Characterization of Coal Combustion Residuals in Florida

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Trace metal concentrations in coal combustion residuals (CCRs) might pose a risk to the environment due to its leaching potential. To assess this risk, 27 CCRs samples were collected from seven coal power plants in Florida. The objectives were: (1) measure the total concentrations of trace metals in CCR samples; (2) measure the concentrations of trace metals following extraction using SPLP (synthetic precipitation leaching procedure); and (3) compare these results to Florida Soil Cleanup Target Levels (SCTLs), EPA drinking water Maximum Contaminant Levels (MCLs) and results from CCR samples from other states. Samples included 11 fly ash, 12 bottom ash and 4 flue gas desulfurization (FGD) residues. The pH of the CCRs was between 1.74 and 11.9 and they were grouped into 3 categories: low (<4), medium (4-8) and high (>8). Total concentrations of V, Mn, Pb, Ni, Cr, Cu, As, and Se and SPLP concentrations of Al, Fe, V, Ni, As, Mo and Sb for most samples were higher than Florida SCTLs and EPA MCLs. When compared to other U.S. CCR samples, the Florida CCRs had a lower Al and Fe content, while Ni and V was higher in some of the tested samples. Therefore, due to potentially leachable concentrations of some trace metals in CCRs, best management practices, as well as engineering standards for storage and beneficial use, might be required.

Use of Biochars Produced from Local Residue Feedstocks to Grow Sugarcane on Sandy Soils in South Florida

Odiney Alvarez, Samira H. Daroub, Jehangir H. Bhadha, Bin Gao, Barry Glaz, and Timothy A. Lang

Sugarcane production on sandy soils of South Florida has been gaining interest due to the need to expand sugar and bioenergy production, and to gradually alleviate production in organic soils. Biochar application has the potential to improve physiochemical properties of sandy soils with low organic matter (OM) by increasing carbon content, water holding capacity (WHC), nutrient retention and cycling. This study was conducted to evaluate biochar effect on soil properties, water quality, and sugarcane crop growth. Mill ash and three biochars produced from local hardwood yard waste (HY), horse barn shavings with manure (HM), and rice hulls (RH) were incorporated at 1% and 2% (by weight) to sandy soils in 70 gallon lysimeters. The experimental design consisted of a randomized block set-up including eight treatments and two controls, with four replications each. Results showed that biochar treatments lowered bulk density, increased WHC, and increased OM compared to the control. Soil pH shifted from slightly acidic to neutral or basic with treatment incorporation at the beginning of the experiment. Monthly drainage water samples showed mill ash 2% to have significantly lower total dissolved phosphorus and ortho-phosphate in comparison to RH 2%. In addition, RH 2% has shown significantly higher tiller count and dewlap height compared to HM 2%. Future work will continue to include monthly water samples and plant measurements until harvest, and the analysis of a second and third soil sampling. Yield and sucrose content will also be evaluated at the end of the experiment.

Fitness of Tetracycline-Resistant *Escherichia coli* O:157 H7 Exposed to Sub-Lethal Doses of Tetracycline in Soil

Alexandra DeBose-Scarlett, Massimiliano Marvasi, Max Teplitski

The application of manure containing antibiotic residuals and antibiotic-resistant bacteria on agricultural soils may facilitate the spread of antibiotic resistance in the environment. Identifying, monitoring, and handling the critical control points affecting the persistence of antibiotic resistant determinants during animal waste and/or soil management is essential to mitigating the spread of antibiotic resistance in the environment. In order to study the effect of persistence of antibiotic residuals in soil, the fitness of antibiotic-resistant and sensitive human pathogens exposed to sub-lethal and lethal doses of tetracycline was compared. In separate experiments, tetracycline-resistant and sensitive *Escherichia coli* O157:H7 were co-inoculated, in a 1:1 ratio, into soft agar and soils with varying antibiotic concentrations. Isolates were sampled over time and grown on XLD plates. The ratio of sensitive and resistant *E. coli* was determined by patching the colonies on tetracycline XLD plates. Our preliminary results show that in the presence of sub-lethal (0.8 and 4 µg/ml) and lethal (20 µg/ml) doses of tetracycline, resistant *E. coli* are strongly selected in the *soft agar* mesocosm. On the other hand, when the fitness was measure *in vivo*, no fitness phenotype was observed. These results suggest that soils with high clay content reduce the antibiotic selection pressure to a negligible level within a few days of antibiotic treatment, even if sub-lethal residual concentrations of antibiotics are added. It appears that in soils with high clay content, land application of wastes containing antibiotic residuals does not put microbes under significant selective pressure.

Cadmium (Cd) contamination of cacao (*Theobroma cacao*, L.) beans in southern Ecuador: its nexus with soil-Cd

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Abstract:

Cadmium (Cd) accumulation in cacao beans has gained great attention among the scientific and chocolate community. Cadmium enrichment has been reported in the southern provinces of Ecuador (Guayas and El Oro). However, minimal information is available if this contamination is related to natural processes or anthropogenic activities. In this study, soil and plant samples were collected from nineteen cacao farms in Guayas and El Oro provinces and analyzed for concentration of Cd in cacao tissues (beans and leaves) and the corresponding soil-Cd chemistry and availability. The concentrations of Cd in plant tissue were determined by digestion with HNO_3, whereas soil available Cd was determined by single extractions: Mehlich 3 (M3), 0.1 M HCl (HCl), and 1 M NH_4OAc (AA). A sequential extraction method (Tessier et al 1979) was applied to determine the distribution of Cd within soil fractions. In twelve sites bean Cd concentration exceeded the critical level (0.6 mg kg^{-1}) established by the European Union; however, to our surprise, Cd concentrations in leaves were mostly below detection limit (0.1 mg L^{-1}). The concentration of bean-Cd was highly and positively correlated with M3-, or HCl-extractable Cd (r = 0.77, 0.79, respectively with $P < 0.0001$). Despite its statistical significance, AA extractable Cd displayed a lower correlation with bean Cd (r = 0.40, $P < 0.0002$), and thus this method may underestimate plant-available Cd in soil. The results from soil Cd fractionation indicate that acid-soluble pool was significantly correlated with bean Cd, M3-, or HCl-extractable soil Cd (r = 70, 99 and 99, respectively with $P < 0.0001$). It is interesting to note that cacao trees accumulate more Cd in beans than leaves, which is in contrast with other plants. The strong correlation between bean Cd and extractable Cd in soil suggests that soil contamination with Cd is likely the cause of Cd accumulation in cacao beans. It is therefore important to reduce soil available Cd in order to decrease the uptake of Cd by cacao trees. In addition, M3 and HCl extraction methods appear to be useful for predicting plant-availability of Cd in the cacao-planting soils.

Since acid-soluble Cd fraction is the major pool of available Cd in the soils, soil management practices need to pay attention to soil acidification.

Genes Involved with Nitric Oxide Biofilm Dispersal

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Biofilms allow bacteria to proliferate in an environment alongside protecting the bacteria from various chemical treatments. For this reason, the identification of a molecule effective as biofilm dispersant is important in industrial applications where produce is often processed in aqueous solution. In our laboratory, previous testing has shown that nitric oxide donors can disperse *Salmonella enterica* biofilms and that a large *Salmonella* genomic region *recA-hydN* may be involved in such dispersion.

The goal was to explore the *recA-hydN* genomic region in order to identify individual ORFs or regulatory elements present during nitric oxide-mediated dispersion.

The lambda-red recombinase method was used to create three mutants with smaller deletions in the desired region (*ΔygaD-srlA*, *ΔmltB-gutQ*, *ΔygaA-ygbD*). The mutants were tested, by exposing 24 hours old biofilms (mutants and wild type-control) to the nitric oxide donor: molsidomine. From there, the biofilms were then gently washed and stained with crystal violet, which was then dissolved and measured with a spectrophotometer. When tested the mutant *ΔygaA-ygbD* was significantly not responsive to the nitric oxide donor, when compared with the control. From that region we are generating two additional mutants. One mutant includes the double deletion of *Salmonella ygaA* (anaerobic nitric oxide reductase transcriptional regulator), *STM2840* (anaerobic nitric oxide reductase flavorubredoxin), and another is *ygbD* (nitric oxide reductase).

Nitrogen Transport from Drip-Dispersal Septic System Drainfield to Shallow Groundwater

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Nitrogen (N) is often a limiting nutrient in coastal water bodies. Among other N sources such as urban stormwater runoff, wastewater from central sewers, atmospheric deposition, septic systems may be one of the major N sources in many of the water bodies in Florida. For example, an estimated 2.5 million septic systems discharge 590 billion liters of wastewater into shallow groundwater each year. The objective of this study was to investigate the dynamics of N transport in the vadose zone and groundwater below a conventional drip-dispersal septic system. We constructed the system using two rows of pipes (with 40 emitters) placed at 0.3 m apart in the center of 6 m x 0.6 m drainfield. From May 2012 to Dec 2013, samples were collected over 64 events (daily, weekly, bi-weekly, monthly intervals) from suction cup lysimeters placed at 0.30, 0.60, and 1.05 m depth below drip pipe and piezometers placed at 3-3.30 m depth below drip pipe. The system received 120 L of septic tank effluent (STE), equivalent to maximum allowable rate 3 L ft^{-2} day^{-1} for Florida's sandy soils. The mean (n=64) pH, EC, and chloride were greater in STE than soil-water and groundwater. Mean total N in STE was 65 mg L^{-1}; of which 90% was NH_4-N, 10% was organic N, and 0.2% was NO_x-N. In the soil-water, mean NH_4-N was <0.5 mg L^{-1}, NO_x-N was 20-36 mg L^{-1}, and organic N was 4-7 mg L^{-1}. This suggests that >99% of NH_4-N was converted to other N forms and the dominance of NO_x-N (81-85 %) in soil-water samples suggests that nitrification was the major mechanism in the vadose zone. Mean (n=16) concentrations of NO_x-N and organic N in groundwater samples collected from upstream of the system were 3.5 mg L^{-1} (57% of total) and 2.6 mg L^{-1} (42% of total), respectively. After plume development (April 2013 onwards; n=16), NO_x-N and organic N in groundwater samples collected from downstream of the system were 19-33 mg L^{-1} (83-88% of total) and 3.6-4.2 mg L^{-1} (11-16% of TN). We conclude that septic systems (1) increased transport of both NO_x-N and organic N forms to groundwater and (2) abundance of NO_x-N in the vadose zone resulted in its greater transport, which was manifested in increased proportion in groundwater.

