Online Proceedings

Poster Session 1

Commons East, Easel 61

11:00 AM to 1:00 PM

Investigation of Indoor Environment Quality (IEQ) during Construction and Renovation

Casiano S. Atienza, Senior, Civil Engineering
Mentor: Amy Kim, Civil and Environmental Engineering

Indoor Environment Quality (IEQ) is a vital topic to address in today's studies as it presents a significant role to the overall well-being of professionals who work indoors. IEQ adheres to overall human reactions to cleanliness/dirtiness, surrounding temperatures, and other irritants that may exist. While studies of IEQ in office environment have been well documented, less is known about IEQ during construction of an interior renovation. There are numerous possibilities of exposure to contaminants and pollutants both during construction and renovation to workers and building occupants, whom become vulnerable to the dusts and odors from construction. Currently there are no enforceable indoor air quality (IAQ) standards targeted specifically for office environment, so it is vital to address these topics and increase awareness, advocate the practice of applying minimal toxic materials, and prevent health concerns. In order to promote productivity and bridge the gaps in awareness concerning IEQ and health in office buildings, this three-phase project at the University of Washington Tower (UW Tower) aimed to addressed and advocated the importance of providing satisfactory IEQ, sustainable renovated workspaces, and shared IAQ strategies that could be implemented during indoor construction and renovation projects. Overall, three phases were implemented in this project. Phase-One took place four weeks before retrofitting. Phase-Two occurred during the construction. Phase-Three occurred after moving to the retrofitted workspace. This project involved collecting and analyzing IEQ data as well as surveying employees at the UW Tower to assess their psychological state, regarding each individuals enjoyment, well-being, at their workspace before and after construction. Future investigations should be directed at understanding what types of construction practices should be used to reduce pollutants, airborne toxins to maintain satisfactory IEQ.

Poster Session 1

Commons East, Easel 64

11:00 AM to 1:00 PM

The Effect of Temperature on Sediment Arsenic Mobility in Urban Lakes

Jonathan H (Jon) Mc Lean, Senior, Aquatic & Fishery Sciences
Mentor: Rebecca Neumann, Civil and Environmental Engineering
Mentor: Pamela Barrett, Civil and Environmental Engineering

The south Puget Sound region has a history of smelting activity, notably the ASARCO smelter that operated in Ruston, WA. Despite the smelter being closed, the consequences of this smelting activity are still felt today. Due to high levels of arsenic contamination in the region's soils, the area was designated a SuperFund site. Preliminary research conducted in 2014 indicated that several urban lakes in the Tacoma/Federal Way area also have high levels of arsenic in their sediments. If the arsenic is mobilized into the water column, where it can be taken up by lake biota and biomagnify up the food chain, it could potentially affect human health and ecosystem health. We examined two lakes, Angle Lake and Lake Killarney, that have the same amount of arsenic in their sediments, but different physical properties likely impact the release of arsenic into the water column. Angle is seasonally stratified, while Killarney remains well-mixed all year. Consequently, the bottom waters of Angle Lake stay at a relatively stable temperature of 4-10C and consistently have arsenic concentrations between 30-100 ppb year-round. In contrast, bottom waters in Lake Killarney warm significantly from 4C in the winter to 21C in the summer and arsenic concentrations increase from 75 ppb to 700-1000 ppb. We hypothesize that temperature is the primary control on the release of arsenic from the sediments. To test this hypothesis, sediment cores were taken from each lake and placed into plastic tubes. To test this hypothesis, sediment cores were collected from each lake in the winter when all lakes have low bottom water temperatures. The cores were placed into two different temperature treatments, 10C and 20C. Samples of the water overlying the cores will be taken every week and measured using ICP-MS to determine the flux of arsenic out of the sediments.

