Undergraduate Research Symposium May 19, 2017 Mary Gates Hall

Online Proceedings

POSTER SESSION 1

Commons East, Easel 72

11:00 AM to 1:00 PM

The Influence of Plant Mediated Carbon Transport on Microbe Populations in Wetlands

Robert James Iii (Bobby) Ardissono, Senior, Civil Engineering
Mary Gates Scholar
Mentor: Rebecca Neumann, Civil and Environmental Engineering
Mentor: Nick Waldo, Civil and Environmental Engineering

Increased atmospheric carbon dioxide (CO_2) concentrations are well documented to contribute to global warming through the greenhouse effect. However, increased CO_2 concentrations can also alter entire ecosystems due to biochemical feedback on a variety of scales. As plants process atmospheric carbon, they exude some of that carbon from their roots into the rhizosphere where it is taken up and metabolized by microbial communities. These populations include methanogens, which produce methane, a much more potent greenhouse gas than CO_2. As atmospheric CO_2 concentrations increase, plants allocate more carbon belowground. In order to investigate the plant mediated interaction between atmospheric CO_2 and rhizosphere microbes, we grew *Carex aquatilis*, a common wetland sedge, in growth chambers and at two points pulse-labeled the plants by exposing them to an atmosphere enriched in $^{1}3CO_2$. We destructively sampled boxes over the course of a week following labeling and extracted microbial DNA from the peat soil. We found that as the week following labeling progressed, more of the labeled carbon was incorporated into soil microbe DNA and emitted from the boxes as methane, demonstrating that carbon exuded from plant roots fuel the microbial populations responsible for methane production. Using the collected DNA we are working to identify microbe species present in our experimental system and to characterize those involved with the transformation of plant carbon exudates into methane. By comparing this initial experiment to a future run with CO_2 concentrations above current ambient concentrations, we can begin to understand how soil microbes may react to projected future CO_2 concentrations and how this may affect greenhouse gas emissions from wetlands.

POSTER SESSION 1

Commons East, Easel 71

11:00 AM to 1:00 PM

Arsenic Mobility in Urban Lake Sediments

Olivia Hargrave, Senior, Civil Engineering
Mary Gates Scholar
Mentor: Rebecca Neumann, Civil and Environmental Engineering
Mentor: Pamela Barrett, Civil and Environmental Engineering

In the Tacoma area, lake sediments contain high levels of arsenic due to past emissions from the now-closed ASARCO smelter. Arsenic is a harmful neurotoxin and carcinogen. When arsenic enters the oxygenated (oxic) water column, it can bioaccumulate in aquatic organisms, potentially causing harmful health effects in people who consume fish from these lakes. Arsenic typically does not remain in the oxic region of the lake, preferring to adsorb onto sediment particles and sink out of the water column. However, elevated arsenic concentrations have been observed in the oxic regions of lakes near Tacoma. This research project investigates the water and sediment characteristics of four fished, urban lakes in the Tacoma area, two of which have elevated levels of arsenic found in the oxic water. The goal of this project is to model the physical and chemical conditions that cause this phenomenon of elevated arsenic in oxic water to better predict unsafe water conditions in other lakes. My research investigates the chemical characteristics of arsenic in the lake sediments, the primary source and sink of the arsenic for the lake water columns, to understand the mobility of arsenic into and out of the water column. The sediment profile is established with a sequential chemical extraction of various species of arsenic measured at various depths in the sediment. The differences in sediment arsenic speciation illuminate its potential mobility. Sediment samples are collected every three months, which allows us to see seasonal effects on solid phase arsenic levels. We also investigated seasonal trends in the concentration of dissolved organic carbon in lake waters, which may increase the lifetime of dissolved arsenic in the water column after it is mobilized from the sediments. Understanding the limnological factors that influence arsenic mobility is the first step toward ensuring public health.