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Are We Getting Closer to or Further from Water? An Analysis of Human Distance to Water in the USA, 1790-2010

Yu Fang and James Jawitz

Water is vital to human life and also an attractive factor when people choose where to live. Early civilizations and modern cities primarily evolved around rivers. Humans need water to satisfy their direct agriculture, industrial, and residential use, and indirect environmental services. However, as population, wealth, and technical prowess grow, reliance on locally available water decreases such that people are not constrained to live only in water-rich places. This study analyzed the temporal change of the relationship between human distribution and freshwater resources from 1790-2010, using two indicators: distance between human settlement and surface freshwater bodies, and the population proportion in areas with different kinds of aquifers (in major aquifer basin, in complex hydrogeological structures, and in local and shallow aquifers). The aim is to test the following hypotheses: 1) humans are settling a larger distance from surface water over time because their reliance on local water resource decreases and they have more measures to get access to water resource; 2) major aquifer basins are becoming more attractive to humans than complex aquifers and local and shallow aquifers because they offer good condition for groundwater exploitation.

Nutrient Recovery from Small Wastewater Treatment Plants

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Global demand for phosphorus (P), a finite resource, primarily derived from phosphate rock (P_2O_5), is estimated at 40 million tons per year, and is increasing by 1.5% annually. An estimated 7 billion tons of P_2O_5 remain in reserves that can be economically mined and are expected to be exhausted within this century. A sustainable source of phosphorus is essential to feed the world's growing population. Municipal wastewater treatment plants (WWTPs) may be an attractive source of recoverable P. The mineral struvite ($MgNH_4PO_4 \bullet 6H_2O$) is thermodynamically favorable to form in some wastewater streams. Struvite may be used as a slow-release fertilizer to supply a renewable source of P. It is estimated that 1 pound of struvite can be generated from ~12,000 gallons of municipal wastewater at a P recovery rate of 55%. Thus, struvite may provide a sustainable P fertilizer while reducing P discharged by WWTPs. The intentional precipitation of struvite for P recovery has focused on large WWTPs, using digestate from the anaerobic digestion of biosolids. However, small WWTPs (< 12 MGD discharge) make up the majority of WWTPs, 97% in Florida and 98% nationally. On the national scale, the total combined discharge of small WWTPs could produce ~2.2 million pounds of struvite per day. Small WWTPs have the same permit limits for nutrients as do large WWTPs and they must achieve these nutrient reductions without the benefit of revenue from large customer bases or economies of scale. Struvite production at small WWTPs may provide an economic benefit while assisting to meet future permit regulations and fertilizer P demand.

THE INFLUENCE OF EUTROPHICATION STATUS ON THE KINETICS OF METHANE OXIDATION IN SOILS FROM A SUBTROPICAL FRESHWATER WETLAND

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Microbially mediated methane (CH_4) oxidation is a significant determinant of the net CH_4 fluxed from wetland soils. With the potential to reduce the soil CH_4 emissions by up to 90%, an increased understanding of this process is essential to improve strategies to reduce CH_4 emissions from wetland systems. A laboratory manipulation study was performed using microcosms containing soils which were collected from the eutrophic (F1) and oligotrophic ridge (U3R) and slough (U3S) sites of WCA-2A in Florida Everglades. The rates of CH_4 oxidation were measured for each site along the depth profile at 0-5, 5-10, and 10-20 cm increments to determine the Michaelis-Menton kinetics among soils of differing nutrient status. Significant differences were found in the maximum oxidation rate (V_{max}) and oxidation affinity (K_m) among the sites and along the soil depth. The V_{max} (20.1±4.7 µg CH_4 g^{-1} h^{-1}) at 0-5 cm in F1 was significantly lower than deeper depths. The V_{max} of F1 at 5-10 cm was significantly higher than U3R and U3S. The K_m at 0-5 cm in F1 (684 ± 313 µg CH_4 g^{-1}) and U3R (1380 ± 230 µg CH_4 g^{-1}) showed significantly higher affinity than deeper depths. The K_m values below 5 cm of U3S were significantly lower than both F1 and U3R. Significant positive correlations with total phosphorus (TP) suggest that TP may be influencing the oxidation activity. Correlations with nitrate (NO_3^-) suggest varying influence of NO_3^- on oxidation activity, with higher NO_3^- concentrations having an inhibitory effect on CH_4 oxidation rates.

Developing Sustainable Soil Management Practices for Shallow Organic Soils of the Everglades Agricultural Area

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Water table management and cultivation of organic soils in fields in the Everglades Agricultural Area (EAA) with as little as 16 cm of soil above bedrock presents a problem for continued crop production. The effects of tillage, water-table, and fertilizer on soil microbial biomass, nutrient cycling, greenhouse gas (GHG; CO_2, N_2O, and CH_4) flux, and sugarcane yield will be investigated. Changes in GHG flux or microbial activity may signify altered subsidence rates and help determine which practices enhance sustainability. Two studies will be conducted to determine the effects of tillage, water-table, and fertilizer on microbial biomass, nutrient cycling, and GHG emissions. One study will be conducted in lysimeters while another will be conducted in the field. Lysimeters with regulated water-tables and fertilizer rates will be used to examine the effects of 3 water-tables and 2 fertilizer application rates. The field trial will examine the effect of 3 tillage treatments. A Gasmet DX4040 will be configured for soil flux measurements to measure soil GHG flux. Increasingly shallow soil depth as a result of oxidation of organic matter in the EAA has led to challenges in managing these soils. These research trials will help achieve a better understanding on the role of tillage, water-table management, and fertilizer on soil oxidation of the organic soils in the EAA. Developing new practices for sustainable soil management has the potential to mitigate management issues and preserve remaining soil depth.

