Lafayette College
Environmental Poster Presentation
Fall 2013

“Think Globally, Act Locally” or
“Think Locally, Act Globally”
Which is it?”
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The 2013 Environmental Poster Presentation was the culmination of a semester long assignment in which students researched environmental topics of their choice. Student teams of one, two, or three students from Professor Waters’s Environmental Biology course (BIOL 234), Professor Kney’s Environmental Engineering and Science course (CE 321), Professor Tavakoli’s Alternative Energy Sources course, and Professor Brummel’s Introduction to the Environment course (EVST 100) came together to collaborate on numerous environmental topics.

Students had the opportunity to gain valuable knowledge through their research as well as through hands on experimentation. Each group had the opportunity to present their findings at the Environmental Poster Presentation held on Thursday, December 5, 2013 in the Marlo Room and the atrium of the Farinon Student Center from 7:00 to 9:00 pm. This year the poster session showcased thirty-five posters.

Throughout the semester, the student teams gathered data and organized their research and other background information to create posters representing their topics. Over the course of this project, various drafts were submitted for critique to enable the groups to revise their work and produce their final poster. The judges selected for this event were a collection of professionals from the Lehigh Valley along with students who previously took one of the courses. Judges were placed in groups of two or three and evaluated six or seven posters each, based on specific criteria including presentation, professionalism, and aesthetics of the poster as well as the grammar and organization. Each category is judged on a scale of one to ten with one being poor and ten being excellent. Each, year prizes are awarded to the five posters with the highest scores.

If you would like more information about the Environmental Poster Presentation or these specific courses, please feel free to contact Dr. Arthur Kney at kneya@lafayette.edu.
The Top Posters

~1st Place~
The Effects of Phosphorus Deposition in the Bushkill Creek
Emily McGonigle and Andrea Jacobs

~2nd Place~
Composting: Application Beyond The Backyard
Monica Wentz, Alexa Gatti, and Carolyn Messer

~3rd Place~
Stream Bank Restoration Along the Bushkill Creek in Easton, PA
Carly Hatch, Allison Zeoli, and Karolina Vera

Where Does Your Old IPhone Go?
Sidney Palmer, Brianna Braswell, and Xiomara Rojas-Asqui

~4th Place~
Can the Quad be a Learning Environment?
Bonnie Malhotra, Nicolas Alarcon, and Andrew Hoff

Pesticide Use: How Does Lafayette Compare?
Stephen Berkin, Victoria Luongo, and Erin Wetzelberger

~5th Place~
Lafayette College Student Awareness of E-Waste
Liana Argios, Anthony Vecchio, and Clyde Gross
Poster Summaries
and
Photographs

Research Topics

1. The Heat Beneath Our Feet
2. Wind Power at Metzgar Fields
3. Learning From Spain’s Mistakes; A Local Approach to Solar Energy
4. Composting: Application Beyond The Backyard
5. Marcellus Shale
6. Best Homeowner Practices: Preventing Water Pollution
7. Could the Deepwater Horizon Oil Spill Lead to a New Era of Environmentalism?
8. Benefits of the Green Roof Initiative
9. Green Building: LEED
10. The Effects of Phosphorus Deposition in the Bushkill Creek
11. Solar Thermal Energy
13. The Ecological Consequences of the American Lawn
14. Can the Quad be a Learning Environment?
15. Recycling Promotion
16. Stream Bank Restoration Along the Bushkill Creek in Easton, PA
17. Flooding in the Lehigh Valley
18. Lafayette College Student Awareness of E-Waste
19. What makes an Invasive Species Invasive?
20. The Cost and Benefits of Reducing Waste in Food Production/Distribution
21. The Organic Label
22. Pesticide Use: How Does Lafayette Compare?
23. Solar Water Technology in Developing Countries
24. Engineering Education K-12: Gender Roles
26. Where Does Your Old IPhone Go?
27. Soil Quality of Local Organic vs. Industrial Farms
28. The Effectiveness of Rain Gardens in Pollutant and Runoff Management
29. Alternative Refrigeration
30. Off the Grid: Biogas Use at Easton’s WWTP and Landfill
31. Bushkill Creek Phosphorus Deposition Analysis
32. Is Organic Farming a Worthwhile Alternative?
33. Engineering Education (K-12)
34. Geoengineering and CO₂ Removal
35. Organic Farming Practices
Energy sources are becoming increasingly scarce in the growing and developing world, and alternate sources of energy will be needed in order to sustain the demand for energy. Geothermal energy is becoming increasingly popular as a source of alternative energy because it is relatively easy and inexpensive to use and it is sustainable and environmentally friendly. In our poster, we answer the question, “Can local implementation of geothermal energy have significant global impacts?” To answer this question, we address what geothermal energy is, how it is used and harnessed, and its application and significance across a variety of different disciplines. We use pictures and diagrams as well as two case studies to help explain our information and ideas to our audiences.

Our poster begins with a brief overview, explaining that geothermal energy is heat energy generated by the Earth due to radioactive decay at the Earth’s core. Then we use pictures and diagrams to discuss the ways in which geothermal energy can be harnessed either through ground-source heat pumps or through district heating systems. Our first case study exemplifies Reykjavik, Iceland as a model of the many effective applications of geothermal energy, and our second case study outline the cost-effectiveness of installing geothermal heat pumps in residential houses in Easton, PA. Lastly, we outline the minimal environmental impacts of using geothermal energy, and conclude by answering our initial question. Throughout the paper, we prove that local uses of geothermal energy do have significant global impacts because the scarcity of energy resources is primarily a global issue and small local changes can significantly improve energy management.
The Heat Beneath Our Feet
Can Local Implementation of Geothermal Energy Have Significant Global Impacts?
Matt Jouney, Bridget Reeve, David Woods

What is geothermal energy?
- Heat energy generated by the Earth
- Originates from radioactive decay in the Earth's core
- Produces more energy than all fossil fuels within 10,000 meters of Earth's surface
- Renewable energy source

Harvesting Geothermal Energy
- Geothermal Power Plants
  - Use geothermal heat energy to drive turbines
  - Low efficiency: 10%-23%
  - Require an accessible ground source

- Ground Source Heat Pump
  - Takes advantage of constant ground temperature (~50°C-60°C)
  - Provide heating and cooling for homes
  - Can be used anywhere

- District Heating Systems (DHS)
  - Widespread local distribution from power plants

Case Study: Reykjavik, Iceland
- Up until 1900, fossil fuels were primary source of electricity and heat
- Gradual transition to geothermal energy and hydro power
- Implementation of a district heating system for dense city
- Five geothermal power plants were built within 30 km
- Today, Reykjavik is considered one of the cleanest cities in the world

- Geothermal energy accounts for 20.3% of electricity, over 90% of heating
- Only 0.1% of energy comes from fossil fuels
- Estimated CO₂ reductions of 3.5 million tons annually

Case Study: Geothermal Heat Pump in Easton
- Central Air (3 New 4 rooms/week, 12 hours/day) +
- Heating (5 rooms, 750 sq ft, 12 hours/day) = 15,000 BTU/year
- Capacity of central heating system
- Can reach up to 3000 BTU/ hr (11,200 W)

Greenhouse Gas Emissions:
- 1 CWT = 4.85 kg CO₂
- 1 CWT = 4.20 kg CH₄
- 1 CWT = 13.60 kg N₂O

Therefore, under these conditions, the amount of money the consumer saves in the long run makes the cost worth of purchasing and installing a geothermal heat pump in Easton, PA.

Environmental Impact
- Water Quality
  - Closed-loop water systems could potentially lead to water pollution
- No reported cases of water pollution in the U.S. due to geothermal energy

- Air Emissions
  - Very little air emissions due to closed-loop systems
  - Small amounts of mercury emissions
  - Sulphur dioxide emissions are approximately 10 times lower per MW hour than those of coal burning power plant

Conclusions
Yes, local use of geothermal energy can have significant global impacts:
- Economically
  - Provides a widely affordable source of energy
  - Renewable, no supply is more likely to demand
  - Uncertainty of fossil fuels causes political/social unrest
  - Geothermal heat pumps can be used almost anywhere

- Environmentally
  - Reduces carbon footprint as an fossil fuel alternative
  - Renewable
  - Emissions little environmental pollution
  - Safe to harness and use, no dangers in maintenance

References as Required
For our poster project, we researched the development of wind power at Metzgar fields to supply energy for Lafayette College. The inspiration of our project came from long, arduous practices on the nearby track, because we are all on the track team. We believe all that wind power could be put to use to offset energy costs and provide the school with a sustainable energy source. Using wind power is beneficial to our environment because it is a clean, sustainable energy source. Therefore, we took the approach of thinking globally and acting locally.

Our specific plan of action is to investigate what it would take for successful small-scale wind power development at Metzgar fields. In order to do so, we looked at how Lafayette invests into its current wind turbine and its performance. We analyzed the data from the current wind turbine and drew conclusions of the system’s efficiency. We gathered the energy consumption data of the campus and of Metzgar and analyzed it to assess the feasibility of wind power for Lafayette College.

Disciplines this poster drew from were: energy technologies, policies, and economics. We have taken different classes and come from different backgrounds giving us understanding of these disciplines such as chemical processes in Environmental Engineering, material and energy balances, VAST: Global Warming, FYS: Solving the Energy Problem, Engineering and Public Policy, and Engineering and Economics.

After a full analysis of wind power development from each discipline we discovered that wind power development was not feasible for Lafayette College. Lafayette has enough land at Metzgar and would be able to produce enough energy to power campus; however the policies are not in place on the local or federal levels to support the economics of such an investment.
Wind Power at Metzgar Fields

By Christopher Castello, Brendan Harney, and Grace Watters

CE 321 Introduction to Environmental Engineering and CHE 370 Alternative Energy Sources

Introduction
- The increasing global energy demand and rising environmental concern of carbon emissions results in increasing popularity and use of clean renewable energy sources around the world.
- At Lafayette, through personal experience we believe Metzgar fields have large potential wind energy that could be put to use by providing energy for the college.
- Wind power is a clean and renewable resource that could be created in the open fields of Metzgar.

Objective: To inspect and determine the feasibility of developing a sustainable energy source at Metzgar Fields through analysis of the technology, policy, and economics of wind power.

Technology
- Although generally horizontal axis wind turbines are more popular, vertical axis turbines are better for Metzgar fields because of their height and higher efficiency with multidirectional wind.
- Easton, PA is classified as low class 2–3 wind zone with average speeds of 4.5 m/s – these are the ideal speeds for a Windspire standard wind unit with a 2.2 kW power rating.
- Theoretical wind power is calculated using the density of air, rotor area, wind velocity, and performance coefficient of a turbine.
- VAWTs can be spaced closer together than HAWTs – the aerodynamic interference between neighboring turbines was eliminated at a distance of four rotor diameters apart.

This table shows the carbon emissions Lafayette would save with installation of different number of turbines.

<table>
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<tr>
<th># Turbines</th>
<th>Energy Produced (kWh/year)</th>
<th>Cost of Installation ($)</th>
<th>Interest Cost (kWh/yr)</th>
<th>Turbine Cost ($)</th>
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References
Reference sheet is available upon request.

Policies
- **Global**
  - Countries committed to wind by 2020
  - 20% increase in RE in EU
  - 15% increase in RE in China
  - Current policies lacking for growth
  - Current electricity 2-3% worldwide
  - IEA projected 5% by 2035

- **Local**
  - Federal tax credit - Uncapped 30% of total cost
  - Pennsylvania Renewable Energy Program
  - Funds geothermal and wind projects
  - Funds based on job creation
  - Renewable Energy Credits - Earned credits for sale of renewable energy
  - Requires certification

Conclusions
- The state of Pennsylvania needs more policies that support the economic development of wind power in order for it to be a viable option for Lafayette.
- Based on the current pricing for the payback period and potential investment, the best choice would be to power the maintenance building division of Metzgar fields.
- This would cost 5795,000.00, save 113,300 pounds of CO2 per year, and take 44 years to pay back the investment.

Economics
Windspire Standard Wind Unit 1.2 kW installed at Metzgar Fields produces 30MWh per year - 2MWh saves around $200.

This table represents the consumption, price ratio, and energy output of the college from July 15, 2012 to June 30th 2013.

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<th># Turbines</th>
<th>Cost per Turbine ($)</th>
<th>Cost of Installation ($)</th>
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<th>Theoretical Payback Period (Years)</th>
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The final table represents savings for Lafayette based on current price from four different divisions of power.

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<th># Turbines</th>
<th>Cost per Turbine ($)</th>
<th>Cost of Installation ($)</th>
<th>With Production (kWh/year)</th>
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Poster #3

**Learning From Spain’s Mistakes; A Local Approach to Solar Energy**
Raji Gunasekera, Nathan Diaz, and Kate Hughes

Solar power—both passive and active—is a source of alternative energy used in the United States as well as the rest of the world. Using the initiative of thinking locally and acting globally in Spain, the government used massive tax credits and subsidies to create a large grid of solar panels to help its energy crisis (in 2010 Spain averaged a net import of energy of 76%). However, the subsidies used to create the solar panels harmed the Spanish economy. The Spanish government generated 34 billion dollars worth of debt due to the “Renewable Energy Plan” passed in 2005. Currently the Spanish government plans to force its citizens to pay for the energy the citizens produce from the solar panels. Spain’s use of solar power on a large scale is currently not feasible; however, home solar power use is both economically feasible and will lessen the world’s dependence on fossil fuels.

In the United States, acting on a local level to include solar power in homes and businesses, will help the world progress in the renewable energy market. A taco bell in California is estimating energy savings of 70% after installing a solar roof on its drive through. Innovations on a local level such as this, will be much more feasible, effective, and economically sustainable than the large scale projects being implemented in Europe. Acting locally while thinking globally in the context of solar energy will lessen a dependence on fossil fuels and increase solar energy use.
Learning From Spain’s Solar Mistakes; A Local Approach to Solar Energy

The Spanish Approach

Nathan Diaz, Kate Hughes, Rajinda Gunasekara

Solar Power in Spain

• The plan was passed in Spain by the government in 2005 with the objective of leading the country to reach 10% of the total energy consumed to be from renewable energy sources.
• The prominence of Solar Heating Plants was quickly increasing after the approval of this plan.
• Actions were being taken at both regional and local levels to promote use of renewable energy sources in the country.
• April 2013, at 5:15 p.m., 54% of Spain’s total energy was generated by renewable sources.