POSTER SESSION 1

Commons East, Easel 62

11:00 AM to 1:00 PM

Information Theoretic Analysis of Hydrological Land Surface Models

Tushar Khurana, Sophomore, Civil Engineering
Mentor: Bart Nijssen, Civil and Environmental Engineering
Mentor: Andrew Bennett

Hydrological models make predictions by either simulating physical processes or by using statistical techniques. When we evaluate the accuracy of model outputs and predictions, we often observe that statistical models perform better than physically-based process models. Investigating why this happens can give us insight into how to improve the process-based models. This research evaluates how information given to different statistical and process-based land surface models at 20 sites around the world affect their performance. For this project, we use the Structure for Unifying Multiple Modeling Alternatives (SUMMA) framework, a modeling framework that allows users to decide what representations of various hydrologic processes to use during simulations. Using SUMMA and statistical measures, we estimate the effects of decisions made at each modeling step. We can also determine which model processes have the greatest effect on the results. We will compare the results from our SUMMA implementations with results from statistical models that were developed and published as part of a previous experiment. The results of this analysis will provide insight into which model components best represent observed hydrological processes and how model components can be improved and refined. Our goal is that we can produce process-based model simulations that perform better than the statistical models we previously compared them to.

POSTER SESSION 1

Commons East, Easel 65

11:00 AM to 1:00 PM

The Impact of Elevated Temperature on Rice Biomass Allocation

Alexander Michael (Alex) Ratcliff, Senior, Environmental Engineering
UW Honors Program
Mentor: Rebecca Neumann, Civil and Environmental Engineering
Mentor: Yasmine Farhat, Civil and Environmental Engineering

This research looks at the impact of elevated temperatures on rice biomass allocation, in the context of rice nutrient and contaminant uptake. Below-ground biomass allocation can influence the rate of mineral uptake, and above-ground biomass can influence how those nutrients are distributed. Rice was grown in four growth chambers set to different temperatures ranging from low (25.4C) to high (33.0C). Rice plants were harvested during two developmental stages, flowering and grain filling. The plants were sectioned into four components before storage and desiccation: roots, leaves, stems, and grain. A total of 256 rice plants were grown over two harvesting periods, thus each treatment has a sample size of 64 plants. To examine biomass allocation, each component is being measured on a high-precision scale accurate to the nearest 10ˆ-5 gram. The impact of temperature will be quantified for the following groups: temperature treatment vs. component biomass, treatment vs. above- and below-ground biomass ratio, and treatment vs. total biomass. Rice is the primary staple food of over half of the world's population and is the main caloric and nutritional source in many developing countries. Increased global temperatures due to climate change may have significant impacts on rice growth, yield, and nutritional quality.

POSTER SESSION 2

Balcony, Easel 106

1:00 PM to 2:30 PM

Changes in Macroscopic Stratigraphy of Snowpack between a Forested and an Open Site

Dylan S. Reynolds, Senior, Civil Engineering
Mary Gates Scholar, NASA Space Grant Scholar
Mentor: Jessica Lundquist, Civil And Environmental Engineering

Advances in remote sensing of snowpack in complex terrain have made it possible to accurately determine snow depth at a high spatial resolution. In order to utilize these measurements for water resource management, snow density is needed at a comparable accuracy and spatial resolution. Current efforts to obtain accurate, fine scale maps of snow density focus on modeling it over broad areas that vary in land surface type. In order to validate these snow density models, measurements of mountain snowpack are needed. Snow density varies significantly depending on the local environment of the snowpack, so measurements are needed at a variety of sites. However, many prior field campaigns to measure snow density have a bias towards open sites since they offer many practical advantages to the surveyor. This results in uncertainty in snow density models in forested areas due to a lack of quality measurements for validation. This project improves our knowledge of differences in snow density between forested and open sites through a field campaign at Snoqualmie Pass. Each week throughout the winter, snow density and changes in snowpack depth were recorded. These measurements are then analyzed over the course of the season to look for significant differences between the two sites. Observations of settlement and densification rates are used to inform an empirical model of snowpack density as well. Detailed notes of the field campaign are also taken to document the practices of the study and suggest improvements in methodology related to snowpack measurements at forested sites.

