Department of Geography and the Environment

Senior Projects Day

Tuesday, 11 December 2012
2:30 – 5:00 p.m.

Mendel Science Center
Villanova University
Projects Day Program: Winter 2012

• Department Faculty

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Adjunct Faculty, Environmental and Green Science

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Program Schedule

Thesis Presentations 2:30 – 3:30 p.m.
Mendel G58

2:30 – 3:00  Cynthia Troy (advisor, Dr. Nathaniel Weston): Infaunal Communities Along the New Jersey Coastline as Indicators of Ecosystem Health

3:00 – 3:30  Margaret Garcia (advisor, Dr. Nathaniel Weston): An Assessment of Heavy Metal Accumulation History in the Delaware River Estuary

Thesis Abstracts

- Margaret Garcia

A Path to Remediation: The Effects of Crude Oil on Salt and Freshwater Marsh Sediment

An experiment was performed to examine oil degradation in salt marsh and tidal freshwater marsh (TFM) soils in the Delaware River Estuary. In view of recent occurrences such as the Gulf of Mexico oil spill, it is imperative that a better understanding of the effects of crude oil on microbial processes and the degradation of oil by the microbial community in marsh environments is attained. Varying oil concentrations were added to incubation jars with salt-marsh or TFM soil under aerobic or anaerobic conditions. The jars were incubated for 243 days and concentrations of carbon dioxide (CO₂) and methane (CH₄) were measured weekly and then biweekly to determine rates of natural soil organic matter and petroleum hydrocarbon degradation. CO₂ production increased with increasing oil concentrations in both soils under aerobic and anaerobic conditions, suggesting that the microbial community actively utilized the petroleum hydrocarbons as an organic matter source and were not inhibited by the oil even at relatively high concentrations. CH₄ was a minor product in all incubations. Rates of oil degradation were higher in salt-marsh soils than TFM soils. A second experiment was executed using six known types of oil under freshwater aerobic conditions. After the jars were incubated and measured, similar trends as the first experiment were discovered. A rapid stimulation of CO₂ production, then a slow inhibition occurred in each oil type. Overall, these data indicate that microbial degradation of oil in tidal marsh environments is an important remediation process following oil spills. Despite the most recent crude oil spill in the Gulf of Mexico, there is little known about the lasting impacts these spills have on coastal environments. Studying the effects is necessary in order to discover more efficient recovery processes. The repercussions are
important to understand so that better precautions could be taken in the future. Scientists also need to investigate this subject to determine how we will be affected in the long-term. Microbes within marsh soils use crude oil as a source of organic matter for respiration. Using the oil in this manner, therefore, partially mitigates the effects of oil spills by breaking through the process of degradation. I studied how the decomposition of crude oil affected microbes in marsh sediment by collecting samples of the sediment from both freshwater and saltwater sites along the Delaware River Estuary and adding various concentrations and types of oil. Within each treatment, there was a control sample to compare the results to. By incubating and measuring these samples over time, I saw the differences in the concentrations of methane and carbon dioxide. I found that both the freshwater and saltwater sites were sensitive to the addition of crude oil. The freshwater aerobic samples produced the most carbon dioxide; however, the saltwater samples in general metabolized the oil more quickly. The results for both experiments showed that little methane was produced with the alteration of the sediment. The freshwater samples in the second experiment responded in a similar fashion, despite the use of various oil samples. Oil degradation is a very slow process. In order to better understand the relationship between marshes and crude oil, further long-term studies need to be done. With more time and more realistic conditions, better accuracy can be achieved. Consequently, better data could be given to scientists to discover improved bioremediation mechanisms.

- Cindy Troy

**Effects of Salinity, Toxicity, Temperature and Moisture Stress on Nitrous Oxide Production in Agricultural Soil**

As current climate models project continuous variances in temperature and precipitation regimes, it is important to know how nitrous oxide production – a highly effective greenhouse gas – and further, the nitrous oxide to nitrogen gas ratio, will be affected by different stress factors. Looking at samples from conventional and organic soils in Lancaster, PA, this study observes the changes in nitrous oxide production fluxes as samples are subjected to varying salinity, toxicity, temperature, and moisture treatments. Increased production of nitrous oxide, as well as higher nitrous oxide to nitrogen gas ratios, were generally found in response to increased stress from these variances. Denitrification rates were highest at the ideal conditions for these communities. In general, there was found to be a higher nitrous oxide to nitrogen gas ratio in the communities that were undergoing higher levels of stress.
• Julia Chase