An Overview Of Solar Energy

• Solar energy is a renewable energy source, that is, energy that comes from resources which are continually replenished on a human timescale such as sunlight, wind, rain, waves and geothermal heat.
• Solar power: the conversion of sunlight into electricity, either directly using photovoltaic cells, or indirectly using concentrated solar power.
• Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the solar energy.

Renewable Energy Plan

• Spain is the country with the highest amount of concentrated solar power plants.
• The map of energy in Spain contains a relatively high solar power potential (3.4 kW/m²).
• Increasing the utilization of solar energy (Ganeri).
• The installation of solar panels generated multiple problems, including environmental problems.
• Economic issues: In the past, Spain was putting pressure on the public to add and maintain solar panels in their personal homes, and in some cases, people were not willing to pay for the energy they personally generate but are attempting to restrict the amount of generated energy.
• The cost to generate energy through renewable sources is higher than in traditional electricity.
• The PV market is complicated, whose success rests on panel prices which are determined by the technology department, which in turn is affected by the consumer demand and PV purchase.

Concentrated solar power (CSP)

• Uses a large area of sunlight and focuses it into a small house and then uses a heat source for a conventional power plant.
• The most developed concentrating technologies are the parabolic trough (see left).
• Thermal storage efficiently allows up to 24-hour electricity generation.

Pastelated Cell (PV)

• A form of photovoltaic cell which, when exposed to light, can generate and supply an electric current.
• Solar cells produce direct current (DC) power which fluctuates with the sunlight’s intensity.
• For practical use, this usually requires conversion to certain desired voltage or alternating current (AC).

The Science

• Photosynthesis in sunlight creates solar panels and are identified by nanomaterials, such as silicon.
• Electrons (negatively charged) are knocked loose from their atoms, creating an electric potential difference.
• Due to the special composition of solar cells, electrons are only allowed to move in one direction.
• An array of solar cells convert solar energy into a usable amount of direct current (DC) electricity.

An Effective Approach

• Active solar water heaters use a simple way to either pre-heat or completely heat water for personal homes.
• Active solar water heater adds 100 to 300 dollars a month to a thirty-year mortgage, so a fixed savings of over $20 makes an active solar water heater immediately profitable.
• Solar heater saves 6000 pounds of CO₂ a year. If every homes in Arizona installed a solar water heater approximately 2,720,679 tons of CO₂ emissions would be cut per year.

Passive Solar Architecture

• Passive Solar Architecture uses building components and design techniques to reduce space heating and cooling demands in buildings.
• In some cases passive solar design can reduce heating requirements by up to 50%.
• Passive Solar Architecture aids very little costs to the construction of a new building, and the addition of passive solar architecture can save $1500 a year in the form of electricity.
• Passive solar does not incorporate mechanical energy by the sun, however, homes can be designed to be almost entirely heated from the sun.
• Well-designed passive solar architecture reduces heat when the building is cool, and stores heat when the building is warm.

References and acknowledgments are available on request.
Composting: Application Beyond The Backyard
Monica Wentz, Alexa Gatti, and Carolyn Messer

Composting is a growing form of recycling that converts organic waste into rich, productive soil. It is a process that both diverts large amounts of food waste from landfills, and creates a useful and necessary product. Composting can be applied on various scales, in both the backyard garden and large cities throughout the world.

Lafayette College has had a composting program for a number of years and has implemented two earth tubs at Hummel Lumber Yard for this process. This poster will examine Lafayette’s composting program as it stands and how it could be improved. The attempts and successes of instituting composting programs on larger scales are also examined. Since Lafayette already has a composting program at all eat-in locations, the goal here was to examine the retail locations on campus and determine how they could potentially benefit from a composting program. A waste audit of Lower Farinon, a dining location on campus, helped to gain a better understanding of the components of waste. The results led to two important insights. First, the take-out containers from all retail locations are creating a majority of the waste. Secondly, Lafayette students produce enough waste that a composting program would be reasonable for these dining locations. A campus-wide survey revealed that the majority of Lafayette students are knowledgeable of composting and willing to participate, also suggesting that a campus-wide program would be feasible.
Composting: Application Beyond the Backyard Garden

An analysis and critique of Lafayette College's composting program, students' perceptions, and municipal programs throughout the world

By Alexa Gatti, Carolyn Messer, and Monica Wentz

Composting Basics
- Recycling organic matter to create high-quality soil
- Ideal ratio of carbon, nitrogen, oxygen, and water
- Broken down by micro- and macro-organisms

Municipal Programs
- The United States
  - Philadelphia, Bethlehem, San Francisco
- India
  - Corporations required to compost
  - Developing nations
    - Algeria, Cameroon, Iran
    - Economically beneficial

Current Food Loop at Lafayette
- Dining halls
- Food Waste
- Pulpers in Marquis & Farison
  - “Earth Tubs” at Hummel Lumber Yard

Students' Perceptions of Composting
- Survey of 476 out of 2,478 students
- Questions:
  1. How much do you know about composting?
  2. Did you know that Lafayette composts?
  3. At which dining location does Lafayette compost?
  4. Would you be willing to personally separate your food scraps from your trash?

Campus Awareness & Support of Composting

Waste Audit
- Took one day’s worth of waste from Lower Farison
- Separated and weighed different components
- Calculated percent of food waste in trash
- Large portion of trash is carry-out containers

Improving Lafayette’s Program
- Promoting awareness on campus
- Implement windows at LaFarm
- Composting in all retail dining facilities
  - Start with Lower Farison
  - Analyze amount of compost received
  - Conduct follow-up waste audit
  - New bins to simplify the sorting of waste

The Potential of Composting No Waste?
- New York City
  - 1.2 million tons of waste per year
  - 10% of food waste to be composted
- San Francisco
  - One of the largest running programs
  - Eliminate trash by 2016
  - BioGas used to generate electricity
  - New technology expands recycling ability
  - Local improvements, global implications

Resources & Acknowledgements
Please ask for a complete list of references.

Thanks to Prof. Kasey, Prof. Braunmeil, Prof. Tawakol, Prof. Water, Plant Operations, Riddle Institute, LEAP
For our poster we chose to explore the economic benefits and environmental effects that may be involved with hydraulic fracturing of the Marcellus Shale. Additionally we explored the policies designed to regulate and the standards set for this relatively new industry. The Marcellus Shale is a shale deposit located primarily under Pennsylvania and New York that contains very large deposits of natural gas that would allow the United States to benefit greatly economically. But this does not come without social and environmental costs. We aimed to answer the question of whether or not the economic prosperity outweighs the detrimental environmental impacts and whether or not the government is doing enough to regulate the industry to be a viable fossil fuel option in the future.

The Marcellus Shale is projected to be one of the largest growth sectors in the energy field. With an estimated 141 trillion cubic feet available for extraction, the next 25 years Shale gas is projected to grow to be 49% of the natural gas production in the United States. This gas can only be extracted by hydraulic fracturing. Fracking is an environmental hazard for a variety of reasons, which are explored in our poster.
The Marcellus Shale: Economic Miracle or Environmental Tragedy?
Austin Lugrinbuhl ’15, Kevin Yell ’16 and Justin Piet ’15

- Shale covers over 100,000 square miles
- Volumetric estimates are uncertain
- EIA in 2012 estimated 141 trillion cubic feet
- Uncertainty accounted for by hydraulic fracturing regulations and recovery rates

Shale gas projected to be largest growth sector over next 25 years. 48% of production in 2035. US projected to become exporter of Natural gas, in 2035 US imported 11% of gas. Projected to export 8% in 2035.

Future projection of domestic prices is a function of economic growth and well recovery rate (EUR). High economic growth is proportional to high consumption of resources leading to higher prices. Low EUR yields less quantity resulting increased prices. Reference annual average of $3.37 in 2003.

Wastewater & Water Consumption
- It takes 2 to 8 million gallons of water to frack a site once & at least 65% of that water remains in the ground
- Western states tend to inject the wastewater back into the ground in reservoirs
- Eastern states “dispose” of the wastewater by putting it in lined pits or ponds

Preserving the Environment
- The high water consumption can disrupt stream flow or lake storage and therefore their ecosystems
- Can trigger seismic activity
- Fracking pre-existing subsurface-fault zones allows gas to travel to aquifers

Water Contamination
- Fluid 0.6% water, 0.5% sand, 0.5% proprietary additives
- Only in 93% of fracking fluid flows back out of wellbores
- Fractures generally form vertically putting aquifers at risk
- Risk of flowback escaping via well-casing cracks
- Greatly based on the geology features of the well site

Issues policy aims to address:
- Ground water contamination
- Proper disposal of flowback
- Impact of lifetime emissions
- Impacts on local infrastructure
- Large amounts of water required

Current National Policy
- Federal:
  - Actively avoiding involvement in most controversial energy sectors
  - EPA to release full report on surface water quality in 2014
  - $26.5 billion to congress from industry and $725 million from lobbying groups
- State:
  - Only 5 states have pursued an independent tracking review
  - 11 states have no disclosure regulations
- Local:
  - Can require additional zoning permits (FEDERAL)
  - PA vs NY: Local cant control vs. Towns have ultimate control

Current Global Policy
- France − moratorium on fracking currently in place
- Poland − unregulated and aggressive production
- There is no global production or consumption regulations currently in place, every country is free to do as they see fit

Conclusion
- The natural gas sector is expected to be the largest energy sector in the coming years
- Natural gas poses less of an environmental risk than any other fossil fuel
- Factors other than emissions affect the environment such as water consumption and no standardized regulations on production or consumption around the world

If the correct measures in terms of a concise and consistent regulatory policy and emission standards are established, predictions of natural gas in the Marcellus Shale and around the world should be pursued.

*References available upon request
Best Homeowner Practices: Preventing Water Pollution
Aliza Furneaux, Emily Lindahl, and Katelyn Arnold

Residential environments are one significant contributors to water pollution. Residential storm water picks up chemicals, garbage, pesticides, and excess dirt and carries it directly to our water systems. The storm water pollutes our watersheds, harming humans and aquatic life. Researching and reporting the methods in which homeowners can reduce their contribution to polluting water systems explores possible solutions to preventing and reducing global water pollution.

For our project, we focused on the best homeowner management practices exclusively related to water pollution. Our project thinks globally about the worldwide aquatic pollution problem, but acts locally by asking homeowners to implement simple methods around their own homes. We researched behaviors that will prevent or reduce pollution. We present practices pertaining to lawn care, auto care, and landscaping. We conducted a three-part survey to determine whether increasing knowledge or providing economic benefit would increase the probability of homeowners adopting these practices.

We found multiple methods to reduce homeowners' pollution by making simple adjustments to current behaviors. From the survey we conducted, we concluded that increasing the knowledge of water pollution had little to no effect on changing homeowner behavior. We supported our findings with research conducted by McKenzie-Mohr.
Best Homeowner Practices: Preventing Water Pollution
Katelyn Arnold, Aliza Furneaux, Emily Lindahl
EVST 100

Objective:
- Provide methods for homeowners to reduce their runoff pollution
- Determine if knowledge affects homeowner behavior

Problem:
- Homeowners play a big role in polluting our storm water
  - Storm water picks up:
    - chemicals    - pesticides
    - garbage      - dirt

Watershed Pollution:
- Poisons aquatic life
- Kills off aquatic plants and animals
- Causes eutrophication and hypoxia

Health Effects:
- Fetuses and children have more risk of exposure to hazardous pesticides
- Pesticide 2,4-D is associated with lymphoma in humans
- Pesticides annually poison
  - 5 million people
  - 50,000 U.S. children

Methods:

Lawn Care
- Pesticides
  - Use minimally
  - Use as directed
  - Do not apply when rain or wind is forecasted
  - Use organic mulch
  - Test lawn soil

- Mowing
  - Leave length 3 in
  - Mow often
  - Leave grass clippings on lawn

- Yard waste
  - Compost yard waste
  - Never burn
  - Never sweep into street or leave in storm drain

Landscaping
- Install rain barrel
- Build rain gardens
- Direct gutter away from driveway
- Direct downspout into a rain garden
- Use a splash guard on downspout

Auto Care
- Wash car on lawn
- Check/maintain vehicle for leaks
- Properly dispose of auto fluids/batteries
- Recycle batteries

Results:
- Experimental survey
  - Control
  - Knowledge
  - Economic benefit
  - Limits?

(Scale 1-5, 5 being most likely)
- Likelihood of purchasing and using organic mulch or organic pesticides on lawn: Knowledge—mean 3.10  Control—mean 3.60
- Likelihood to compost and mulch yard waste: Knowledge—mean 3.80  Control—mean 4.20
- Likelihood to dispose properly of auto fluids and batteries: Knowledge—mean 4.82  Control—mean 4.60

Conclusions:
- Changing local homeowner practices can reduce water pollution on the global scale
- Increases health of global water systems
- Knowledge was not significant in changing homeowner behavior

Suggestion:
- Eliminate barriers, increase benefits
The overarching subject of our poster project revolves around the causes and lasting repercussions of the Deepwater Horizon Oil Spill, the United States’ greatest environmental disaster to date. Through our project, we will examine how offshore drilling regulations have been abused or blatantly ignored in the past and how—as a result of the oil spill—those very regulations are witnessing a new level of heightened responsibility and revision, to prevent another tragedy from occurring. Other than examining the regulations involved in the oil spill, we will also elaborate on the lasting environmental impact the spill will have on the surrounding biodiversity and what current innovations are being worked on to help minimize future consequences. Our poster will hopefully leave the audience with an idea of why future oil spills will not occur and, if they do, why we will be more prepared to readily clean up afterwards. Furthermore, the Deepwater Horizon Oil Spill can be approached from dozens of fields of study and each field can provide in-depth analyses. However, our poster project focuses on the policy, the environmental science and the engineering practice involved in the disaster.
Could the Deepwater Horizon Oil Spill Lead to a New Golden Era of Environmentalism?

Colin Cavanaugh, CS231; Zachary Fedrick, EVST 100; Jeremy Casady, EVST 100

Problem Statement

The Deepwater Horizon disaster was one of the largest oil spills in history, occurring in 2010 in the Gulf of Mexico. The oil leak lasted for several months, causing extensive damage to the marine ecosystem and周边的人类经济.

Road to Recovery

- The Oil Pollution Act of 1990 is the leading piece of federal legislation protecting the marine environment.
- The National Oil and Gas Program was established to respond to the oil spill.

