Online Proceedings

Poster Session 1

MGH 241, Easel 147

11:00 AM to 1:00 PM

Additive Manufacturing of Concrete Structures

Hailey Briann Stenslie, Senior, Civil Engineering
Mentor: Dawn Lehman, Civil And Environmental Engineering

Advancements in fabrication of manufacturing and medical systems is focusing on using computer-aided fabrication methods, also called additive manufacturing or 3D printing. In civil engineering, we still rely on traditional methods of construction. Although there are researchers and companies investigating 3D printing of concrete, most focus on form, not on engineering properties. This research project has begun to remedy that by investigating mix design methodologies, new extrusion techniques and use of large-capacity testing equipment to advance engineering of 3D printed concrete structures. The first phase has investigated extrudable and stable (in its fresh state) mix design(s); a new protocol is being developed to test the engineering properties, including stiffness, strength of the extruded material, as well as multilayer adhesion and deformation. The second phase will investigate the hardened properties. The research is funded by Pactrans, with the ultimate goal of printing components for multi-modal concrete structures, such as pedestrian and bicycle bridges.

Poster Session 1

MGH 241, Easel 152

11:00 AM to 1:00 PM

Transformation Kinetics and Products of Synthetic Progestin and Their Environmental Implications

Ken Ji (Kenji) Lam, Junior, Civil Engineering
Mary Gates Scholar
Mentor: Edward Kolodziej, Science and Mathematics/ Civil and Environmental Eng.

Altrenogest (ALT) is a potent synthetic steroidal progestin commonly used as a veterinary pharmaceutical to maintain pregnancy in females, match estrus periods for breeding, or postpone the estrus period. ALT usage was estimated as several thousand kg across ˜3,600,000 horses and ˜66,000,000 swine; it subsequently enters the aquatic environment through agricultural runoff. ALT can act as an environmental endocrine disruptor because it has progestogenic and androgenic activity, however, little is currently known on its environmental fate, persistence, and ecological risks. Our study focuses on characterizing the biodegradation kinetics and product identification for ALT and its primary photoproducts.To evaluate altrenogest fate, we build microcosms by mixing altrenogest, water and growth media for mixed microbial communities collected from representative agroecosystems and municipal waste waters. We then concentrate water samples through solid- phase extraction and then use liquid chromatography and triple quadrupole mass spectrometry to analyze remaining ALT concentrations over time, to understand transformation kinetics. To identify transformation products, sample extracts are analyzed using high resolution mass spectrometry. Study results will aid in the risk assessment of ALT by improving our understanding of its environmental fate and management.

Poster Session 1

MGH 241, Easel 137

11:00 AM to 1:00 PM

Understanding Seattle's Water Resources through the Half of 21st Century

Kateryna Gomozova, Fifth Year, Civil Engineering
Mary Gates Scholar
Mentor: Bart Nijssen, Civil and Environmental Engineering
Mentor: Oriana Chegwidden, Civil and Environmental Engineering

Freshwater is one of the most valuable resources in Washington State. In recent decades, water supply has been affected due to climate change and population growth. Understanding changes in water supply and demand is crucial for ensuring an abundance of water for residential, economic, and industrial needs. The proposed research analyzes changes in the streamflow regime of the Cedar and Tolt Rivers which provide drinking water for the greater Seattle area. The main goal is to calculate the water budgets for the Cedar and Tolt watersheds and estimate how the inputs and outputs to these budgets change over the 21st century. An existing ensemble of streamflow projections for the Cedar and Tolt Rivers are used to analyze changes in water supply. The mean streamflow for each month is compared between a 30-year control

period (water years 1971-2000) and a 30-year future period (water years 2031-2060). For each of these periods, I determine "optimistic" and "pessimistic" scenarios for the streamflow. For the "drought" month the highest streamflow value is considered as "optimistic", and the lowest as "pessimistic" since the goal is to assess potential shortages. I use existing monthly demand values provided by Seattle Public Utilities and create different future scenarios, based on the predictions of population and employment growth. Supply and demand values are compared to evaluate (1) the potential for water shortage and (2) water management and conservation methods to satisfy the unmet demand. One potential water management method is the construction of a new reservoir. The results of the research are aimed at helping to inform society and water managers about the potential changes in the water system. Based on this information, they might be able to introduce changes in their future plans to accommodate the predicted needs.

SESSION 1B

FROM RIVERS TO THE SEA

Session Moderator: Virginia Armbrust, Oceanography
MGH 082A
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Utilization of Unmanned Aerial Vehicle (UAV) Imagery to Understand Interactions Between Wave-Driven Mixing and Riverine Discharge at the Quinault River Mouth
Casey Paige Madill, Senior, Environmental Engineering
Mary Gates Scholar
Mentor: Alex Horner-Devine, Civil & Environmental Engineering
Mentor: Jim Thomson, CEE/APL
Mentor: Sam Kastner, CEE