Greenhouse Gas Fluxes from Peatlands Influenced by Flooding and Draining Cycles

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Globally, around 10–20 % of peatlands have been drained for agricultural purposes. Drainage of peatlands increases soil aeration, resulting in soil subsidence and net carbon dioxide (CO_2) emission into the atmosphere. To protect peatlands, mitigate CO_2 emissions and continue agricultural production, one land management approach under consideration is intermittent flooding and draining, accompanied by growth of crops which are tolerant of periodic flooding. However, the alternating flooding and draining cycles could lead to increases in methane (CH_4) and nitrous oxide (N_2O) emissions, which have 34 and 298 times, respectively, higher global warming potential than CO_2. The objectives of this study were to (i) compare total greenhouse gas fluxes (CO_2, CH_4, and N_2O) from peatlands under different flooding and draining cycles, and (ii) determine the impacts of water table fluctuation, i.e. flooding and draining events, on greenhouse gas fluxes. 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 durations of alternating flooded and drained periods for 6 months. Average daily fluxes of CO_2 and N_2O were significantly higher under drained conditions than flooded conditions ($P < 0.001$), but the fluxes did not differ between treatments. Fluxes of CO_2 and N_2O were 667 mg N_2O-N m^{-2} d^{-1} and 135 μg CO_2-C m^{-2} d^{-1} under drained conditions, respectively, and 86 mg CO_2-C m^{-2} d^{-1} and 48 μg N_2O-N m^{-2} d^{-1} under flooded conditions. Methane fluxes did not vary between treatments or drained/flooded conditions, with an average flux of 116 μg CH_4-C m^{-2} d^{-1}. Pulses of CH_4 and N_2O fluxes were observed after flooding events and lasted no longer than 24h. The highest fluxes were 0-1 h after flooding, which were approximately 8 and 19 times higher than the mean CH_4 and N_2O fluxes, respectively. Overall, the results indicate that CO_2 was the dominant component of greenhouse gas fluxes, irrespective of different hydrological treatments, accounting for more than 93% of the total greenhouse gas emissions (CO_2 equivalent). Total greenhouse gas emissions were inversely proportional to the hydroperiod of peatlands.

Nitrogen Speciation and Concentration Dynamics from Agricultural Fields to Indian River Lagoon

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Surface runoff water from agricultural field and urban area has been considered as nonpoint sources of pollution to the Indian River Lagoon (IRL) in South Florida. However, influence of waterway biology and chemistry on the speciation and bioavailability of nitrogen is not yet accounted for. In this study, surface water samples were collected along the waterways from agricultural fields to the discharge point at the IRL and analyzed for nitrogen speciation and related water quality properties. The concentrations of total N (TN), organic N (ON), dissolved N (DN), particulate-N (PN), NO_3-N (NN), and NH_4-N (AN) in the surface water samples were in the range of 2.97-19.8, 2.61-19.4, 2.67-17.6, 0-6.09, 0-6.89, and 0-0.54 mg L^{-1}, respectively, with corresponding mean values of 6.86, 6.29, 6.13, 0.73, 0.43, and 0.13 mg L^{-1}. Organic N was the dominant form of N, which accounts for >90% of the total N while DN dominated over PN, indicating that dissolved organic N is likely the major N form lost from agricultural soils to the environment. The concentration of total N was highest in runoff water from agricultural fields, sharply decreased in ditch and canal water, implying that waterways such as farm ditch and canals can, to a certain degree, attenuate N flux from sources to the receiving waters. The concentration of TN in agricultural water was high in April-June (~15 mg L^{-1}), decreased in July-September (~10 mg L^{-1}), and relatively lower in October-December and January-March period (5 mg L^{-1}). Which agree with the pattern of fertilization and rainfall in south Florida.

Key word: Agriculture, nitrogen forms, spatial and temporal variation, storm water

Rhizobacterial Community Structure in Two Chilean Volcanic Soils Revealed by Pyrosequencing

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Here, we report the results of a pyrosequencing study on the bacterial composition of the rhizosphere microsites (root tips and mature root zones) of *Lolium perenne* grown in rhizotrons containing two Chilean ash-derived volcanic soils. Andisols were chosen based on agronomic managements, and include a natural pasture with no fertilizer applications for >5 years (Andisol Freire series), and a pasture under periodic fertilization (Piedras Negras series). Analysis of the community structures showed significant differences between the bacterial communities present in the Freire and Piedras Negras series, particularly the relative abundances of *Cyanobacteria* and *Firmicutes* phyla. Our results did not show major differences in the structures of bacterial communities between rhizosphere microsites (root tips and mature zone) for either soil. *Proteobacteria*, *Actinobacteria* and *Acidobacteria* were the predominant taxa in all samples. Moreover, the results showed a high proportion of low-abundance bacterial groups, including members of novel groups not yet described for soils and rhizospheres. This information is relevant to studies on microbial ecology in the rhizosphere and use of bacteria-based biofertilizers in agriculture.

Mass Balance of Phosphorus in the Drip-Dispersal Septic Drainfield

Sara Mechtensimer and Gurpal S. Toor

Elevated concentrations of phosphorus (P) below the drainfield of septic systems or onsite wastewater treatment systems (OWTS) can impact shallow groundwater and eventually nearby surface water. Our objective was to determine the mass balance of P in the drainfield of a conventional drip-dispersal OWTS. Three replicate drainfields were constructed (1.5 m length x 0.9 m width x 0.9 m height) using Florida sandy soils (Zolflo fine sand). St. Augustine grass was planted on top of drainfield to mimic a residential OWTS. Each drainfield received 9 L per day (maximum allowable rate for sandy soils in Florida) of septic tank effluent (STE) for 1-year. STE and leachate samples were collected and analyzed for total P and dissolved reactive P (DRP) at weekly intervals (n=55). Plant samples collected at approximately monthly-intervals were analyzed for total P. After 1-year, the drainfields were de-constructed and a grid (15 cm x 15 cm) was used to collect approximately 37 soil samples from each drainfield. Results showed that plant uptake removed 3% of total P and 0.3% of total P was recovered in leachate. The remaining 96.7% of total P was stored in the drainfield soil. The collected drainfield soil samples were analyzed to determine various P pools of liability such as water-soluble ($CaCl_2$-extractable) and plant-available (Mehlich-3-extractable) P, as these pools have the highest potential for P leaching. Preliminary data shows 22-131% increase in $CaCl_2$-extractable P after 1-year of STE dispersal. Although most of the P was retained in the drainfield there is still a concern of long-term build up and potential leaching of P to groundwater.