Road to Recovery: The Science Community

- The scientific community played a crucial role in understanding and mitigating the spill's impact.
- New research and technologies were developed to address the spill.

New Innovations

- New technologies and methods for cleaning oil spills were developed.

The Environmental Impact

- The oil spill had a significant impact on the environment and local communities.
- Species such as the bald eagle and the American flamingo were affected.

The Gulf of Mexico Environment

- The Gulf is a diverse and productive ecosystem.
- The spill had a serious impact on the marine life.

The Future

- There is ongoing recovery and restoration efforts.
- The focus is now on preventing future spills.

Conclusion

- The Gulf of Mexico is a critical ecosystem that must be protected.
- Future efforts must focus on prevention and preparedness.

References

- Gulf of Mexico Oil Spill (2010).
- Gulf of Mexico Environment (2020).
- Gulf of Mexico Oil Spill (2015).

Discussion

- The spill had a significant impact on the Gulf of Mexico.
- Future plans focus on prevention and preparedness.

Appendix

- Additional data and research on the spill.
Increasing urbanization has brought about several environmental problems associated with green space removal. Green roofs act as replacements for the removed green spaces and can be implemented during new construction or in the renovation of existing structures. This green roof initiative is beneficial to the local environment, economy, and surrounding community. A main component of the research was devoted to the costs and revenues associated with the implementation of green roofs. This implementation is financially attractive to building owners because it is cost-effective in the long term. To better understand these benefits, further research was conducted on an existing case study of the Whatcom Lightcatcher Museum in Bellingham, Washington. Based on the data collected from the case study, it can be inferred that the green roof initiative can bring about many positive changes to a bigger urban environment.

To sum up the research, the implementation of green roofs is a viable option for an urban setting as it provides the environment, economy, and surrounding community with benefits that offset the damage caused by green space removal. To further examine environmental benefits, specifically storm water runoff, a small-scale model green roof can be built. Then, various comparison tests can be run against a similar impervious roof model.
Green building practices have been part of a growing trend around the globe. New rating systems have originated in many different countries using a variety of standards and parameters to rank buildings. Leadership in Energy & Environmental Design, LEED, is a rating system put forward by the USGBC. It has taken hold in the United States and internationally. Other countries have their own standards such as BREEAM in the UK, Green Star in Australia, and CASBEE in Japan.

Every rating system has its own strengths and weaknesses; our goal was to evaluate these dominant systems and pick out the best components of each. We looked at the categories of design, credit scoring and weighting, cost, and global scale of each system. Additionally, we assessed the relative environmental efficiency associated with the ranks given by each system.

In our conclusion section, we compared and contrasted the various aspects of each system and provided commentary on possibilities for improvement. In a perfect world, these systems would unite under a common system to standardize all green building efforts making it easier to compare across borders. This standardization would also allow for increased implementation in any country.
Can We LEED the Way?
Christopher Nelson, Mary Madden, and Brian Skalla
Lafayette College, Civil and Environmental Engineering Dept.

Objective: To research and evaluate various leading national green building rating systems and determine the most effective approach.

**BREEAM (UK - BRE)**
- Scale (as of 2013):
  - 250,000 certified buildings
  - over a million registered
  - scheme used in over 50 countries
- Assessment Categories: New Construction, Refurbishment, Code for Sustainable Homes, Communities, In-Use
- Assessment Criteria: (Diagram)
  - Management: 12%
  - Health and Wellbeing: 23%
  - Transport: 12%
  - Water: 8%
  - Materials: 16%
  - Energy: 33%
- Assessment Method:
  - BRE accredited assessors
  - Score is produced based on the following criteria:
  - Score is given based on a sum of credits awarded based on CO2 emissions from energy efficiencies
- Costs (2009):
  - Assessment Costs: £9,871–18,657
  - Certification Costs: £1,465–2,979

**CRITICISMS**
- BREEAM adaptable to local contexts, credits based on carbon: LEED fixed to ASHRAE standards, credits based on US dollars
- Green Star certification occurs at the design stage. Time restraints and ratings during construction are in place.
- BREEAM is much less tenent about the giving of points.
- LEED does not emphasize reuse and adaptation of existing buildings or use of the building, focusing on technologies.

**LEED (US - USGBC)**
- Scale (as of 2013):
  - Focused in the United States, yet expanding internationally
  - 5,797 Projects
  - 8,767 Accredited Professionals
- Assessment Criteria: (Diagram)
- Assessment Method:
  - Accredited professionals (not required) gather evidence and advises
  - USGBC assess and issues certificate
  - Score is given based on sum of credits awarded based on money saved from energy efficiencies
- Costs (2009):
  - Assessment Costs: $75,000
  - Certification Costs: $2,250–22,500

**GREEN STAR (AU - GBCA)**
- Scale (as of 2011):
  - Australia
  - 931 certified buildings
  - 952 Accredited Professionals
- Assessment Criteria: (Diagram)
- Assessment Method:
  - Required validation from third party
  - Two Rounds of Assesment (Design and As Built)
  - Costs (2009):
  - Assessment Fee - $4,002–5,004
  - Certification Fee - $5,063–14,200

**CASBEE (JP - JaGBC)**
- Strictly Japan
- Over 6600 reported buildings (mandated by 24 local governments)
- 193 certified buildings
- Over 10,000 CASBEE Accredited Professionals
- Assessment Criteria: (Diagram)
- Assessment Method:
  - JSBC third party evaluation
  - Cost: NA

**RELATIVE RANKINGS**

**CONCLUSION**
- Most effective criteria from each compiled into a global standard, but weight of each category based on regional environmental concerns.
- Major strengths of BREEAM highlight crucial aspects of the ideal green building rating system.
- LEED has expanded internationally, which is a huge step in promoting green building.

References available as a handout.
The Effects of Phosphorus Deposition in the Bushkill Creek
Emily McGonigle and Andrea Jacobs

This poster details the problems associated with nutrient loading (of Phosphorous specifically) in the Bushkill Creek. Nutrient loading is when there is an abnormally high level of nutrients in the water due to human actions. The most common cause of nutrient loading in water systems is agricultural runoff. Phosphorous and Nitrogen are essential to growth of organisms. They are both found in limited quantities in nature, which means they are limiting the growth of those organisms. This makes Nitrogen and Phosphorous large components in fertilizer, so much so that not all of it can be absorbed into the plants. All of the excess nutrients are washed into the water source when it rains. This causes nutrient loading, which leads to eutrophication. Eutrophication is an excessive growth of algae in water that causes problems like hypoxia (lack of oxygen) and spikes in pH. This poster details the numerous problems associated with this natural phenomena, the results of accelerated eutrophication in other locations, and the risk level of this occurring in the Bushkill Creek.
The Effects of Phosphorus Deposition in the Bushkill Creek

Emily McGonigle 2015 – Civil and Environmental Engineering (EVST 100)
Andrea Jacobs 2016 – Civil and Environmental Engineering (CE 321)

Objective
To determine levels of Phosphorus in the Lower Bushkill Creek and if they are in accordance with the EPA suggested levels.

Phosphorus in Nature
- Phosphorus is an essential nutrient to the growth of organisms
- Phosphorus is present in small amounts in nature, limiting the growth of plants making it an important nutrient in fertilizers
- Phosphorus comes from natural and human sources such as:
  - Soil and rock
  - Wastewater treatment plants, run-off from fertilizers, and manure storage areas
  - Failing septic systems, drained wetlands, and commercial cleaning phosphorus

Case Study: Chesapeake Bay
- The Chesapeake Bay naturally acts as a natural buffer with forests, vegetation, and wetlands
- Due to urbanization and an exponential increase in agriculture, buffers have vanished, changing the land from a Green Filter to a Greasy Funnel
- Greasy Funnel allows polluted water runoff containing excess Phosphorus to enter the bay
- Agricultural runoff is the largest source of pollution to the Chesapeake Bay contributing 50% of its Phosphorus
- About 400 million pounds of Phosphorus per year enters the bay

Resources

Eutrophication
- Definition
  - "The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates. These typically promote excessive growth of algae. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the water of available oxygen, causing the death of other organisms, such as fish. Eutrophication is a natural, slow-aging process for a water body, but human activity greatly speeds up the process."

- In 1990, the EPA reported that accelerated eutrophication was one of the leading problems facing the Nation's lakes and reservoirs.

Sources of Excess Nutrients
- The largest source of additional phosphorus is farm runoff. The amount used in fertilizers is too high for complete uptake. The excess remains on the surface until it is removed by rain or runoff.
- Waste water treatment plants and septic systems also use a large amount of phosphorus. When human wastes are used, they release phosphorus that enters septic tanks or treatment plants. Leaky septic tanks can release phosphorus. Waste treatment plants are not mandated to eliminate phosphorus, but reduce the level.
- The logical and cost-effective solution is to alter the agricultural pollution sites by creating nutrient management plans by:
  - Addition of cover crops
  - Rotational grazing
  - Adding grass and forested buffer strips along farms

Effects of Eutrophication
- This build up creates "dead zone" as it not only blocks the sunlight required by plants, but also consumes oxygen which in turn suffocates and kills fish and other aquatic species.
- Algal blooms also cause a sudden increase in pH which disrupts the living conditions for all aquatic life.

Policies for Water Quality Standards
- The EPA listed water quality standards as the level of pollution that is acceptable in water bodies. These levels are set by the EPA in consultation with states and tribes. The states and tribes then adopt them as their own standards. These standards are designed to protect the natural habitat and the wildlife that depend on the water bodies. This is done by regulating the amount of pollutants that can be discharged into the water bodies. The standards also regulate the amount of sediments that can be discharged into the water bodies.

Conclusions from Sampling
- The red line represents the EPA's safe level of phosphorus in surface water.

Sample Locations
- Lafayette College
- Beara Schoenbeck
- After Schoenbeck
- 3rd Street

Staten Island
We studied solar thermal energy and the possible applications for both commercial and residential use of the technology to determine whether or not solar thermal energy is a viable alternative energy technology. Solar thermal energy can be used for commercial power production through concentrated solar power. CSP has multiple different configurations that each have their own advantages and weaknesses. By examining each of these configurations, the use of solar thermal energy can be optimized for each specific application. Commercial use of solar thermal energy also involves storing the thermal energy so that electrical production can occur at maximum efficiency. The different processes for storing thermal energy must be considered by their efficiency and cost to use the best one for individual applications. In addition to commercial applications we examined how solar thermal energy can be used on a residential level. By using solar thermal panels to heat water, individuals can conserve energy and save on power costs. Residential solar thermal energy is versatile and can be optimized for different residences. In addition to looking at the applications of solar thermal energy, we researched how the price of the technology can be subsidized through government incentives and how these programs are growing. We conducted a survey of people on campus to analyze what people know and think of solar thermal energy. The public opinion on the technology is important in encouraging the improvement and implementation of the technology. We also examined what kind of environmental impacts the technology has. The two major environmental impacts of solar thermal energy are the water and land usage. By considering all of these attributes, it is possible to determine that solar thermal energy is a viable alternative energy source that has many potential applications.
Poster #12

**Organic Pest Management Practices at Lafayette**

Kaitlin Geraghty, Conner Lenox, and Yinan Xiong

Organic gardening is an agricultural system that provides consumers with fresh and authentic foods without disrupting the environment. This is achieved through strict limitations on the use of herbicides, insecticides and other chemicals that have adverse effects on ecosystems. Organic gardening enhances soil conditions, helps to preserve native and endangered animal and plant species and improves and maintains rural landscapes. Pest Control is an important aspect of organic gardening; insects and other unwanted visitors can be detrimental to a garden’s health, production and aesthetic appeal. Despite the urgency to remove pests from a garden, however, one must be careful how one goes about such extraction. While pesticides and herbicides are useful in that they can quickly and effectively rid gardens of unwanted pests, they are detrimental to the surrounding environment.

Lafayette College’s community garden, LaFarm, is an organic garden that provides the Lafayette community with an opportunity to grow its own produce in an environmentally sustainable way. LaFarm practices organic pest management strategies through their use of both cultural and biological techniques. Such techniques include crop rotation, hand removal of pests and organic sprays. The practices used in LaFarm can be used as a model for the average gardener; there are simple and effective methods that can reduce pests and enhance the quality of a garden with little to no environmental impact. Our project looked into what LaFarm is doing to rid itself of pests and what it could do to better its environmental impact in the future.
Organic Pest Management Practices at Lafayette

Organic Solutions to Lafayette’s Pest Management Problems
By Katie Bರr Anatomy, Conor Lenox, and Yinian Xiong

Origins and Significance of Organic Pest Management
- Rachel Carson’s Silent Spring changed the way we look at chemicals and the environment.
- Described the dangers of agrochemical pesticide use.
- Proposed society had to re-evaluate the environment and agriculture.
- Sustainable method to control pest populations.

Why Garden Organically?
- Pros:
  - Environmental
  - Practical
  - Social
  - Economic
- Cons:
  - Labor intensive
  - Not very amenable to large-scale applications
  - Not as reliable as conventional methods

What do Lafayette Students Think About Organic Products?
- Given the 20-30% added cost of organic products, would you choose conventionally grown produce over organic products?

Case Study: LaFarm
- Experiment: Pest Control Methods in the Lafayette Organic Garden
- Questions: Which organic pest management techniques are more effective in Lafayette?
- Controls: Integrated Pest Management (IPM), Organic Fungicides, Neem Oil
- Results: Initial data shows promising results.

Future
- Increased healthy soil
- Reduced toxicity
- Sustainable agriculture
- Organic Solutions to Lafayette’s Pest Management Problems
- Lafayette Organic Garden

The Rodale Institute
- Natural Agriculture
  - Encourages returns to its own sustainable balance
  - Growth of soil without fertilizers, chemicals, or additives
  - Relationship between the soil, crops, and environment
- Natural Agriculture and Pest Management
  - Ecological Aspects
  - Growth rate of a pest past peak and harvest earlier

Resources
Our project examines the cultural pressures behind the ideal American lawn. It explores the perceptions about chemical input use in regards to lawn aesthetics and maintenance commitment. We performed soil texture analysis and moisture density tests to determine percent bulk density of different soil samples. We examined lawn soil quality under varying management practices and the relationship between the quality and the chemical inputs.
The Ecological Consequences of the American Lawn

Steve Allenco and Elizabeth Osborn, Lafayette College

Introduction

Modern gardening and lawn care practices present many challenges to scientists concerned with the drastic anthropogenic changes to the environment in recent decades. Turfgrass lawns have become the standard for urban landscapes in North America. The total turfgrass area in the United States is estimated to be 10.1 million hectares (31,553 km²) and is expanding rapidly due to urbanization (Cheng, Z. et al. 2006). The cultural obsession with perfect, suburban lawns is largely responsible for the growth of turfgrass lawns and the downfalls of fertilizers and pesticides. These chemical inputs are expensive and can result in pollution and reduced water quality, due to runoff and leaching (Cheng, Z. et al. 2008).