**Food for Thought: Societal Impacts & Growth of Community Support Agriculture in the Greater Philadelphia Area**

Growing concern about climate change and health among American consumers has promoted a growing interest in sustainability and food production. Over the past two decades, Community Supported Agriculture has responded to this concern by providing healthy, sustainably grown produce. Its growth has been rapid and extensive. The effects of this growth are critical to analyze due to their reflection of American consumer values, shift in agricultural practices and environmental impact. This study analyzes the potential economic, societal, and environmental effects of Community Supported Agriculture through Local Harvest, farm websites, and ArcGIS. Farm websites gave insight to the goals or values of the farms; organic practices, sustainability, fresh and healthy food, diversity of products, fair wages, and connecting members to the farm were common themes. Through ArcGIS, it was determined that most farms provide between 100 and 400 shares at an average cost of $705.68 for a season that runs from May to November. 71% of the farms were USDA organic certified or utilized organic, sustainable farming methods. CSAs raise environmental awareness, support sustainable farming methods, foster communities, and provide healthy, organic produce to their local area. They are economically beneficial to their community and provide a financially feasible option for consumers to obtain organic produce. Based off current spatial distribution, the societal benefits of and demand for CSAs, their continued growth is likely. ★

Advisor: Dr. Francis A. Galgano

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• Lindsey Hagens

**Triclosan in the Presence of Chlorine and Sunlight**

Antimicrobial ingredients are commonly found in everyday consumer products. Many wastewater treatment facilities are unable to completely remove these ingredients from wastewater and therefore, a growing concern regarding the emergence of these compounds in the environment has been discussed. One such antimicrobial agent, triclosan (2-(2,4-dichlorophenoxy)-5-chlorophenol), can be found in a wide variety of personal care products, such as soaps, deodorants, toothpastes, mouthwashes, and cosmetics. The presence of triclosan in the environment is of particular concern due to its endocrine disrupting properties, the ability for antimicrobial resistance to develop, and for the potential of triclosan to react with free
chlorine to form toxic derivatives, such as chlorophenols. Initial studies have shown the effective removal of triclosan from municipal effluent along with the subsequent production of toxic derivatives can vary widely depending on treatment plant size and methodologies. Furthermore, these studies have overlooked sampling during storm events where treatment plants can become overwhelmed and residence time of wastewater in the plant itself is diminished. In this study, I sought to determine whether municipal treatment plant utilizing aerobic treatment through activated sludge could effectively remove triclosan from the water. Furthermore, I examined whether triclosan could transform into chlorinated by-products in the presence of sunlight and typical chlorine concentrations used during treatment. Finally, I compared these results with those from a water sample collected downstream of the plant during Hurricane Sandy in order to evaluate the persistence of triclosan and its derivatives during a storm event.

Advisor: Dr. Steven Goldsmith

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- Jade Hamilton

**An Environmental Analysis of Solar Energy Systems**

As the true environmental and societal costs of coal and petroleum become increasingly known, the search for alternative energies becomes more prevalent and essential. Solar power, or photovoltaic (PV), technology, is becoming the obvious choice for many power applications because of PV module’s declining costs, independent operation systems, and ability to simply harness the free, constant energy source that is provided for our planet by the sun. In this study, I compared production between October 1, 2011, and October 1, 2012, of two live solar generation sites located at Smith College in Southampton, MA, and Eastern University in St. Davids, PA; both are pioneered and operated by Community Energy, Inc (CEI). I conducted geographical information systems (GIS) map analysis on these solar sites by looking at digital elevation maps (DEMS) for the two respective quadrants provided by the United States Geological Survey (USGS). The energy generated by both sites over the past twelve months is in line with the predicted yearly production determined by CEI, as well as with the average yearly production to date (calculated from their three-year lifetime data). The sites are productive and efficient, but are quite different. Eastern University’s system is double the size of Smith College, and generates twice as much kW hours per month (for the majority of the year). The overall geography of the quadrant regions of the observed sites differ as well; Eastern (in the Norristown Quadrant) has a much smaller range of solar radiation measurements but overall higher radiation values, and Smith (in the Easthampton Quadrant) has an extremely large range of solar radiation represented in the recorded values. Along with this theme, the Easthampton quad also has a much higher range of altitude, more than double the range of the Norristown quad. The average temperature and precipitation by month for Northampton, MA, and St. Davids, PA, is only
slightly different which accounts for the consistencies of generation within and between the two sites when considering environmental efficiency factors. ★

