apparent that it is necessary to understand the influence of the changing biomass on the partitioning solute tracers used at sites following bioaugmentation. To assess the biomass effect on solute transport, a series of sand packed columns are injected with dissolved phase tetrachloroethylene (PCE) followed by varying amounts of a commercially available DHC-containing consortia and lactate to simulate a range of microbial growth similar to the effect of bio-stimulation activities at a field site. The columns are exposed to a partitioning tracer suite both before and after enhanced bioaugmentation. Following the tracer tests, biomass is estimated in the columns by analyzing the fatty acids of the total microbial community attached to the sand. The breakthrough of the tracer suite is used to quantify retardation and assess the effect of the biomass on the tracer studies.

Yaquian, Antonio

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Category: Managing water for people and the environment
Session Title: Water Supply Planning

Current and future water vulnerability in Florida

Florida's population has been increasing at a sustained pace for several decades, and this is not slowing down, in the next two decades it is projected to become the state with the third largest population in the country. Expansion in population, together with agriculture, are the main drivers in the change of the use of the land throughout the state. Consequently, natural ecosystems are under more pressure from human activities in an increasingly smaller area. This makes management of these scarce resources crucial to sustain the expansion of human activities. It is vital, then, to develop a deep understanding of future availability of resources and implications of human activities in them. However, developing the understanding of how the atmospheric, surface and groundwater dynamics affect the Florida peninsula is challenging, since these dynamics are highly affected by a changing global climatic phenomena. In this context, it becomes evident that research has to be developed to assess the extent of present and future impacts of human activities in the state's water resources in response to the expansion of human activities in a climatic uncertain scenario.
Current and future water usage in the state is highly heterogeneous. In some areas, like south Florida, water resources are typically more affected by human activities in both quality and quantity compared to its northern counterpart. Thus, the aim of this research is to develop a statewide analysis of water vulnerability will be generated based on the following: current water consumption, projected agricultural and population expansion, projected changes in surface and groundwater, water resources pollution, geological features, and the overall condition water availability and quality of groundwater. This GIS (Geographic Information Systems) based map provide with vital information on present and future water vulnerability throughout the state.

Yowell, Doug

Authors: **Doug Yowell**, Duke Energy

Category: Water security: the water-energy-food nexus
Session Title: Water-Energy Nexus

Alternative Water Supply Opportunities in the Electric Utility Industry

Water supply challenges in Florida are considerable. Between 1980 and 2010 the population of Florida nearly doubled from 9.7 million to 18.8 million. Additionally, it has been estimated that Florida has 76 million visitors every year. Population growth in Florida has resulted in concerns regarding the sustainability of Florida's supply of fresh water, which primarily comes from groundwater.

Florida has responded to its water supply/water level challenges through several regulatory initiatives. For example, the Florida Department of Environmental Protection and the state's five water management districts advocate and direct the reuse of reclaimed water (highly treated POTW effluent) as well as the development of non-traditional "alternative" water supply sources as an integral part of water management programs, rules and plans. These efforts have paid significant dividends. Water utilities in Florida have increased use of reclaimed water by approximately 500 percent since 1986, and Florida's current reuse capacity is approximately 64 percent of the total permitted domestic wastewater treatment capacity. These successes would not be possible without willing partners in the regulated community, including the steam electric generation sector.

Duke Energy has implemented a number of alternative water supply projects at its Hines Energy Complex and is developing additional supplies as well as recycling projects at other facilities in Florida. These projects include: expanded use of reclaimed water, on-site capture and storage of stormwater, use of off-site industrial wastewater, and recycling of internal wastewater sources.

These projects amount to a two-fold benefit to the environment. First, water supply resources are conserved which is consistent with the Florida regulatory paradigm that places a considerable premium on maximizing use of alternative water supplies, including reclaimed water. Second, pollutant discharges are reduced to receiving bodies of water. Consequently, use of alternative water supplies is environmentally beneficial both in terms of resource conservation and pollution management.

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Water Systems Management and Diarrheal Incidence during the Monsoon Season in India

India's largest environmental burden of disease is diarrhea. The prevalence of diarrheal disease is exacerbated by flooding during the six-month monsoon season, overcrowding, and lack of adequate water and sanitation systems. A direct correlation exists between rain and flooding during the monsoon season and increases in cases of water- and vector-borne diseases, specifically diarrhea, cholera and leptospirosis. This study examines literature on the seasonality of diarrheal and other communicable diseases and the effectiveness of infrastructural interventions in India to curb their prevalence.
Articles were identified using PubMed, Lancet and JSTOR databases, using terms such as "diarrheal disease," "epidemics after floods," and "environmental health risks." Research indicates that there has been a seasonal increase in the number of cases of diarrheal and other diseases since the mid-1990s. Leptospirosis and cholera outbreaks often occur after major floods. Persons living in overcrowded or unhygienic areas are at higher risk for contracting diarrheal and other diseases due to lack of access to potable water and improved sanitation. Open defection, reportedly practiced by 50-60% of India's population, increases the risk for pathogenic transmission. Flooding exacerbates this risk when unimproved water sources are contaminated by runoff. In rural and urban areas, human and animal fecal matter mix with floodwaters and contaminate rivers and ponds. Moreover, India's potable water supply system often becomes damaged during floods. The consumption of contaminated water due to pipeline leakages and run-off causes hundreds of cases of diarrheal disease during the monsoon season.
This study concludes that flood-resistant water systems may help reduce the prevalence of diarrheal and other communicable diseases in India. An impenetrable water supply system, coupled with an effective storm water system, would steer contaminated groundwater away from people and unprotected water sources while providing protection for improved water sources that are safe for consumption.