The purpose of this study was to examine the soil quality at various locations under different management practices and to explore the connections between biological and social perception of how to cultivate the perfect lawn. We expected to find significant differences in the soil quality indicators, which might justify the tempest of high chemical inputs on turfgrass lawns.

Methods

Soil Texture Analysis and Soil Restorion Density tests are described in Soil Lab. Yield. Dr. Nancy Nettles (2015) found that bulk density has an inverse relationship with % moisture density.

Soil collection at Elizabeth's House

- Hagley, Arlington, VA
- This soil had the lowest % sand, indicating that it has the least amount of soil compaction. This is likely due to the fact that the soil is on a hillside, not subject to frequent use, located on a slope, or near a road.

Soil collection behind Farber Hall

- This soil has the highest % sand, indicating that it is more porous, allowing greater aeration.

Soil collection at the Organic Gardens

- The soil at the Organic Gardens has a higher % clay, indicating that it is more moisture-retentive.

The perfect lawn is one that is weed free, trim, uniformly thick, vibrantly green, and aesthetically pleasing.

- Joseph Dorsey (2010)

Table 1: Bulk Density

<table>
<thead>
<tr>
<th>Location</th>
<th>Bulk Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elizabeth House</td>
<td>0.74</td>
</tr>
<tr>
<td>Crystal Lake</td>
<td>0.78</td>
</tr>
<tr>
<td>Bushkill Creek</td>
<td>0.80</td>
</tr>
<tr>
<td>Farber Hall</td>
<td>0.77</td>
</tr>
<tr>
<td>Organic Gardens</td>
<td>0.71</td>
</tr>
</tbody>
</table>

Results

- Figure 1: Soil Texture Analysis
- Table 1: Bulk Density

Discussion

While there is no scientific consensus on what makes a "good" soil, we examined soil texture and bulk density to determine soil type and composition. We found that the soils we collected were all relatively similar and fit healthy types (loam and sand loam), good for growing turf grass (Ohio State Extension).

In 2011, Americans spent $170 billion on pesticides and $32 billion on fossil fuel-based fertilizers (Simonsen et al. 2011). One study found that DIY lawn care regimens did not result in more aesthetically pleasing lawns than lawns without fertilizers and pesticides, suggesting that the results of homeowners' chemical inputs do not justify the costs associated with these inputs (Cheng et al. 2008). The social pressure to achieve the perfect lawn coupled with the cultural belief that more is better has resulted in a $1.5 billion lawn care industry (Dorsey 2010). While large scale agriculture might warrant a high intensity regimen of fertilizers and pesticides, the average lawn does not require such inputs.

References Available on Request
Can the Quad be a Learning Environment?
Bonnie Malhotra, Nicolas Alarcon, and Andrew Hoff

The overarching theme of this poster session is the slogan “Think Globally, Act Locally.” With this in mind, our group studied the effect of green space on the overall health of a population. We found that being more involved and closer to green spaces increases overall happiness, quality of life and mental distress. However, according to Nisbet and Zalenski, people, specifically college students, don’t experience the full hedonic benefit of nature. If students interact more with nature, they hypothesize they will adhere to sustainable behaviors because they care more about nature. If college students become more active in green spaces wouldn’t the benefits they receive (lower mental distress, higher quality of life, higher overall happiness) be beneficial for them in the classroom? We were able to look at some of these variables by observing the effect of the Quad on campus life, surveying students about their thoughts and use of the Quad, including the sustainability of the Quad. For example, we asked students how guilty they felt about throwing trash on the Quad. An overwhelming amount of students responded, on a scale from 1 – 10, with 1 being no guilt at all and 10 being extremely guilty, with 10s. However, as part of our project, we threw garbage onto the Quad and waited to see how long it would take for people to notice the garbage and pick it up. Out of the 363 people who walked by the trash, only 4 people picked it up, which is contrary to what people indicated on the survey.
Recycling is one of the most important ways to cut down on the use of raw materials and is key in promoting sustainability both locally and globally. In our project, we examined the state of recycling at Lafayette College. We researched many factors that influence participation in recycling—as well as the extent to which individuals recycle. We saw that factors like convenience, personal responsibility, financial and social incentives, and education in the importance of recycling can help citizens to improve their rates of recycling.

In the last few years, Lafayette has made a tremendous effort to improve the recycling culture on campus. For example, the college has recently implemented a program that allows students to give their old clothes, bedding, and furniture away at the end of the semester. Even though these changes have been extremely successful, we believe many fundamental improvements can be made. Convenience is arguably the biggest factor in determining whether someone will recycle, and the improved placement of recycling bins at Lafayette will help increase rates of recycling. In a small population, like Lafayette’s, any results can be assumed to be applicable to a more global community, and any improvements that are noticed in Lafayette’s sustainability can be used as an example of how to improve recycling practices on a large scale.
Recycling Promotion: Improving Sustainability on Lafayette College Campus
Andrew Halloran, Faris Chugthai & Tory Bingaman

Research Questions:
What is the current state of Lafayette’s recycling program?
What are possible improvements to this program?

Significance:
Increasing recycling reduces:
• The demand on raw materials
• Waste disposal by landfill or incineration
• Air & water pollution and global warming
By studying which variables influence recycling participation, we can maximize sustainability

Recycling Variables & Local Factors:
influential variables for recycling participation:
• Personal Responsibility
• Environmental Concern
• Goal Setting
• Convenience
• Incentives (financial & social)
• Education
• Feedback

Recent Initiatives:
Lafayette has recently employed programs like:
• Green Move Out – 30,000 lbs of bedding, clothes, furniture etc. donated to local charities
• Increased recycling spectrum to include ink cartridges, toner, batteries etc.
• An expansion of electronic recycling
• 114 new recycling containers and signage
• Dining Halls obtain from using Styrofoam cups or trays
• This has allowed Lafayette to sustain an upward trend in recycling
• Earth week: $0.50 Refills with Reusable Containers in Skillman Café

Further Research:
- Incorporate the block program through the RHC to promote recycling on campus
- Experimenting with the placement and convenience of recycling receptacles on and around campus

Comparison:

Global:
• Results from small scale experimentation leads to large scale application
• Similar behavior throughout demographics
• Our research is collected from studies in various countries, states, and environments

Acknowledgments & References:
George Xieou (personal correspondence, Oct 2013)
Anthony Post (personal correspondence, CCI 2013)
LPAP
Background image courtesy of GLSANY
References available upon request
Streambank restoration is a collection of techniques used to improve the stability, geometry, and ecological health within a streambank. The restoration can be carried out in a variety of ways depending on the stream and surrounding community. Our team visually assessed the Bushkill Creek, specifically along the 3rd street location, for stream bank restoration opportunities. After researching potential solutions previously and successfully implemented on other sections of the Bushkill Creek, our goal was to recommend solutions for the documented problem areas with regards to the three aspects of sustainability: environmental, economic, and social.

It is our hope that this project will help the Bushkill Creek become more of a focal point for the community. We are interested in researching the restoration from a multidisciplinary perspective, and therefore looked into multiple types of restoration, including hydrological, biological, environmental, social and more. Our team kept the community in mind when proposing restoration options so the project is not only environmentally successful, but also an asset to the community both economically and culturally.

The research and accompanying recommendations will be used by students in the CE 421 Hydrology course in the design of a restoration project along the Bushkill Creek that will be entered into the EPA RainWorks competition at the end of the semester. The information gathered from this project will also make the Bushkill Creek another step closer to being a self-sustaining, functional hydrological system that does not require periodic human interaction.
Streambank Restoration Along the Bushkill Creek in Easton, PA
Carly Hatch, Karolina Vera, Allison Zeoli

OBJECTIVE
To visually assess and document restoration needs along a section of the Bushkill Creek in Easton, PA, and then propose remediation options that will improve streambank health.

THE BUSKILL CREEK

SITE LOCATION

Site Location:
- Watershed boundary: intersection of Bushkill St and Bushkill Dr.
- Eastern boundary: N. 3rd St.

LAND USE:
- Commercial, residential, and natural areas

CURRENT ISSUES:
- Dam
- Rip out banks
- Trash and debris
- Invasive species

METHODOLOGY

Visual Site Assessment
- Methodology: The assessment involved walking along the stream bank and evaluating its condition.

Delineation Restoration Solution
- The Visual Assessment of Stream Planners Contributing to Flooding was used to determine which solutions would be feasible on the Bushkill.

SOLUTIONS
- Remove sediment from the stream bed

BENEFITS
- Reduced flows
- Increased water elevation
- Increased floodplain capacity

RELATIVE PRIORITY: Medium
- Cost: $5,000 per unit depth

REFERENCES

EFFECTS ON STREAMBANK HEALTH

With the implementation of the proposed streambank restoration techniques in the Bushkill Creek, the stream will be another step closer to:
- Restoring and maintaining the natural stream
- Regaining its equilibrium with the landscape and surrounding components
- A more self-sustaining, functional stream system that does not require periodic human intervention
- Preventing erosion and sedimentation

EROSION

CAUSES:
- Excess sediment and nutrients
- Downed aquatic habitat
- Streamlined stream banks
- Erosion of stream beds
- Direct deposition and flooding

SOLUTIONS
- Add native plants

BENEFITS
- Stream restoration
- Improved water quality
- Enhanced ecological diversity

RELATIVE PRIORITY: High
- Cost: $7,770 (includes study and removal)

DAM

CAUSE:
- Sedimentation
- Prevention of fish migration
- Changes in temperature, composition, and DO levels
- Economic and social benefits associated with future dam failure

SOLUTIONS
- Remove the dam

BENEFITS
- Allowing natural stream migration
- Improving water quality
- Restoring ecological diversity

RELATIVE PRIORITY: High
- Cost: $7,770 (includes study and removal)

EXCESS DEBRIS

CAUSE:
- Excess sediment
- Prevention of fish migration
- Changes in temperature, composition, and DO levels
- Economic and social benefits associated with future dam failure

SOLUTIONS
- Remove the dam

BENEFITS
- Allowing natural stream migration
- Improving water quality
- Restoring ecological diversity

RELATIVE PRIORITY: High
- Cost: $7,770 (includes study and removal)
The topic of flooding in the Lehigh Valley is extremely important as residents of this area need an understanding of their surroundings and how they can affect their life. The components that come alongside it such as education, prevention, and adaptation are all important for all Lehigh Valley residents to understand.

Our overarching topic is flooding in the Lehigh Valley, however our main focus points will be on the education of this issue. We focused on information to educate residents on flood prevention methods, as well as ways to adapt their lives due to the flooding. Our investigations are based off of research from major flooding events that have occurred in Northampton County, and research that the Nurture Nature Center has done on the topic of flooding.

Within our topic of flooding in the Lehigh Valley, we were able to integrate the disciplines of both education and engineering into our goal of educating the residents of the Lehigh Valley as well as adapting to the flooding by anticipating the possibility of flooding in the area. With education about flooding, residents would have the ability to be prepared for a flood. By researching the engineering around flooding, we were able to figure out the best ways to adapt houses and roads for the inevitable flooding. Since it is difficult to prevent flooding altogether, it is in the best interests of the citizens of the Lehigh Valley to focus on ways to cope with the flooding, which is exactly what our poster seeks to do.
Flooding in the Lehigh Valley: Education, Prevention, and Adaption
By: Julia DeFranco, Jennifer Oddo, and Joan Haling EVST 100

What is there to know about flooding?
• Identify patterns of increased flooding
• Understand the role of flooding adaptation and education
• To increase awareness of Lehigh Valley residents

Why does flooding happen?
• It’s natural: In order to improve water quality and help to keep the habitats of species that live in or around rivers.
• Floods leave behind nutrients that help soil, and the flooding process also helps the water from the river or stream.
Flooding is caused by these natural processes:
• Heavy rain
• Melting snow
• After forest fires because the burned land cannot absorb rain

Flood Education
How to prepare yourself for a flood:
• Sign up for flood alerts
• Get flood insurance if you live in an area that has a high chance of flooding
• Watch the weather
Things to know before floods:
• Do you live in a flood area?
• What is your river’s flood stage? This is the height at which the water flows and begins to fill surrounding areas.
• Know about flood watch warnings. Watch the weather.
• Flash floods can happen in a matter of minutes, so know if they’re going to happen
• The term “100 year flood”
• What height of water affects your property?
• Your evacuation route

Flooding on a Global Scale
Figure 1. Estimated population by flooding events
How do underdeveloped countries prevent flooding?
• Flooding is common in Bangladesh: raise houses, plant trees to prevent erosion and build flood shelters for protection.

“From my neighborhood route 611 is the fast way to get to school. However, due to the flood the road was closed off and school had to be cancelled for days, leaving me feeling trapped.”
—Elizabeth DISebatino, Lehigh Valley, PA

“Citizens of this area can blame themselves for sending representatives to government who have failed to exert the force necessary to create public works which would have alleviated or prevented the 1955 August flood.”
—Easton Express editorial,
Devastation on the Delaware

Probability of Flooding in Easton, PA
Figure 2. Chance (%) of river volume going above the max river stage (ft) during the period from 11/12/2013 to 12/12/2013

“What’s your number?”
• A flood stage number defines the level that the water has to get to in order to flood is assigned to areas surrounding rivers.
• If you know your flood stage number, you’ll be better prepared for floods.

Flooding in Easton’s Past
1955:
• 2 Hurricanes that went over the Delaware River within the same week
• Hurricane Connie and Hurricane Diane
• Lehigh River in Bethlehem reached 29.5 ft, its highest recorded flood crest.
• Caused $2.8 billion damages in Delaware River Basin
• Caused over 70 deaths

Can this happen again?
What’s better now?
• Higher technological communication (e.g., radars and satellites)
What’s worse now?
• Permeable soil has been paved over by building development. Without the natural recharge of rain percolating the soil, the aquifers can run dry and there can be a drought.

