Arsenic recovery from As-hyperaccumulator *Pteris vittata* biomass: coupling extraction with precipitation

Evandro B. da Silva, Letuzia M. de Oliveira, Ann C. Wilkie, Lena Q. Ma

Disposal of As-hyperaccumulator Chinese brake fern (*Pteris vittata*) biomass is one of the keys to improve phytoremediation application. This study aimed to optimize As removal from *P. vittata* (PV) biomass by testing different particle sizes, extractants, extraction times and solid-to-liquid ratios. Different extractants followed by different Mg-salts were used to remove As from dry PV biomass and to recover soluble As via precipitation. Water-soluble As was mostly arsenate (AsV) (99%) with recovery ranging from 6.8% to 61% of total As depending on extraction time. Extraction with 2.1% HCl, 2.1% H_3PO_4, 1 M NaOH and 35% ethanol recovered 81, 78, 47 and 14% of As from PV biomass. Second extraction using HCl recovered 27-32% with ethanol recovering only 5%. Although ethanol presented the lowest As recover, it was the best extractor to remove As from PV biomass, presenting the lowest residual As in the biomass. Maximum recovery was ~90% using particle size < 1 mm at solid: liquid at 1:50 and pH 6 for 2 h. Adding $MgCl_2$ at As:Mg ratio of 1:400 with pH 9.5 was effective to precipitate soluble As. Effective As removal from PV biomass combining extraction, precipitation prior to disposal helps to turn phytoremediation more practical.

In Situ Measurement of Nitrate Fluxes and Attenuation in a Mixed-Land Use Springshed

Amanda Desormeaux, J.W. Jawitz, M. Annable, D. Dobberfuhl, P. Inglett, and M. Yang

The 2,500 km^2 Silver Springs springshed is subject to a wide range of N inputs, which vary based on land use type and intensity. This N loading can drive increases in groundwater nitrate concentrations when N inputs exceed N attenuation. The karst aquifer that underlies the springshed is especially vulnerable to nitrate contamination, as nitrate can be rapidly transported to the aquifer in unconfined regions. Only a fraction of surface loading reaches the groundwater, and direct measurements of soil nitrate fluxes below the root zone are critical for quantifying actual nitrate leaching and attenuation. We designed an ion-exchange resin column to measure soil N fluxes and attenuation in sandy, unsaturated soils characteristic of the Silver Springs springshed. Resin columns were installed in sites representing major land uses with known surface N inputs, allowing for the *in situ* measurement of soil nitrate fluxes and attenuation in the upper 30-cm. In addition to vadose zone nitrate attenuation, a series of push-pull tests were performed to measure denitrification rates in the Upper Floridan Aquifer underlying the springshed.

Understanding Soil Organic Carbon Spatial Variability in the Peruvian Central Andes using Digital Soil Mapping

Carla Gavilan[1], Sabine Grunwald[1], and Roberto Quiroz[2]

[1] Soil and Water Sciences, University of Florida, Gainesville, FL; [2] International Potato Center (CIP), Lima, Peru

The Andes represent the largest and highest mountain range in the tropics and is considered an important reserve of biodiversity, water provision and soil organic carbon (SOC) stocks. Nevertheless, limited attention has been given to estimate these stocks due to the lack of recent soil data, the poor accessibility and the wide range of coexistent ecosystems. This study aimed to model the spatial distribution of SOC stocks and understand the underlying relationships with environmental factors. Three study areas were identified across the Peruvian Central Andes and a total of 400 topsoil samples (0-30 cm) collected and analyzed for SOC and bulk density to derive SOC stocks. A large suite of environmental variables and six machine learning and data mining approaches were used to model SOC stocks. The observed mean and median SOC stocks from all sample points were 10.58 kg m^{-2} and 8.48 kg m^{-2}, respectively. Variables related to topography, climate and vegetation were found relevant as SOC stock predictors. Random forest (RF) outperformed the other models in predicting the spatial distribution of SOC stocks, explaining more than 85% of its variation. The maps generated using RF showed high SOC stocks (> 20 kg m^{-2}) in areas where grasslands and seasonal peatlands were located, moderate values (10 – 20 kg m^{-2}) in areas covered by native forests or herbaceous vegetation and low values (< 10 kg m^{-2}) in agricultural areas or hills with pronounced slopes. These findings suggest that integrating digital soil mapping with machine learning algorithms constitutes a promising approach in predicting the spatial variability of SOC stocks at regional scale in the Andes.

Struvite Recovery from Aerobically Digested Municipal Wastewater Filtrate: A Sustainable P Recovery Source

John Hallas, Cheryl Mackowiak, and Ann Wilkie

While demand for phosphorus (P) continues to increase, economically accessible reserves may be exhausted within this century. Municipal wastewater treatment plants (WWTPs) represent approximately 40% of the discharged wastewater in the United States and are an attractive source of recoverable P, with 4.6 million metric tons (MT) P per year passing through the WWTP. P recovery from small, aerobic WWTPs may provide useful renewable P fertilizer; however, little research has been conducted on these systems. Four small WWTPs in north Florida with treatment capacities from 371 to 2,650 cubic meters per day (m^3 d^{-1}) and incoming P loads from 2 to 14 kilograms per day (kg d^{-1}) were investigated. A chemical equilibrium model was developed with Visual MINTEQ Version 3.0 to predict the feasibility of struvite production from the aerobically digested sludge filtrate. Model results confirm the potential for aerobic digesters at small WWTPs to form struvite with the use of minor pH modifications. P recovery via struvite formation ranged from 27–60% by mass if the wastewater filtrate pH was increased to 7.0 via NaOH addition or air sparging. Struvite formation in the air sparged experiments improved product yield over using NaOH for pH adjustment. The struvite solids were relatively pure, with no competing solids, as determined by analysis-ray diffraction analysis. Based upon these results, recoverable P from small WWTP can potentially recover 200,000 t of P_2O_5 equivalents per year.

Landscape Self-Organization and the Development Regular Topographic Patterning of Karst Depressions

Carlos Quintero, Matthew Cohen

Abstract:

Thousands of wetland depressions dot the sub-tropical limestone landscape of Big Cypress National Preserve in South Florida. Characterized by cypress trees, deep organic soils and bedrock elevations several meters lower than the adjacent uplands, these basins are thought to have formed during the Holocene in response to feedbacks between hydrologic forcing, organic matter respiration and dissolution of calcite rocks. To evaluate this landscape's biogeomorphic origins, we analyzed the morphology and spatial distribution of cypress-dome depressions in six 2.5 km^2 domains across Big Cypress using high resolution Light Direction and Ranging (LiDAR) measurements of ground surface elevations. We tested the hypothesis that the emergent pattern is spatially regular by evaluating three linked predictions about landscape structure. First we used semi-variance and radial spectrum analysis to evaluate pattern periodicity. Our results strongly confirm regular patterning with a characteristic wavelength between 120 and 180 meters. Second, we evaluated distributions of depression sizes and their spatial arrangement. Unlike depressions in other settings, those in Big Cypress are exponentially distributed, indicating locally constrained basin expansion, while mean nearest neighbor distances indicate non-random geographic placement (i.e., overdispersion). Finally, we evaluated the inundation depth to achieve surface connectivity (i.e., percolation) necessary to export weathering solutes. Individual wetlands activate surface connections nearly simultaneously across the landscape, and do so at well below the 60% threshold predicted for random landscapes. The presence of regular patterning, constrained basin sizes, and coherent connectivity thresholds strongly imply spatial-self organization of basin formation controlled by coupled feedbacks operating at different spatial scales.