POSTER SESSION 1

Commons East, Easel 68

11:00 AM to 1:00 PM

Pass Subsidies and Employee Transit Utilization: An Analysis of the Impact of Commute Trip Reduction Programs Using ORCA Smartcard Data

Rohan Aras, Senior, Informatics: Data Science, Community, Environment, & Planning, Mathematics
Mentor: Mark Hallenbeck, TRAC - CEE

This research aims to understand how Commute Trip Reduction (CTR) transit subsidy programs, when controlling for various built environment variables and the structure of the transit network, impact employee transit utilization commuting to the worksites of large employers in the Central Puget Sound region. This transit utilization is measured using the ORCA fare card records over two nine week periods in 2015 and 2016 of the major transit agencies in the Central Puget Sound. Manipulating monetary costs is a known method of transportation demand management. Earlier research on preliminary data has suggested that these transit subsidies do have a significant impact on transit utilization. However, results in the wider literature suggest that transit utilization was operationalized in a way—defined on the level of an individual card without accounting for the existence of people who never take transit—that may have altered the significance of the control variables. Indeed, some of the results were counterintuitive. In this research I attempt to avoid this by focusing solely on trips of employees of large employers to and from their worksites. This allows me to incorporate data on how many employees are not utilizing transit. Specifically, I create a regression tree model that predicts the number of trips taken to and from a worksite on an individual card. The features include subsidy values associated with each card, the closeness centrality of the stops around worksites weighted for travel time and headways, and built environment variables measured around each worksite. The built environment variables measured include, among other things, density, free parking price, demographics, and the design of the street network. I expect that higher centrality of worksites and higher pass subsidies will both increase transit utilization.

POSTER SESSION 1

Commons East, Easel 58

11:00 AM to 1:00 PM

UW Solar: Initiators of Solar Energy in UW Community

Yuxuan Chen, Junior, Electrical Engineering
Kenneth W. Wilhelm, Senior, Electrical Engineering
Alexander (Alex) Ratcliff, Senior, Civil Engineering
UW Honors Program
Ishana Sharma, Senior, Electrical Engineering
Christoph Strouse, Sophomore, Urban Planning, Sustainability, North Seattle College
Mentor: Jan Whittington, Urban Design and Planning

UW Solar is an interdisciplinary student-led organization focusing on developing solar energy on the UW campus as well as in the greater Seattle area. Our research concentrates on performing feasibility studies for stakeholders interested in integrating solar energy on their property, both for existing buildings and sites. We are involved in the entire process of the solar project: feasibility studies, initial design, grant applications, construction, and commissioning. Throughout several projects, we have been able to extensively explore different development strategies for solar projects with various sizes and restrictions, the vast environmental benefits of solar energy, and how to financially model a solar array and make it feasible. To date we have completed two solar projects, and we are working on multiple projects right now. We would like to highlight our recently completed project: Clean Energy Institute Testbeds installed on UW Residence Halls. This is a 105 kW system distributed on Alder, Maple, and Elm halls. The project is currently completing the commissioning process and will begin gathering data in April. During the design phase of the project, we researched the suitable components of the solar system, the eligibility of applying funding from various sources and helped to coordinate between the stakeholders (HFS) and the contractor (Artisan Electric). In the near future, this testbed will be used for renewable energy and power electronics research on behalf of the Clean Energy Institute and the Pacific Northwest National Laboratory.

POSTER SESSION 2

Commons East, Easel 60

1:00 PM to 2:30 PM

Detoxification and Treatment of Textile Dye in Wastewater Using a Bacteria-Based Reactor System

Elizabeth (Liz) Guilford, Junior, Civil Engineering
Sterling Thomas (Sterling) Bath, Senior, Civil Engineering
Keenan Joseph Ferar, Fifth Year, Civil Engineering
Mentor: Heidi Gough, Civil And Environmental Engineering

The purpose of this project is to demonstrate using bacterial comunities in a reactor to detoxify and decolor wastewater that is discharged from textile factories. Currently available methods include chemical and physical treatment, which are expensive. Four specific bacteria that have these abilities were previously isolated. These were used in an experimental

design that incorporated three major components: Anaerobic reactors, aerobic reactors, and toxicity tests. The anaerobic reactors were designed to cycle synthetic textile wastewater, decoloring the discharge before flushing and repeating. This was done both with and without biomedia. Data was collected in order to determine the growth kinetics of the different bacteria. Preliminary results suggest that repeated filling and flushing of media with bacteria successfully decolors wastewater and growth kinetics for the bacteria can be modeled. The decolored 'flushed' media was then run through a second aerated reactor for detoxification. In this step, COD (chemical oxygen demand) tests were run in order to determine and model growth and chemical degradation. The third and final component was phytotoxicity tests. These tests were run by sampling media throughout both reactors' cycle. The results of these phytotoxicity tests will determine whether or not detoxification has successfully occurred. In conclusion, this study suggests that these bacteria are promising for both detoxification and decoloration of textile factory wastewater and that, moving forward, a two reactor system should be considered for scaling up.

