Enhanced Cr(VI) reduction and As(III) oxidation in ice: Important role of biochar dissolved organic matter

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ABSTRACT: Dissolved organic matter (DOM) can serve as both oxidizing and reducing agent for redox reaction. This study evaluated (1) the impact of DOM from two biochar (sugar beet tailing and Brazilian pepper) on Cr(VI) reduction and As(III) oxidation in both ice and aqueous phase, one soil derived DOM was used as a control, (2) the influence of pH, temperature and dissolved organic carbon (DOC) concentration for these two redox experiments and (3) the mechanisms governing Cr and As conversion in the system containing all three components. Both Cr(VI) reduction and As(III) oxidation of were significantly enhanced in the ice phase. FTIR analysis demonstrated that carboxylic group participated in Cr and As conversion. DOC concentration and pH played an important role for both reactions. However, the Cr(VI) reduction rate decreased while the As(III) oxidation rate increased with increasing pH. The decrease of DOC concentration confirmed DOM was oxidized to CO2 during Cr(VI) reduction. ESR study demonstrated semiquinoic radicals were responsible for As(III) oxidation. The enhanced conversion of Cr(VI) and As(III) in the ice phase was due to the freeze concentration effect that elevated concentrations of electron donor (DOM, Cr(VI)), electron acceptor (semiquinoic radicals, As(III)), protons and hydroxyls in the grain boundary. Simultaneous conversion of Cr(VI) and As(III) with the presence of DOM demonstrated DOM and Cr(VI)/As(III) redox couple dominated the redox conversion at different situation.

ROLE OF PHYSICOCHEMICAL AND BIOCHEMICAL SOIL CHARACTERISTICS ON FATE OF PATHOGENIC BACTERIA

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The Center for Disease Control and Prevention estimates that each year in U.S. roughly 48 million people (or 1 in 6 Americans) get sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases. Although the consumption of contaminated food is the major cause of foodborne diseases, soil is a recipient of solid wastes and has an important role in the transmission of these enteric diseases. Indeed, use of human and animal waste as manure appears to be one of the most significant sources of pathogens in soils. Moreover, the ability of micro-organisms to migrate through soil increases the probability of surface water and groundwater contamination and recently, pathogenic bacteria have been shown to be incorporated or associated with the surface of vegetables grown in manure-amended soil. It appears thus necessary to better understand the fate of these bacteria in agricultural environment in order to limit the contamination of water or food and help develop good management practices. We propose a three steps approach to assess the role of physicochemical and biochemical soil characteristics on: bacterial sorption, bacterial survival and bacterial transport within different characterized soils. The first results suggest that the clay content, the total organic content and the bacteria to fungal ratio had a strong influence on bacterial attachment whereas soil pH is negatively related to bacterial sorption. In the future, our studies will focus on the survival and transport of bacteria in these soils in order to understand the soil characteristics and mechanisms affecting the fate of pathogenic bacteria in soils.

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Influence of arsenic and phosphorus competitive uptake on arsenic tolerance in bacteria and arsenic-hyperaccumulator *Pteris vittata* L.

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Arsenic contamination of soil and water has created serious health concern all over the world. Arsenic hyperaccumulator *Pteris vittata* L. (Chinese Brake fern) is capable of extracting arsenic from both soluble and insoluble forms, due to composite action of the plant roots and rhizosphere microorganisms. Seven As-resistant bacteria (ARB; tolerant up to 10 mM AsV) from 3 genera were isolated from the rhizosphere soils.

The siderophores produced from rhizobacteria solubilized arsenic from $FeAsO_4$/$AlAsO_4$ minerals, increasing arsenic uptake by *P. vittata* from 18.1–21.9 to 35.3–236 mg kg^{-1} arsenic in the fronds. The root biomass of *P. vittata* increased from 1.5-2.2 to 3.4-4.2 g dw/plant when amended with the bacteria in the growth medium due to arsenic-induced P uptake. As AsV and P are chemical analogs they affect the uptake of each other. We tested the influence of different AsV concentrations of 0.1 and 1 mM AsV compared to no arsenic control on P uptake, utilization and AsV reduction rates and vice versa. Bacteria take up 3-8.4 times more P in presence of 1 mM AsV than in no AsV condition due to arsenic-induced P uptake. In bacteria we have also found that higher P concentration in the bacterial medium can lower the uptake of AsV resulting in less AsV reduction to AsIII. So, in presence of P plants and bacteria may be more tolerant to arsenic. In contaminated sites arsenic-resistant rhizosphere bacteria can aid plant growth and enhance phytoextraction of arsenic-contaminated soil.

