Department of Geography and the Environment

Senior Projects Day

Tuesday, 10 December 2013
2:30 – 4:00 p.m.

Mendel Science Center
Villanova University
Department of Geography and the Environment
Villanova University

Projects Day Program: Fall 2013

• Department Faculty

Francis A. Galgano, Ph.D.
Associate Professor and Department Chair

J. Harold Leaman, Ph.D.
Associate Professor, Geography

Bangbo Hu, Ph.D.
Associate Professor, Geography

Keith G. Henderson, Ph.D.
Associate Professor, Geography

Lisa J. Rodrigues, Ph.D.
Assistant Professor, Environmental Science

Nathaniel B. Weston, Ph.D.
Assistant Professor, Environmental Science

Bonnie Henderson, Ph.D.
Assistant Professor, Geography

Steven T. Goldsmith, Ph.D.
Assistant Professor, Environmental Science

Lori Sutter, Ph.D.
MSE Post-Doctoral Teaching Fellow

John L. Kelley
Adjunct Faculty, Geography and Remote Sensing

Ross Lee, Ph.D.
Adjunct Faculty, Environmental and Green Science

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Thesis Abstract

Are Wintertime De-icing Salts Harming our Environment?: The Response of Soil, *Quercus rubra*, and *Pinus strobus* to NaCl Rock Salt Treatment

Each year, several thousand tons of rock salt are spread on American highways, roads, sidewalks, and porches following winter precipitation storms. When the salt successfully melts the ice and snow, it enters the natural environment in the form of runoff. This study examined the effects on soil quality and tree health by mimicking rock salt runoff in a controlled experiment. Two tree species, the deciduous northern red oak (*Quercus rubra*) and the coniferous eastern white pine (*Pinus strobus*) were sprayed with a 10% NaCl rock salt solution three times a week over the course of three months. Monthly soil samples were tested for salinity, soil moisture content, and concentrations of NO₃⁻ and phosphorous. Tree height and tree diameter was measured bi-weekly and two collections of leaf samples were analyzed for chlorophyll content to assess overall tree health. Together, these analyses provided a comprehensive assessment of the impacts of de-icing salts. It was hypothesized that rock salt would decrease soil moisture, major soil nutrients, plant growth, and leaf chlorophyll levels; additionally, rock salt would increase soil salinity. During the three months of treatment, plant growth, base diameter, NO₃⁻ concentrations, and soil salinity were negatively impacted. Soil moisture content, phosphate concentrations, and chlorophyll levels were not significantly impacted by NaCl treatment. This experiment has important implications because rock salt is used in large amounts in areas that experience winter precipitation. Although it is effective and inexpensive, its application may lead to unforeseen costs due to losses in ecosystem services.
Amy Begay

The Impact of Beach Restoration on Sea Turtle Populations in Florida

Sea turtle populations are declining in areas that have been exposed to beach restoration projects. Different methods have been used in the past to inject new sand to help reduce beach erosion. These beach restoration projects affect the sand’s grain size, structure, and water retention which affect female turtle’s eggs incubation. Florida companies have different techniques and some techniques have a much lower impact on sea turtle nesting grounds. This research assesses restoration techniques to determine which have less of an impact on sea turtle nests. I have compared various companies in Florida as to their technique and the structure of their sand replenishment plans in order to determine which disrupt the turtles as minimally as possible. The companies that complete the restoration projects during the off season of the turtle nesting period have minimal interference with the sea turtle eggs compared to companies that disregard the nesting period. Companies can take note of what techniques are less harmful to the sea turtle population to minimize impacts and help maintain the natural beach conditions which are suitable for sea turtle nesting.

Advisor: Dr. Keith Henderson

Juan Castillo

Urban Development in the District of Columbia is making the region susceptible to racial tension and stereotypes

During the past few decades, America has seen a wave of immigrants of various backgrounds, making America a multicultural country. Despite having many cultures around, racism is still prevalent today. One cause of this atrocity is the urban landscape of many cities in America. While racial diversity has increased in many cities, the segregation of these races still exist. The focus of this paper will be on the District of Columbia. An analysis of this area shows spatial patterns of socioeconomic problems such as crime, low education attainment, and low property values overlapping patterns of racial segregation. The results show that this overlap re-enforces the idea that certain minority groups face certain socioeconomic problems, thus portraying a negative image which could therefore lead to racial tension and stereotypes. While there has been vast improvements in the acceptance of other races, the road to improvement can continue if men and women of all races are exposed to each other in a more multicultural environment rather than being separated.