Florida Wildfires during the Holocene Climatic Optimum (9,000-5,000 BP)

Kalindhi Larios, Stefan Gerber, and Mark Brenner

Fire is an important ecological driver in Southeastern pine forests, and species composition and fire pose the distinct possibility of positive feedback loops in a landscape. With global warming in the coming century, it is uncertain how fire regimes will change. To better understand the main players controlling fire occurrence we reconstructed fire history, using macroscopic charcoal as a fire proxy, in two lakes in the Orange Creek Basin in Florida. A rise in charcoal around 8010 cal BP was observed in a 3.9m core from Newnans Lake (8, 860 yrs cal BP) and a 5.4m core from Lochloosa Lake (9,280 yrs cal BP). We found that between depths 290 and 380 cm the number of charcoal particles per cm^3 was higher by a magnitude of 20 for Newnans Lake. In Lochloosa Lake at a depth between 375 and 535 cm there was a 110 fold magnitude difference in the number of charcoal particles per cm^3. The rise in charcoal is not a relic of sedimentation. Newnans Lake averaged ~ 9.14 charcoal particles per cm^3 and Lochloosa Lake averaged ~40.42 charcoal particles per cm^3. In agreement with our empirical observations, fire frequency as calculated from a dynamic global vegetation model was approximately 26% greater during the Holocene Climate Optimum (HCO, ca. 6,000 BP) compared to pre-industrial values (ca. AD 1800). Pollen was also sampled during charcoal peaks and valleys. The dominant pollen grains observed in late Holocene sediments included *Pinus*. "Mesic" grains such as *Carya* and *Taxodium* were also found. Early Holocene sediments were dominated by weeds such as *Chenopodium* and *Ambrosia*. *Pinus* and *Quercus* also were found throughout the Early Holocene. We are currently analyzing pollen and selecting samples for ^{14}C dating, to explore wildfire-vegetation relations during the HCO. Our findings will be useful towards a better understanding of the feedback between fire and vegetation in a shifting climate.

Abbreviations: HCO=Holocene Climatic Optimum

Soil Water and Nutrient Use in Low-input Rhizoma Peanut-Bahiagrass Mixes

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Bahiagrass is a warm-season, tropical perennial forage and turf grass, commonly used for recreational areas, medians and highway right of ways, in the southern U.S. Increased stresses from extreme weather (including droughts), more aggressive mowing practices, and disease pressures, along with declining soil fertility, is resulting in periodic, partial stand declines. Stand loss leaves sloped areas susceptible to water erosion and weed encroachment. Biological dinitrogen fixing (BNF) rhizoma peanut originates from the same South American region as bahiagrass. A blended rhizoma peanut-bahiagrass sward may provide a healthier and more resilient groundcover under low-input management. A field plot study was initiated to compare two rhizoma peanut cultivars, Ecoturf and experimental line Q6b, mixed with either of two bahiagrass cultivars, Argentine and experimental dwarf line, F9. Rhizoma peanut and bahiagrass were grown in monocultures or as peanut-grass mixtures at two Florida locations. Soil moisture, water infiltration, soil pore water N and P, soil and tissue N and P, and yields were measured in 2013 and 2014. Natural abundance N-15 was used to track legume N in mixed plantings in 2014. Mixed plantings produced as much and sometimes greater yield than the experimental dwarf bahiagrass in monoculture and they produced similar yields to Argentine bahiagrass monoculture. The Argentine-Q6b mixture used more water from deeper in the soil profile (76 cm) than other treatments. Using BNF perennial legumes in a perennial grass sward for highway right of ways is a promising sustainable practice.

Using Chitosan and Graphene Oxide to Produce Controlled Release Fertilizers

Tiantian Li, Bin Gao, and Yuncong Li

Fertilizers are chemical compounds applied to promote plants growth. But almost fifty percent of essential agrochemicals is lost to the environment and cannot be absorbed by plants, which cannot only cause serious pollution but also economic losses. Fertilizer use efficiency can be significantly increased with slow/controlled-release fertilizers because they release nutrients gradually and coincidentally with requirements of plants. Controlling release can be achieved by coating a film outside the conventional fertilizes and the release and dissolution rates of nutrients are depend on coating materials and coating methods. In our research, we will review and compare different materials and additives used for fertilizer coating including chitosan (CS) and graphene oxide (GO).