How can we adapt to this natural process?
Figure 3. Money spent on flood prevention
• Build with water-resistant materials: withstand direct contact.
• Dry-risk-proof property: applying waterproof coating to exterior walls, anchoring building to resist flotation.
• Adding waterproof barrier to exterior walls: seals openings.
• Raise electrical system components: avoid potential fire.
• Anchor rain tanks: prevent damage.
• Raise/flood proof HVAC Equipment: move to upper floor or build flood proof wall around equipment.
• Protect vital flood communications.

What does this all mean?
• It is completely necessary to be prepared because at any point flooding can naturally occur.
• Climate change is increasing chances of flooding.
• It is imperative to check your flood stage number to prevent property devastation and to raise your awareness.
• Being prepared for a flood can save your life or someone else’s by taking the proper precautions.
Lafayette College Student Awareness of E-Waste
Liana Argios, Anthony Vecchio, and Clyde Gross

The disposal of electronic waste from the United States poses adverse environmental and social effects on communities. Our study will focus on Lafayette students’ consumption of electronics and their disposal methods. Furthermore, this study aims to assess possible behavioral changes of students after learning about the impact of improper recycling on the environment and communities. The consumption and disposal of the college’s e-waste was evaluated and compared to surrounding schools to gain a better understanding of the path electronic waste takes. The case study of Guiyu, China was used to illustrate the consequences of improper recycling such as the degradation of soil, water, and air quality, as well as human health.

According to Greenpeace, 20-50 million tons of e-waste is produced annually with most illegally sent to India and China. The United States generates about 3 million tons per year, while Lafayette College produced about 3.5 tons this year. The college’s e-waste is sent to schools and non-profits for reuse, while obsolete electronics are sent to Jontech, a recycling company. Personal electronics can be disposed of through Liberty Recycling.

After surveying 193 students, most do not buy more than one electronic device every 2 years and responsibly dispose of their e-waste. Most students said they are willing to reduce their purchase rate and if given the opportunity, would pay more for proper disposal. This results in fewer opportunities for electronics to be sent to countries where e-waste will not be recycled properly.
Lafayette College Student Awareness of E-waste and the Implications of Continued Consumption and Improper Disposal
By Anthony Vecchio, Liana Argyros, and Clyde Gross

What Is E-Waste?
Any discarded electronic or electrical device.
- e.g. Computers, iPod, MP3, Cell Phone

Objectives
To assess the consumption of electronic devices by Lafayette College students. To determine their awareness of e-waste and the consequences of improper disposal.

Survey Findings
- 193 Lafayette students
- 67% familiar with e-waste
- 33% unfamiliar with e-waste
- 47% aware of Lafayette College’s E-Waste disposal program
- 48% aware of personal electronics disposal

Rate of Replacement of Electronics
- About 1 per 2 years: 41%
- Less than 1 per 2 years: 36%
- More than 1 per 2 years: 23%

Willingness to Reduce Rate of Replacement and Pay More for Proper Disposal
- Yes: 69%
- No: 29%
- Don’t know: 2%

Disposal Method
- Thrown in trash: 15%
- Bring to electronics provider: 36%
- Mail it down: 30%
- Keep it: 19%

Who Produces E-waste?
- 520 million tonnes/year
- United States: 3 million tonnes/year
- China: 2.3 million tonnes/year
- India

Where Does Lafayette College’s E-Waste Go?
- College-owned electronics: Schools, Non-Profits
- Personal electronics: Liberty Recycling, Raven Valley Disposal

How do Surrounding Colleges Handle E-waste?
- Middlebury College—no student disposal program; recycle/return college-owned equipment with 85-90% going to community groups
- Connecticut College—Earth Day sponsored by SR Processors event to pick up/recycle e-waste

Case Study: Guiyu, China
Environmental Effects
- Groundwater Pollution: Samples of rice, soil, river sediment, and groundwater taken by Greenpeace indicated high levels of toxic heavy metals (e.g. Pb, Cu, Hg, Cd, Ni, Zn) and organic contaminants (e.g. PCBs)
- Atmospheric Pollution: The smell of burning solder and melting plastic
- Water Pollution: About 50% of the e-waste is disposed of, resulting in lead levels in the river that are 130 times higher than acceptable levels (according to WHO)

Social and Health Effects
- Shanty University Medical College conducted research that tested 105 children for concentrations of lead in their blood; 82% of the children had blood/lead levels of more than 10μg
- Villagers along the river report asthma and breathing problems
- Levels of human exposure to lead is 10-15 times higher than the WHO recommended maximum intake
- Approximately 60,000 laborers do e-waste recycling
- Computer wires are sorted during the day and then burnt at night, leaving the village exposed to some residue from the fire

Economic Effects
- Processing 1.5 million tons of e-waste per year (as much as 80 percent from overseas) generates $7.5 million in revenue
- An average computer is worth only $5.50 to $7.80 in materials
- Officials are reluctant to regulate e-waste businesses because they provide Guiyu with 90% of its commercial and industrial taxes

Conclusions
Most Lafayette College students do not buy more than one electronic device every 2 years and properly dispose of their e-waste. This result in fewer opportunities for electronics to be sent to countries where e-waste will not be recycled properly. Most students said they are willing to reduce their purchase rate and if given the opportunity would pay more for proper disposal.

References
- New York Times
- Microsoft Corporation
- Shanty University Medical College
- Greenpeace
- WHO
What makes invasive species invasive? Many things. The topic of invasive species is interesting because it covers a broad spectrum of fields. It touches upon the environment and biology, and how invasive species alter the ecosystem. It is also a cultural battle because most invasive species are brought over by humans coming from another area of the world. This brings in the political value because the question now is, whose responsibility is it to control the problems that come when another species becomes invasive?

We have listed two main case studies on our poster, the more relevant one being about the invasive European honey bee and native honey bees. Invasive species have a role in our economy. Reducing honey bee populations will increase a loss of pollination, services that reduce crop yields and additionally lessen production costs. The second case study we talk about was about freshwater snails. The biotic interactions between the invasive New Zealand mud snail and freshwater snail were measured. Observed was the grazing of each snail on a shared resource as well as the shell growth during consumer-consumer interactions in streams.

Invasive species are not only animals, but plants too. In many cases, plants from other parts of the world are welcomed, putting extreme pressure on native plants and animals, and threatened species may succumb to this pressure. Ultimately, invasive plants alter habitats and reduce biodiversity.

In Conclusion: It’s All Economic: What makes an invasive species invasive is how people think it affects our economy and way of living.
What Makes an Invasive Species Invasive?

Bethany Rack CE 321 and Leslie Tittle EVST 100

What is an Invasive Specie?
An invasive species can be introduced to a new area via ships, intentional and accidental releases of aquaculture species, aquarium specimens or bait, and other means. Invasive species are capable of causing extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats.

Cultural Impact
The invasive species may deplete the endemic species that are culturally important to the residents of that area in turn disrupting their way of life and causing a cultural battle.

Economic Impact
The economic impact of invasive species is derived from direct and indirect costs. Direct costs are those related to controlling the spread of invasive species, such as the use of pesticides applied in an attempt to contain the spread of pests. Indirect costs relate to the ecosystem services lost through such destruction. Worldwide, billions of dollars are spent annually as a result of invasive species.

Environmental Impact
The introduction of invasive species can result in the extinction of local species and irreparable changes to the habitat and biodiversity of invaded ecosystems. These species lead to the killing or crowding out of native species through predation, parasitism, disease, and competition. They also alter ecological processes such as the water, nutrient, and energy cycles, thus completely changing how ecosystems function.

Positive Economics
Invasive species have a role in our economy. Reducing honey bee populations will increase a loss of pollination services which reduces crop yields and additionally lessens production costs.

Invasive Plants
Why are they a problem?
It's a matter of ecology. In many cases, plants from other parts of the world are welcomed, manageable additions to our gardens. However, in some situations these non-native species cause serious ecological disturbances. This puts extreme pressure on native plants and animals, and threatened species may succumb to this pressure. Ultimately, invasive plants alter habitats and reduce biodiversity.

Case Study
The Invasive European Honey bee (Apis Mellifera) and Native Bumble Bees (Bombus Occidentalis)
- Proximity to higher densities of Apis hives reduced Bombus colony reproductive success by gyno number, gyno ratio, mean gyno size, male sightings.
- No significant effect of proximity to Apis hives. However, effects of Apis on Bombus gyno ratio were stronger than for gyno number.
- Mean gyno size and relative male reproductive success increased with greater distance from Apis colonies.

Who Cares about Snails?
Case Study: Freshwater Snails
The Problem: Invasive species continue to be a large contributing factor to the reduction of biodiversity. Some of these problems arise from the competition, facilitation, and predation between the native and invasive species. The strength of biotic interactions is a huge indicator.

The Study: The Biotic interactions between the invasive New Zealand mud snail and freshwater snail were measured. Observed was the grazing effect on algae in a shared resource as well as the shell growth during consumer-consumer interactions in streams.

The Results: Grazing effects on algae were similar and negative. When interacting with each other the endemic snail's growth rates were lowest whereas for the invasive snail they were highest.

In Conclusion
It's All Economic
What makes an invasive species invasive is how people think it effects our economy and way of living. An invasive species such as bees help us to produce food, and if they were not there people would be in a panic. The majority of invasive species, however, are a nuisance and are extremely costly to remove.

Resources
Americans waste about 40% of edible food. This is a staggering number that we as a nation need to address. A lot of Americans are not aware of how much food they waste or even cognizant of where their food waste goes. Food waste occurs at many stops along the way; might it be at the neighborhood butcher who throws away excess meat or at home when you throw away vegetable peelings.

A survey was conducted at Lafayette to gauge students’ knowledge of the food waste crisis in this country. While many people might know that 40% of edible food is thrown away, they are not doing anything to fix this issue. Buffet style dining halls contribute immensely to the food waste on college campuses. At Lafayette, the waste is taken to a composting unit on the campus grounds, but the unit is not as efficient as it could be. Composters release methane gas which is 21 times more potent than carbon dioxide. An efficient composter could harness the methane and be run on its own emissions; in essence, be completely self-sufficient.

Food waste can be overcome if people would be more conscientious about their food choices. Last year the United States spent $1 billion on disposing food waste. If composting became the social norm, an enormous amount of food could be kept out of landfills and utilized as a fuel source. This transition from landfills would save money and create a safer environment for generations to come.
Food Waste
Patrick Grundy (CHE 370), Dejana Harris (CE 321), Jenna Kulback (CE 321)

Striking Facts about the US
- 40% of food is thrown away in the US
- 30 Mt of food waste is sent to landfills every year
- Food waste is the second largest category of municipal solid waste sent to landfills
- $100-160 billion is spent on food that is wasted
- Spends about $1 billion dollars to dispose food waste
- In 2010, over 33 Mt of food was wasted
  - Enough food to fill the Empire State building 91 times
- Food waste has increased by 16% in the last decade
- The average person wastes 200 lbs of food annually

Environmental View
- Gas given off by rotting food waste contributes heavily to greenhouse gas emissions
- Food waste releases methane which is 21 times more potent than carbon dioxide
- Fertilizers and pesticides that go into producing excess food is harmful to the environment
- 28% of agricultural land is used to produce food that will be wasted
- Decomposition rate of garbage in landfills is very slow

Landfills
- Generate bad odors
- Rotten food releases methane into the atmosphere
- 23.9 Mt of food gets taken to landfills each year
- One billion dollars is spent transporting food to landfills
- Although composting does have costs, some financial benefits will reimburse them

Composting
- Used to convert post-consumer food scraps into fertilizers
- Uses anaerobic digestion to break down biodegradable materials with microorganisms
- The apparatus breaks down waste and releases methane
  - Can be harnessed and used as a renewable energy
  - Could potentially have the compost run self-sufficiently
- “Need to make sure a steady supply of waste is collected for digesters; there is a market for electricity at the end.” ~ Murray-Phillips
- The goal is to turn all food waste into clean energy and some reusable products to make landfills a thing of the past

How much food do you think the US wastes?

Composting at Lafayette
- Lafayette has a composter on campus
- Payback isn’t there
  - $10-15,000 to set up
- Saves money for mulch on campus
- Eliminates dumpster smell
  - The issue is that you need to pay workers to transport waste and maintain composter
- Lafayette doesn’t harness the methane
- Lafayette does not use the fertilizer from the compost because Bon Appetit is concerned with coliform count

What Lafayette Students Think...
Why students feel they waste food at Upper:
- “My eyes are bigger than my stomach.” ~ Vergona ’13
- They are more likely to try new foods
- They believe that upper Farinon offers poorer quality food than Lower Farinon

Where students think the food goes:
- The ocean
- Mexico, China
- Give it to the poor

Dickinson Grant Application
- Goal is to collect, transport, and recycle organic wastes and divert it from landfills
- Increase organic material composited increase from 56,000 to 91,000 pounds
- Dickinson has 2,400 students and serves over 4,000 meals a day
- Over 9,000 pounds of food is thrown away each week
- About 2.5 tons of waste that could have been composted is transported to landfills each week
The Organic Label
Shawn Hogan, Ben Williamson, and Miranda Wilcha

What lies behind the symbol of the organic label is the push for and against the movement itself. Implementing organic agriculture and a more organic-based food industry could yield positive results for our health. Societal demand and policy implementation are driving the organic market towards a promising future. However, the difficulties of becoming certified organic, subsidies for monocultures, problems in the structure of our food economy, and red tape for farmers hold the United States back. Alleviating these issues by making the organic certification process easier and less expensive for local farmers has the potential to benefit the global environment. Jim Gannon, a local organic food storeowner from Wrightstown (PA), attests to the ability for local trust to equate to a USDA approved label in his hometown. What are the barriers that regulation poses for local farmers? How can defining ‘organic’ become simpler and revert back to local agriculture for health, environmental, and even economic benefits? With a rising demand both nationally and internationally for organic foods, the market itself needs to compensate. While USDA certification is helpful for large-scale organic operations, small uncertified producers are able to flourish in local markets with a tightly-knit community setting. By protecting organic regulation, promoting fair prices, and ensuring “conscious capitalism,” national and international organic producers can ensure greener practices. An important principle, however, is promoting locality in food and focusing on the importance of local economics to push the organic movement past its current barriers.
Although humans have used many natural pesticides since antiquity, the last century has seen a marked increase in the availability and use of synthetic pesticides that target a wide range of undesired organisms. These pesticides come in many forms, including herbicides that target unwanted plants, insecticides designed to kill bugs, and fungicides aimed at destroying fungal colonies.