Advisor: Dr. Keith Henderson
Hannah Caswell

Examining the Relationship between Storm Intensity and Permitted Outflow Exceedance at the Downingtown Wastewater Treatment Plant

The introduction of point-source pollution into bodies of water from wastewater treatment plants can result in a variety of environmental problems, such as contaminating public drinking water supply, endangering human health for recreational activities and impairing ecosystems. During storm events and peak flow periods, the processing time for sewage treatment is decreased, which ultimately leads to reduced efficiency in the removal of contaminants. As a result, effluent from treatment plants can often exceed set permits, and polluted water is discharged into an adjacent body of water. Although effluent entering rivers during storm events consistently poses a problem to river and stream health, little attention has been given to the study of the characteristics, magnitude, duration and frequency of storm events that trigger sewage overflow and the exceedance of effluent permits. This study examines the link between precipitation and discharge records for the East Branch of the Brandywine Creek and the frequency of exceedance of set permits along with the decrease in efficiency from the Borough of Downingtown Sewage Treatment Plant between January and September 2013. Understanding the magnitude of a storm event that triggers violations and overflow is critical for the maintenance of water health and can assist treatment plant with preparations for predicted storms.

Advisor: Dr. Steven Goldsmith

John Devine

Hydraulic Fracking in the Susquehanna River Basin

Databases show that during hydro-fracking, water used in the processes can mix with brine and obtain a higher conductivity level than normal freshwater. Over the last ten years the United States, and in particular the regions of Pennsylvania that lie over the Marcellus Shale, have become big regions for the building of hydraulic fracturing wells to harvest natural gas. Natural gas is a cheaper and cleaner source of energy today than coal, gas, oil, and most other versions of fossil fuels. The combination of large amounts of natural gas available in shale’s and the increasing interests in natural gas as a source of energy have led to abundant hydro-fracking wells to be built in regions of Pennsylvania. The goal of this project was to evaluate changes in the surface water conductivity over the past decade in watersheds draining into portions of the Susquehanna watershed. This project examined any correlation between an increase or decrease in conductivity levels with the density of hydraulic fracturing well pads per area drilled within the watershed. It is expected that with an increase in well pads along the watershed, there will be a large increase in conductivity levels in the river water. Examination of the major rivers in the Susquehanna watershed over the last 12 years shows that 23 rivers had enough information on them to evaluate. Of the 23 rivers examined, 5 rivers evaluated were deemed statistically significant by data analysis. Four
out of the five rivers were deemed to have enough documented testing to be considered legitimate resources for information. These four streams all showed a clear positive linear correlation increase in conductivity over time with hydro-fracking wells nearby. Next a geographic information system (GIS) was utilized to evaluate the number of natural gas wells drilled in each of the four target watersheds. All four watersheds contained fracking wells within the drainage basin that were possibly draining runoff into streams used for freshwater in the Susquehanna watershed. This water could then run off from well sites to freshwater streams and possibly affect the water supply. From examining all of the data and the resources given it was concluded that hydro-fracking in the region of the Susquehanna watershed is becoming an issue. Streams near well pads have shown higher conductivity each year since the first installation of hydro-fracking wells. The literature and correlation between wells per kilometer and conductivity show that wells are to blame for the higher conductivity levels in freshwater near the sites.

Advisor: Dr. Nathaniel Weston

• Michele Engelbert

A Comparative Analysis of Green Cities

As large cities in the United States continue to grow in population, they face ever increasing environmental pressures, especially in terms of energy usage, waste production, and pollution. By creating greener cities, more inhabitants can experience a higher quality of life and live more sustainably. New York City, Philadelphia, and San Francisco have been confronting environmental issues with proactive programs that seek to implement sustainable practices and create a functioning green city model. The following criteria are used to determine the “greenness” of each city: air quality, management of waste (recycling), land use (green space and LEED buildings), energy sources (renewables), transportation, water quality (stormwater management), contamination of resources, and accessibility of local foods (farmers markets and urban gardens). In this study, the aforementioned criteria is used to independently assess the greenness of the City of San Francisco, which has traditionally ranked the highest in evaluating green cities; New York City, which has undertaken substantial green initiatives in recent years by implementing PlaNYC 2030; and the City of Philadelphia, which has recently embraced the idea of becoming a green city by implementing Greenworks Philadelphia. This multi-faceted approach revealed San Francisco as the most sustainably operating city, due to green infrastructure, well-functioning recycling programs, clean energy sources, and the least contamination of resources. New York is the next greenest city, with high levels of public transportation, increased recycling and energy efficiency. Philadelphia ranks as the most contaminated and least green city, however in evaluating the Greenworks Philadelphia program, it is the most ambitious and has the greatest potential as it seeks to green a city that has had an unsustainable infrastructure for decades.