Effects of flood level and midseason drawdown on water quality and rice yield

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Abstract

Soil loss due to oxidation of organic matter is a concern in the Everglades Agricultural Area in South Florida. Growing flooded rice can help mitigate losses by maintaining anaerobic conditions of flooded fields throughout the growing season. This study was conducted to determine an optimum flood water level to increase rice yields while conserving water and improving drainage water quality. Four water level treatments: 15 cm midseason drawdown, 5 cm midseason drawdown, 15 cm continuous flood and 5 cm continuous flood and two rice cultivars: Cheniere and Taggart were tested in a split-plot experimental design with four replications. The effects of different flood levels and midseason drawdown on rice grain yield were studied. Water quality was also examined by measuring the phosphorus (P) concentration from the inflows and outflows of each experimental plot. Phosphorus concentrations in outflows were reduced comparted to inflows. The highest P reductions were observed in the 15 cm continuous flood and 5 cm midseason drawdown with 58% and 46% reduction respectively. Greatest grain yields were observed from Cheniere in 15 cm continuous flood (5.1 Mg ha^{-1}) and in 5 cm midseason drawdown (5.0 Mg ha^{-1}). Statistical analysis will be done to determine the most economic flood level considering the effects of each different treatment on grain yield, water quality and their interactions.

Single Point Simulation Setup for Everglades using Community Land Model

Yan Liao and Stefan Gerber

Wetlands perform many services at the global, population (biodiversity) and ecosystem levels. They are "ideal environments" for balancing the global nitrogen cycle; it also contains large amount of carbon storage in the planet. Everglades, located in the southern part of Florida, performs many social and biological services at the regional and global level. The nutrient cycles of everglade system is one of the key components to support the plant and other biological activities within and near Everglades.

This research focus on simulate the carbon and nitrogen cycles of Everglades in Everglades in macro aspects through a Dynamic Global Vegetation Model named CLM which was developed by scientists at National Center for Atmospheric Research (NCAR).

CLM was designed to represent and enable study of the physical, chemical, and biological processes by which terrestrial ecosystems affect and are affected by climate across a variety of spatial and temporal scales. Each grid of the land surface can be customized by revising or adding new processes. This poster shows the basic structure of CLM; the mechanism of biological simulation processes, including relevant variables; the detaisl of model set-up in specific location as well as the first simulation results of carbon and nitrogen cycles including, NPP, litter fall, soil and vegetation carbon and nitrogen within this specific grid cell. The future work of this project is also addressed in this poster.

Reference

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The Interaction between *Phytophthora spp*. and *Candidatus* Liberibacter spp. Damage to Citrus Fibrous Roots

Jian Wu, Evan Johnson, Diane Bright, Kayla Gerberich and Jim Graham.

Phytophthora nicotianae (*P.n.*) causes root rot of citrus, damaging the fibrous roots which depletes carbohydrate reserves and reduces water and nutrient uptake capacity. Huanglongbing (HLB) is a systemic citrus disease that disrupts photosynthate transport, and is caused by phloem-limited *Candidatus* Liberibacter asiaticus (Las). High *P.n.* populations were reported as HLB spread though Florida. To understand the possible interaction between these two pathogens and host, two rootstocks -Cleopatra mandarin (*Citrus reticulata*) and sour orange (*Citrus aurantium*) were inoculated with Las, *P.n.* or both. *P.n.* infection, root loss and carbohydrate content of citrus fibrous root were assayed. *P.n.* infection increased on both rootstocks indicating that Las reduced their tolerance to *P.n.*. Different *P.n.* infection on Las positive seedlings at 5 and 11weeks after inoculation suggests the interaction changed over time. Both pathogens caused significant root loss alone, but in combination *P.n.* did not cause additional loss compared to the total root loss caused by each pathogen alone. Based on these results, we hypothesize that 1) early in disease development, Las increases susceptibility to *P.n.* infection by increasing zoospore attraction or facilitating penetration; 2) Las induces root loss resulting in a temporary drop in *P.n.* population by reducing available food supply; 3) As new roots flushes occur, *P.n.* starts the infection cycle again and repeats until there is a complete loss of fibrous root system.

Effects of Different Land Uses on Base-Flow Nitrogen Concentrations on the Main Campus of University of Florida

Jiexuan Luo, Mark Clark, and George Hochmuth

Export of nitrogen from different watersheds across the United States is receiving increasing attention due to the impairment of water quality in streams. Researchers have indicated that different land uses exerted a substantial influence on the water quality. A nitrogen budget based on different land uses is being developed to quantity the nitrogen inputs and outputs in base flow at the University of Florida in Gainesville, FL. Unlike large watersheds in other studies that involve mixed land uses with a dominating land use, this study focuses on several small sub-basins each with a single land use. This approach eliminates the effects from mixed land uses by identifying the specific storm drainage system. Land uses have been classified in this study based on the different practices: urban with reclaimed water irrigation, urban without irrigation, recreation with fertilization, and recreation without fertilization. The hypothesis in this study is that the recreational land use with fertilization and irrigation will result in the greatest nitrogen loads in the runoff, and should be the priority consideration for nutrient management in the university in the future. Water samples and flow volume measurements are being taken in both urban study areas and the recreational study area with fertilization. Flow in the recreational study area without fertilization will be estimated based on the other recreational study area The results showed that runoff from the fertilized recreational area field can contain nitrate-nitrogen concentrations up to 23.87 mg/L with an average of 17.09 mg/L , the average nitrate-nitrogen concentration from the unfertilized field was 0.78 mg/L, the nitrate-N concentration in the runoff from the urban without irrigation was 0.5 mg/L.