Advisor: Dr. Lisa J. Rodrigues

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• Michael Cariello Noblit

**Somali Pirates: Maritime Piracy in a Modern World**

Contemporary maritime piracy is a significant threat to global commerce. With approximately 80% of global trade moving through the world’s oceans, it is important to keep the waters safe and navigable without the threat of violent hijacking of peaceful merchant vessels. Piracy is difficult to pinpoint, however, because of the many geographic issues regarding what defines and governs acts of piracy. If trends in how piracy is enabled and committed with regard to lack of governance due to geographic disputes can be located, a more thorough understanding of how to combat contemporary maritime piracy may emerge. Due to geographic issues concerning geographic location, globalization, and boundary disputes, a problem has emerged in defining, resisting, and henceforth mitigating piracy. The problem has emerged largest in the waters around the failed-state of Somalia and its adjacent states and waters. In analyzing this area through geospatial analysis in conjunction with data provided from the International Maritime Bureau, a comprehensive report of the causes and enablers of piracy due to geographic issues can be compiled. Within the project, data was collected and analyzed through Geographic Information Systems, while extensive research was performed on current understanding of the major enablers of contemporary maritime piracy. In analyzing geospatial data, it became apparent that the main factors of piracy are a lack of international law governing the issue and evidence of larger criminal organization. The largest issue revolves around the governance of territorial waters. Changes in policy are necessary to allow for successful combating and mitigation of contemporary maritime piracy. Until this is done, merchant vessels will be at continually high risks, continuing to drive up prices for goods in the market. ★

Advisor: Dr. Francis A. Galgano

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• Christofer Nicoletta

**Impacts of Hydraulic Fracturing in the Susquehanna River Basin**

Hydraulic Fracturing is a rapidly expanding field. With changing technology and limited regulation, the definitive impacts of fracking on earth’s resources is relatively unclear. It is particularly difficult to determine the quantity of water being consumed by fracking activities, and to understand the collective effect of this consumption on a region. This information could be useful in recognizing problems such as public water supply stress, and risk of groundwater,
surface water, or soil pollution. In this study, I collected data from the Susquehanna River Basin Commission to determine how much water on average is being consumed by the fracking industry, in north central Pennsylvania over a two-year period. I also obtained and compiled existing data on exported waste fluid produced by individual wells in Wyoming County and extrapolated to determine the average amount of waste generated per well to be 146,088 gallons. Differences observed when comparing levels of water use with produced wastewater were attributed to evaporation rates and the percent of water that remains trapped underground during hydraulic fracturing operations. Evaporation rates were also used to calculate an average water residence time on-site of 31 to 220 days. Based on an additional summary of existing violation data for these wells, there is a high probability of waste leakage contributing to the difference as well. These findings show that the Susquehanna River Basin likely loses an average of 10 billion gallons of water per year to hydraulic fracturing, and subsequently has a high risk of pollution. ⭐

Advisor: Dr. Steven Goldsmith

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• Lauren Ribant

**Phosphate and nitrate nutrient concentration levels in the San Diego Bay**

Anthropocentric activities overtime have increasingly polluted coastal areas through the excessive addition of nutrients. The amplified populations around coastal environments have created threats to local aquatic ecosystems through the increased urban runoff produced. Phosphate and nitrate inputs from anthropocentric uses have polluted many bodies of water throughout the globe as well as in the United States. The excess nutrients of phosphate \( (\text{PO}_4^{2-}) \) and nitrate \( (\text{NO}_3^-) \) can cause algae growth, which eventually can suffocate the aquatic life living in the polluted area, creating a dead zone. By testing water samples taken from the various bays in San Diego, I sought to test for marine watershed nutrient pollution. Phosphate and nitrate were measured in each sample to analyze the concentrations and the possible effects that these levels could have for the marine ecosystem in the San Diego Bay. By comparing these results with the population density of the watershed, I examined the relationship between population density and \( \text{PO}_4^{2-} \) and \( \text{NO}_3^- \) levels at different locations in the San Diego Bay. These data demonstrated that there was no clear relationship between population density and \( \text{PO}_4^{2-} \) and \( \text{NO}_3^- \) concentrations in seawater, suggesting that water treatment or natural retention mechanisms prevent excessive nutrient loading to the San Diego Bay. ⭐

Advisor: Dr. Farrah Fatemi

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The practice of developing large urban areas on the US Gulf Coast has occurred for the last two centuries, but it disregards the threats posed by tropical cyclones. This area, and all of those who live along it, is vulnerable to potential hurricane strikes. Galveston County, Texas is one such location. Notable storms, such as Hurricane Ike in 2008 or the Galveston Hurricane of 1900, have killed thousands and inflicted millions of dollars in damages, yet the population continues to grow putting more residents in danger’s path. By analyzing United States Census data, I determined which parts of Galveston County are most socially sensitive to hurricanes by generating a “vulnerability index” to determine the overall vulnerability for each tract and to allow for a comparison. Spatially, this is shown by utilizing a Geographic Information System to illustrate which parts of the county are socially sensitive. The results suggest that the highest concentrations of socially vulnerable tracts are on the mainland and the least sensitive places are the mainland coasts and barrier islands. Ultimately, these results give a general sense of parts of the region that are most in danger and would require the most assistance after a major storm event. Additionally, it shows how more money has been used to develop the coast and how this increased growth will amplify the amount of damage caused when hurricanes do strike.

Advisor: Dr. Keith G. Henderson