Pesticides are used abundantly throughout the globe and can be found anywhere from schools and forests, to farms and public parks. While they provide many benefits, economically and socially, they can also cause a significant amount of harm when used incorrectly.

With this information in mind, we decided to investigate how Lafayette’s pesticide use compares with that of the nation and the world. To do this, we interviewed employees of Lafayette’s Plant Operations in order to determine the types and amounts of pesticides used on campus, as well as the methods used to apply them. We compared this information with national and global data collected from sources such as the US EPA and others. This comparison allowed us to make observations regarding Lafayette’s pesticide use and suggest actions that Lafayette could take to achieve a more sustainable approach to pesticide use on campus.
Pesticide Use: How Does Lafayette Compare?
Erin Wetzlerberger, Stephen Berkin, and Victoria Luongo

Question: Why does Lafayette's pesticide use compare with that of the national and global use?

Significance: Pesticides are used abundantly throughout the globe and can be found everywhere from schools and homes to farms and public parks. While they provide many benefits economically and socially, they can also raise a significant amount of harm when used improperly.

Background: • Red-bay and American chestnuts, that we want to prevent, have to be cut • Interacts with wildlife (poisonous to pests)

Pros: • Decreased agricultural yields — economically beneficial • Increased production of food leads to elimination of famine • Prevents plant diseases — causes less disease • Helps protect plants that can harm to humans, birds, other animals

Cons: • Pesticides include insecticides, herbicides, fungicides, and rotenone • Risk to maintain aesthetic value of high-profile areas

Pesticide Use: Global vs. National

<table>
<thead>
<tr>
<th>World Pesticide Use</th>
<th>US Pesticide Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicides</td>
<td>38%</td>
</tr>
<tr>
<td>Fungicides</td>
<td>38%</td>
</tr>
<tr>
<td>Insecticides</td>
<td>22%</td>
</tr>
<tr>
<td>Other</td>
<td>2%</td>
</tr>
</tbody>
</table>

Pesticide Use at Lafayette
- Decrease in pesticide use annually by 25-50 percent from 2013
- Reduced need for more efficient pest control
- Integrated pest management used for control

Analysis: Lafayette’s pesticide use is significantly lower than national levels.

Pesticide Usage at Lafayette in 2007 and 2013

Comparing Lafayette’s Pesticide Use
- Lafayette uses only 10% of the number of pesticides used in the US.

Observations on Lafayette’s Pesticide Use
- Although Lafayette’s pesticide use is lower than national levels, it is still significantly higher than other cities with similar populations.
- Lafayette’s pesticide use is significantly lower than national levels.

Steps for the Future
- Educate in products that are less harmful to the environment and human health
- Decrease the amount of pesticides used
- Use products that need to be applied less frequently
- Create and implement an action plan to begin to decrease our pesticide use

Major Liquid and Solid Pesticides Used
- Lesco Three Way (liquid)
- Aflatox (dry)

References

Additional References Available Upon Request.
Solar water technology is a reliable source of renewable energy in developing countries. The use of nonrenewable resources, such as coal and firewood, is inefficient and limited. Furthermore, these resources are environmentally destructive. This creates an incentive for alternative, environmentally friendly, technologies such as solar water heating and disinfection. Clean and hot water are basic human necessities. Many of the countries that lack these basics have access to solar energy. We have discovered that solar water disinfection is the cheapest form of water sanitation with easy implementation. This is also effective in reducing diseases as seen in Kenya, Cambodia, and South Africa. Solar water heaters are beneficial to communities in proximity to the equator and receive ample sunlight; this is seen in Taiwan and India.

Benefits of both of these technologies include simple construction and no pollution, while barriers consist of high installation costs. Many of the countries that would benefit from these technologies have low funding for such projects. We constructed a positive feedback loop showing the effects of government subsidies on the installation of solar water heaters. Another way solar water technologies can be implemented is through the Kyoto Protocol’s Clean Development Mechanisms, as seen in South Africa. Developing technologies, such as more efficient solar panels, can help reduce the initial startup cost. As new designs develop, the incentive to use these technologies increases.
Engineering has always been a male dominated field with a masculine perception. A traditional outlook on engineering has denied females the opportunity to view engineering as a viable career path. Female engineers only represent about 17% of the engineering workforce. In today's society engineers are not seen as females and the small percentage that are, are either denied the credibility or expected to be some kind of genius. With half of the world's population being female it is important to have the female perspective within the engineering field. As engineers, we realize how important the study and practice of engineering is to the future of the world. As a result, we want to learn why young women choose not to pursue engineering, and eventually implement a solution to solve the problem. Through our research we would like to examine why women are not only underrepresented in the engineering fields, but why they are dissuaded from the field from a young age. We acknowledge that several factors may impact female involvement and presence within the engineering and science fields but believe that engineering and science curriculum (K-12) in particular may be the initial source of their reluctance.
**Research Question**

Why are women underrepresented within the engineering fields?

**Objective of Research**

**Purpose:** The purpose of our study is to examine why women are not only underrepresented in engineering fields, but dissuaded from the field as a whole beginning at a young age.

**Interest:** As engineers themselves, we realize how important the study and practice of engineering is to the future of the world. As a result, we want to learn why young women choose not to pursue engineering, and eventually implement a solution to solve the problem.

**Gender Roles: Predetermined vs. Societal Influences**

- Studies indicate males naturally tend to work alone, argue with their peers more, and begin working on projects without any prior planning, while females tend to work together, communicate, and plan before executing projects.
- Women are determined from math and science fields because they feel as a gender, they are not supposed to participate in these fields nor are they supposed to excel.
- Science and math fields are dominated by men, and are thus associated with male values. To be a good engineer, one must possess inherently “male” qualities.

**Current Initiatives**

**Engineering is Elementary**

A program developed by the Museum of Science in Boston, MA. Serves as a preliminary program to get children more interested in STEM fields, and improve instruction ability to teach engineering.

**Future World**

An interactive computer learning system that introduces students to the concept of sustainability.

**Girls in Science and Engineering (WISE)**

A program that provides high school females who are interested in the science and engineering fields, with the opportunity to work with a nearby university's professors and students on science and engineering projects.

**Solutions**

We understand that several factors impact female involvement and presence within the engineering and science fields. We do however believe that the engineering and science curriculum (K-12) may not provide them with equal opportunities.

Through science curriculum reform, we believe that young female professionals may see the long lasting benefits and opportunities offered within the engineering field, thereby not being a greater females participation within engineering.

These curriculum changes would include:

- Incorporating environmental science and the concepts of engineering at a younger age.
- Creating examples and projects that emphasize the ways that science can improve the world.
- More interactive and outdoor school days
- The majority of curricula, if the curriculum tends to devalue both men and women from math, science, and engineering courses. We feel that having the children interacting with the environments and integrating their work into real effect will greatly increase the students interest in not only engineering, but the environment as well.
- More group projects

 wise

- We offer opportunities for engineering fields not because they are ill-equipped to work in the field, but because their lack confidence. We feel that if there were more small projects undertaken at the K-12 level, especially those where the females take on leadership roles, there would be a resultant boost in confidence, and thus participation in engineering.

**Plans for Future Study**

We would like to closely observe how dynamics, psychology, and social aspects may lead to early age discouragement in females.

Through the development of a community-based education class module we would like to see the effects of a single sex classes.

Conducting a STEM Camp with children who have not been exposed to the different aspects of the STEM field.

**References**

- Indiana University Libraries.
With the current problem of global warming in the United States, Americans are facing an increased responsibility to change their behaviors and live more sustainably. Many of the environmental problems faced by Americans come from the abundant consumption of energy. In recent years, countries around the world have increased their reliance on renewable energy sources such as wind. In the United States, the potential for the development of wind harnessing technologies is greater than ever, but will we embrace this potential? Our paper sought to answer the questions of where wind energy stands in the future of US energy development. Our research focused on the benefits and barriers of wind energy across three different disciplines. These were economics, government involvement and ecological and environmental impacts. Furthermore, we used the case study of the Cape Wind Project to analyze levels of local support and the impacts of the NIMBY principle when it comes to the construction of a wind farm.

Our research provided some interesting results. While we learned that the potential for the growth of the wind energy is greatly supported by technology improvements and decreased construction and electricity costs, it became evident that the industry is heavily reliant on government incentives and restricted by local opposition to construction. Thus we concluded that while the future of wind energy allows for extensive growth on paper, the dependence on government incentives and weak public support makes for a questionable and potentially unstable future for wind.
The Economic Cost Of Wind Energy

- The driving costs of wind energy are project construction and technology. With constantly developing technology, and city regulations to set costs to benefit ratios and war the buy in costs to the industry.

- Power Purchase Agreement (PPA) is a long-term, price power agreements offering a contract certainty to electricity utilities and consumers. With the technology improvements in the industry, PPA rates will likely continue to fall.

- Major economic drawbacks of wind energy are the high costs of transmission lines. Because wind farms often have very little, the construction of transmission lines might be a large cost in order to link the energy produced by the wind farms to the existing grid. The cost of construction for transmission lines can reach $1,000,000 per mile.

- While the price of wind energy is still falling, there are still heavy upfront costs to the installation of wind farms. Without great government subsidies, wind projects often don’t stand a chance in the wind industry.

Figure 2. The average cost of wind energy is competitive with traditional fuel sources and is a significant cheaper than other renewables.

Figure 3. Wind energy provides a low cost and a way of thinking of the possibility of future environmental regulations and increasing prices of traditional fuels.

Government Involvement

- The federal government plays a key role in the development of US wind energy.

- States under the Renewable Energy Standard (RES), which mandates certain levels of renewable electricity production per year. While the current law has an established RES, the standards don’t currently exist on a federal level.

- Investments in wind rely heavily on government incentives such as the Production Tax Credit (PTC).
- PTCs have been a crucial part of the wind industry's growth.

Figure 4. Production Tax Credit (PTC) for wind energy.

Environmental and Ecological Costs and Benefits

- Wind is a natural, reliable, abundant, and easily accessible alternative energy source.
- Wind farms produce clean energy that is detrimental to the environment.
- Instead of altered land, wind farms require less space than a traditional power plant.

- Wind farms are the only birds, but they don't kill nearly as many birds as other forms of human infrastructure.
- The installation of wind farms and transmission lines can disrupt animal habitats, specifically fish and wildlife
- The consistency of wind on certain sites is often very predictable.

Figure 5. Positive and negative aspects of wind energy.

Motivations And Barriers

The NIMBY Principle

This is the concept that people usually support renewable energy, if they are often opposed to projects that directly affect their lives. This principle is the non-involvement of our local communities.

Figure 6. A wind farm near Cape Cod, Massachusetts.

Cape Wind: A Case Study

- 130 turbines covering 25 square miles on the outer continental shelf.
- 4 miles off Cape Cod, location of the worst air quality in MA.
- Will reduce New England’s reliance on imported fossil fuels.
- Towers will reach 804 feet tall.
- Great amounts of local resistance on the project are slowing progress of the project.
- People are disturbed by potential aesthetic impacts.
- Wind farms can take up to 20 years to become a wind farm.

Figure 7. A map of Cape Wind.

Conclusions

- The United States has a capacity to support widespread wind energy.
- Technology advancements and dropping costs are making wind power a real option for the alternative energy market.
- People understand that investing in clean energy is the right thing to do, but the NIMBY principle can limit large scale investments.
- The market is still reliant on government incentives, such as tax credits and subsidies.
- Despite a growing interest in clean energy, the US is still far behind in terms of wind energy production.
Electronic waste or E-waste has become an increasing global issue that lacks standardized regulation. The accumulation of E-waste results in environmental, economic and health implications. Research for our inquiry was plentiful, but lacked a cohesive definition of what E-waste is. We used a socio-ecological and material engineering perspective to break down this issue. From an engineering standpoint, we looked at the materials (ex: metals, chemicals, etc.) and how they affect the environment. As socio-ecologists we want to promote awareness within our community about these processes including production and recyclability. To better understand of E-waste on Lafayette College's campus, we focused our research on the iPhone. In a generation fixated on owning the newest technology available and the frequent iPhone upgrades, understanding our community's awareness of the issue is a main concern. From an anonymous survey, we gained insight into what our peers know about the subject and proper disposal of an iPhone. While general awareness was present in the responses, minimal action was taken to dispose of the iPhones in a sustainable way. In the near future more information should become readily available about the effects of E-waste as a local and global issue. Hopefully, this will generate new forms of legislation and more positive action.
Where Does Your Old iPhone Go? E-Waste and its Implications

Survey of Lafayette Students

- Percentage of students that have an iPhone:
  - Yes: 75%
  - No: 25%

Materials in Mobile Phones and Methods of Disposal

<table>
<thead>
<tr>
<th>Materials</th>
<th>Measured</th>
<th>Sustainable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>Gold</td>
<td>Material Recovery Facilities (MRF)</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>Copper</td>
<td></td>
</tr>
<tr>
<td>Polyvinylchloride</td>
<td>Lithium</td>
<td></td>
</tr>
<tr>
<td>Lithium Ion</td>
<td>Recyclable</td>
<td></td>
</tr>
<tr>
<td>Lithium Polymer</td>
<td>Plastic</td>
<td></td>
</tr>
<tr>
<td>Plastic</td>
<td>Glass</td>
<td></td>
</tr>
<tr>
<td>Glass</td>
<td>Textile</td>
<td></td>
</tr>
<tr>
<td>Textile</td>
<td>Paper</td>
<td></td>
</tr>
</tbody>
</table>

What is E-waste?
- The Organisation for Economic Co-operation and Development (OECD) states that e-waste is any appliance or equipment containing hazardous substances that has reached the end of its life.
- However, there is no set definition of e-waste. The diversity of e-waste creates confusion, which contributes to its global issue.

The Flow of E-Waste
- E-Waste travels from domestic areas, through the dismantlers, and to recycling plants, where it is sorted and processed.
- The 15% that is exported is sold to the United States.

Conclusion
- Lafayette Students' disposal practices vary, with many students unsure of the impact of their actions.
- Environmental Impact: A lack of regulation and improper disposal can cause significant harm to the environment.
- Economic Impact: A lack of regulation and improper disposal can lead to financial losses for businesses.
- Health Impact: Disposal methods such as incineration can release toxic fumes into the atmosphere, affecting human health.