Shifts in Microbial Phosphorus Requirements within a Sub Tropical Peatland

E. Morrison, A. Ogram, S. Newman, R. Reddy

Microbial processes drive numerous biogeochemical cycles, and microbial turnover of nitrogen (N) and phosphorus (P) can greatly influence internal carbon and nutrient cycling in many systems. However, external nutrient loading can disrupt these nutrient cycles and can cause widespread ecosystem shifts. This has occurred in the northern Everglades, which has seen changes in vegetation communities and biogeochemical cycling as a result of nutrient enrichment from agricultural areas in the north. Through the quantification of functional genes and the analysis of enzyme activities, we sought to elucidate how external P loading in this historically oligotrophic peatland may impact microbial nutrient requirements. Our study sites were located in the Everglades Water Conservation Area 2A, which has developed an anthropogenic P gradient due to decades of nutrient loading. Our sites ranged from a site impacted by P loading, an intermediate site, and a site that is, to date, unimpacted by anthropogenic nutrient inputs. Quantitative PCR was used to enumerate genes for alkaline phosphatase (*phoX*) and nitrogen reductase (*nifH*), while enzyme assays were run to determine phosphatase, phosphodiesterase, and leucine aminopeptidase activities along the phosphorus gradient. The gene *phoX* was used in conjunction with phosphatase and phosphodiesterase enzyme activities to assess microbial investment in P acquisition, while the gene *nifH* and the enzyme activity of leucine aminopeptidase were used to determine microbial investment in N acquisition. Changes in functional gene copy number and enzyme activity were seen between sites along the P gradient. Changes in *phoX:nifH* and phosphatase:leucine aminopeptidase along the transect suggest that the microbial communities of the unimpacted, oligotrophic site are allocating more resources to P acquisition relative to N acquisition. Sensitive molecular techniques such as q-PCR provide an opportunity to develop indicators of microbial nutrient requirements and potential nutrient enrichment within sensitive, impacted areas, such as the Everglades.

Soil Organic Matter Response to Climate Warming in a Subarctic Peatland

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Climate change will result in increased temperature of northern latitudes ultimately affecting carbon (C) cycling of peatland ecosystems. Increased temperature will likely alter the balance of primary production and decomposition in peatlands, yet the magnitude of biological responses is poorly understood. At an experimental warming site of a peatland in Northern Sweden, respiration rates increased during the summer and spring after nine years of ~1^{o}C increased warming treatments. Furthermore, soil depths below 25 cm contributed to 69% increase in respiration rate. Soil organic matter (SOM) quality is a strong regulator of peat response to increased temperature; therefore, ^{13}C ssNMR was used to determine SOM quality and humificiation index (HI) after 15 years of warming treatments (ambient, winter warming, spring and summer warming, and year warming). NMR analysis of 0-20 cm soil indicated that year warming treatments had more labile SOM (0.19 HI) compared to further humified signatures from winter warming (0.25 HI). The labile signatures of year warming treatment may be due to augmented primary production of *Sphagnum*, thus contributing more readily decomposable SOM for increased respiration. NMR signatures of the soil profile did confirm greater humification at the soil depth where a large contribution of increased respiration was observed from summer and year warming. Deep layers (30-50 cm) of some soil profiles had highly humified composition (0.5-0.6 HI). Combining respiration data with SOM quality analysis showed that increased respiration from climate warming may be a function of additional labile SOM inputs and sensitivity of more humified deep layers.

SOM – soil organic matter
SS ^{13}C NMR – Solid State ^{13}C Nuclear Magnetic Resonance
HI – humification index

Determining the Effect of Salinity on Nitrogen and Phosphorus Preference in Harmful Algal Bloom Species from the Northern Indian River Lagoon

Joshua R. Papacek, Edward J. Phlips, Margaret A. Lasi & Patrick W. Inglett

Harmful algal blooms (HABs) pose a serious economic and ecological threat to coastal and estuarine ecosystems. The Northern Indian River Lagoon (NIRL) is a subtropical estuary in eastern Florida that is experiencing HABs at an increasing rate. The NIRL "superbloom" in 2011 was unprecedented in size and intensity and consisted largely of pico-cyanobacteria and a currently unidentified species of the class *Pedinophyceae*. Such bloom events are often correlated with eutrophication, and bloom-forming species have been shown to be competitive for both inorganic and organic forms of nitrogen (N) and phosphorus (P). However, in the case of the phytoplankton that dominated the NIRL in 2011, it is currently unknown which forms of N and P are preferred or the degree to which salinity may effect nutrient uptake. In this study, we use isotope tracer techniques and Michaelis-Menten kinetic modeling will be used to identify the nutritional preferences of the NIRL pico-planktonic species under various salinity regimes. The potential for the pico-cyanobacteria to utilize atmospheric N through N_2 fixation will also be assessed. The results from these experiments will increase our understanding of the potential for "bottom up" influence on HABs in the NIRL and similar estuaries. The results will also help direct future management decisions aimed at prevention and mitigation of HABs in these systems.

Field Study of the Use of Aluminum Water Treatment Residuals in a Permeable Reactive Barrier System to Reduce Soluble Phosphorus Movement in Groundwater

William Schmahl and James Jawitz

High phosphorus (P) loading in Lake Okeechobee during past decades has resulted in advanced eutrophication with corresponding impacts on the lake's ecosystem. A large portion of this P loading is a result of agricultural and livestock operations in the Northern Lake Okeechobee Basin (NLOB). A major source of P is from cow manure originating from intense livestock operations or from land applications as fertilizer. In many types of soils this P is bound within the soil however the Spodosols of South Florida lack the capacity to retain much P and a large percentage of the soluble P is leached through the soil and transported via groundwater to the surface water drainage network, eventually making its way into Lake Okeechobee.