POSTER SESSION 2

Balcony, Easel 107

1:00 PM to 2:30 PM

Melting Layer Variability on the Windward versus Leeward Side of the Olympic Mountains

Hannah M. Hampson, Senior, Civil Engineering
Mary Gates Scholar
Mentor: Jessica Lundquist, Civil And Environmental Engineering
Mentor: Lynn McMurdie, Atmospheric sciences

A greater understanding of snow accumulation patterns in our mountains has proven critical in predicting water supply, preventing floods, forecasting avalanches, and generating hydropower. One way to improve this understanding is through study of the melting layer, or the layer within a cloud where falling snow and ice begin to melt into liquid during a precipitation event. The upper bound of the melting layer is the 0C temperature level, and the lower bound the altitude at which snow has fully melted into rain. This project aims to improve understanding of the melting layer and its variation in thickness and elevation on the windward (southwest) versus leeward (northeast) side of the Olympic Mountain Range. Hypotheses are explored through the analysis of radar imagery on opposing sides of the mountain range, weather balloon profiles of temperature, wind and humidity, and ground observation data - including hourly temperature values from sites throughout the mountains. Results of these data are compared to snow and weather models and reanalysis products such as WRF (Weather Research and Forecasting Model), NARR (North American Regional Reanalysis) and ERA-Interim, to explore the predictability of melting layer behavior for use in hydrologic forecasting. Through analysis of preliminary results, the occurrence of a lower leeward melting level has been captured through vertical temperature profiles that reanalysis products failed to account for. One hypothesized process contributing to this melting layer variability could include the trapping of cold air at lower elevations from continental sources on the lee-side thus lowering the melting layer, and further altering the thickness of the melting layer as this trapped air mixes with the air modified over the windward slopes originating from the Pacific Ocean.

POSTER SESSION 3

MGH 258, Easel 190

2:30 PM to 4:00 PM

Inner Shelf Wind and Wave-Driven Circulation Dynamics Off the Coast of South Carolina

Kexin Chen, Senior, Civil Engineering
Undergraduate Research Conference Travel Awardee
Yuzhu Huang, Senior, Civil Engineering
Undergraduate Research Conference Travel Awardee
Mentor: Nirnimesh Kumar, Civil and Environmental Engineering

Inner-shelf (5-30 m water depth) circulation is driven by a combination of cross- and alongshore winds, and anti Stokes drift as a response to onshore directed surface gravity waves. These physical processes control cross-shore exchange of tracers (pollutants/biota/contaminants) from the surf zone to deeper waters, and also movement along the coastline. Their relative role in material movement, along with seasonal variability in local circulation is not yet understood, and investigated here using a long-term (2005-2009) continuous record of inner-shelf (5m water depth) velocity and surface waves off the coast of South Carolina, USA. Alongshore flows are primarily driven by alongshore winds, as indicated by strong correlation between depth-averaged alongshore velocity and alongshore wind variability (r2=0.72). This correlation decreases in winter due to the shelf response to rapid synoptic meteorological frontal passages along the South Carolina coast. Further, the correlation is strongest near-surface, weakening close to the sea-bed, possibly due to near-bed flow reversals. Cross-shore dynamics is not completely explained by wind-forcing, as depth-averaged cross-shore velocity is poorly correlated to cross- and alongshore winds (r2<0.01). However, some variability in depth-averaged cross-shore velocity is explained by the cross-shore depth-averaged Stokes drift (r2˜0.11). This correlation is strongest in mid-water column, decreasing near-surface and near-bed. These local flow dynamics will be further explored to determine mechanisms for, and seasonal variability in cross-shore exchange.