Our Recommendations:
- The lack of regulation and improper disposal of e-waste is a global issue.
- Proper legislation and regulation are necessary to prevent the negative impact of e-waste.
- Responsible disposal practices are crucial for protecting the environment and human health.

Future Study
- The data collected in this study can be used to further research the effects of e-waste on the environment and human health.
- Collaboration between local and national authorities is necessary to implement effective e-waste management strategies.

Table: Total E-Waste (in thousand) 2021

<table>
<thead>
<tr>
<th>Products</th>
<th>Domestic</th>
<th>Imported</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computers</td>
<td>421,000</td>
<td>83,000</td>
<td>504,000</td>
</tr>
<tr>
<td>Monitors</td>
<td>320,000</td>
<td>43,000</td>
<td>363,000</td>
</tr>
<tr>
<td>TVs</td>
<td>150,000</td>
<td>20,000</td>
<td>170,000</td>
</tr>
<tr>
<td>Electronic Equip.</td>
<td>420,000</td>
<td>84,000</td>
<td>480,000</td>
</tr>
<tr>
<td>Electrical Equip.</td>
<td>420,000</td>
<td>84,000</td>
<td>480,000</td>
</tr>
<tr>
<td>Total (in total)</td>
<td>2,482,000</td>
<td>520,000</td>
<td>3,002,000</td>
</tr>
</tbody>
</table>

Left to right: E-Waste stream, Mobile Phones from a Local to Global Scale, Lafayette College, United States, International.
Soil Quality of Local Organic vs. Industrial Farms
Lucy Bass, Alexandra Sousa, Prisca Ratsimbazafy

Our research project focuses on understanding the differences in farming practices used on industrial farms versus local, organic farms. Ultimately, the goal of this study is to discern the varying environmental impacts that these differing farming practices have on the quality of the soil in the surrounding area. We drew from the fields of biology and chemistry to help understand the scientific impacts of both industrial and local, organic farming on the environment and public health. Additionally, we used the fields of economics and policy-making to evaluate the economic incentives inherent within policies that motivate either industrial or local, sustainable farming methods. These findings are relevant because of the negative impact that reduced soil quality has on the environment, both locally and globally.

Firstly, our group compared separate soil quality tests conducted from the soil of industrial farms and the soil of local, organic farms in the Lehigh Valley area to establish concrete quantitative data results. We acquired qualitative data through an extensive literature review on the difference in soil quality between industrial and local, organic farms. After acquiring the quantitative and qualitative results of our research project, we determined that while there are clear differences in farming practices, the soil testing did not reflect the expected differences. Through our literature review and our qualitative research, we were able to explain the lack of major differences in soil quality due to circumstance, simple testing equipment, and systems of monitoring that have recently been implemented.
**Soil Quality of Local Organic vs. Industrial Farms**

Lucy Bass (CE 321), Prisca Ratsimbazavy (EVST 100), Alexandra Sousa (EVST 100)

### The Dichotomy Between Local Organic and Industrial Farms

**Local Organic Farming**
- Pros: 
  - Increases soil fertility
  - Protection of the environment
  - Local economic development
  - Production of healthy food
  - Practice of good ethics
- Cons: 
  - Economically unsustainable
  - Decline in crop yields
  - Limited food production
  - Lack of local community
  - Adversarial climate

**Industrial Farming**
- Pros: 
  - Increases efficiency in mass production
  - Resilience in farming
  - Enterprise growth
  - Enables large-scale export
  - Increases GDP
- Cons: 
  - Environmental risk
  - Frequent use of inputs and outputs
  - Decrease in productivity
  - Intensive farming
  - Monoculture system of monoculture agriculture
  - Overutilization of fertilizers and pesticides
  - Waste of water usage
  - Nutrient loss
  - Public health risk

### Dismantling the Idea of Farms as Green Spaces Through a Comparative Study of Soil Quality Surrounding Local Organic and Industrial Farms

**Soil Tests**
- **pH:** The measure of acidity or alkalinity in a solution.
  - Measured on a scale from 0 to 14
  - Pure water is “neutral” at pH 7
  - Soils pH for missing skills: 5.5 to 7
- **Phosphorus:** Commonly limiting nutrient required for plant growth.
- **Nitrogen:** A nutrient often in combination with ammonia which optimizes plant growth.
- **Potassium:** An essential nutrient required for plant life.
- **Calcium:** Often used with phosphorus and potassium to support vegetation.

### Analysis of Soil Test Results
- **Predicted Results**
  - **Local Organic Farm:** Good pH range between 5.5 and 7
  - **Industrial Farm:** pH range below 4 or above 8
- **Actual Results**
  - Actual results did not reflect the predicted values.
  - Calcium needed to be increased in both local organic and industrial farms.

### Research Methods
- Collected soil from three local organic farms and three industrial farms in the Lehigh Valley area.
- Tested soil to determine differences in chemical composition based on pH, nitrogen, phosphorus, and potassium levels.

### Implications for the Future
- What is the future of farming in the US?
  - Integration of local organic and industrial farming.
  - Quality vs. Quantity
  - Organic food movement
  - Support local farmers' markets
  - More sustainable practices
  - More economic support
  - More effective distribution
The purpose of our study was to assess the value of a rain garden as a type of green infrastructure designed to manage stormwater runoff. Our interest in the topic stemmed from our participation in the EPA’s annual Campus RainWorks Challenge, which asks students to plan a green infrastructure project that will benefit their campus and the environment. We chose to study rain gardens because they are commonly believed to slow incoming runoff, enhance infiltration, and filter out contaminants. Since both water volume and water quality are important factors in the livelihood of an ecosystem, we examined a rain garden’s contribution to both runoff and pollutant management. We found that rain gardens effectively reduce runoff volumes and peak flows, but exhibit limited success in larger rainfall events. Rain gardens have also been shown to reduce concentrations of several different pollutants, but with varying success. The most consistent and significant reductions appeared to be those of the total suspended solids and heavy metals. Based on this information and on some site analysis, we concluded that a rain garden would be especially beneficial to an area such as that surrounding Bushkill Creek. The high volume of runoff from impervious surfaces and the concerning source of pollutants from the parking deck further up the road pose problems that we believe would be best resolved with a rain garden.
The Effectiveness of Rain Gardens in Pollutant and Runoff Management

Future Applications: Bushkill Drive

Pollutant Management
- Total Suspended Solid Reduction
- Nutrient Reduction
- Heavy Metal Reduction

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Initial</th>
<th>Flow</th>
<th>Outflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS</td>
<td>75%</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>75%</td>
<td>9%</td>
<td>3%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>95%</td>
<td></td>
<td>&lt;0.5%</td>
</tr>
</tbody>
</table>

Table 1: Reduction of pollutants in stormwater

Importance of Pollutant Reduction
- Infiltration
- Filtration
- Erosion control

Mechanisms of Pollutant and Runoff Management

- Reduce the volume of stormwater
- Increase water infiltration
- Control overland flow

Introduction
- A rain garden is an erosion control practice used to control overland flow and increase infiltration
- First implemented in 1993 at Swenson, Maryland

Runoff Management
- Water Quality Mechanisms
- Peak Flow Delay
- Nutrient Reduction

Sources:
- Stormwater Management
- Importance of Pollutant Reduction
- Runoff Management

References

- 100% reduction of TSS, 60% reduction of Nitrogen, 50% reduction of Phosphorus
- Significant reduction of heavy metals

We conclude that rain gardens are effective in reducing the high volume of stormwater and the pollutants it contains.
Many areas of the world do not have the commodity of having easy and ubiquitous access to electricity like most of the United States. Most of these countries also experience severe poverty, poor hygiene, and rapid disease spread. Doctors and engineers from around the world devote their lives to finding a solution to this problem. By inventing self-sustaining vaccine refrigerators, doctors are able to store live cultures and vaccines in a cooled container without the use of an electrical grid. Bill Gates, inventor of Microsoft, and his wife, Melinda Gates, began an initiative called the “Bill and Melinda Gates Foundation” in which they further the goals of the Decade of Vaccines. The Decade of Vaccines is a collaboration of leading figures from around the world with a common goal to end the vaccine shortage in these countries by providing funding for projects like research on a rechargeable refrigerator.

Intellectual Ventures and Bill Gates teamed up to create the Passive Vaccine Storage Device. This device can keep vaccines between 0 and 8°C for 30 to 60 days without using electricity. It has been field tested, and can provide vaccine refrigeration for small villages of up to 15,000 people in a cost effective way. For larger villages a larger refrigerator is more practical. The SolarChill Project has created solar coolers that can serve up to 50,000 people. These innovative solutions will help to improve vaccination worldwide.
**Introduction**

- Every 20 seconds, a child dies from diseases such as diarrhea and pneumonia that are preventable with vaccines.
- More than 2.5 million lives are saved each year as a result of vaccines.
- Decade of Vaccines Collaboration

**The Passive Vaccine Storage Device**

- Keeps vaccines at the appropriate temperatures (0 to 8 deg C) for 30 to 90 days without electricity.
- High vacuum and multilayer insulation to prevent heat transfer through conduction, convection, and radiation.
- Device costs $2,100.
- Three sensor & KATS capabilities built in.
- Most cost effective in smaller villages of 5,000 to 15,000 people.
- Intellectual Ventures & Bill Gates.

**Environmental Impact**

- Solar Powered Refrigerators:
  - These refrigerators utilize both R-400 hydrocarbon compressors and cyclopentane blown insulation foam, instead of commonly used hydro chlorofluorocarbons (HCFCs) and hydro fluorocarbons (HFCs), which have no affect on ozone depletion or global warming.
  - Energy storage in ice-packs through the use of direct current compressor therefore, no harmful lead batteries are required.

**The SolarChill Project**

- The cost of solar coolers ranges from $3500 to $4500.
- One unit can serve up to 50,000 people for preserving vaccines.
- Cost reduced by using commercially mass produced freezer cabinets rather than custom made.
- Uses hydrocarbons for insulation foam instead of HCFCs and HFCs.
- Project partners Greenpeace, DIT, PATH, WHO, UNDP, UNICEF, etc.
- Field tested.

**Percentages of Population Vaccinated**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Global</th>
<th>Africa</th>
<th>Americas</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTP1</td>
<td>91</td>
<td>80</td>
<td>97</td>
</tr>
<tr>
<td>DTP3</td>
<td>83</td>
<td>72</td>
<td>93</td>
</tr>
<tr>
<td>HepB</td>
<td>79</td>
<td>72</td>
<td>91</td>
</tr>
<tr>
<td>His3</td>
<td>45</td>
<td>65</td>
<td>91</td>
</tr>
<tr>
<td>MCV</td>
<td>84</td>
<td>73</td>
<td>94</td>
</tr>
<tr>
<td>P&amp;H</td>
<td>81</td>
<td>75</td>
<td>85</td>
</tr>
<tr>
<td>PCV7</td>
<td>19</td>
<td>21</td>
<td>77</td>
</tr>
<tr>
<td>PolS</td>
<td>94</td>
<td>77</td>
<td>93</td>
</tr>
<tr>
<td>RT_Inst</td>
<td>11</td>
<td>5</td>
<td>66</td>
</tr>
<tr>
<td>TTplus</td>
<td>75</td>
<td>68</td>
<td>70</td>
</tr>
</tbody>
</table>

**Conclusion**

- Innovative forms of refrigeration are key to providing adequate vaccinations worldwide.
- These new technologies provide environmentally friendly refrigeration, helping decrease harmful emissions.

**Sources**

The Easton wastewater treatment plant and landfill have excess biogas created from anaerobic digestion of organic material. Currently, this biogas is not fully harnessed. What if the plant and landfill captured and used this fuel as electricity to take their operations off the city’s energy grid and make them self-sufficient?

The biogas created during the anaerobic processes of landfills and wastewater treatment plants consists mainly of methane and carbon dioxide, two of the major greenhouse gases affecting the Earth’s atmosphere. Converting this gas to a form of energy to power generators will greatly reduce the amount of greenhouse gases released to the atmosphere from landfills and treatment plants.

Furthermore, the biogas will have economic benefits. The generators can take Easton’s wastewater treatment facilities and the landfill facilities off the city’s grid, thus reducing the cost on taxpayers. If bioactivity within the waste at the facilities is high, excess biogas can be converted to electricity and sold back to the grid, further reducing costs. Though the implementation of the technology necessary to do so will have a cost, the long term benefits will outlast the initial investment, both economically and environmentally.

This process of converting biogas to energy from treatment plants is not a new idea, as it is done in many places around the world. The Easton landfill already sells a small portion of its biogas. However, there is a lot of biogas that can still be harnessed. This biogas conversion could help deter the amount of greenhouse gas emitted to the atmosphere in Easton. To connect to the theme of think globally act locally, if this technology is implemented in other communities like Easton around the world, the quest for renewable resources, reduction of waste, and economic viability of a sustainable infrastructure are taking a step in the right direction.
Purpose
Think Globally Act Locally. To understand how biogas can be implemented on a local level to make strides towards a more sustainable planet.

Background
What is biogas?
• About 70% methane, 29% carbon, and 1% inert gases
Where does biogas come from?
• Anaerobic digestion, the decomposing organic matter
• Produced mostly at landfills, Wastewater Treatment Plants (WWTPs), and livestock operations
How can biogas be used?
1. Electricity
2. Heat
3. Vehicle fuel

Why use biogas?
• Reduce greenhouse gas emissions
• Save on energy costs and consumption

Environmental Effects
• Methane accounts for 9% of US greenhouse gas emissions; CO₂ accounts for 84%
• Methane lasts 12 years in the atmosphere and retains large amounts of heat
• WWTPs produce 26.7 MMTCO₂E and landfills 169.0 MMTCO₂E of methane a year

Converting Biogas to Energy
• After collection, biogas is scrubbed to remove impurities and increase energy value
• Processes include biological fixation, chemical dosing, and water scrubbing

Above: Flow diagram of the water scrubbing technique

• After scrubbing, biogas is ready for a generator
• BTU (British Thermo Unit) content helps to predict how much energy biogas will produce

Left: 120 kW engine generator. Purpose: combust biogas, producing electricity. Right: heat exchanger. Purpose: recovers thermal energy

Cost/Benefit of Biogas Energy
• Electricity can be produced at $0.038/kWh compared to national electricity rates of $0.056 to $0.228/kWh
• Based on data for a 240 MGD plant, the Easton WWTP can make about $4 kW per day, enough energy to power an estimated 4 houses

Case Study
• Wilmington, DE will use biogas to fuel the WWTP
• Plant will receive about 90% of its electricity from biogas and also use biogas for thermal drying of sludge
• Initial project cost is about $35 million
• Expected to lower greenhouse gas emissions by approximately 13,000 metric tons/year

The Future of Biogas in Easton
Current Situation at EW/WTP
• Biogas is used for some heating during the winter
• No biogas storage, so excess biogas is flared
• Not currently producing electricity from biogas
• With cooperation from the landfill there could be enough methane to create enough energy to support the WWTP

Plan of Action

- Biogas to be collected and scrubbed at each location
- Storage at WWTP, landfill, or reasonable middle location
- WWTP and landfill are approximately 1 mile apart and connected by a road, making transport of biogas feasible
- Biogas energy to be used for heat and electricity to take WWTP off the grid

Future Study
• Presentation of project to WWTP and Landfill
• Application of plan of action
• Collection of biogas production data
• More development of the specifics of implementation of actual project: choose scrubbing technique, generator, and logistics of installation

*References available upon request*
In the natural environment, phosphates and nitrates “limit” growth by being in high demand but scarce supply. While they are essential nutrients for life, high concentrations can lead to excessive algal growth and the subsequent destruction of an ecosystem. This process is known as eutrophication. Eutrophication is a serious concern throughout the world and therefore phosphorus levels should be monitored and regulated to prevent this process.