Keywords: arsenic, arsenic-resistant bacteria, rhizosphere, *Pteris vittata,* plant-microbe interaction

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TEMPERATURE SENSITIVITY OF ENZYME KINETIC PARAMETERS IN SUBTROPICAL WETLAND SOILS OF CONTRASTING NUTRIENT STATUS

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Extracellular enzyme activity is a rate limiting step of soil organic matter decomposition. These enzyme activities are direct responses of dominant soil microbial communities to nutrient availability, nutrient limitations, and the existing external environmental conditions in soils. The overall goal of this study was to investigate how nutrient limitation in soils affects the kinetic parameters of extracellular enzymes and if these parameters exhibit differences in their temperature sensitivity to soil warming. In this laboratory study, V*max* and K*m* of six extracellular enzymes (phosphatase, bisphosphatase, ß-D-glucosidase, cellobiohydrolase, leucine aminopeptidase, N-Acetyl-ß-D glucosaminidase) was determined in soils from a subtropical wetland exhibiting an increasing gradient of phosphorus (P). Temperature sensitivity of these enzymes were also determined at each site to investigate the interaction of temperature with nutrient on the properties of enzymes. Results from this study revealed that maximal activities of C and N enzymes were positively correlated with the soil P concentrations unlike the P enzyme activities. The substrate affinity of the six enzymes also showed significant differences. Observed differences in the both kinetic parameters and the Q_{10} values determined under both conditions suggest that the presence of oxygen either directly or indirectly effects the functional activity of the enzymes. Results from this study will help us understand the local adaptation of the soil C, N, P enzymes and may provide insight into how their response to altered external conditions may affect the enzyme products.

Carbon Dynamics, productivity and efficiency
of a beech forest under climate change
- a simulation study at individual and stand level for a NW Europe region -

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As a part of the research program 'Transnational Forestry Management Strategies in Response to Regional Climate Change Impacts', we focus on uncovering growth patterns influenced by changing climate conditions as well as on the simulation by using the forest growth models BALANCE. In the first step, sensitivity analysis was applied to test how the species specific parameters influence the behavior of the model. Several parameters in the biomass model were calibrated and the model was validated for a pure beech stand in the Palatinate Forest in Germany. We then subjected the model to potential future climate conditions. Results showed the future biomass increment was less than one half of that under the present climate conditions in a ten years period. Net primary productivity (NPP) was more sensitive to the precipitation: dry scenarios had strongly negative effect on the NPP. The results also showed a large divergence of diameter growth under future climate which was clearly less than that under present conditions. The outputs of the water module displayed a pretty low soil water content as well as decreasing water use efficiency under the predicated future dry and wet scenarios. The simulation results thus indicated a high possibility of drought in future. A relatively high mortality in the predicted future was also found in this study.

References

Rötzer T, Seifert T, Pretzsch H (2009) Modeling above and below ground carbon dynamics in a mixed beech and spruce stand influenced by climate. European Journal of Forest Research 128: 171-182.