This study involves the use of aluminum water treatment residuals (Al-WTRs) as a permeable reactive barrier (PRB) installed in a trench perpendicular to groundwater flow which is intended to inhibit the movement of the soluble P. The chemical attributes of Al-WTRs are such that the P will readily adsorb to the aluminum oxides and will remain stable over long periods of time. These Al-WTRs are available locally and cost effectively making this an attractive method for P removal.

Two field sites were chosen for PRB implementation and studies over a two year period showed a high percentage of P removal from GW as well as highlighting important characteristics for future PRB design.

Removal of Arsenic by Magnetic Biochar Prepared from Pine Wood and Natural Hematite

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There is a need for the development of low-cost adsorbents to removal arsenic (As) from aqueous solutions. In this work, a magnetic biochar was synthesized by pyrolyzing a mixture of naturally-occurring hematite mineral and pine wood biomass. The resulting biochar composite was characterized with X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM) and energy-dispersive X-ray analysis (EDS). In comparison to the unmodified biochar, the hematite modified biochar not only had stronger magnetic property but also showed much greater ability to remove As from aqueous solution, likely because the γ-Fe_2O_3 particles on the carbon surface served as sorption sites through electrostatic interactions. Because the magnetized biochar can be easily isolated and removed with external magnets, it can be used in various As contaminant removal applications.

Long-term (1890-present) Actual Evapotrasnpiration Estimates for Silver Springs and Rainbow Springs Basins using the Budyko Framework.

Antonio Yaquian and James Jawitz

Effective water management requires thorough understanding of the different natural and anthropogenic factors affecting water availability. This knowledge will enable the implementation of adaptive water management practices, for current and future scenarios, as well as better water allocation to urban, ecological and agricultural users. Although multiple climatological factors, like temperature and precipitation, of regional water budgets are monitored through extensive networks, regional evapotranspiration estimates on the other hand can be inadequately assessed, producing reliable and replicable evapotranspiration estimates becomes vital for places, like central Florida, where the largest water output is evapotranspiration. Florida has an extensive network of meteorological stations, however only few stations and for a relatively short period have been collecting potential evapotranspiration data. Thus, the great need for reliable methodologies for long-term evapotranspiration estimates based on simple parameters. This research estimated long-term (1890-present) actual evapotranspiration for two adjacent groundwater basins in Central Florida, Silver Springs and Rainbow Springs. This was achieved by calculating potential evapotranspiration with an empirical equation, Turc. Calculated potential evapotranspiration, precipitation and solar radiation data were used as inputs for the Budyko equation which generated the actual evapotranspiration estimates. These estimates were corroborated with a water balance approach. Since regional precipitation and runoff, flow from the spring systems, is known, evapotranspiration estimates should match the difference between precipitation and runoff. This research allows for the development of long-term historical evapotrasnpiration estimates in places where minimal amounts of climatic data are available.

Irrigation Water Salinity Impacts in the Tri-County Agricultural Area, Northeast Florida

Eunice Yarney and Mark Clark

Soil salinity concentration within the Tri-County Agricultural Area (TCAA) during recent low rainfall years has been of concern, and questions regarding the salinity of groundwater in the region and what can be done to mitigate salt stress have been asked by growers. The potential source of elevated salts in the groundwater of this region is not explicitly understood, but is generally the result of vertical saltwater intrusion through a semipermeable confinement layer between the saline rich Lower Floridan Aquifer and the Upper Floridan Aquifer. This movement of salts can be exacerbated by up-coning associated with local irrigation well pumping and regional water withdrawals. There is a need to improve our understanding of spatial and temporal variability in groundwater and soil salinity in the TCAA to inform future water management decisions regarding the allocation of water in the area and to mitigate for increased soil salinity if necessary. This research has the following objectives: 1) to survey irrigation wells in the TCAA to determine the extent of salinity and contrast them with a survey conducted in the mid 1970's, 2) to evaluate the temporal variability in salinity concentrations in response to pumping during the growing season, and 3) to evaluate the effects of different irrigation practices on in-field soil salinity concentrations in selected farms. The project is presently in a sampling phase to locate and resample wells surveyed in 1975 and to monitor a network of grower wells within the TCAA to determine temporal variability of irrigation water salinity.

Nitrogen Starvation of Algae – A Stress for Lipids

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Microalgae strains, such as *Chlorella cf. vulgaris*, *Chlorella minutissima*, and *Scenedesmus obliquus* have been researched as potential feedstocks for biofuels because of their fast growth rate and ability to produce lipids. In order for commercial-scale algae biofuel plants to become a reality, however, the conversion of algal lipids into biofuels needs to become more efficient. One strategy to improve biofuel yields from algae is to induce lipid production using a two-stage nitrogen starvation method. In this method, microalgae are grown in nutrient-replete conditions such as wastewater to achieve high biomass and are then transferred to nitrogen-depleted conditions to stimulate lipid production and increase overall lipid content. The objective of this research is to test the viability of different aqueous conditions including tap water, distilled water, and deionized water, to determine which nitrogen-depleted medium results in the maximum lipid induction. The results will indicate the optimal media characteristics including pH, conductivity, and trace organics for maximum lipid induction. *Chlorella cf. vulgaris* was used for preliminary trials because of its availability and metabolic ability to produce lipids. The reason for using water instead of a modified growth medium (nitrogen lacking) is cost, availability, and ease of access for commercial purposes. Microscopic monitoring showed large amounts of lipids in both deionized and distilled water and very small amounts of lipids in tap water and the control. The experiment is ongoing and lipid content measurements by nuclear magnetic resonance will be used to confirm and quantify results obtained by microscopic monitoring.