POSTER SESSION 3

MGH 258, Easel 187

2:30 PM to 4:00 PM

Examining Nitrogen By-Product Management for Microbially Induced Calcite Precipitation

Colin Michael Kolbus, Junior, Civil Engineering
Mentor: Michael Gomez, Civil and Env. Engineering

Microbially Induced Calcite Precipitation (MICP), or biocementation, is a bio-mediated soil improvement process that can improve the engineering properties of granular soils through the precipitation of calcite on soil particle surfaces and contacts. In the urea hydrolysis driven process, soil microorganisms containing urease enzymes can catalyze a hydrolysis reaction that degrades urea, producing total ammonium, dissolved inorganic carbon, and hydroxide ions. In the presence of sufficient soluble calcium, the resulting carbonate production can supersaturate solutions with respect to calcite and initiate precipitation. The process has shown significant promise as an environmentally-conscious alternative to traditional ground improvement methods, which oftentimes rely on high mechanical energy and energy-intensive materials to improve soils. Despite many recent advances in MICP, environmental concerns regarding the fate of nitrogen by-products have remained largely unaddressed. In this study, soil column experiments were performed to examine the transport, removal, and transformation of nitrogen by-products following MICP. Columns were 7.6-cm in diameter, 17.8-cm long, and contained a poorly-graded sand material. Soil columns received identical treatment solution injections over 14 days targeting a post-treatment calcite content of 4% to 5% by mass. During treatments, non-destructive geophysical measurements were completed to monitor changes in soil stiffness and pore fluid compressibility resulting from carbonate degradation. Aqueous samples were obtained from all columns in time to examine changes in solution chemistry related to microbial urea hydrolysis, calcite precipitation, and ammonium sorption and transport. Following cementation treatments, columns received rinse injections of differing ionic strengths and pH values to investigate the effect of rinse solution chemistry on by-product removal. The results of this study will address critical knowledge gaps currently limiting practical application of MICP technology and will guide future efforts to model the transport and removal of ammonium by-products following bio-cementation.

POSTER SESSION 3

MGH 258, Easel 191

2:30 PM to 4:00 PM

How Much is the Columbia River's Snow Reservoir Shrinking?

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

Anthropogenic climate change is gradually reducing snowpack and shifting the timing and volume of streamflow in the Columbia River Basin. Mountain snowpack plays a key role in the water cycle by storing water in the winter and releasing it as snowmelt runoff in spring and summer. Snowmelt and the resulting streamflow are critical for a variety of sectors: irrigation, hydropower, flood risk management, and ecosystem services, particularly regarding salmon. There is a large network of reservoirs along the Columbia River and its tributaries that water managers use to store water from snowmelt to satisfy the needs of industries and communities. Snow can also be thought of as a reservoir, as it delays the streamflow response to a precipitation event. With anticipated increases in temperature due to a changing climate, the size of that snowpack reservoir is expected to decrease. We will analyze projections of changes in the amount of water contained within the snowpack and determine the volumetric size of the snow reservoir that will be "lost" due to a warming climate. We will compare it to existing reservoirs in the western United States. As the basis for these analyses we will use an ensemble of 160 different hydrologic projections included in the Columbia River Climate Change dataset. We will relate these changes in snowpack to changes in streamflow timing. The results of this study may help inform discussions about the need for changes to reservoir operations on the Columbia River.

POSTER SESSION 3

Commons East, Easel 76

2:30 PM to 4:00 PM

Ferries for Science: Using Ferry-Based Velocity Measurements to Understand Tidal Circulation and Energy Dissipation Across Admiralty Inlet in Puget Sound

Timothy Joseph (Tim) Prusa, Senior, Civil Engineering
Mentor: Jim Thomson, CEE/APL
Mentor: Maricarmen Guerra, Civil and Environmental Engineering

This project seeks to understand tidal circulation between Puget Sound and the Pacific Ocean using data captured by sensors on board Washington State Ferries traveling across Admiralty Inlet. As the most important passage between Puget Sound and the Pacific Ocean, understanding circulation across Admiralty Inlet is critical to monitoring water quality in Puget Sound. Data from this research is being used by the Washington State Department of Ecology to manage water quality issues such as nutrient enrichment, algal blooms, dissolved oxygen concentrations, and transport of toxic chemicals across the region. In addition to managing existing data, my role has been to develop a tidal-energy dissipation map of Admiralty Inlet. While site specific energy dissipation has been calculated in areas of Admiralty Inlet, a cross-channel model has never been developed. Understanding tidal-energy dissipation at the mouth of Puget Sound will benefit future large-scale tidal-energy research by assisting tidal-energy forecasting, characterization, and assessment.