POSTER SESSION 2

Commons East, Easel 61

1:00 PM to 2:30 PM

Disaster Migration and Civil Infrastructure: Water and Wastewater Utilities' Response to Rapid Population Increase

Katarina Kubiniec, Junior, Civil Engineering
Mary Gates Scholar
Mentor: Jessica Kaminsky, Civil & Environmental Engineering
Mentor: Miriam Hacker, Civil & Environmental Engineering

The recent refugee crisis has shown an unprecedented increase in people seeking asylum in European countries over the last five years. This sudden change in population creates potential challenges for water and wastewater utilities in providing services. These challenges may include interagency coordination and assessing network capacities. As such, it's important to understand how utility employees prioritize their responses to an unexpected population influx. Identifying these patterns in response will be useful for utility providers to accurately predict demand and efficiently plan systems for municipalities. There is a lack of literature regarding utility involvement in urban emergency response, ergo an exploratory analysis was conducted to document water and wastewater utilities' responses to disaster migrations. The project goals are twofold: identify areas of response from German utilities involved with coordinating emergency housing for displaced persons, and compare those results to a hypothetical utility disaster response survey conducted in the United States in 2016. Ten ethnographic interviews with German water and wastewater utility employees were recorded during summer 2016. Four significant areas of response have been identified through qualitative analysis of the interviews: Coordination, New Infrastructure, Technical Capacity, and Financial Capacity. Based on relative frequency, Coordination was predominant in the German interviews while Technical Capacity was prevalent in the US. This suggests the utility employees may have different perspectives and priorities between the two countries. Understanding these patterns provide a clear representation of utility employees' primary priorities and concerns in the event of rapid population increase.

SESSION 2I

MCNAIR SESSION - GOING MOLECULAR

Session Moderator: Ray Malfavon-Borja, OMAD

MGH 254

3:30 PM to 5:15 PM

* Note: Titles in order of presentation.

Applying MP UV Disinfection with Low Wavelength Monitoring to Achieve Sustainable Public Health Protection

Alexandria (Lexy) Hidrovo, Junior, Environmental Engineering, Univ New Hampshire
McNair Scholar
Mentor: James Malley, University of New Hampshire

Drinking water treatment is essential to obtain a healthy regulated source of water that is distributed throughout a community. There are various methods to disinfect water; some have more negative effects toward public health than others. For example, disinfection with chlorine causes disinfection byproducts (DBP) to be produced within treated drinking water. The Environmental Protection Agency (EPA) regulates DBPs because they have the potential to cause cancer and other negative health effects if levels of exposure exceed legal limits. Ultraviolet(UV) light disinfection does not produce these DBPs which is why it is becoming a preferred method for water disinfection. The issue that medium pressure UV disinfection technology faces currently, is the lack of a proven, regulatory accepted method to monitor low wavelengths(LW). These low wavelengths (200-240nm) have been demonstrated in the literature to effectively inactivate regulated viruses, such as adenovirus, that are found in drinking water. The EPA, 2006 Groundwater Rule requires demonstration of 4-log removal/inactivation of human enteric viruses. Being able to take advantage of these LWs could help many communities develop more sustainable performance and compliance. This research is determining if innovative sensors can accurately record LWs that will help prove disinfection. Also, will taking advantage of these LWs

result in energy and cost savings providing a more sustainable UV disinfection systems while improving public health protection. The hypothesis is that there will be savings in energy consumption and cost when the UV system operates taking advantage of the LWs. Data was recorded and analyzed from a drinking water treatment plant to determine the effectiveness and reliability of the sensors while demonstrating the potential energy savings. The preliminary results show that when taking full advantage of the LWs the system operates using about 40% less energy which can be correlated with an overall lower operation and maintenance cost.