Algal Bioremediation of Reverse Osmosis Pretreated Landfill Leachate: Optimization and Outdoor Growth

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Landfill leachate is fluid that accumulates on the bottom liner of municipal solid waste landfills after it has passed through the solid waste within the landfill. Landfill leachate poses an environmental threat to surface and groundwater quality and must be managed for a minimum of thirty-years after landfill closure. Currently, the Alachua County Southwest Landfill is testing an experimental 2-stage reverse osmosis system for its viability in physical removal of leachate contaminants. Reverse osmosis (RO) uses high-pressure membrane filtration, which is an energy-intensive remediation method. Ammonia is a primary contaminant of the landfill leachate, which can be found in concentrations above 1000 mg-N/L. A 2-stage RO system is necessary in order to approach groundwater cleanup target levels of 2.8 mg-N/L. An alternative to using the second stage of the RO system is the implementation of biological remediation to utilize residual ammonia in the filtered product from the first stage of RO, which contains concentrations closer to 100 mg-N/L. A native alga, *Scenedesmus*, found on site was cultivated in laboratory and outdoor experiments to optimize bioremediation of the material. Results showed that these algae have the ability to grow on this material to densities near 1 g/L in outdoor cultivation tanks, under appropriate growth conditions. At these growth rates, remediation rates averaged 1.18 mg-N/L/hour. This algal biomass is a valuable by-product that can be utilized as a biofuel feedstock or for derivation of other valuable co-products.

Denitrification Potential of Urban Impacted Riparian Zones throughout Tampa, FL and Surrounding Areas

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Population growth and land use change has presented coastal areas with considerable challenges for the conservation of water resources while sustaining communities. Urbanization and the associated increase in impervious surfaces have been established as being detrimental to water quality. The major nutrient implicated for water quality deterioration in many water bodies in coastal regions, including our study site, is nitrogen (N). The long-term goal is to understand the fate and transport of N in urbanized watersheds within a coastal plain environment and the role vegetation plays in improving water quality in urban areas. Riparian zones have been shown to have disproportionately greater denitrification rates relative to most areas of a landscape. Our research objective of this study is to determine the denitrification potentials of common land-use categories in a subtropical, coastal-urban landscape. Due to anthropogenic alteration to vegetation and hydrology, riparian zones within relatively close proximity to urbanized areas were expected to exhibit some degree of diminished denitrification potential relative to riparian zones in less disturbed rural areas. Soil samples were collected from varying distances perpendicular to the riparian zone, and the microbial denitrification potentials of these soils were measured using the acetylene block method. Denitrification enzyme activity (DEA) assays were analyzed through gas chromatography to measure potential rates. Initial results suggest significant differences based on land-use category. Remnant forest and high residential riparian zones showed comparatively greater denitrification potential rates relative to zones within emergent forest and light residential land-use categories.

ASSESSING STREAM-MEDIATED SEED AND SHOOT DISPERSAL OF INVASIVE PLANTS IN FLORIDA

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Understanding invasive species dispersal and recruitment mechanisms is important in order to best allocate financial resources when managing invasive exotic species. Yet, the dispersal characteristics of invasive plants remain poorly known. This study assesses the importance of stream conditions combined with high seed or shoot production to allow rapid re-colonization of invasive plants such as *Ruellia simplex* (Mexican petunia) and *Tradescantia fluminensis* (small-leaf spiderwort). The importance of stream dispersal of invasive plant seeds and shoots and the subsequent retention and recolonization of these species within a wetland floodplain are being determined. Frequency of dispersal events are being quantified in relation to stream flow regimes by using nets to intercept seeds and shoots as they float downstream. Travel times and relative mobility are being assessed by releasing marked seeds and shoots upstream of the nets and recording recapture rates. The buoyancy of seeds and shoots for water dispersion are being assessed using in-stream chambers. Viability of *R. simplex* seeds and *T. fluminensis* shoots to extended submergence and burial events (to 180 days) are being tested using field and lab techniques. Out of 13,269 seeds and 180 shoots intercepted in the stream, few were from *R. simplex* (1.0% of seeds, 11.7% of shoots) and *T. fluminensis* (3.3% of shoots). Preliminary results suggest *R. simplex* seeds can survive submergence for at least 90 days while *T. fluminensis* shoots have poor survival by 7 days of submergence. This study is important because the State of Florida alone spends tens of millions of dollars annually to combat invasive species in natural areas including wetland habitats. The results of this ongoing study will help elucidate the importance of conducting control efforts at the watershed scale that include management of upstream sources thereby minimizing the recolonization of downstream riparian wetlands by invasive plants.

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