The physics behind wave-driven mixing of river and ocean waters and current-driven wave breaking are not well understood. The current body of work surrounding river-ocean interactions focuses on large rivers. However, small rivers, which are much more strongly influenced by waves, make up the majority of such systems, and contribute significantly to global riverine discharge. Examining the momentum balance of river flow in opposition to wave-driven forcing from the ocean is necessary to understand how waves influence the travel and mixing of river water. One way to measure this interaction is using instrumental drifting buoys that follow the path of the river water and take temporal measurements of water properties. These leave gaps in our knowledge, as such buoys do not provide a description of the entire system, only specific points. To fill in these gaps, Unmanned Aerial Vehicle (UAV) footage was used to understand broader wave-current interactions at the Quinault River mouth, a small river that feeds directly into the Pacific Ocean. The town of Taholah, WA, is on its banks, and faces challenges due to wave-driven flooding. The size of the surf zone, the nearshore region where waves break at high frequency, was mapped with UAV footage, and related back to local environmental conditions, such as tidal phase. At low water, the momentum from the river is maximized, and so is the cross-shore extent of the surf zone. This decreases salinity around the river mouth, as freshwater is trapped by the surf zone. At high tide, these conditions are reversed, and fresh water streams can be detected past the surf zone, suggesting the river water has escaped from this region of high turbulence. The conditions under which these escapes occur are to be understood by combining analyses of UAV footage with drifter and tidal data.

SESSION 1N

MCNAIR SESSION - PROBLEMS OF ACCESS, SUSTAINABILITY, AND HEALTH IN THE SOCIAL AND PHYSICAL ENVIRONMENT

Session Moderator: Clarence Spigner, Health Services
MGH 287
12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Predicting Streamflow, Snowpack, and Stream Temperature Sensitivities to Climate Change in the Pacific Northwest's Green River Basin
Jane Harrell, Senior, Atmospheric Sciences: Climate
McNair Scholar
Mentor: Bart Nijssen, Civil and Environmental Engineering
Mentor: Yifan Chang
Mentor: Andrew Bennett

Climate change will have significant impacts on Pacific Northwest hydrology. Rising temperatures and shifts in precipitation will lead to changes in snowpack, runoff, and streamflow timing, impacts that will have implications for water and environmental resource management. The Pacific Northwest's Green River Basin is a valuable water supply and provides habitat to several cold-water aquatic species including the threatened Puget Sound Chinook salmon, but also has a major flood risk. Streamflow in the basin is seasonally regulated for flood prevention and ecosystem health, and changes in the annual hydrologic cycle will have consequences for flood risk and ecosystem habitat. To investigate the implications of climate change on streamflow, snowpack, and stream temperatures in the Green River Basin, climate

sensitivity analysis and future climate impacts are simulated using two watershed models with varying spatial and process complexity: 1) the conceptual Snow17/Sacramento Soil Moisture Accounting model (Snow17/Sac) implemented with two elevation zones and 2) the process-oriented Structure for Unifying Multiple Modeling Alternatives (SUMMA) model implemented using twelve USGS HUC-12 subareas. Stream temperature climate sensitivities are modeled using the River Basin Model (RBM) Semi-Lagrangian Stream Temperature model. Future climate change impacts on basin hydrology and stream temperatures are assessed using an ensemble of statistically downscaled climate projections from 34 Global Climate Models (GCMs) run as part of the Intergovernmental Program on Climate Change 5th Assessment Report. The future warming scenarios show moderate changes in streamflow volume, shifts in streamflow timing, and reductions in snowpack, which differ depending on the watershed model. The presentation provides key results and findings from the study, and comments on potential impacts on stream temperature and fish.

POSTER SESSION 2

MGH 241, Easel 139

1:00 PM to 2:30 PM

Understanding Methylmercury Accumulation in Rice: Experimental Control of Oxygenation and Root Carbon Levels in the Rhizosphere of *Oryza sativa*

Sarah Katherine Larson, Senior, Biology (Plant)
Mary Gates Scholar, NASA Space Grant Scholar
Mentor: Rachel Strickman, Civil and Environmental Engineering
Mentor: Rebecca Neumann, Civil and Environmental Engineering

Methylmercury (MeHg) is a bioaccumulative neurotoxin, dangerous to human health even at trace levels. In inundated soils, MeHg is formed from inorganic mercury by mercury-methylating microorganisms; a process termed methylation. Demethylation, by contrast, converts MeHg into less-dangerous inorganic mercury, and also occurs via microbial activity throughout the aquatic soil profile. Rice grains can be contaminated with MeHg when grown in soils where methylation rates are high; human exposure to MeHg is thus a serious public health concern in places where rice cultivation, high rates of consumption, and soil mercury (Hg) contamination overlap. Our research aims to better understand the soil conditions that favor demethylation over methylation – this information can then be used to reduce rice grain contamination through agricultural practices or rice breeding programs. Specifically, our research focuses on the role of oxygenation and carbon root exudates on the net MeHg accumulation throughout the soil profile. Rice plants grow in flooded, oxygen-free (anoxic) soils, but their roots can leak oxygen (making the rice rhizosphere oxygenated in varying degrees), as well as carbon root exudates. Our project simulated both fully oxic and transiently-oxic (transition) zones, with two different levels of root exudates; we use isotopic tracers to assess respective methylation and demethylation rates in all four treatments in both the vegetated (rhizosphere) and non-vegetated (bulk) soil. Carbon root exudates have been collected from hydroponically-grown rice variety *M-206,* and can be applied to different soil zones via tubules. Oxygenation of the soil can be measured with mm-scale optode imagery, which allows delicate testing of various oxygen-introduction designs. My role in this interdisciplinary project has been to develop, scale-up, automate, and verify the accuracy and dependability of root-oxygenation and root-exudate introduction systems to be used in upcoming experiments.