This study focuses on phosphorus deposition in the Upper Bushkill Creek. Samples were collected and tested to see if phosphorus levels were below mandated limits. According to the EPA’s Quality Criteria for Water, surface waters maintained at less than 0.01 to 0.03 mg/L of phosphorus tend to remain uncontaminated by algal blooms. The Lafayette College Department of Environmental Engineering supplied additional data, which was acquired during the previous summer.

Using the EPA’s Quality Criteria for Water as a standard, all waters of the Upper Bushkill Creek fell below this limit with the exception of the Little Bushkill tributary. These high concentrations in the Little Bushkill are likely due to agricultural land uses in its surrounding watershed. Fertilizers used in farming are a major source of phosphorus deposition into waterways. Overall, however, we conclude that eutrophication is not a major concern in the Upper Bushkill Creek.
**Objective**
To access phosphorus levels in the Upper Bushkill Creek and to determine if they are below mandated limits.

**Phosphorus in Water**
- Anthropogenic Sources:
  - Runoff containing fertilizer and manure
  - Wastewater Treatment Plants
  - Human waste from failing septic systems
  - Household Products (e.g., Detergents)
- Natural Sources:
  - Decaying organic matter
  - Erosion of rocks and soils

**Reducing Phosphorus**
- Using fewer fertilizers and adjusting the timing of fertilizer applications to limit runoff of excess nutrients from farmland
- Adding grass and forested buffer strips along farm boundary
- Control animal wastes
- Monitor septic systems and sewage treatment facilities to reduce discharge of nutrients
- Control industrial practices such as limiting discharge of nutrients, organic matter, and chemicals from manufacturing facilities

**Mississippi River Delta**
- The Gulf of Mexico acts as a drainage area for all the major rivers and tributaries in the Mississippi–Atchafalaya River Basin (3.5 million)
- Nutrients are predominately sourced by agriculture
- Over 6,000 square miles are affected by eutrophication and hypoxia

**Eutrophication**
In the natural environment, phosphates and nitrates “limit” growth by being in high demand but scarce supply. While they are essential nutrients for life, high concentrations can lead to excessive algal growth and the subsequent destruction of an ecosystem. This process is known as eutrophication.
- 1) Excess amounts of phosphorus enter the water, triggering algal blooms
- 2) Sunlight can penetrate the surface, killing submerged aquatic vegetation
- 3) Algae dies and is consumed by bacteria
- 4) Oxygen demand of bacteria leads to anoxic conditions in the water
- 5) Marine organisms die and are also consumed by the bacteria

**Water Quality Policy**
- Clean Water Act (1972)
  - Established basic structure for regulating the discharge of pollutants into waters and regulating quality standards for surface waters
  - The FW Act Criteria for watershed (1 kg)
  - Section 305(b) of the Clean Water Act (cwa) requires the EPA to publish and periodically update ambient water criteria.
  - Phosphates should not exceed:
    - 0.05 mg/L in streams or flowing waters not discharging into lakes or reservoirs
    - 0.2 mg/L within a lake or reservoir
    - 1 mg/L in streams or flowing waters not discharging into lakes or reservoirs to control algal growth
  - Surface waters that are maintained at ≤0.1 to ≤0.3 mg/L of Total Phosphorus tend to remain uncontaminated by algal blooms.

**Conclusions from Sampling**
According to the Bushkill Creek Conservancy, phosphorus levels in the Bushkill Creek are equal to zero at all locations, with the exception of the Little Bushkill Creek. Our data reflect Total Phosphorus levels, with the highest concentration occurring in the Little Bushkill Creek.

**References**
Is Organic Farming a Worthwhile Alternative?
Daniel Ma, Joey Canfield, and Chanler Fraser-Pauls

Organic food production is a worthwhile topic because it affects everyone worldwide even if the individual does not consume organic food themselves. The movement to the production of organic foods not only affects the nutritional habits of consumers, but also affects the aspects that are critical to the environment (such as biodiversity and soil health) and economy. Our group will plan on doing extensive research on the topic while concentrating on the economic, nutritional, and environmental impacts. After researching, we still take a step back and act as analysts to figure out and determine if organic food production is worthwhile and if so, in what sense.

In regards to the economics portion, we plan on evaluating and finding a healthy balance between optimizing the economic benefits/profits and keeping the nutritional standard of organic food production high. With the environmental aspect of the project, we plan on analyzing how organic food production affects biodiversity and the soil’s health compared to how much conventional food production does.

Upon finishing and evaluating our research, we believe the sustainability and long lasting effects that organic farming has on the ground and environment outweighs the lower yields and higher costs that come with organic food production. We believe that organic farming is not an answer to feeding the world and that organics shouldn’t fully replace conventional methods but, if many organic farms can start small and sell locally, then we believe that it can work out for the betterment of our country and world.
Past studies have made it very clear that minority students are underrepresented in STEM (Science, Technology, Engineering, and Mathematics). In particular, there are significantly fewer blacks and Hispanics graduating with STEM degrees and working in STEM professions. At the beginning of this project, we intended to determine the causes of minority underrepresentation in STEM. We also intended to explore early exposure through extracurricular STEM education camps as a possible means of increasing minority participation in STEM fields. Our initial thesis was that black and Hispanic students do not enter STEM fields as often as white students because they do not see engineering as a realistic profession. We therefore felt that early exposure and familiarity with engineering could substantially increase minority participation in STEM fields.

Our results largely confirmed our initial thesis. We identified several key causes of minority underrepresentation through a literature review. Some of these causes are, socioeconomic inequality, the belief that engineering is not a realistic career path, lack of educational resources, and lack of successful STEM mentors. We used Camp SEEK (Summer Engineering Experience for Kids) as a case study to determine the effectiveness of early exposure to engineering in increasing minority participation. Using surveys collected from over 1500 SEEK students in eight cities across the US, we found that SEEK helped combat several of the primary causes of minority underrepresentation. Programs like SEEK cannot correct for socioeconomic status or lack of resources. However, they are a low-cost, effective means of fostering the belief that STEM fields are achievable, realistic professions for blacks and Hispanics.
Underrepresentation of Minority Students in STEM: Causes and Solutions

Kwaw Lugo, Justin Horn, Chris Vern
Department of Civil and Environmental Engineering, Department of Chemical and Biomolecular Engineering
Lafayette College, Easton, PA

The Problem
- Blacks and Hispanics are significantly underrepresented in STEM fields
- STEM: Science, technology, engineering, and mathematics
- Graduate with STEM degrees at lower rate
- Blacks are half as likely to work in a STEM field
- Hispanics are a third as likely

Causes of Underrepresentation
- Economic constraints
  - Low-income families
  - 28% of blacks/Hispanics impoverished
  - Limited access to educational resources
- Lack of mentors
  - No successful STEM role models
- Not enough exposure
  - Low awareness of STEM fields
  - Low understanding
- Lack of confidence
  - STEM not seen as viable career
  - Stereotype threat

Possible Solution
- Extra-curricular STEM programs:
  - Hands-on experiences
  - Interaction with mentors
  - Free of charge
- SEEK (Summer Engineering Experience for Kids)
- 3-week intensive engineering-focused program
- No cost, minority students exposed to STEM

Results and Influence
- Our data:
  - Over 1500 students
  - 8 cities across U.S.
  - 3rd-5th Grade
- 54% did not know an engineer before camp
- 100% met successful engineering mentors
- 68% had very good relationship with mentor
- 73% better understand what engineers do
- 80% of children were excited to attend camp

Conclusion
- Blacks and Hispanics are underrepresented
- Lack role models, direction towards STEM fields
- Teaching STEM early increases interest in STEM and makes students feel like they can succeed in STEM fields
- More black and Hispanic STEM graduates
  - Better economy
  - More equality

*References available upon request
The overall looming issue with climate change is the fact that we are depleting the Earth’s natural resources and in turn things are only worsening. Technological solutions and options have been proposed and implemented, though not on a grand enough scale to make an impact. Currently the concentration of Carbon Dioxide in the atmosphere is at an all time high. As a response, technology has been growing and aiming to ameliorate the current predicament through a variety of methods. Environmentalists have been striving to find ways to lower the amount of carbon we are releasing into the atmosphere in a variety of ways, from: Carbon Capture and Sequestration to other known Carbon Dioxide removal practices, such as Ocean Alkalinity Enhancement. There are a plethora of barriers that complicate the already perplexing problem, though the objectives we desire are certainly attainable. It just takes a community effort on a worldwide scale. The cost benefit analysis provided show how successful this can be as well as how much could go wrong if the trends continue. Additionally, by identifying the source of the issue, we can see who is to blame. Whether industry, individual or even entire nations are to blame, it comes down to common but differentiated responsibilities to fix what mankind is on the verge of destroying.
Geoengineering & Carbon Dioxide Removal

Jesse Chazen

Carbon Dioxide Removal (CDR) and Carbon Geoengineering address the root cause of climate change by removing Carbon Dioxide (CO2), which is a major greenhouse gas from the atmosphere. The processes directly counter the increased greenhouse effect and ocean acidification.

Carbon Capture and Sequestration (CCS)

Carbon Capture and Sequestration (CCS) is a three-step process that can greatly reduce CO2 emissions from new and existing coal- and gas-fired power plants and large industrial sources:

1. Capture the CO2 from power plants or industrial processes
2. Transport of the compressed and captured CO2, usually via pipelines
3. Injection of the captured CO2 into porous geologic rock formations deep underground, typically more than a mile deep, that holds the gas.

Figure 2

What Benefits Does CCS Provide?

1. It is a key tool to mitigating climate change
2. It provides energy security for this nation
3. Creates economic opportunity by creating a plethora of jobs and a clean energy industry

Objective of CDR

1) Assist natural processes to remove and absorb CO2 from the atmosphere
2) Address not only industrial CO2 sources but also transportation sources
3) Remove the CO2 in an efficient and timely manner

Barriers of CDR

1) It is more expensive to remove the CO2 than to continue emitting it
2) It must be done on a global scale to be effective but the issue remains in common but differentiated responsibility
3) We do not know the unintended consequences and their potential magnitude
4) The practices attempt to ameliorate the issue but allow people and industry to continue emitting and consumption rates
5) Transportation accounts for 24% of emissions but 95% % of the answer is to switch to petroleum based fuels and natural gas

Global Energy Use By Type

Figure 3

References:


Figure 4

Figure 5
My project is focused on dispelling the myth that organic farming methods are not as productive as conventional farming methods. The motivation to expand organically managed food production is clear. Conventional agriculture is an immediate source of greenhouse gas emissions, soil mineral depletion, water pollution, eco-system destruction and, as a whole, is unsustainable and vulnerable to market fluctuations and price shocks due to its heavy reliance on fossil fuels. Based on the literature that I studied I found that organic farming is much better for the environment overall. It is also considerably more sustainable. Organic farming is beneficial to farm workers who are not exposed to toxic synthetic pesticides. Throughout my research on this subject I found consistently that organic farming does not produce as much as conventional farming. Despite of this, organic farms generally have less cost per acre of crop production and as stated previously, are better for local eco-systems and the planet as a whole. Using specialized organic practices such as biodynamic organic farming and intercropping, organic farmers can readily produce crops in a way that prioritizes nutritious food, healthy soil, healthy people and healthy eco-systems.
Organic Farming Practices: Preserving ecosystems and enhancing productivity?

By: Peter Todaro

Changes are needed in our Conventional food system to cut greenhouse emissions, preserve and protect eco-systems and provide ethical treatment for animals. But how can we do that while at the same time maintaining the productive output that conventional agriculture provides? The goal of my project was to investigate whether or not Organic farming can be just as productive as Conventional farming if certain practices are applied.

Problems with Conventional Agriculture:
- Rationales for Organic Farming:
  - Unsustainability of conventional agricultural systems.
  - Specialization and concentration of seed varieties.
  - Reduction of bio-diversity caused by conventional agricultural use of pesticides.
  - Vulnerability to price shocks.
  - Unethical treatment of animals.
  - Generally centralized

What Organic methods can be used to increase crop yields?
- Annualy rotating crops.
- Organic compost application.
- Reduced tillage or no till.
- Application of Organically certified fungicides or insecticides.
- Testing of soil and adding soil amendments to make up for missing nutrients.
- Beneficial weeds.
- Intercropping
- Permacultural systems.
- Organic fertilizers.

Benefits of Organic methods:
- Increased development of microbial soil communities.
- Dramatically better for surrounding eco-systems.
- Less input of fertilizers, pesticides.
- Not as reliable on petrochemicals, less vulnerable to price shocks.
- Generally de-centralized

Conclusion: Throughout my research, I found time and again that while Organic Farms did not produce as much as their Conventional counterparts, they generally had less variable cost per acre of crop production. Organic agricultural practices are far less environmentally destructive, resource intensive and also lead to healthier soil-based microbial communities and high species diversity. So while Organic agriculture is less productive overall, its practitioners will be less likely to experience price shocks, have their local environment and soil degraded and at the same time will be able to maintain the fertility of their soil and farm in a more sustainable fashion.
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