Advisor: Dr. Steven Goldsmith
Molly Haggerty

Ecosystem Services of a Constructed Wetland: Sediment Retention Dynamics and Denitrification

Wetlands play an essential role in watersheds by fulfilling ecosystem services such as the removal of nitrogen and the retention of sediment. Human activity has led to increased amounts of nitrogen and sediment that enter the watershed, especially after precipitation events. While some studies have been conducted to assess wetland dynamics, little is known about the roles of denitrification and sedimentation. The purpose of this study is to examine the spatial and temporal patterns of sedimentation and denitrification in the constructed wetland on Villanova University’s campus. Soil samples were collected throughout the wetland on several dates during the spring and summer of 2013 to evaluate spatial and temporal patterns of sedimentation using 7Be as a tracer of short-term sediment deposition. In addition, denitrification was measured by incubating intact sediment cores and using an acetylene-block technique to examine rates under oxic and anoxic conditions. The results show that both rates of sedimentation and denitrification are highest in the first receiving pool. Denitrification is found to be higher under anoxic conditions, and removal of nitrogen is relatively high throughout the entire flow path. In addition, sedimentation decreases as the distance from the inlet increases, and rates of sediment retention decrease from spring to summer. Based on these findings, a design and management plan for wetlands can be created based on the existence of a receiving basin at the inlet and maximizing the flow path and residence time of water in the wetland for increased rates of denitrification and sedimentation.

Advisor: Dr. Nathaniel Weston

Toni Iaria

Effects of Hydraulic Fracturing Activity on Sedimentation in Northern Pennsylvania Streams

Due to the rapid increase of hydraulic fracturing activity in the area underlain by the Marcellus Shale in northeastern Pennsylvania, water quality issues within regional streams has come under greater scrutiny. While much of the previous environmentally related research has focused on chemical contamination of ground water due to hydraulic fracturing, there is significant lapse in research regarding the effects of hydraulic fracturing activity and infrastructure implementation on surface water quality. This study was based on the hypothesis that impacts to surface water would be a direct function of hydraulic fracturing related well-pad density within a watershed or the distance or the distance of the closest well-pad to the stream itself. During May to August 2013, approximately 35 streams (well pad density = 0-65) in northeastern Pennsylvania were sampled for total suspended solids. Instantaneous discharge measurements were also collected in in order to calculate particulate loads. Further data
analysis will examine the relationships between water quality and land use practices, as well as total length of pipelines within a given watershed.

Advisor: Dr. Steven Goldsmith

• Katharine O’Hanlon

Taking the Green Initiative: Why a Bike Share Program Works for Villanova

In recent years, Villanova University has made great strides with regard to its Globally we have seen a cultural shift within our various transportation systems, as we continuously seek to minimize our carbon footprint. Bike share programs have become increasingly popular across the country, particularly at colleges and universities. At Villanova University, the implementation of a bike share program would not only benefit the University’s students, but it would impact the local community as well by setting the standard of sustainable progress. In a comprehensive survey taken by 70 Villanova University students, approximately 48 responded that they lived off campus. However, when asked if students thought Villanova provided convenient transportation alternatives, almost 70% of students responded no, alternative transportation options were not made available. With an overwhelmingly positive response from students when asked if they would use a bike share program if it were implemented, 44.29% of students responded that they would, and 31.43% of students responded that they might. Only 25.71% of students responded that they would not use this program. Not only is a bike share program a more eco-conscious means of transportation, it also encourages an active lifestyle for all those who participate. A bike share program on Villanova’s campus would not only be an asset to students, but would also serve as a catalyst to future sustainability initiatives here at Villanova University. Through these efforts we hope to create a generational shift, not only within our own transportation systems, but also in terms of our ecological values--standards that eventually all colleges should emulate.

Advisor: Dr. Lisa Rodrigues

• William Pepe

The Spatial Distribution of Healthcare

There is certainly a discrepancy in the spatial distribution of healthcare between urban areas and rural areas; this then boils down to how many healthcare facilities there are per capita. Two types of analyses of Pennsylvania’s healthcare landscape were conducted for this project: the first was a simple visual analysis of a GIS map which includes specified urban area boundaries created by the Pennsylvania Department of Transportation. The second method was a statistical comparison of each county’s population as of 2010 to its number of eight specific types of providers: hospitals, rural health clinics, intermediate care facilities, ambulatory surgical centers, home health agencies, hospice care facilities, mental health centers, and nursing homes. Each county was classified as being either metropolitan or as micropolitan / non-core based on
information gathered from the United States Department of Agriculture. According to the GIS analysis, healthcare provider availability was far more concentrated in urban areas. Interestingly, though, upon completing the statistical analysis, I discovered that the actual ratio of the providers to the populations in the micropolitan and non-core counties was higher than in metropolitan counties.