POSTER SESSION 3

Commons East, Easel 72

2:30 PM to 4:00 PM

Forest Snow Interception

Max Mozer, Senior, Civil Engineering
Mary Gates Scholar
Mentor: Jessica Lundquist, Civil And Environmental Engineering
Mentor: William Currier, Civil and Environmental Engineering

For efficient water management, quantifying the amount of water stored in mountains through accurate hydrologic modeling is critical. Snow is an essential aspect of water resources because it acts as a natural storage, and melted snow accounts for a large amount of our water supply. Snow forest interception is the process of trees blocking snow from reaching the ground. Forests cover almost 40% of snow covered regions, and trees can intercept up to 60% of the total annual snowfall. Thus, forest interception has a large influence over how much water is stored in surrounding watersheds. Current methods for modeling forest-snow interception are based on parameterizations from few observations in non diverse areas. Evaluation of such methods is necessary and improvements in modeling will lead to improved hydrologic forecasting and planning. To evaluate such forest-snow interception parameterizations, I used time-lapse photography and citizen science through a project called Snow Spotter. Snow Spotter is an online tool where users can answer questions about the presence of snow intercepted by trees, from time-lapse photography throughout the western United States. Based on the classifications of our users, I created a time series of data containing the interception patterns which I used to develop a temporal understanding of forest snow interception which I compared to modeled parameterizations. The differences outlined in my research allows the time-lapse photography to improve these parameterizations. Thus, it improves the modeling process and the quantification of water resources in general, enabling better water resource management in the future.

POSTER SESSION 3

Commons East, Easel 62

2:30 PM to 4:00 PM

Interactive Electric Vehicle Queueing Simulation

Hyun (Haley) Cho, Senior, Physics: Applied Physics
Mentor: Don MacKenzie, Civil & Environmental Engineering

As the usage of electric vehicles (EV) expands around the world, there are numerous challenges to overcome. One of the biggest challenges encountered is the efficiency of EV charging systems. This research explores the trade-offs between maintaining availability of DC fast chargers and other variables including waiting times, station utilization, and cost per vehicle served. To determine the utilization rate of chargers, we created a queueing model by using characteristics of EV models and chargers such as charging rates, battery size, and range. A queueing system is a generic model that is comprised of three elements: a user source, a queue, and a user facility. For this research, the three elements of the queueing model are linked to a cost model to evaluate the attractiveness of private sector investments in charging infrastructure. Since there are many uncertainties and results are sensitive to assumptions, we developed an interactive R Shiny app that allows users to specify assumptions and visualize the relation between the number of vehicles served and key performance metrics. This visualization can help decision makers determine the optimal number of chargers required to balance the tradeoffs between availability of chargers and utilization rate in order to provide satisfying services for users and beneficial business for operators. Ultimately, our model shows that it is difficult to maintain high reliability of utilization and low cost per vehicle served, and that improving this trade-off demands significant growth in the total number of EVs on the road.

POSTER SESSION 4

Commons East, Easel 64

4:00 PM to 6:00 PM

Developing Filtering Algorithms that Improve Mobile Navigation Applications

Timothy (Tim) Adamson, Senior, Civil Engineering
Mentor: Xuegang Ban, Civil and Environmental Engineering
Mentor: Choudhury Siddique, Civil & Environmental Engineering

Current mobile navigation applications use large amounts of computing power and battery to frequently update the server on the user's location. This makes sense, considering that the end user is expected to be moving. When the user is not moving however, possibly while sitting at a stop light, or waiting for the bus to arrive, the app continues to send

the user's location to the server, expending energy, and computational power for absolutely no gain. To address this issue, our research team decided to develop a smarter way of sending data to the navigation servers. The algorithm developed quickly analyzes the location data before sending it to the app's server. The algorithm considers whether the user is stationary, moving with a constant velocity, or changing velocity, and uses this information to determine when to send location data to the server. If the user is stationary, then sending the same coordinates to the server is redundant and can be simplified by only sending the coordinates of the user once the user's position changes. When the user is moving with a constant velocity, the sampling frequency can be lowered to further reduce data size. To develop and test this algorithm, our research team made an app that tracks the user's coordinates, and sends them to the server when the algorithm approves. This allows our team to test the algorithm's filtering, and make sure that the server still knows where the user is always. Upon large scale testing of the application, we expect it to greatly reduce the amount of data sent to navigation servers when tested for a common use case.