POSTER SESSION 3

MGH 241, Easel 128

2:30 PM to 4:00 PM

Assessing a Method of Quantifying Foam-Causing Filamentous Bacteria in Anaerobic Digesters

Aden Yohannes Afework, Sophomore, Pre Public Health
Mentor: Kota Nishiguchi, Civil and Environmental Engineering
Mentor: Kota Nishiguchi, Civil and Environmental Engineering

In this research project, a method was developed to quantify Gordonia and Microthrix parvicella filamentous bacteria in primary, secondary and digester sludge from three different wastewater treatment facilities in King County. The goal of developing this method was to determine the concentrations of filamentous bacteria for the purpose of relating those values to the foaming process in anaerobic digesters. The method utilized gram staining to identify Gordonia and M. parvicella by microscopy. After visual identification, the method required counting of the filamentous bacteria. These counts were then related to the measurements of biomass to calculate the overall concentrations of Gordonia and Microthrix parvicella in sludge samples. The method was validated by quantitative polymerase chain reaction (qPCR), which used DNA to quantify the filamentous bacteria. This method was successful in determining the concentration of these filamentous bacteria in sludge samples manipulated in the lab. However, it did not succeed with sludge samples directly from wastewater treatment plants. To ensure this method determines the concentration of Gordonia and Microthrix parvicella in samples directly from treatment plants, suggestions for future improvement of the method was made. Suggested improvements include different drying methods, different dilutions or additional preparation to homogenize sludge samples.

POSTER SESSION 3

MGH 241, Easel 137

2:30 PM to 4:00 PM

Ammonium By-Product Remediation during a Meter-Scale Microbial Induced Calcite Precipitation Experiment

Colin Michael Kolbus, Senior, Environmental Engineering
Mary Gates Scholar
Mentor: Michael Gomez, Civil and Env. Engineering

Traditional geotechnical ground improvement processes oftentimes rely on hazardous chemicals and high energy. Microbially Induced Calcite Precipitation (MICP) offers an eco-friendly alternative and is a bio-mediated cementation method that can improve the shear stiffness and strength of soils by cementing particle contacts. In this process, calcite precipitation is initiated by indigenous bacteria through the hydrolysis of urea, which produces solution alkalinity and ammonium. Following treatment, bio-cemented soils contain high concentrations of ammonium by-products that have the potential to harm environmental and human health. Previous research work has been performed to evaluate the ability of rinse injections to remove nitrogen by-products. In this study a meter-scale bio-cementation experiment was performed and developed rinse techniques were examined. Five 3.7-meter, horizontally oriented, rectangular soil columns were cemented and subsequently rinsed with 13 pore volumes of a high pH, calcium chloride solution. Columns varied in applied treatment techniques and soil types. The first received a standard enrichment stimulation solution to achieve a higher bulk ureolytic activity. The second was treated with a reduced enrichment stimulation solution to reduce ureolytic activity and aim for improved uniformity of cementation over the column length. The third column was augmented with Sporosarcina pasteurii to match the ureolytic rate in the standard enrichment column. Fourth and fifth columns both received the reduced enrichment treatment on different soil types, a marine fine sand and a different alluvial sand, respectively. Shear wave velocities, aqueous samples, pore pressure measurements, and soil samples were collected over the course of the experiment. After injecting 13 pore volumes of rinse solution, aqueous samples suggest that ammonium concentrations were reduced from ˜500 mM to less than 2 mM in all columns. After a 24 hour retention period, however, increases in concentrations were observed suggesting the potential for ammonium by-product leaching in time. This work moves MICP closer to field implimentation and wider-use.

POSTER SESSION 4

MGH 241, Easel 150

4:00 PM to 6:00 PM

Structural Analysis Research and Education Through K'Nex

Tatsu Sweet, Fifth Year, Civil Engineering
Mary Gates Scholar
Mentor: Richard Wiebe, Civil and Environmental Engineering

With an increasing demand for more complex and efficient structures, the world is in need of more structural engineers. I have been developing educational tools to make structural engineering more intuitive, tactile, and approachable. Using K'Nex, a readily available construction toy system, I build structures accompanied by computer models to illustrate key structural engineering principles. These products will aid in the education and promotion of structural engineering and are targeted towards children and undergraduates students. This research involves the investigating of physical properties of K'Nex members in order to create accurate numerical (computer) models. Experiments include load tests to determine material properties, buckling stresses, and failure modes. Many of these tests are designed to be approachable and can be performed using everyday household objects. Numerical models are created in MATLAB and are used to predict behaviors under certain load combinations, as well as highlight shortcomings of simplified elastic theory. The results and methodology of this research are designed to focus on building an intuition and interest for structural engineering.