Advisor: Dr. Francis Galgano

- Danielle Post

**The Future of Sea Level Rise: Projected Saltwater Intrusion and Contaminated Drinking Water in New Jersey**

With a warming planet comes rising sea levels. An increase in sea level can cause beach erosion, flooding, and higher water tables. An effect of particular importance is saltwater intrusion in coastal aquifers. As sea levels continue to rise, incidences of this intrusion are expected to increase as saline waters move into freshwater aquifers. This poses many risks to coastal zone populations that depend on freshwater aquifers for drinking water. Consequently, the purpose of this study is to evaluate the extent of sole source aquifers that will be contaminated with salinity in the next 100 years. According to the median projections, sea levels will rise 4.1mm/yr for a total increase of 0.41m by the year 2113. Using GIS, the extent of the coastal area and aquifers affected were calculated. The calculated rise in sea level will cause at least 3.83% of the sole source aquifers in New Jersey to be intruded upon by saltwater. Understanding the extent of future saltwater intrusion is important for enacting policies and management strategies to combat its further contamination.

Advisor: Dr. Francis Galgano

- Jaclyn Prazenica

**A feasibility study in support of wind and solar power for the newly proposed dormitories at Villanova University**

The world’s energy consumption has become an enormous strain on the health of the environment, as well as our economy. The need for new energy sources with less of a detrimental impact on the environment as well as potential costs is of utmost importance. Wind and solar energy technologies have come a long way in advancements and are making headway into the competitive range with conventional energy sources. The objective of this study is to determine the feasibility of an investment in wind and solar energy for Villanova University’s proposed new dormitories on the south side of Lancaster Avenue. Using the master plan provided by Villanova University, estimated roof dimensions were calculated for each of the proposed dormitory structures. Existing wind data for the Philadelphia area was analyzed to determine the potential for wind energy, looking for average wind speeds above 6.5 mph. Monthly data for a two-year period provided by a local company with a
moderate-scale solar panel installation was used to estimate the potential energy production, potential cost savings, and potential CO2 savings. Average wind speeds showed very little promise for wind energy being technically feasible. The solar energy calculations showed substantial energy and cost savings potential for Villanova University. Therefore, this investment in solar panels for the new dormitories would not only benefit Villanova’s public appearance but also promote the renewable energy movement.

Advisor: Dr. Steven Goldsmith

• Channing Press

Abstract not available for printing

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• Connor Supple

**Concentrations of limiting nutrients in small eastern Pennsylvania creeks and streams**

Nitrogen and phosphorus are limiting nutrients for primary production in most aquatic systems, and excess nutrients can lead to algae and phytoplankton blooms in streams, lakes, and coastal oceans. Introduction of limiting nutrients and excess primary production can lead to eutrophication of aquatic ecosystems, instances of low oxygen availability, and deleterious impacts on aquatic life. In this experiment I tested streams in Eastern Pennsylvania for concentrations of nitrogen and phosphorus. 21 Samples of water were collected from streams at three equidistant points along 7 separate streams. Samples were analyzed to determine the concentration of nitrogen and phosphorus in each sample. A GIS map was created to present the results spatially. These streams were analyzed to see if one or a few streams in particular had abnormally high levels of nitrogen and phosphorus which would then be fed into the Delaware River. The land use around each sample was evaluated, and analysis was undertaken to establish a connection between certain land use types and concentrations of limiting nutrients.

Advisor: Dr. Nathaniel Weston

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Isabella Todero

Sea surface temperature influence on hurricanes in the Atlantic Basin

An increase in global temperature due to climate change will alter ocean and weather patterns increasing the risk of extreme events. As more people are moving to low-lying, coastal areas of the eastern seaboard, social and economic vulnerability to hard-hitting hurricanes will also increase. The ocean absorbs enormous amounts of heat thereby increasing sea surface temperature (SST) with the potential to affect associate weather systems. This study investigates the maximum sustained wind speed of tropical storms, hurricanes and major hurricanes from 1960 to 2012 in the Atlantic Basin to see if there is a correlation between wind speed and patterns of SST. The study tracks whether SSTs influence the storm tracks up the Atlantic or into the Gulf and in which country they make landfall. Using data from NOAA, storm paths and corresponding data were tracked and recorded, then created graphs to show the average wind speed and the storm frequency per year. Results show that although there was no apparent correlation between wind speed and hurricane intensity there was an increase in storm frequency associated with SSTs. As sea surface temperatures are expected to rise due to anthropogenic induced climate change, an increase in the number of strong storms will impact coastal erosion and cause long lasting social and economic effects such as that of Hurricane Katrina and Hurricane Sandy.

Advisor: Dr. Keith Henderson