POSTER SESSION 3

MGH 258, Easel 188

2:30 PM to 4:00 PM

Impact of Interactions with Eelgrass on Native and Aquaculture Oyster Essential Fatty Acid Composition
Kristine Avygail Estrada (Kristine) Leano, Junior, Biochemistry
Mentor: Michael Brett, Civil & Environmental Engineering
Mentor: Alexander Lowe, Biology

Oysters support a multi-million-dollar aquaculture industry in Washington State and provide important ecosystem services in estuarine habitats. Sustaining aquaculture and restoring native oysters depends on oyster health. Food availability is a driver of oyster health that interacts with environmental effects of global climate change. These global changes may be altered by the effects of local species interactions like association with eelgrass. Measuring essential fatty acids, which are necessary for survival and physiological processes of oysters, can show the level of food availability to oysters in environments with and without eelgrass. We tested the hypothesis that eelgrass alters oyster health by growing oysters inside and outside of eelgrass at 5 sites in Washington state. We used fatty acid composition of tissue from Pacific and Olympia oysters to look at changes of assimilated food in relation to habitat and environment. We predict that eelgrass will slow water flow, resulting in a decrease in food availability and thus essential fatty acid concentration in oysters grown in eelgrass. Looking at essential fatty acids of oysters from different environments, specifically with or without eelgrass, provides a better understanding of environmental impacts on oyster health and contributes to a collaborative effort in Washington state focused on sustaining the valuable food production and ecosystem services of oysters in our ever-changing climate.

POSTER SESSION 4

Commons West, Easel 21

4:00 PM to 6:00 PM

Rhizosphere Changes Help Explain the Reduced Nutritional Quality of Rice under Elevated Carbon Dioxide: Evidence from a Controlled Greenhouse Study
Sarah Katherine Larson, Junior, Biology (Plant)
Mentor: Rachel Strickman
Mentor: Rebecca Neumann, Civil and Environmental Engineering

Increased levels of atmospheric carbon dioxide (CO2) reduce the nutritional content of rice grains, particularly iron (Fe) and zinc (Zn). Rice serves as a staple food crop for more than two billion people across the world; substantial portions of these rice-dependent populations also suffer from iron and zinc deficiencies. In rice, the effect of increased CO2 on Fe and Zn differs between cultivars. With better mechanistic understanding as to why, informed plant breeding and cultivar selection is a likely path towards ameliorating this problem. Little is known about the mechanisms behind CO2-induced reduction of grain nutrition. Increased CO2 changes the pH of rice paddy soil, facilitating the release of cations (including Fe and Zn), which leads to increased uptake to above ground plant tissues. However, this does not result in increased concentrations of these compounds in the rice grain. Several explanations have been advanced for this paradox, but most work on the topic has relied on free-air carbon enrichment (FACE) installations, which cannot control many potentially important variables. In particular, reduced transpiration under elevated CO2 may obscure differences between CO2-induced carbohydrates. Additionally, the fine-scale impacts of elevated CO2 on the rice rhizosphere have been poorly studied. Our study is attempting to close these knowledge gaps: we have grown rice plants under elevated and current CO2 conditions, while maintaining even transpiration between treatments via controlled relative humidity. We have paired these experimental manipulations with oxygen optode-based visualizations of the undisturbed rice rhizosphere, which has directed accurate soil sampling of rhizosphere and bulk soil porewater samples for analysis of pH, redox, total organic carbon (TOC), and quantification of Fe, As, Ca, Mg, and Zn. Our study seeks to better understand the mechanistic role of increased CO2 on the rice rhizosphere, and its downstream effect on rice grain nutrient quality.